Congress Host

ENGINEERS AUSTRALIA

ICEF13

INTERNATIONAL CONGRESS ON ENGINEERING AND FOOD

MELBOURNE, AUSTRALIA
23-26 SEPTEMBER 2019

Congress Handbook

Melbourne Convention and Exhibition Centre

23-26 September 2019

Congress Hosts

Engineers Australia is the largest and most diverse body of engineers in Australia. As Australia's principal engineering association we serve and represent around 100,000 professionals at every level, across all fields of practice. We are committed to advancing engineering and the professional development of our members.

ENGINEERS AUSTRALIA

We are the trusted authority of a profession that shapes the lives of every Australian. With countless organisations, institutions and government agencies relying on our expertise to create, accredit and assess engineering programs and practitioners, our proven dedication to engineers and the Australian industry is unparalleled.

With a rich history and awards programs to highlight the dedication and accomplishments of engineers, we have created a legacy for all to take part in. And with diverse groups and thousands of events each year, we have created a unified forum for engineers like no other.

www.engineersaustralia.org.au/

The Australian Institute of Food Science and Technology Incorporated (AIFST), the Institute of Chemical Engineers in Australia Limited (IChemE) and Engineers Australia support the ongoing operations of a technical interest group, the Australian Food Engineering Association (AFEA).

AFEA

Objectives of AFEA are:

- To be the Australian focal point for food engineering within the engineering, food science and food technology community.
- To develop and promote the profession of food engineering.
- To mutually support professional organisations on food engineering related areas of science, engineering, technology and other areas.
- To provide the forum for dissemination of technical information relating to food engineering.
- To promote the development of personal "networks" between professionals with an interest in food engineering.
- To encourage collaboration, consistency of professional conduct and mutual sharing of information and experiences.
- To promote the awareness of the role and contribution of food engineering to the industry policy makers, food technologists, scientists and engineers, and the general public.
- To foster education and continuing professional development for food engineers.
- To promote research and development that advances food engineering.

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Committee and Support Staff

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Ms Meltem Bayrak, RMIT University
Dr Roman Buckow, CSIRO (Congress Chair)
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Mr Andrew Watkins, Australian Food Engineering Association
Mr Gordon Young, Food Industry Engineering (and Associate of FoodStream)

Engineers Australia Support Staff

Nicole Appleby, National Manager, Professional Development

Cara Maltman, Senior Coordinator, Professional Development

Engineers Australia Victorian Office

Level 31, 600 Bourke Street
Melbourne VIC 3000, Australia
T +61 1300 653 113
E memberservices@engineersaustralia.org.au

Congress Office

WALDRONSMITH Management
119 Buckhurst Street
South Melbourne VIC 3205, Australia
T +61 3 9645 6311
E icef13@wsm.com.au

Welcome to ICEF13

Roman Buckow

ICEF13 Convenor

On behalf of the Organising Committee, I would like to extend a warm welcome to the 13th edition of the International Congress on Engineering and Food (ICEF13) in Melbourne, Australia. ICEF13 is presented by the International Association for Engineering and Food (IAEF) with support from Engineers Australia and the Australian Food Engineering Association (AFEA) and we feel very honoured to organise ICEF in the Australasia region for the very first time of its 50-year tradition.

Global population growth and consumer trends have put the food supply chains and industry at the verge of threatening both human and planetary health. Thus, we have created an exciting program covering a wide array of topics around the Congress theme "Engineering Innovations for Food Supply Chains". We have invited many distinguished international speakers, both from academia and industry, who will undoubtedly stimulate vigorous debate around the critical role of engineers in securing human nutrition and health and support environmental sustainability. Some of the sessions will also focus on new aspects of food engineering and related disciplines such as the use of new protein sources and Industry 4.0 solutions and hopefully will provide an insight into the future of the industry and society that we are servicing.

I also do not want to miss the opportunity to introduce Melbourne as a Congress destination. The greater Melbourne area is home to a soaring food industry sector and Australia's largest exporter of food products including dairy, meat and cereal products. Major food manufacturers include Cargill, Simplot, Chobani, Saputo, Fonterra, Nestle, and many others. Innovative food manufacture is supported by vivid agri-food research facilities including Food Innovation Australia Limited, the Monash Food Innovation Centre, the CSIRO Food Innovation Centre, and the RMIT Food Research and Innovation Centre among many others.

The Congress venue is the ultra-modern Melbourne Convention Centre with its ability to host more than 10,000 delegates. It is in easy walking distance from Southbank and the CBD with fine dining, craft brewing, luxury shopping options. Thus, we trust ICEF13 will also create an opportunity to network with old friends and colleagues, make new friends, and to enjoy the Australian culture, and, of course, the best coffee in the country!

Finally, we gratefully acknowledge the support of our sponsors and exhibitors and the many colleagues that volunteered their time to make this event possible and promote it globally.

Keynote Speakers

Professor Gustavo Barbosa-Cánovas

Washington State University, USA

Presentation title:
Novel and future processing technologies for the food industry of the 21st century

Date: Wednesday 25 September 2019

Time: 0945-1020

Gustavo V. Barbosa-Cánovas is a Professor of Food Engineering and Director of the Centre for Nonthermal Processing of Food (CNPF) at Washington State University, USA. Quite recently he was awarded an Honoris Causa Doctorate at Polytechnic University of Cartagena, Spain. He has received several prestigious awards such as the IFT Nicholas Appert Award, IFT International Award and is an IFT, IFST, and IUFoST Fellow as well as Member of the Uruguayan Academy of Engineering.

Professor Xiao Dong Chen

Soochow University, China

Presentation title:
Food engineering for digestion tracts

Date: Monday 23 September 2019

Time: 0950-1025

Professor Xiao Dong Chen is Soochow University Distinguished Professor and Head of School of Chemical Engineering. He has BE (Tsinghua 1987); PhD (Canterbury 1991); MSc (UNSW 2014); and Docteur Honoris Causa (Agrocampus-Ouest 2017). He is Fellow of Royal Society of New Zealand (2001-); Fellow of Australian Academy of Technological Sciences and Engineering (2007-); Fellow of IChemE (UK) and Member of AIChE (USA). By 2018, he has published >550 journal articles and > 230 conference papers in food and chemical engineering. He was recipient of Young Food Engineer Award at ICEF6 (Mexico, 2008) and Lifetime Achievement Award at ICEF12 (Canada, 2015).

Dr Grace Douglas

NASA, USA

Presentation title:
Food system development for the final frontier: challenges and integrative solutions

Date: Wednesday 25 September 2019

Time: 0910-0945

Dr Grace Douglas serves as the lead scientist for NASA's Advanced Food Technology research effort, which focuses on determining methods, technologies, and requirements for developing a safe, nutritious, and palatable food system that will promote astronaut health during long-duration space missions. Her responsibilities include assessing the risk of an inadequate food system to crew based on vehicle design and mission concept and developing the research path that will ensure the food system meets crew health requirements on spaceflight vehicles. She earned a B.S. and M.S. in food science from the Pennsylvania State University and North Carolina State University, respectively, and a Ph.D. in functional genomics from North Carolina State University.

Dr Silvia Estrada-Flores

Food Chain Intelligence, Mexico

Presentation title:
Resolving conflicting drivers in global food security through agri-food innovation

Date: Thursday 26 September 2019

Time: 0905-0940

Silvia Estrada-Flores is Principal Consultant and founder of Food Chain Intelligence, a niche consultancy firm that specializes in the application and evaluation of innovative technology in agri-food chains. Her latest project deals with the market case for the use of solar irrigation in Tanzania. Silvia holds a BSc (Food Eng) from the National University of Mexico and a PhD from Massey University (New Zealand). She has held senior roles in CSIRO, Plant & Food Research NZ, Mabe/General Electric, Bayer CropScience and Food South Australia. Silvia has authored over 40 commercial reports and several book chapters, scientific articles and trade articles.

Dr Christoph Hartmann

Nestlé Research, Switzerland

Presentation title:
Riding the wave of new food trends: how to do research to the point?

Date: Monday 23 September 2019

Time: 0915-0950

Christoph holds a degree in mechanical engineering and a PhD in Computational Fluid Dynamics. He was appointed Associate Professor at Technische Universität München in 2004, and full Professor at the German University in Cairo in 2005.

Christoph joined Nestlé in 2006, studying biophysics of in-mouth food breakdown. From 2012, he set up the Nestlé Food Safety Institute in Beijing, and, in 2016, took over the Consumer Science department in Nestlé Research.

Since October 2018, Christoph leads Academic Alliances and Expertise Development. He has global responsibility for strategic academic partnerships, internal science and technology networks, and expert competence development.

Dr Tristan Hunter

Fonterra, New Zealand

Presentation title:
Going digital in food manufacturing – what does this mean?

Date: Thursday 26 September 2019

Time: 0940-1015

Tristan Hunter leads the Automation and Operational Technology (AOT) group, which provides OT solutions across Fonterra Global Operations. Fonterra is the world's largest dairy exporter and heavily leverages technology within its manufacturing operations.
The AOT group has a broad scope from traditional automation systems to rapidly evolving areas such as IIoT, OT cyber security, predictive analytics and edge computing systems. As a result he has a pragmatic view of both the opportunities and challenges presented by the introduction of transformational new technologies into manufacturing.
Tristan completed his PhD in Advanced Process Control at the University of Canterbury (New Zealand). He initially developed and commissioned factory control systems before moving into leadership and technology strategy roles.

Professor Bart Nicolaï

University of Leuven, Belgium

Presentation title:
A new paradigm for computer aided design of food processes at multiple scales

Date:	Time:
Wednesday 25 September 2019	0835-0910

Bart Nicolaï has an MSc in Agricultural Engineering (Ghent University, Belgium) and Applied Mathematics (University of Leuven, Belgium). He obtained a PhD in Applied Biological Sciences in 1994 at the University of Leuven (Belgium) where he now is a full Professor. He is also Director of the Flanders Centre of Postharvest Technology, a public-private partnership which was established by the University of Leuven and the Association of Belgian Horticultural Co-operatives in 1997. Since 2016 he is chair of the Biosystems department at the University of Leuven and also leads the postharvest research group of this department. His main research interests are postharvest biology and technology, refrigeration technology, heat and mass transfer, quality of fruit and vegetables, and mathematical modelling. He is editor-in-chief of the journal Postharvest Biology and Technology.

Professor Karin Schroen

Wageningen University, Netherlands

Presentation title:
Microtechnology used as a tool for rapid development of new and sustainable food products

Date:	Time:
Tuesday 24 September 2019	0940-1015

In 1995, Professor Schroen obtained her PhD degree in Food Process Engineering from the then Wageningen Agricultural University. Since then she has worked as a post-doc at University College London, and the Biotechnology group of Wageningen Agricultural University. After becoming an Assistant Professor at Wageningen University in 2001, she has successfully gone through the tenure track and been appointed full Professor in September 2012, and reappointed last year.

Currently Karin heads a research group of approximately 16 people excluding many international guests. In the last 5 years she has acquired research projects worth approximately 5M€ from various sources including the national science foundation. She has 174 publications in scientific journals according to Web of Science, approximately 15 book chapters, and 7 patents to her name. Her h-factor in Web of Science, Scopus and Google Scholar is: 32, 33, and 40 respectively. She is frequently invited as a (keynote) speaker at conferences, workshops, etc., and is a member of the Dutch chemistry top team, has been Program Director within NanoNextNl, Vice-President of the alumni organisation, co-organiser of science cafés in Wageningen and so on. She did sabbaticals and short stays at DTU (Denmark), Princeton (USA), CSIRO (Australia), and Tarragona (Spain), and has an extensive national and international network in the field of emulsions, food, and membranes.

Within her research group, many aspects of science come together. Often the micrometer scale is taken as a starting point, and from basic observations the underlying mechanisms are elucidated. Based on these insights, novel process technology that is mostly mild and low in energy density is designed, typically for the emulsification, and membrane separation field.

Besides research, Karin also dedicate a lot of time to teaching, and innovation thereof. She has been in the top 20 of best teachers of Wageningen University a number of times.

Dr Lana Zivanovic

MARS Petcare, USA

Presentation title:
Paving the way to market for proteins from alternative sources

Date:
Tuesday 24 September 2019

Time:
0905-0940

Lana Zivanovic is Global Innovation Protein Program Director at Mars Petcare. She holds a BSc in Food Engineering, MSc in Food Biotechnology, and PhD in Applied Biochemistry. Prior to joining Mars Inc., Lana was a Professor of Food Chemistry and Biochemistry at Food Science Department at University of Tennessee (2001- 2015) and served as a Senior Adviser to the Minister of Agriculture in the Republic of Serbia (2013/14). During her academic tenure, Lana's research was funded by the USDA, USEPA, USDOE, USDOD, USAID, NASA, and the food industry. Lana joined Mars Petcare in 2015 to lead the Applied Science program focused on finding practical and sustainable solutions for global protein supply.

Congress Program: Oral Presentations

Monday 23 September 2019

0730-1730	**Registration** | Foyer, Level 1
0730-1915	**Exhibition** | Foyer, Level 1
0830-0915	**Opening Ceremony**
Room	Meeting Room 105 & 106, Level 1
Chair	Roman Buckow
0830-0845	Welcome to Country
0845-0900	Welcome to ICEF13 *Roman Buckow*
0900-0910	Opening speaker *The Hon. Jane Garrett*
0915-1025	**Plenary Session**
Room	Meeting Room 105 & 106, Level 1
Chair	*Ulrich Kulozik and Victoria Jideani*
0915-0950	**Keynote Presentation** Riding the wave of new food trends: how to do research to the point? *Christoph Hartmann*
0950-1025	**Keynote Presentation** Food engineering for digestion tracts *Xiao Dong Chen*
1025-1100	Morning Tea | Foyer, Level 1

1100-1230	Concurrent Sessions					
Session	**Concurrent 1A** Advances in nonthermal food processing in China	**Concurrent 1B** Beyond the farm gate: the role of the food engineer in addressing food security and humanitarian situations	**Concurrent 1C** Phase or state change and water dynamics in foods	**Concurrent 1D** Integrated sustainability assessment of global food systems and processing	**Concurrent 1E** Engineering solutions to control food digestion	**Concurrent 1F** Short oral 1 – Advances in food process engineering
Room	Meeting Room 106, Level 1	Meeting Room 105, Level 1	Meeting Room 104, Level 1	Meeting Room 103, Level 1	Meeting Room 102, Level 1	Meeting Room 101, Level 1
Chair	*Baocai Xu and Xin-An Zeng*	*Dominique Bounie and Silvia Estrada-Flores*	*Nasser Al-Habsi and Mohammad Shafiur Rahman*	*Alexander Mathys and Liz Specht*	*Paul Singh and Ruud van der Sman*	*George Chen*
	The application of pulsed electric field (PEF) technology for food processing in China *Xin-An Zeng*	Sustainable food security for all: opportunities to enhance nutrition and decrease food waste in resource-limiting settings *Robyn Alders*	Food materials science importance in food process and product engineering *Yrjö Roos*	Holistic sustainability assessment of global food systems – challenges, needs and available tools *Alexander Mathys*	An application to understanding food digestion: Degradation mechanisms of phytometabolites of antibiotics *Gail Bornhorst*	Refer to short oral program
	Enhancing the activity of superoxide dismutase by high pressure processing *Xiaojun Liao*	System engineering approach to design solutions for humanitarian food security situations *Dominique Bounie*	Applications of state diagram in food engineering: past, present and future *Mohammad Shafiur Rahman*	The future of meat: sustainably meeting future demand with plant-based and cell-based meat *Liz Specht*	Role of oral processing in in vitro digestion: a case study of bread *Jing Gao*	
	The mechanism and application of ultrasound in food preservation and sterilization *Donghong Liu*	Towards a more food secure world – the role of postharvest technologists and engineers *Suzie Newman*	Impact of amorphous sugars ratio and fiber addition in crystallization, in model food systems as affected by different water activities *Vaios Karathanos*	Food supply chains as cyber-physical systems: engineering a path for more sustainable personalised nutrition *Sergiy Smetana*	Digestibility of milk proteins in elderly *Kataneh Aalaei*	
	Presence of sodium chloride and high hydrostatic pressure improve the stability of chlorophyll *Yan Zhang*	Food security, income generation, through enterprise skills development for village level food processing *Alastair Hicks*	Thermal characteristics and proton mobility of date-pits and hemicellulose extracted from date-pits *Nasser Al-Habsi*	Pathways to reducing water-scarcity impacts from Australian food consumption *Brad Ridoutt*	Engineering common beans for the generation of microstructures with specific in vitro nutritional functionality: a kinetic approach *Andrea Katherine Pallares Pallares*	
	Synergistic effect of high pressure processing and two spice extracts on quality and shelf life of low-salt sausage during storage *Peijun Li*	Roundtable Discussion	In situ characterization of crystal growth process in raisin: 3D image-based using micro-CT *Maria Moreno*	Quality-based life cycle assessment of protein dietary sources *Jen-Yi Huang*	Unlocking the functionality of sugar and its replacers for structuring of bakery products *Ruud van der Sman*	
1230-1345	Lunch | Foyer, Level 1					

1345-1515	Concurrent Sessions					
Session	**Concurrent 2A** Engineering food digestion: from understanding to consumer-oriented applications	**Concurrent 2B** Novel drying approaches and optimisation	**Concurrent 2C** Beyond 2020: the importance of refrigeration in the future food supply chains	**Concurrent 2D** Microwave processing of foods under batch and continuous flow conditions	**Concurrent 2E** Rheological, textural and structural properties of foods	**Concurrent 2F** Short oral 2 – Engineering properties of food and packaging
Room	Meeting Room 106, Level 1	Meeting Room 105, Level 1	Meeting Room 104, Level 1	Meeting Room 103, Level 1	Meeting Room 102, Level 1	Meeting Room 101, Level 1
Chair	*Uri Lesmes and Harjinder Singh*	*Sakamon Devahastin and Alain Le-Bail*	*Don Cleland and Silvia Estrada-Flores*	*KP Sandeep and Juming Tang*	*Magdalena Kristianan and Minh Nguyen*	*Antonio Derossi*
	The effect of processing on the kinetics of digestion *Alan Mackie*	BRICE project: solutions to monitor and to mitigate checking and breakage of dry cereal products *Alain Le-Bail*	Sustainability of refrigerated facilities *Don Cleland*	Commercialization of continuous flow microwave processing of foods *KP Sandeep*	Artificial oral processing of extruded pea flour snacks *Guy Della Valle*	*Refer to short oral program*
	Comparative performance of proteins and emulsion in adults and the elderly *Uri Lesmes*	Product design in drying processes based on structure visualisation by μ-CT *Volker Gaukel*	Refrigerated seafreight of food products *David J Tanner*	Control viral and bacterial pathogens in ready-to-eat meals using microwave assisted pasteurization systems *Juming Tang*	Development of a marking methodology for X-Ray μCT to describe the microstructure of cereal products *Sylvie Chevallier*	
	Role of food structures in lipid digestibility and absorption *Harjinder Singh*	Ultrasound assisted low temperature drying of food materials *Henry Sabarez*	Technologies for dynamic controlled atmosphere of fruit and vegetables *Bart Nicolai*	Mathematical modeling of microwave thawing: cavity geometry effect and design for scale-up of an industrial process *Torstein Skåra*	Investigating the microstructure of frozen foods using X-ray microtomography: a comparative study *Fatou-Toutie Ndoye*	
	Turning phytates into a natural Iron delivery system *Edwin Habeych*	Making spray drying cool: a novel approach to low temperature electrostatic spray drying of probiotic microorganisms *Bogdan Zisu*	Safety and quality degradation of foods stored in residential refrigerators *Antonio Torres*	Combined prototype with ultrasounds, microwave, and spiral heat exchange in an industrial olive oil extraction plant: impact on olive oil quality and yield *Pablo Juliano*	Microstructural characterization of vacuum-fried matrices and its influence on the starch bioaccessibility *Ingrid Contardo*	
	Formulation and processing factors affecting bioaccessibility of polyphenols *Avi Shpigelman*	Prediction of drying rate of nectarines (Prunus persica var. nucipersica) from real-time ambient weather factors during direct sun drying *Rebecca Milczarek*	Effect of magnetic field coupled with cold storage on the postharvest quality of fruits and vegetables *Zhao Yang*	Coupled transport and CFD modelling framework for intermittent microwave convective drying of plant based food *Azharul Karim*	Transient localized changes in fresh-cut papaya microstructure as determined by environmental scanning electron microscopy (ESEM), confocal laser scanning *Gabriela Caez*	
1515-1545	Afternoon Tea | Foyer, Level 1					

1545-1715	Concurrent Sessions			
Session	**Concurrent 3A** Insights into the scope of food engineering education	**Concurrent 3B** Innovative technologies for product modification and process intensification	**Concurrent 3C** New tools and models to enhance food processing and quality	**Concurrent 3D** New technologies for sustainable food and ingredient manufacture
Room	Meeting Room 106, Level 1	Meeting Room 105, Level 1	Meeting Room 104, Level 1	Meeting Room 103, Level 1
Chair	*Barry McGookin and Keshavan Niranjan*	*Ferruh Erdogdu and Anet Režek Jambrak*	*Kasiviswanathan Muthukumarappan and John Tobin*	*Torstein Skåra and Paulo Sobral*
	Strengthening food engineering education with courses on novel and emerging topics *Paul Singh*	Low pressure and moderate to high temperature are required for meat tenderization using high pressure processing *Robyn Warner*	The application of ecoefficient electrotechnologies for the production of biologically active peptides *Sergey Mikhaylin*	Supercooling technology for extended shelf life of perishable foods *Soojin Jun*
	Re-engineering bachelor's degree curriculum in food engineering: hypothesis and proposal *Keshavan Niranjan*	High voltage electrical discharges in extractions of bioactives from Oregano leaves (Origanum vulgare L.): process control and impact on antioxidative properties of extract *Anet Režek Jambrak*	A nutrikinetic model linking broccoli processing conditions to ITC bioavailability *Matthijs Dekker*	Prediction of liquid loss from frozen and thawed cod by hyperspectral imaging *Torstein Skåra*
	Simulation-based enhancement of education: food safety for engineers *Ashim Datta*	Factors influencing calcium infusion using high pressure processing *Noopur Gosavi*	Applications of hydrodynamic cavitation for instant rehydration of high protein milk powders *John Tobin*	Novel Application Potentials of CO2 Gas Hydrate Technology for the Commercial Juices Concentrating Process *Soebiakto Loekman*
	Food and agribusiness engineers – how to play in 2030 *Barry McGookin*	The use of pulsed electric fields technology for carrot texture modification on human oral processing and in vivo bioaccessibility of β-carotene *SzeYing Leong*	Prediction of millet extrudates properties using response surface modelling and artificial neural networks *Kasiviswanathan Muthukumarappan*	The importance of processing of microalgae in the design of healthy food products with desired rheological properties *Tom Bernaerts*
	A call for developing a collaborative education and training platform dedicated to humanitarian food engineering *Dominique Bounie*	Photopolymerization by UV and blue light in salmon gelatin with different molecular weight *Javier Enrione*	Identification of mechanisms of multistage structure-formation in processed cheese model products *Ulrich Kulozik*	Printed, flexible pH sensors for wet environments in food application *Fariba Dehghani*
1715-1915	**Welcome Reception** | Exhibition, Foyer, Level 1			

Tuesday 24 September 2019

0730-1730	**Registration** | Foyer, Level 1	
0830-1700	**Exhibition** | Foyer, Level 1	
0745-0845	**Breakfast Session**	*Sponsor: Journal of Food Engineering by Elsevier*
Room	Meeting Room 103, Level 1	
0745-0800	Introduction *Paul Singh*	
0800-0845	Food safety from farm to gut: opportunities and challenges *Nitin Nitin*	ELSEVIER
0900-1015	**Plenary Session**	
Room	Meeting Room 105 & 106, Level 1	
Chair	*Gilles Maller and Donghong Liu*	
0900-0905	Welcome and housekeeping announcements *Janet Paterson*	
0905-0940	**Keynote Presentation** Paving the way to market for proteins from alternative sources *Lana Zivanovic*	
0940-1015	**Keynote Presentation** Microtechnology used as a tool for rapid development of new and sustainable food products *Karin Schroen*	
1015-1050	Morning Tea | Foyer, Level 1	

1050-1220	Concurrent Sessions					
Session	**Concurrent 4A** Advances in freezing technologies	**Concurrent 4B** Food industry 4.0 – current and future state	**Concurrent 4C** Food process modeling: across the scales, food-health linkages and enablers	**Concurrent 4D** Cold plasma functionalised liquids for food and agriculture	**Concurrent 4E** Innovation in food processing and value addition in Australasia	**Concurrent 4F** Short oral 3 – Food engineering for nutrition and health
Room	Meeting Room 106, Level 1	Meeting Room 105, Level 1	Meeting Room 104, Level 1	Meeting Room 103, Level 1	Meeting Room 102, Level 1	Meeting Room 101, Level 1
Chair	*Alain Le-Bail and Osato Miyawaki*	*Filip Janakievski and Leonie Wong*	*John Bronlund and Ashim Datta*	*Paula Bourke and Patrick Cullen*	*Mohammed Farid and Sandra Kentish*	*Zamantha Escobedo-Avellaneda*
	Crystallization assisted by electric, magnetic, electromagnetic, MicroWaves and Radio Frequencies; a review *Alain Le-Bail*	Beyond blockchain – an overview of useful digital technologies for the food industry *Serafim Bakalis*	Coupling poromechanics, transport and kinetics as modeling framework for process, quality and safety *Ashim Datta*	Plasma functionalized water: from bench to prototype for fresh food safety *Uta Schnabel*	A novel ice encapsulated storage system-field trial on farm for cooling of milk *Mohammed Farid*	Refer to short oral program
	Progressive freeze-concentration and its application to new food products *Osato Miyawaki*	Industry 4.0 and digitalization in food and beverage *Leonie Wong*	Large scale modeling of food systems: from molecules to food quality and safety *Olivier Vitrac*	Technology advantages and challenges of plasma activated liquids in a circular bio-economy *Ximena Yepez*	Creamed pomace – a new process for a new product from an old waste *Richard Archer*	
	The effect of Cells Alive System (CAS) *Norio Owada*	Asahi 4.0 *Anna Reid*	Application of constrained optimization techniques in optimal shape design of a freezer to dosing lines splitter for ice-cream production *Fabrizio Sarghini*	PlaSmarter – Cold Plasma functionalised liquid platform for food and agriculture interventions *Paula Bourke*	Novel approaches to dairy processing *Sandra Kentish*	
	Pasteurization effects of food model during vacuum freeze drying combined with high frequency dielectric heating *Atsushi Hashimoto*	Future of agrifood industry and technologies that will disrupt it *Ingrid Appelqvist*	Modelling as a tool to link food structure to sensory experience and digestion *John Bronlund*	Ecotoxicological and Life Cycle considerations of cold plasma as an advanced oxidation process for contaminated wastewaters *Dana Ziuzina*	From small computers to big data, food process analytical control and beyond *Brent R. Young*	
	Comparative study of supercooling freezing with conventional freezing on the pork meat with various storage periods *Rajib Poudyal*	Development and validation at industry scale of a fluorescence and infrared backscatter fluorescence PAT tool to monitor rennet induced coagulation kinetics of milk *Colm O'Donnell*	Gas transfer modelling in foods with a heterogeneous porous microstructure *Bart Nicolai*	Inactivation of Listeria monocytogenes and Salmonella Typhimurium planktonic cells and biofilms using plasma activated liquid (PAL) *Jan Van Impe*	Heating uniformity as a function of tray position in a MATS microwave food processing system *Ross Coad*	
1220-1335	Lunch | Foyer, Level 1					

1335-1505	Concurrent Sessions					
Session	**Concurrent 5A** Next gen 3D printing of foods	**Concurrent 5B** Food packaging and biodegradable packaging materials	**Concurrent 5C** Resource recovery for nutritional food engineering and health	**Concurrent 5D** Advances in membrane filtration systems for food applications	**Concurrent 5E** Next generation sustainable food processing	**Concurrent 5F** Short oral 4 – Food process systems engineering and modelling
Room	Meeting Room 106, Level 1	Meeting Room 105, Level 1	Meeting Room 104, Level 1	Meeting Room 103, Level 1	Meeting Room 102, Level 1	Meeting Room 101, Level 1
Chair	*Bhesh Bhandari and Claire Gaiani*	*Benu Adhikari and Yoshio Makino*	*Fariba Dehghani and Liping Zhao*	*Lilia Ahrné and Martin Hartinger*	*Sergiy Smetana and Vanessa Jury*	*Serafim Bakalis*
	Current situation, challenge and prospect of 3D food printing in China *Min Zhang*	Starch-polyurethane flexible packaging films: synthesis, compostability and application *Benu Adhikari*	Gut microbiome: a new target for managing human metabolic health *Liping Zhao*	Concentration of whey using cheese salt brine in direct forward osmosis using aquaporin-based hollow fiber membranes *Lilia Ahrné*	Heterotrophic microalgae as a sustainable source of highly technofunctional proteins *Lutz Grossman*	Refer to short oral program
	Structuring meat through 3D Printing *Sangeeta Prakash*	Biopolymer applications in agriculture and packaging *Paul Luckman*	Microbial engineering of carotenoids synthesis from waste substrates *Jaslyn Lee*	Quantification of osmotic pressure of whey under Forward Osmosis for whey concentration *Anna Artemi*	Renewable heating above 100C for use in food processing *Don Cleland*	
	Post-processing feasibility of dual-nozzle-extruded 3D printed beef products *Arianna Dick*	Analysis of dynamic changes in metabolites in green soybeans (Glycine max (L.) Merr.) under modified atmospheres by statistical methods *Yoshio Makino*	Effects of technological treatments on dietary fiber structure, digestion of plant proteins and bioaccessibility of amino acids: cooking extrusion of brewer's spent grains *Emilie Korbel*	Concentration of coconut water using aquaporin-based hollow fiber and tubular forward osmosis membrane *Xuan Tung Nguyen*	Impact of thermal processing on the microbial diversity of cricket flour *Antje Fröhling*	
	Design and production of 3D printed food with desired textural properties *Antonio Derossi*	Disintegrability under composting conditions of biopolymers-based films containing Boldo-of Chile extract *Paulo Sobral*	Processing strategies for enhancing the bioactive profile of Brassica vegetables *Netsanet Shiferaw Terefe*	Influence of spatial dependency on filtration performance of spiral-wound membranes *Martin Hartinger*	Sustainable performance of nitrites reduction scenarios in ham production *Vanessa Jury*	
	Innovative, economical 3D printed reactor designs for the cultivation of photoautotrophic microorganisms *Alexander Jahn*	Sprayable biodegradable polymer membrane for agriculture systems *Raju Adhikari*	Processing techniques for donated human milk optimized for minimal damage to milk proteins *Katherine Blackshaw*	Forward osmosis for dairy processing – a pilot scale study on milk and whey concentration *George Chen*	Sustainable use of Hermetia illucens insect biomass for feed and food: extensive Life Cycle Assessment *Sergiy Smetana*	
1505-1535	Afternoon Tea | Foyer, Level 1					

1535-1705	Concurrent Sessions					
Session	**Concurrent 6A** A new aspect of food rheology: expansion from processing and eating stage to postprandial digestion	**Concurrent 6B** Microencapsula-tion and glass transition of foods	**Concurrent 6C** Food supply chain engineering, sustainability, and world hunger	**Concurrent 6D** New opportunties of extrusion processing for functional foods and ingredients	**Concurrent 6E** Food engineering education: from undergraduate learning to doctoral research training	**Concurrent 6F** Short oral 5 – Novel food processing technologies
Room	Meeting Room 106, Level 1	Meeting Room 105, Level 1	Meeting Room 104, Level 1	Meeting Room 103, Level 1	Meeting Room 102, Level 1	Meeting Room 101, Level 1
Chair	*Yukiharu Ogawa and Jaspreet Singh*	*Bhesh Bhandari and Claire Gaiani*	*Dennis Heldman and Jose Reyes*	*Dennis Forte and Danyang Ying*	*Jan Van Impe and Janet Paterson*	*Cristina Silva*
	A new aspect of food rheology on postprandial digestion *Yukiharu Ogawa*	A continuous alginate micro-encapsulation technique – an innovative technology *Bhesh Bhandari*	Sustainability of the food supply system; energy, water and waste *Dennis Heldman*	Extrusion: a tool for food innovation *Gilles Maller*	FOOD4S – towards a european master of science in sustainable foood systems engineering *Monika Polanska*	Refer to short oral program
	Foam performance measurement for beer based on the Helmholtz resonance phenomenon *Takahisa Nishizu*	Spray-drying as an encapsulation process to protect lactic acid bacteria in enzyme pre-treated dairy protein matrix *Claire Gaiani*	Food logistics and supply chain *Rodolfo Garcia-Flores*	Modulation of protein aggregation by extrusion mechanical energy *Bo Zhang*	Food process models for training purpose through knowledge engineering methods (MESTRAL) *Guy Della Valle*	
	Cooking methods altered the nutrition and digestibility of potato *Jinhu Tian*	Development of controlled delivery functional systems by microencap-sulation of plants extracts with health benefits and food technological interest *Berta Estevinho*	Production and inventory optimization problems in food industry *Regina Berretta*	Challenges in development of extruded functional foods for improved food and nutritional security *Danyang Ying*	A digital library to aid curriculum internationalisation in biosystems and food engineering *Enda Cummins*	
	Change of protein digestibility, protein availability, amino acids and antioxidant potential among digested fractions of raw, cooked and fermented soybeans *Sunantha Ketnawa*	Extrusion based Food Layered Manufacturing of casein-whey protein mixtures differing in pH, protein content and denaturation parameters *Kilian Daffner*	Food excess and by-product processing 'ecosystem' model *Paulomi Burey*	The use of dimensional analysis – modeling the direct expansion process *Dennis Forte*	Development of a multidisciplinary post-graduate educational activity on quantitative tools for sustainable food and energy in the food chain (Q-Safe): from problem based learning to e-learning *Serafim Bakalis*	
	Biomimetic plant foods: nature inspired food structures to control starch digestion *Jaspreet Singh*	Continuously distributed glass transition and caking of maca (Lepidium meyenii Walpers) powder *Alex Eduardo Alvino Granados*	The scale factor in food manufacture: a tool for the assessment of decentralised food production scenarios *Peter Fryer*	Influence of thermomechanical treatment on the reaction behavior and functionality of highly concentrated whey proteins *Maria Gabriela Quevedo Barahona*	"Glow to make your plants grow": connecting discovery and community engaged research to the Undergraduate curriculum *Paula Bourke*	

Wednesday 25 September 2019

0800-1730	**Registration** | Foyer, Level 1
0800-1700	**Exhibition** | Foyer, Level 1
0830-1020	**Plenary Session**
Room	Meeting Room 105 & 106, Level 1
Chair	*Nikolaos Stoforos and Miriam Hubinger*
0830-0835	Welcome and housekeeping announcements *Pablo Juliano*
0835-0910	**Keynote presentation** A new paradigm for computer aided design of food processes at multiple scales *Bart Nicolaï*
0910-0945	**Keynote presentation** Food system development for the final frontier: challenges and integrative solutions *Grace Douglas*
0945-1020	**Keynote presentation** Novel and future processing technologies for the food industry of the 21st century *Gustavo Barbosa-Cánovas*
1020-1055	Morning Tea | Foyer, Level 1

1055-1225	Concurrent Sessions					
Session	**Concurrent 7A** Global perspectives of food engineering: current status and vision	**Concurrent 7B** Engineering digestion: development and utility of dynamic digestion models	**Concurrent 7C** Advances in food sensors technologies	**Concurrent 7D** Pulsed electric field processing: new applications for the bio-based industry	**Concurrent 7E** Food structure engineering	**Concurrent 7F** Short oral 6 – Novel food processing technologies
Room	Meeting Room 106, Level 1	Meeting Room 105, Level 1	Meeting Room 104, Level 1	Meeting Room 103, Level 1	Meeting Room 102, Level 1	Meeting Room 101, Level 1
Chair	*Yrjö Roos and Sam Saguy*	*Gail Bornhorst and Erich Windhab*	*Jose Reyes and Michael Ngadi*	*Leandro Buchmann and Indrawati Oey*	*Simon Lawton and Edgar Chavez Montes*	*Antje Fröhling*
	Food engineering vision and strategy towards 2050 *Sam Saguy*	Controlling satiety by tailored interfaces under consideration of gastric mixing in emulsion-based food systems *Erich Windhab*	To wire or not to wire that is the question *Jose Reyes*	Pulsed electric field use in food industry – application examples and equipment design *Oleksii Parniakov*	Process, structure and property relationships in food powder agglomeration and performance *Edgar Chavez Montes*	Refer to short oral program
	Global challenges and opportunities to inspire food engineers – millennials era to digital generations *Yrjö Roos*	Monitoring mixing during gastric digestion using the human gastric simulator (HGS) *Gail Bornhorst*	Predicting intramuscular fat quality in pork loin by hyperspectral imaging *Michael Ngadi*	Emerging pulsed electric field process development for the bio-based industry *Leandro Buchmann*	Drop break-up in rotor stator mixers *Fredrik Innings*	
	Food industry in the digital era: virtual tools, smart systems and connectivity *Francisco Marra*	The use of oral processing models for food design *John Bronlund*	Predicting freshness quality and shelf-life of strawberries using visible and near-infrared spectroscopy technology *Fernando Mendoza*	Pulsed electric field systems and applications *Mike Kempkes*	Towards heuristics for food product design *Simon Lawton*	
	Food engineering in China – highlights and concerns *Xiao Dong Chen*	In vitro investigation of the behavior of nanocellulose in human gastro-intestinal tract and the influence on food digestion *Fanbin Kong*	ITEX/GC-MS: an analytical method to a better detection of sulfur compounds in food products *Emilie Descours*	Effects of electric fields on enzymes: molecular dynamics simulations and experimental approaches *Sudhir Sastry*	A new gelation technology and its application in improving the edible quality and health value of dried noodles *Ying Yang*	
	New Zealand insights towards a new era of food engineers *Richard Archer*	Scaling plasma technology for the food industry *Patrick Cullen*	Potential of fluorescence-based process analytical technologies as quality assurance tools for the dairy industry *Eoin Murphy*	Pulsed electric fields (PEF) as a pre-treatment for sous vide processing to improve the quality of tough meat cuts *Indrawati Oey*	Food structure assessment for the optimization of dairy products and manufacturing processes *Sally Gras*	
1225-1340	Lunch | Foyer, Level 1					

1340-1510	Concurrent Sessions					
Session	**Concurrent 8A** Commercialisation case studies of foods and ingredients in Australasia	**Concurrent 8B** The new era for food engineering	**Concurrent 8C** Separation processes using green solvents	**Concurrent 8D** Innovative processes and approaches for enhanced food safety and product quality	**Concurrent 8E** Food process modeling: state-of-the-art	**Concurrent 8F** Short oral 7 – Food engineering properties, nutrition and packaging
Room	Meeting Room 106, Level 1	Meeting Room 105, Level 1	Meeting Room 104, Level 1	Meeting Room 103, Level 1	Meeting Room 102, Level 1	Meeting Room 101, Level 1
Chair	*Filip Janakievski and Christian Ruberg*	*Peter Fryer and Yrjö Roos*	*José M. del Valle and Antonio Torres*	*Netsanet Shiferaw Terefe and Pilar Cano*	*Ashim Datta and Francesco Marra*	*Avi Shpigelman*
	In pursuit of the world's best steak – advanced robotics and x-ray technology to transform an industry *Christian Ruberg*	Emerging food processing techniques to target more sustainable food systems *Alexander Mathys*	Pressurized fluid options to produce cannabis-containing products for the food industry *Jerry W. King*	The international regulatory environment of novel food processing technologies *Dominique Taeymans*	Hybrid mixture theory based framework for modeling unsaturated transport in poroviscoelastic biopolymers *Pawan S. Takhar*	Refer to short oral program
	A new process in instant coffee production *Paul Ahn*	Engineering protein digestibility: insights form in vitro digestion models and digestomics analyses *Uri Lesmes*	Sustainable extraction of bio-actives: the mini-biorefinery concept applied to food industries *María Angela Meireles*	Synergistic antimicrobial effects of ultrasound and natural compounds against foodborne pathogens *Rohan Tikekar*	From Hz to GHz: electro-assisted processes in food industry *Francesco Marra*	
	Australian tales of the future of sustainable nutrient recycling *James Sackl*	Food structure engineering: the product design principles revisited *Azad Emin*	Assessing the impact on scale-up of "nonidealities" in supercritical CO2 extraction of solid food materials: mathematical simulation and experimental verification *José M. del Valle*	A comparison study on the effects of radio frequency electric fields (RFEF) and thermal treatments on orange juice processing *Ernest Tse*	High pressure thermal processing – modelling case studies *Kai Knoerzer*	
	From innovative concept to commercialisation of high pressure processing – The Presha Fruit story *Alastair McLachlan*	New processes for new products? *Peter Fryer*	High value-added products obtained by processing with subcritical water and supercritical carbon dioxide *Marleny Saldaña*	Clean steam in food and beverage manufacturing *Spirax Sarco*	Modelling ultrasound processing based on acoustic cavitation *Francisco Trujillo*	
	Processing a new crop for Australia; seaweed biomass as a challenge for food processing technologies *Pia Winberg*	Engineering products of the future *Christoph Hartmann*	Subcritical water extraction of bioactive compounds from kānuka (Kunzea ericoides) leaves *Sinemobong Essien*	Non-thermal preservation of wine using high pressure processing and pulsed electric fields *Sanelle van Wyk*	Mechanistic 3D modelling of solid foods with varying shape and size using statistical shape analysis: roasting of whole chicken breast meat *Felix Rabeler*	
1510-1540	Afternoon Tea | Foyer, Level 1					

1540-1710	Concurrent Sessions					
Session	**Concurrent 9A** Alternative proteins and food supplements: processing and consumption challenges	**Concurrent 9B** Advances in food packaging	**Concurrent 9C** Encapsulation and powder technologies for healthy food ingredients	**Concurrent 9D** Radio frequency applications for innovative thermal food processing: from thawing to pasteurization – sterilization	**Concurrent 9E** Modeling quality, safety and sensory aspects	**Concurrent 9F** Short oral 8 – Sustainability, security, and supply chains
Room	Meeting Room 106, Level 1	Meeting Room 105, Level 1	Meeting Room 104, Level 1	Meeting Room 103, Level 1	Meeting Room 102, Level 1	Meeting Room 101, Level 1
Chair	*Myriam Loeffler and Brijesh Tiwari*	*Juming Tang and Deniz Turan*	*Nitin Nitin and Cordelia Selomulya*	*Ferruh Erdogdu and Francesco Marra*	*Mukund Karwe and Petros Taoukis*	*Rebecca Milczarek*
	Transformational strategies to address current and future protein deficit *Brijesh Tiwari*	High gas-barrier polymer packaging for advanced food processing technologies *Juming Tang*	Improving fat encapsulation in spray-dried dairy powders *Cordelia Selomulya*	Radio frequency for innovative thermal processing – mathematical modeling for process optimization and industrial scale-up *Ferruh Erdogdu*	Crack in rusks: modelling and simulation of stress and displacement fields *Jean-Yves Monteau*	Refer to short oral program
	Influence of protein source on the functionality and the digestibility of infant formulas *Linda Le Roux*	Alternative testing method for water vapor permeability of packaging materials based on polar polymers: thermoplastic polyurethane *Deniz Turan*	Milk fat globules – a universal delivery systems for bioactives *Nitin Nitin*	Recent development of radio frequency treatments for pasteurizing agricultural products *Shaojin Wang*	Engineering coffee aroma: the steam stripping of roast and ground coffee for instant coffee manufacture *David Beverly*	
	Multi-functional mixed plant cell wall fibers from natural food colors side streams *Kai Reineke*	Polydiacetylene film-based sensors as an indicator for food spoilage at low temperatures *Long Nguyen*	Tuning the intrinsic stress tolerance of probiotic cells for enhanced survival ratio in spray drying for production of active dry probiotics *Meng Wai Woo*	Recent advances in the radio-frequency tempering and thawing of frozen foods *Yvan Llave*	Impact of shelf life models kinetic parameter uncertainty on predictions and management of the frozen fruits and vegetables cold chain *Petros Taoukis*	
	Mechanisms to functionalize or restructure alternative proteins for future application in meat-based products *Myriam Loeffler*	Migration kinetics of carvacrol from active cellulose acetate films to food simulant fluids *Bruno Carciofi*	Effect of various encapsulation methods on the stability of probiotic bacteria *Chinnaswamy Anandharamakrishnan*	Pasteurization of dehydrated food powders with radio frequency heating *Fanbin Kong*	Microbial inactivation by cold atmospheric pressure plasma: a numerical study *Mukund Karwe*	
	Role of the protein composition and rheological properties on the structuring of soy-based meat analogues in extrusion processing *Patrick Wittek*	Application of the genetic algorithm for smart packaging optimisation *Gonzalo Martinez*	Continuous process using protein-carbohydrate matrices for structuring and encapsulation *Mackenzie Hansen*	Radiofrequency tempering of frozen blocks of cod *Svein Kristian Stormo*	Modelling of Ohmic heating and kinetics of texture change of solid food products *Aberham H Feyissa*	
1900-2300	**Gala Dinner** | Aerial, 17 Dukes Walk, South Wharf					

Thursday 26 September 2019

0830-1330	**Registration and Exhibition** | Foyer, Level 1
0900-1015	**Plenary Session**
Room	Meeting Room 105 & 106, Level 1
Chair	*Mitsutoshi Nakajima and Tiago Oliveira*
0900-0905	Welcome and housekeeping announcements *Minh Nguyen*
0905-0940	**Keynote presentation** Resolving conflicting drivers in global food security through agri-food innovation *Silvia Estrada-Flores*
0940-1015	**Keynote presentation** Going digital in food manufacturing - what does this mean? *Tristan Hunter*
1015-1050	Morning Tea | Foyer, Level 1
1050-1230	**Closing Ceremony**
Room	Meeting Room 105 & 106, Level 1
Chair	*Kim Staples*
1050-1105	ICEF13 Highlights *Peter Fryer*
1105-1120	IAEF Lifetime Achievement Awards *Roman Buckow*
1120-1140	**ICEF13 Awards**
	ICEF13 Best Oral Awards sponsored by The University of Queensland *Bhesh Bhandari*
	ICEF13 Best Poster Awards sponsored by RMIT University *Benu Adhikari*
1140-1200	**Other Awards**
	International Food Engineering Award presented by ASABE *Sudhir Sastry*
	Nestlé Young Scientist Award *Christoph Hartmann*
	SCI Seligman APV Award *Keshavan Niranjan*
	Young Food Engineer Award provided by Elsevier's Journal of Food Engineering *R. Paul Singh*
1200-1215	Announcement and Introduction of ICEF14 *Roman Buckow*
1215-1230	Closing Remarks and Farewell *Roman Buckow*
1230-1330	Lunch | Foyer, Level 1
1330-1700	**Technical Tours**

Congress Program: Short Oral Presentations

Monday 23 September 2019

0730-1730	**Registration** | Foyer, Level 1
0730-1915	**Exhibition** | Foyer, Level 1
0830-0915	**Opening Ceremony**
Room	Meeting Room 105 & 106, Level 1
0915-1025	**Plenary Session**
Room	Meeting Room 105 & 106, Level 1
1025-1100	Morning Tea | Foyer, Level 1
1100-1230	**Concurrent Sessions**
Session	**Concurrent 1F** Short oral 1 – Advances in food process engineering
Room	Meeting Room 101, Level 1
Chair	*George Chen*
	Effect of pre-heat treatment of skim milk on reverse osmosis membrane filtration performance and storage stability of concentrated milks *Morten Vormsborg Christiansen*
	Physical, textural, and microstructural properties of extruded puffed products affected by inclusion of high biological value proteins *Ingrid Contardo*
	Megasonic-assisted aqueous extraction of canola oil from canola cake *Fouad Gaber*
	Screening of mixed surfactants based reverse micellar system for Lactoperoxidase extraction from whey *Shwetha Karanth*
	Novel natural emulsifiers derived from biomass-based by-products: case of argan (Argania spinosa) nut shell powder *Mitsutoshi Nakajima*
	The formation and stability of carbon dioxide nanobubbles designed for potential applications in food processing *Khanh Kim Thi Phan*
	ElectroHydroDynamic enhancement of heat and mass transfer in food process: a review *Olivier Rouaud*
	Impact of pH and ionic strength on temperature dependent diffusion of micellar bound casein monomers into the serum phase during microfiltration *Simon Schiffer*
	On the length-dependent milk protein deposit layer in hollow fiber membranes *Roland Schopf*
	Increased inactivation of bacterial endospores by ohmic heating *Felix Schottroff*
	Technical-scale extraction of bovine αS-, β- and κ-casein using decanter technology *Thomas Schubert*
	Influence of food microstructure on thermal inactivation dynamics of Listeria monocytogenes in the SHAKA reciprocal agitated retort *Jan Van Impe*
	Production of dried apple snacks incorporated with Bacillus coagulans *Fabiano Fernandes*
	The science of making mayonnaise on an industrial scale *Fredrik Innings*
	High-pressure nitrogen injection prior to spray drying improves the solubility of milk protein concentrate powders *Noel McCarthy*
	Effects of salt and lipids on heating parameters for the achievement of sterility in a microwave food processing system *Roger Stanley*
1230-1345	Lunch | Foyer, Level 1

1345-1515	**Concurrent Sessions**
Session	**Concurrent 2F** Short oral 2 – Engineering properties of food and packaging
Room	Meeting Room 101, Level 1
Chair	*Antonio Derossi*
	Characterising the textural properties of beef boluses using instrumental techniques through oral processing *Esther Onguta*
	Dielectric properties of mango pulp (Mangifera indica L.) and mango nectar for microwave heating at 915 and 2450 MHz *Tiago Augusto Bulhões Bezerra Cavalcante*
	Confined compression as an analytical tool to quantify juice release kinetics from meat and meat analogues *Steven Cornet*
	New insight on the use of statistical correlation functions to describe structural complexity of food and to estimate their essential properties *Antonio Derossi*
	Effect of fat globule size on whippability of dairy creams *Pramesh Dhungana*
	Production of functionalized low viscosity gelatin: thermo-mechanical and rheological properties *Javier Enrione*
	A new route to develop renewable non-isocyanate polyurethanes for food packaging applications *Mehran Ghasemlou*
	The fluid mechanics of mayonnaise mixers – the effect of stator slot width *Fredrik Innings*
	Effect of native fat globule size on foaming properties of milk *Minh Thao Ho*
	Vibrations as a cause of texture defects during yogurt manufacturing *Adrian Körzendörfer*
	Analysis of vertical compression of corrugated fiberboard tubes using digital image correlation *Celia Kueh*
	Elucidating the role of lecithin in the wettability of agglomerated cocoa beverage powders *Edgar Chavez Montes*
	NIR spectroscopy and chemometrics for detection of starch, gum and annatto in paprika powder *Douglas Fernandes Barbin*
	Synthesis and characterisation of silver nanoparticles with antimicrobial properties *Sholeem Griffin*
	Physicochemical changes during ageing of spray dried infant milk formula powders *A K M Masum*
1515-1545	Afternoon Tea | Foyer, Level 1
1715-1915	**Welcome Reception** | Exhibition, Foyer, Level 1

Tuesday 24 September 2019

0730-1730	**Registration** | Foyer, Level 1
0830-1700	**Exhibition** | Foyer, Level 1
0900-1015	**Plenary Session**
Room	Meeting Room 105 & 106, Level 1
1015-1050	Morning Tea | Foyer, Level 1
1050-1220	**Concurrent Sessions**
Session	**Concurrent 4F** Short oral 3 – Food engineering for nutrition and health
Room	Meeting Room 101, Level 1
Chair	*Zamantha Escobedo-Avellaneda*
	Cell disruption improves in vitro bioaccessibility of ω3-LC-PUFA and carotenoids in the microalga nannochloropsis *Tom Bernaerts*
	Liposome based delivery of α-linolenic acid and α-lipoic acid *Jeyan Moses*
	Hydration kinetics and nutrient loss with increased temperature for two popular seed bean (phaseolus vulgaris) varieties *Lavaraj Devkota*
	Role of bacterial cellulose fibrils on the retrogradation of starches with different amylose content *Javier Enrione*
	Engineering plan protein-based yoghurt products for nutrition and health *Stephan Drusch*
	Systematic study on the extraction of phycoerythrin from Gracilaria gracilis for natural food colorants *Maria Manuel Gil*
	From food to medicine: use of functionalized polyclonal antibodies from cow's milk for the treatment of bacterial infections *Hans-Jürgen Heidebrecht*
	Effects of the degree maturity and the drying process on the composition of the aroma components in Japanese pepper (Zanthoxylum piperitum DC) *Moegi Horibe*
	Beer and beer-based beverage containing lignans *Milan Houska*
	Seaweed and sweet potato: key ingredients for promoting a healthier diet in processed foods *Susana Mendes*
	Effect of xanthan gum on rheological property and bioaccessibility of β-carotene loaded filled hydrogel *Shinjae Park*
	Obtaining and characterization of mango peel powder, as a functional ingredient and dual additive added in natural yogurt *Maria Fernanda Redondo Julio*
	In vitro fecal fermentation of high pressure processed fruit peels dietary fibers *Viridiana Tejada-Ortigoza*
	Protein digestibility of Arthrospira maxima evaluated in a dynamic simulated human digestion model *Nicolás Troncoso-León*
	Hypoallergenic and low protein ready-to-feed (RTF) infant formula by high pressure pasteurization: A novel product *Md Abdul Wazed*
	Development of functional powders for improved digestion of dairy products *Qianyu Ye*
	Extrusion processing modifies the microstructure and in vitro digestibility of broken rice *Wenhan Yang*
1220-1335	**Lunch** | Foyer, Level 1

1335-1505	**Concurrent Sessions**
Session	**Concurrent 5F** Short oral 4 – Food process systems engineering and modelling
Room	Meeting Room 101, Level 1
Chair	*Serafim Bakalis*
	Selection and breakage functions of foods during human mastication *Muhammad How*
	Integrating text mining and network analysis for ethnomedicinal profile of Bambara groundnut in Mpumalanga province, South Africa *Victoria Jideani*
	Techno-economic analysis of the enzymatic production of dairy oligosaccharides for nutritional supplements *Masih Karimi Alavijeh*
	Modeling and simulation of temperature and lethality distributions in a unit for continuous flow pasteurization of mango puree *Tamires Kawahara Oishi*
	Reduced order phase-field models for crystallisation *Estefania Lopez-Quiroga*
	A framework for multi-objective optimization of small-scale food processes *Martial Madoumier*
	An overview of thermal inactivation kinetic parameters determination *Nikolaos Stoforos*
	Calculation of thermodynamic activities of components of concentrated milk and honey *Ken Morison*
	A Finite Element Modelling (FEM) and ultra-fast X-Ray tomography study of soft cereal foods damage during chewing *Guy Della Valle*
	Modeling of phenolic acid diffusion in rice kernels during boiling in spearmint aqueous extracts of various concentrations *Vaios Karathanos*
	A new fractional differential model for anomalous heat and mass transfer during food drying *Azharul Karim*
	Modeling of fluid flow, starch digestion, and glucose absorption in the human small intestine *Mukund Karwe*
	Modelling Trade-offs in Nutrition-sensitive Processing of Common Beans *Michael Ngadi*
	Mathematical modeling of momentum transfer for effect of mixing in screw-drive systems *Fabrizio Sarghini*
	Modelling the effect of surface washing treatment on inactivation of spoilage bacteria and shelf life extension of fresh fish *Petros Taoukis*
	3D simulation of oxidation reactions in real deep-fryers: interactions with anisothermal oil flow and design *Olivier Vitrac*
	Mathematical modeling of thawing in a staggered through-field electrode radio frequency system: a case study for frozen tuna for process efficiency *Ferruh Erdogdu*
1505-1535	Afternoon Tea | Foyer, Level 1
1535-1705	**Concurrent Sessions**

Session	**Concurrent 6F** Short oral 5 – Novel food processing technologies
Room	Meeting Room 101, Level 1
Chair	*Cristina Silva*
	Kinetic modelling on colour development during frying of pulsed electric fields (PEF) pre-treated potatoes *Setya Budi Muhammad Abduh*
	Enhancing clean-in-place efficiency through microbubble pre-rinsing *Monique Mi Song Chung*
	Butylparaben improves the thermal inactivation rate of Escherichia coli O157:H7 in low-moisture foods *Rohan Tikekar*
	Sweet potato starch as a structural enhancer for 3D printing of surimi *Xiuping Dong*
	New potential of using pulsed electric fields to modify the thermal properties of flour fractions of oat *Sheba Mae Duque*
	How barrier discharge plasma affects ochratoxin a production of Aspergillus niger or Penicillium verrucosum on barley *Julia Durek*
	Feasibility of using pulsed electric fields as a pretreatment technique during edible films development *Stephen Giteru*
	Enhancement of anti-inflammatory and antioxidant activities of prickly pear fruits by high pressure applications: a phytochemical approach *Andrea Gómez Maqueo*
	Concentration-induced sodium alginate gel inhibits retrogradation of rice starch by in situ immobilization of starch molecular state *Qinlu Lin*
	Effect of starch modification in the whole white rice grains on physicochemical properties of two contrasting rice varieties *Malik Adil Nawaz*
	Enhancement of light utilization efficiency and vegetable seedling production on indoor farming racks using novel adjustable reflector *Junhui Huang*
	Non-thermal processing of açaí (Euterpe oleracea Mart) berry *Sueli Rodrigues*
	Study of continuous cake pre-baking in a rectangular channel using ohmic heating *Olivier Rouaud*
	High pressure assisted gelation of potato proteins: Mechanism of gelation, rheological and functional properties *Avi Shpigelman*

Wednesday 25 September 2019

0800-1730	**Registration** | Foyer, Level 1
0800-1700	**Exhibition** | Foyer, Level 1
0830-1020	**Plenary Session**
Room	Meeting Room 105 & 106, Level 1
1020-1055	Morning Tea | Foyer, Level 1
1055-1225	**Concurrent Sessions**
Session	**Concurrent 7F** Short oral 6 – Novel food processing technologies
Room	Meeting Room 101, Level 1
Chair	*Antje Frohling*
	Fingerprinting as a tool to assess merlot wines produced from PEF treated grapes *Biniam Kebede*
	Synergistic low intensity non-thermal food processing for enhanced microbial inactivation *Nitin Nitin*
	The application of pulsed electric fields (PEF) in volatile acidity control during wine making substitute for sulfur dioxide (SO2) addition *Xin-An Zeng*
	The investigation of electro tolerance development of escherichia coli by RFEF in saline water *Adel Rezaeimotlagh*
	The synergistic effect of combining low and high radio frequency electric fields on microbial inactivation of Escherichia coli in saline water *Adel Rezaeimotlagh*
	Electric heating – assisted extraction of biocompounds from seaweeds *Cristina Rocha Vicente*
	Continuous pulsed electric field decontamination of liquid whey protein formulations – influence of process parameters and media properties on inactivation efficiency *Felix Schottroff*
	Energy requirements of equivalent HPP, PEF, ultrasound and thermal pasteurization processes *Filipa Silva*
	Electromagnetic fields assisted blanching – effect on the dielectric and physicochemical properties of cabbage *Yuchuan Wang*
	Understanding the mechanical performance of raw and cooked potato cells for the design of biomimetics *Ioanna Zafeiri*
	Pepper seed oil extraction by pressure-assisted, ultrasound-assisted and conventional solvent methods *Liang Zhao*
	High pressure processing improves quality and storage stability of sodium-reduced chicken sausages *Ying Zhou*
	High pressure processing applications in food industry and immunology – overview *Milan Houska*
	Pulsed-UV light treatment for inactivation of Salmonella on black peppercorn *Yen-Con Hung*
	High hydrodynamic pressure generated with electricity and detonation tenderises various beef, chicken and pork, but not turkey muscles *Robyn Warner*
1225-1340	Lunch | Foyer, Level 1

1340-1510	**Concurrent Sessions**
Session	**Concurrent 8F** Short oral 7– Food engineering properties, nutrition and packaging
Room	Meeting Room 101, Level 1
Chair	*Avi Shpigelman*
	A novel mechanistic understanding for the stabilization of emulsions and foams by native or aggregated whey proteins *Franziska Kurz*
	Crispiness and microstructure of breaded deep-fried chicken nuggets *Michael Ngadi*
	The use of rutin hydrate pickering particles to combat lipid oxidation in food emulsions *John Noon*
	Protein concentration and protein-hydrocolloid interactions on the tribo-rheometry behaviour of resulting protein solutions *Sangeeta Prakash*
	Airflow resistance characteristics of sliced sweet potato for CFD modeling of a novel solar-driven drier in Ethiopia *Petros Tegenaw*
	Production of concentrated brewer spent yeast protein hydrolysate with a low content of RNA *Gabriela Vollet Marson*
	Milk protein fractionation by crossflow microfiltration – how low-frequency pulsation can ease the fouling dilemma *Maria Weinberger*
	Cleaning walls by intermittent impinging jets *David Ian Wilson*
	Dynamic gauging for studying rapidly swelling or shrinking layers *Georgina Cuckston*
	Inspection of semi-solid food products for the presence of fungal contaminants using hyperspectral imaging *Sholeem Griffin*
	Effect of Surfactants and Oil-in-Water Emulsions on Reverse Osmosis Membrane Performance *Aymen Halleb*
	Shifting food engineering to food-packaging engineering *Olivier Vitrac*
	Analysis of physical and chemical digestion of starch-containing hydrogels using an in vitro gastrointestinal method *Zaitian Wang*
	Camel milk fouling and its comparison with bovine milk *Yizhe Zhang*
	Crystallization of glucose in model honey *Ken Morison*
	Hardness and Syneresis of Alginate-protein Composite Gels *Tezar Ramdhan*
	Manipulation of water droplet size in structuring novel water-in-oleogel system *Tuyen Truong*
1510-1540	Afternoon Tea | Foyer, Level 1

1540-1710	**Concurrent Sessions**
Session	**Concurrent 9F** Short oral 8 – Sustainability, security, and supply chains
Room	Meeting Room 101, Level 1
Chair	*Rebecca Milczarek*
	An original program to train and support small food entrepreneurs in central and west Africa *Dominique Bounie*
	Effects of moisture contents on extruded meat alternatives made from Maillard-reacted beef bone hydrolysate and plant proteins *Jie Hong Chiang*
	Novel humidity-controlled chlorine dioxide-superabsorbent polymer technologies for military textiles (uniforms, parachutes, shelters), packaging, and ballistic and blast protection *Chris Doona*
	Transcriptomic analysis reveals key genes related to antioxidant mechanisms of pitaya quality improving by trypsin during storage *Xin Li*
	Foresight study: influence of the new information and communications technology on the food value creation network *Katrin Mathmann*
	Technical review of shea butter processing methods and product utilization along the supply chains including potential for improved techniques *Adesoji Olaniyan*
	Status of rice food security of small farmer households under intermediate level of mechanization in Kampar region, Indonesia *Ujang Paman*
	Discrimination of fresh and frozen-thawed beef based on ultrasound imaging *Zongbao Sun*
	Approaches for food scientists to model gut microbiota dynamics *Viridiana Tejada-Ortigoza*
	Application of air nanobubble water for the improvement of microalgae culture *Jiangyu Zhu*
	Investigation of market failures in agriculture: case studies on intellectual property rights *Camille Aouinait*
	Effects of different smoking processes on color and flavor of Chinese bacon *Baocai Xu*
	Key Components and Corresponding Bioactivities of Different Teas Processed from the Same Fresh Leaves *Heyuan Jiang*
	Extraction of proteins from Tenebrio molitor and Gryllodes sigillatus and evaluation of their potential as future protein source *Martin Mondor*
	Brewer spent yeast protein hydrolysate as an emulsifying agent *Gabriela Vollet Marson*
	Pulsed electric field treatment of red wine: inactivation of Brettanomyces and potential hazard caused by metal ion dissolution *Sanelle van Wyk*
1900-2300	**Gala Dinner** | Aerial, 17 Dukes Walk, South Wharf

ePosters

A number of electronic posters will be on display in the foyer to complement the Congress program.

Paper Title	Presenting Author
Water crystallisation in model sugar solutions by in situ CO2 nano-bubbles generation	Bhaskar Mani Adhikari
Impact of wet-mix processing conditions on rehydration properties of powdered milk infant formula	Lilia Ahrné
Non thermal processing of a protein functional beverage using pulsed electric fields: Escherichia coli inactivation and effect on proteins	Sally Alkhafaji
Impact of sound attenuation on ultrasound-driven yield improvements during olive oil extraction	Miguel Amarillo
Continuously distributed glass transition and caking of maca (Lepidium meyenii Walpers) powder	Alex Alvino Granados
Determination of glucose absorption in small intestine using dynamic human digestive model	Chinnaswamy Anandharamakrishnan
Effect of Various Encapsulation Methods on the Stability of Probiotic Bacteria	Chinnaswamy Anandharamakrishnan
Microencapsulation of omega-3 fatty acid from chia seed oil and studies on its efficacy in food systems	Chinnaswamy Anandharamakrishnan
Study on hydration kinetics of selected Indian paddy varieties	Chinnaswamy Anandharamakrishnan
Investigation of market failures in agriculture: case studies on intellectual property rights	Camille Aouinait
Controlling starch digestion through formulation	Serafim Bakalis
Using digestion models to develop healthier bread formulations	Serafim Bakalis
Effect of air plasma-activated water on the inactivation of Salmonella Typhimurium and Pseudomonas fluorescens	Javiera Barrales Astorga
Effect of the differences in protein structure on digestibility	Meltem Bayrak
Impact of heat pump drying on quality of Arabica green coffee	Chaleeda Borompichaichartkul
A call for developing a collaborative education and training platform dedicated to humanitarian food engineering	Dominique Bounie
An original program to train and support small food entrepreneurs in central and west Africa	Dominique Bounie
Dielectric properties of mango pulp (Mangifera indica L.) and mango nectar for microwave heating at 915 and 2450 MHz	Tiago Augusto Bulhões Bezerra Cavalcante
Changes in cellular microstructure and viability in sanguinos prickly pear fruits submitted to high hydrostatic pressure	M. Pilar Cano
Effects of ultrasonic treatments on prickly pear cellular microstructure: An application for enhanced health benefits	M. Pilar Cano
Evaluation of secondary structure and conformational change of mushroom polyphenol oxidase during microwave and conventional heating by FTIR and circular dichroism spectroscopy	Rodrigo Cavalcanti
Investigation of the microwave and conventional heating effect on secondary structure and conformational change of horseradish peroxidase by FTIR and circular dichroism spectroscopy	Rodrigo Cavalcanti
Agglomeration of sugar reduced cocoa beverage powders: an industrial perspective	Edgar Chavez Montes
Elucidating the role of lecithin in the wettability of agglomerated cocoa beverage powders	Edgar Chavez Montes
Simulation on thermal sterilization of liquid canned foods containing headspace based on COMSOL multiphysics	Shuhang Chen
Influence of whey protein isolate-gum Acacia conjugate on the physicochemical stability and in vitro bioaccessibility of β-carotene emulsion	Weijun Chen, Jianwei Zhou
Food engineering in China – highlights and concerns	Xiao Dong Chen
Mono-disperse droplet spray dryer for improving spray drying based food product development	Xiao Dong Chen
Effects of moisture contents on extruded meat alternatives made from Maillard-reacted beef bone hydrolysate and plant proteins	Jie Hong Chiang
Characterization of the Jeju horse (Jejuma) oil treated by low-temperature crystallization	Jiyeon Chun
Enhancing clean-in-place efficiency through microbubble pre-rinsing	Monique Mi Song Chung
Physical, textural, and microstructural properties of extruded puffed products affected by inclusion of high biological value proteins	Ingrid Contardo
Effect of pH and ionic strength on the water holding capacity of meat analogues	Steven Cornet
Dynamic gauging for studying rapidly swelling or shrinking layers	Georgina Cuckston
Laser-induced breakdown spectroscopy: from Mars to food safety	PJ Cullen
Enabling easy, automated property prediction for everyone	Ashim Datta
Mechanisms of bacterial retention and infiltration into leafy greens during water film evaporation	Ashim Datta
Plant stomatal defense against bacterial infiltration: a mechanistic model	Ashim Datta
Identification of bubble breakup mechanisms by high speed imaging in a microfluidics foaming process	Dominique Della Valle
A finite element modelling (FEM) and ultra-fast x-ray tomography study of soft cereal foods damage during chewing	Guy Della Valle
Post-processing feasibility of dual-nozzle-extruded 3D printed beef products	Arianna Dick
Measuring freezer burn of foods by x-ray computed tomography	Gabsoo Do
Emulsion containing sacha inchi (Plukenetia volubilis L.) oil stabilized by nonionic surfactants and sodium alginate	Miriam Dupas Hubinger
New paths for targeted food ingredient modification: cold atmospheric pressure plasma for protein and fiber functionalization	Julia Durek
Evaluation of shape memory properties of gelatin-cellulose nanofibers composites	Javier Enrione
Purification of salmon gelatin methacryloyl solutions by diafiltration	Javier Enrione
Mathematical modeling of thawing in a staggered through-field electrode radio frequency system: a case study for frozen tuna for process efficiency	Ferruh Erdogdu
Synergetic inhibitory effects of ultrasound and nisin/carvacrol against germination, outgrowth and vegetative growth of spores of Bacillus subtilis ATCC6633 in laboratory medium and milk	Lihua Fan
Production of dried apple snacks incorporated with Bacillus coagulans	Fabiano Fernandes
NIR spectroscopy and chemometrics for detection of starch, gum and annatto in paprika powder	Douglas Fernandes Barbin
An Intestine-on-a-chip for studying anti-inflammatory properties of food	Chiara Anna Maria Fois
Plasma processed air as a tool to enhance food safety of dried products on pilot scale	Antje Fröhling
Basic analysis of flavor compounds of food combined with the color changes during grilling process	Mika Fukuoka
Preliminary assessment of consumer exposure to trihalomethanes by consumption of IV gamma products	Maria Manuel Gil
Systematic study on the extraction of phycoerythrin from Gracilaria gracilis for natural food colorants	Maria Manuel Gil
Feasibility of using pulsed electric fields as a pretreatment technique during edible films development	Stephen Giteru
Different lignocellulosic biomasses as a source of xylan for the production of xylooligosaccharides by enzymatic hydrolysis	Rosana Goldbeck
Supercritical carbon dioxide technology for fermentable sugars release from sugarcane bagasse	Rosana Goldbeck
Enhancement of anti-inflammatory and antioxidant activities of prickly pear fruits by high pressure applications: a phytochemical approach	Andrea Gómez-Maqueo
Inspection of semi-solid food products for the presence of fungal contaminants using hyperspectral imaging	Sholeem Griffin
Synthesis and characterisation of silver nanoparticles with antimicrobial properties	Sholeem Griffin
Effect of surfactants and oil-in-water emulsions on reverse osmosis membrane performance	Aymen Halleb
Effect of physical hardening and internal shrinkage of cookies during cooling on its checking	Kohei Hasegawa
Effectiveness of cleaning-in-place (CIP) using ozonated water for cleaning of biofilms	Dennis Heldman
Freezing of palletized food and time-to-freeze prediction	Dennis Heldman
Modeling and Simulation of Smoking of Protein-Based Food Products	Dennis Heldman
Optimization of tempering process for a frozen protein-based on the basis of food physical properties simulation	Dennis Heldman
Sell-by, best-by or use-by? Understanding how standardized date labels can alter consumer food waste	Dennis Heldman
Activation and conformational changes of chitinase induced by ultrasound	Furong Hou
Beer and beer-based beverage containing lignans	Milan Houska
High pressure processing applications in food industry and immunology – overview	Milan Houska

Paper Title	Presenting Author
Selection and breakage functions of foods during human mastication	Muhammad How
Enhancement of light utilization efficiency and vegetable seedling production on indoor farming racks using novel adjustable reflector	Junhui Huang
Mechanism of industrial fouling elucidated through deconstructing ultra-high temperature deposits during clean-in-place	Holly A. Huellemeier
Pulsed-UV light treatment for inactivation of Salmonella on black peppercorn	Yen-Con Hung
Development of optimum carrot chip processing by using infrared light and hot air dryer	Ji Eun Hyun
The science of making mayonnaise on an industrial scale	Fredrik Innings
Key components and corresponding bioactivities of different teas processed from the same fresh leaves	Heyuan Jiang
The preparation and functional properties of whey protein concentrate-polysaccharides composite film modified by TGase	Shujuan Jiang
Fermentation and microbial source affect the physicochemical properties, citric acid, total phenolics and antioxidant activity of nonalcoholic finger millet malt beverage	Afam I. O. Jideani
Effect of coarse and superfine-ground wheat bran fortification on dough properties and quality of dried Chinese noodle (DCN)	Xiaoxuan Jin
Production of bioactive peptide-loaded double emulsions: influence of emulsification devices, concentration of bioactive peptide and type of hydrophilic surfactant on droplet stability	Yeon-Ji Jo
Effect of heating and freezing on the physical properties of bean sprout	Kana Jodo
Stability enhancement of natural antioxidants in black rice flour by heat and enzyme treatment	YunKyoung Jung
Development and evaluation of an experimental fish dryer	Yusuf Kamaldeen Ayinla
Modeling of phenolic acid diffusion in rice kernels during boiling in spearmint aqueous extracts of various concentrations	Vaios Karathanos
A new fractional differential model for anomalous heat and mass transfer during food drying	Azharul Karim
Modeling of fluid flow, starch digestion, and glucose absorption in the human small intestine	Mukund Karwe
Comparative study on the effect of cold atmospheric plasma, ozonation, pulsed electromagnetic fields and high pressure technologies on sea-bream fillets quality indices and shelf-life extension	George Katsaros
Production of cheeses in brine applying high pressure technology: quality and safety improvement, shelf-life extension and necessary ripening time decrease	George Katsaros
Modeling and simulation of temperature and lethality distributions in a unit for continuous flow pasteurization of mango puree	Tamires Kawahara Oishi
Effect of water state on microwave thawing of frozen food	Kota Kawaura
Fingerprinting as a tool to assess merlot wines produced from PEF treated grapes	Biniam Kebede
Encapsulation of curcumin using rice starch modified by 4-α-glucanotransferase: solubility, stability and bioaccessibility improvement	Yong-Ro Kim
Effects of onion skin powder addition on chocolate truffles and peanut butter	Celale Kirkin
Inactivation of beer yeast by pressurized carbon dioxide microbubbles and its mechanism analysis	Fumiyuki Kobayashi
Investigation of the frozen strawberry quality prepared by freezing accompanied supercooling	Rika Kobayashi
Vibrations as a cause of texture defects during yogurt manufacturing	Adrian Körzendörfer
Combined microwave/rotating-pulsed fluidized bed drying of okara: evaluation of nutritive properties of dried product	Louise Kurozawa
Effect of glass transition on soymilk powder stability during storage	Louise Kurozawa
A hybrid-solar-vacuum dryer to produce crisp fruits and vegetables with zero greenhouse gas emission	João Borges Laurindo
Disinfestation of stored cowpea (vigna unguiculata) from callosobruchus maculatus using heat and vacuum treatments	João Borges Laurindo
Temperature control by power modulation for improving sweet potato chips quality in microwave vacuum drying	João Borges Laurindo
Impact of mixer geometry on dough structure and dough aeration	Alain Le-Bail
Particle size-dependent characterization of rice flour-zein composites for gluten-free noodles slit from sheeted doughs	Suyong Lee
Utilization of hydrocolloid-based organogel with a foam-structure as an alternative to solid fat	Suyong Lee
Impact of high-pressure homogenization on Carrageenan and subsequent ramifications to digestive proteolysis in children	Uri Lesmes
Antidiabetic effect of jujube leaf tea and optimum extraction conditions	Seokwon Lim
Effect of tamarind (Tamarindus Indica) kernel powder on characteristic of extruded riceberry snack	Nipat Limsangouan
Impact of whole-wheat flour particle size on bread structure and in vitro digestion	Suyun Lin, Jing Gao
Ultrasound-assisted thawing of mango pulp effect on thawing rate, sensory and nutritional properties	Yi Liu
Reduced order phase-field models for crystallisation	Estefania Lopez-Quiroga
Optimization of ultrasound assisted extraction of bioactive compounds with maximum antioxidant capacity in cold brewed black tea	Kumar Mallikarjunan
Ultrasound assisted cold brewing of chamomile tea – a kinetic approach	Kumar Mallikarjunan
Novel educational efforts to help sustain food process modeling	Francesco Marra
Blueberry cuticular wax removal promoted by mechanical motion	Gonzalo Martinez-Hermosilla
Physicochemical changes during ageing of spray dried infant milk formula powders	A K M Masum
High-pressure nitrogen injection prior to spray drying improves the solubility of milk protein concentrate powders	Noel McCarthy
Defatting of Assai waste using supercritical CO2: determination of kinetic behavior and mathematical modeling	Maria Angela A Meireles
Supercritical fluid extraction of volatile oil from Sucupira (Pterodon emarginatus) seeds	Maria Angela A Meireles
Modeling buffering capacity of protein model food systems in the context of gastric digestion	Yamile Mennah-Govela
Whey demineralization by electrodialysis with pulsed electric field: a more energy-efficient approach	Sergey Mikhaylin
Thermal relaxations, glass transition and water activity of food powder blends	Takumi Mochizuki
Nanobubble technology improves shelf life of salmon fillets	Maneesha Mohan
Determining the level of freshness of vegetable oils by means of optical spectroscopy and volatile analysis	Martin Mondor
Extraction of proteins from Tenebrio molitor and Gryllodes sigillatus and evaluation of their potential as future protein source	Martin Mondor
Enhancement of the nutritional value and functionality of grain sorghum via solid state fermentation with co-culture of aspergillus oryzae and bacillus subtilis	Ruben Morawicki
Calculation of thermodynamic activities of components of concentrated milk and honey	Ken Morison
Crystallization of glucose in model honey	Ken Morison
Liposome based delivery of α-linolenic acid and α-lipoic acid	Jeyan Moses
Argan (Argania spinosa) nut shell powder as a source of microfibrillated cellulose: preparation and characterization	Nakajima Mitsutoshi
Food texture evaluation of tempura by time-series data processing	Hiroyuki Nakamoto
Effect of starch modification in the whole white rice grains on physicochemical properties of two contrasting rice varieties	Malik Adil Nawaz
In situ analysis of cooking properties of rice by Thermal Mechanical Compression Test (TMCT) method	Malik Adil Nawaz
Modelling trade-offs in nutrition-sensitive processing of common beans	Michael Ngadi
Prospects for membrane distillation and osmotic distillation in the food industry	Minh H Nguyen
Modulating in vitro bioaccessibility of a model bioactive compound using engineered cell microstructures	Nitin Nitin
Understanding the potential synergistic effect of milkfat with omega-3 fatty acids	Mitra Nosratpour
Effect of power ultrasound on skim milk coagulation kinetics	Colm O'Donnell
Improving product quality in local rice processing through design and integration of small scale parboiling and drying devices	Adesoji Olaniyan
Characterising the textural properties of beef boluses using instrumental techniques through oral processing	Ms Esther Onguta
Effect of processing on the angle of repose of different Rice (Oryza sativa) and Sorghum (Sorghum bicolor) Germplasm	Chijioke Osuji
The potential of multiresponse modelling in the context of in vitro lipid digestion	Andrea Katherine Pallares
To what extent can oil-in-water emulsion characteristics tailor the kinetics of in vitro lipid digestion?	Andrea Katherine Pallares
Characteristics of rice chips mixed with green whole rice	Kihwan Park
Influence of meat texture on the oral processing and bolus formation	Nelum Pematilleke
Thermal characteristics of date-pits as affected by heating rate of differential scanning calorimetry	Md Shafiur Rahman
Depth cameras as a means of determining spatial deformation during box compression testing	Gabe Redding
Elaboration of coastal type cheese added with Lactic Bacteria (BAL) and yeasts isolated from artisanal cheeses sold in the municipality of Valledupar Cesar and neighboring districts	Maria Fernanda Redondo Julio
Obtaining and characterization of mango peel powder, as a functional ingredient and dual additive added in natural yogurt	Maria Fernanda Redondo Julio

Paper Title	Presenting Author
Free radical detection in water and herb extracts after processing by high voltage electrical discharges and high power ultrasound	Anet Režek Jambrak
Non-thermal processing of açaí (Euterpe oleracea Mart) berry	Sueli Rodrigues
Study of continuous cake pre-baking in a rectangular channel using ohmic heating	Olivier Rouaud
Simulation and evaluation of spatial distributions of shockwaves	Henry Sabarez
Modification of functional and rheological properties of apple pomace via extrusion	Vera Schmid
Continuous pulsed electric field decontamination of liquid whey protein formulations – influence of process parameters and media properties on inactivation efficiency	Felix Schottroff
Increased inactivation of bacterial endospores by ohmic heating	Felix Schottroff
Technical-scale extraction of bovine αS-, β- and κ-casein using decanter technology	Thomas Schubert
Relationship between solids content and viscosity after evaporating soymilk prepared in a laboratory	Makoto Shimoyamada
High pressure assisted gelation of potato proteins: mechanism of gelation, rheological and functional properties	Avi Shpigelman
Effect of non-thermal processing on the aromatic profile of Cantaloupe melon juice	Cristina L.M. Silva
Improved inactivation of spoilage enzymes in fruit and vegetable products by ultrasound combined with thermal processing	Filipa Silva
Pasteurization of different food and beverages by thermosonication	Filipa Silva
Pulsed electric field equipment for the food industry	Filipa Silva
Up-to-date knowledge on the heat assisted HPP inactivation of bacterial spores in foods	Filipa Silva
Up-to-date knowledge on the HPP inactivation of mold and yeast spores in foods	Filipa Silva
Physico-chemical, structural and emulsifying characteristics of sonicated milk protein systems with varying casein to whey protein ratios	Mayumi Silva
Application of CO2-laser micro-perforation technology to freeze-dry whole Strawberry in reduced processing-time	Ricardo Simpson
Improved quality of freeze-dried blueberries by applying CO2-laser technology	Ricardo Simpson
Influence of osmotic dehydration pre-treatment on the drying with Refractance Window™ of apple (cv Granny Smith) slices	Ricardo Simpson
Controlled ice crystal formation in ice cream by ice structuring proteins	Sergiy Smetana
Grinding of sucrose particles influences the viscosity of the chocolate mass due to locally different amorphization of surface areas	Sergiy Smetana
How contact materials influence the gloss of the chocolate bar molded at these surfaces	Sergiy Smetana
Inline rheometry and die entry flow simulation of high moisture extruded meat analogues	Sergiy Smetana
3D laser scanning as a novel method for measuring heat shrinkage of meat cuboids	Rozita Spirovska Vaskoska
Effects of salt and lipids on heating parameters for the achievement of sterility in a microwave food processing system	Roger Stanley
Computational fluid dynamics in thermal processing	Nikolaos Stoforos
Quality improvement of shredded cabbage employing mixed ultra-fine bubble and microbubble	Kotaro Suzuki
Application of pulsed electric fields to improve product yield and waste valorization in industrial tomato processing	Petros Taoukis
Effect of high pressure homogenization and autolysis on the recovery of beta-glucans from yeast cell walls	Petros Taoukis
Innovative application of β-galactosidase in acid and sweet whey for the production of oligosaccharides with prebiotic properties	Petros Taoukis
Modelling the effect of surface washing treatment on inactivation of spoilage bacteria and shelf life extension of fresh fish	Petros Taoukis
How do dry heating treatments at different pH alter the interfacial activity of whey proteins?	Guilherme Tavares
Approaches for food scientists to model gut microbiota dynamics	Viridiana Tejada-Ortigoza
In vitro fecal fermentation of high pressure processed fruit peels dietary fibers	Viridiana Tejada-Ortigoza
Effect of digestion on the immunoreactivity and proinflammatory properties of recombinant peanut allergen Ara h 1	Yang Tian
Application of emerging technologies for the extraction of antioxidant compounds from seaweed	Brijesh Tiwari
Development of honey powder produced by spray drying	Taíse Toniazzo
Protein digestibility of Arthrospira maxima evaluated in a dynamic simulated human digestion model	Nicolás Troncoso-León
Phenolic variability of Hass avocado peel (Persea americana Mill.): the size matters	Igor Trujillo
MRI measurement of moisture distribution inside root vegetables during microwave-vacuum drying for a relation to shrinkage	Takaharu Tsuruta
Development of selective heating method with surface-temperature control	Toshifumi Udo
Radio frequency heating of pouch packaging foods in water	Kunihiko Uemura
The combined effect of Cold Atmospheric Plasma (CAP) and hydrogen peroxide (H2O2) on the inactivation of Listeria monocytogenes and Salmonella Typhimurium biofilms on abiotic surfaces	Jan Van Impe
Relationship between chemical composition and bioactivity performance of commercial oregano essential oil and green tea and rosemary oil extracts when incorporated into biodegradable food packaging films	António A. Vicente
Inactivation of Listeria innocua in ground meats by ohmic heating at different voltages	Sebastien Villeneuve
Three sisters: from Canadian First Nations ancestral knowledge to innovative modern food processing technologies	Sebastien Villeneuve
3D simulation of oxidation reactions in real deep-fryers: interactions with anisothermal oil flow and design	Olivier Vitrac
Shifting food engineering to food-packaging engineering	Olivier Vitrac
Brewer spent yeast protein hydrolysate as an emulsifying agent	Gabriela Vollet Marson
Production of concentrated brewer spent yeast protein hydrolysate with a low content of RNA	Gabriela Vollet Marson
New technology driving energy efficiency in snack processing	Mick Walsh
Differences of characteristic biogenic amines between grass carp and silver carp fillets during cold storage	Jianhui Wang
Isolation of lactoferrin and immunoglobulins from dairy whey by an electrodialysis with filtration membrane process	Qiuyue Wang
Analysis of physical and chemical digestion of starch-containing hydrogels using an in vitro gastrointestinal method	Zaitian Wang
Direct observation and analysis of disintegration of hydrogel particles with different mechanical properties using a gastric digestion simulator	Zaitian Wang
High hydrodynamic pressure generated with electricity and detonation tenderises various beef, chicken and pork, but not turkey muscles	Robyn Warner
The effect of fermented-milk containing probiotic Lactobacillus casei Strain AP on the concentration of Monocyte Chemoattractant Protein-1 (MCP-1), blood glucose, and lipid profiles in obese people	Widodo Widodo
Cleaning walls by intermittent impinging jets	David Ian Wilson
Novel micro-aeration technologies by minimal energy dissipation approach	Erich Windhab
Role of the protein composition and rheological properties on the structuring of soy-based meat analogues in extrusion processing	Patrick Wittek
Design novel food supplements from herbal medicines for postnatal care	Jiadai Wu
Identification of aroma-active compounds of mango juices and analysis of the effect of processing methods on aroma profile	Jihong Wu
Development of sorghum grain tea: investigating the effect of processing on sorghum grain tea during the tea production	Yun Xiong
Effects of different smoking processes on color and flavor of Chinese bacon	Baocai Xu
Effect of HHP treatment on the myofibrillar protein structure of cultured yellow croaker	Hua Yang
MicroRNA-497-5p regulates acrylamide-induced neurotoxicity in the rat primary astrocytes through apoptosis and autophagy pathways	Liuqing Yang
Extrusion processing modifies the microstructure and in vitro digestibility of broken rice	Wenhan Yang
Development of functional powders for improved digestion of dairy products	Qianyu Ye
A KECA identification method based on GA for E-nose data of six kinds of Chinese spirits	Yong Yin
The application of the E-nose coupled with ICA and wavelet energy threshold method in the vinegar discrimination	Hui'chun Yu
Effects of pulsed electric fields pretreatment on the quality of jujube wine	Xin-An Zeng
Efficacy of low-energy X-ray irradiation in inactivating mono- and co-cultures of Listeria monocytogenes and Pseudomonas fluorescens	Hongfei Zhang
Characterization of the major aroma-active compounds in raspberry juice during high hydrostatic pressure processing	Wentao Zhang
Camel milk fouling and its comparison with bovine milk	Bruce (Yizhe) Zhang
High pressure processing improves quality and storage stability of sodium-reduced chicken sausages	Ying Zhou
Application of air nanobubble water for the improvement of microalgae culture	Jiangyu Zhu

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13	**Flavourtech** 32 Lenehan Road, PO Box 413, Griffith, NSW 2680 Australia T +61 2 6969 1111 E sales@flavourtech.com www.flavourtech.com
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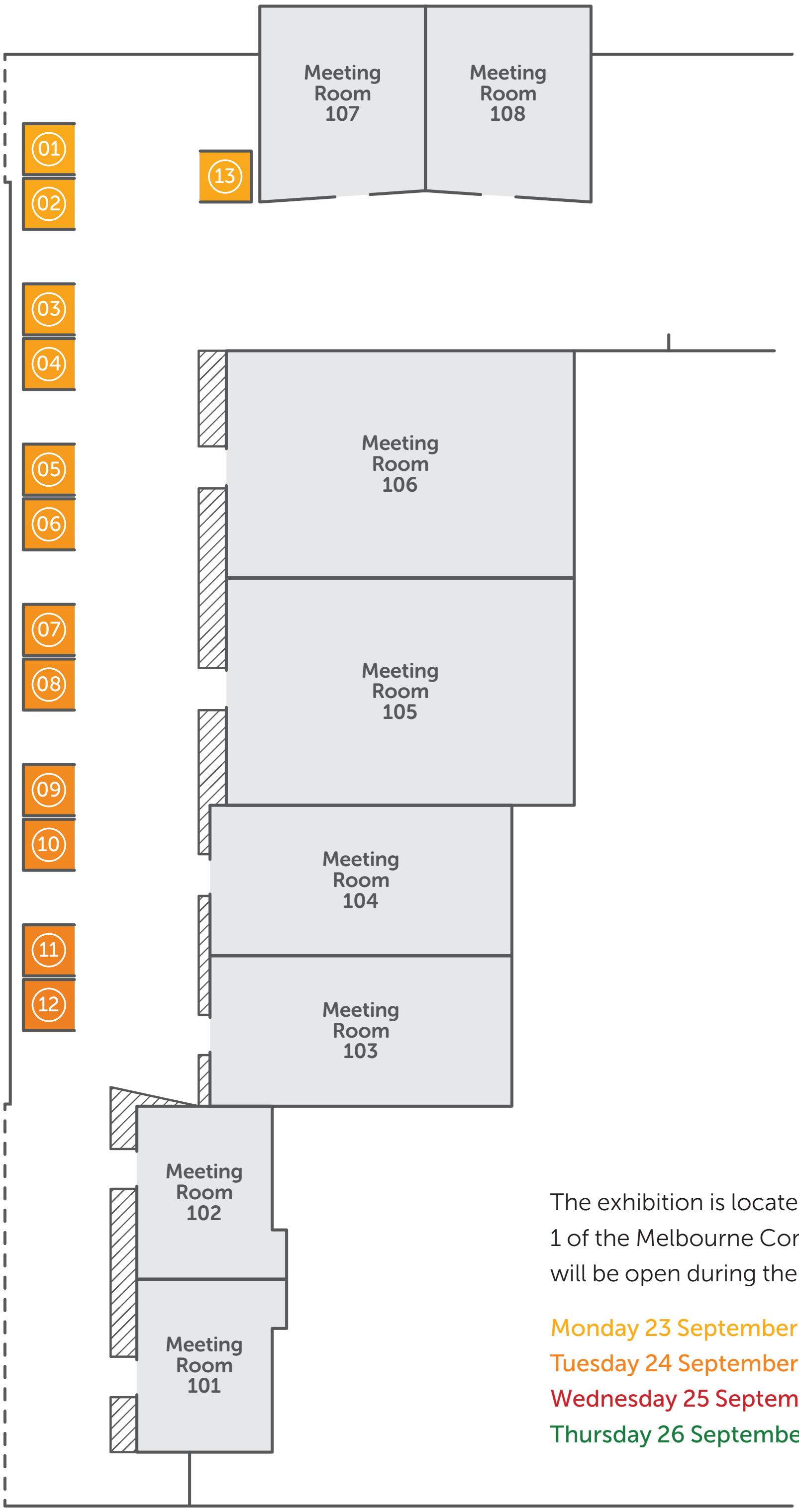
10	**Heat and Control** 407 Creek Road, Mount Gravatt East, QLD 4122 Australia T +61 7 3877 6333 E info@heatandcontrol.com www.heatandcontrol.com
12	**PlasmaLeap Technologies** U302, 30 Buckland Street, Chippendale, NSW 2008 Australia T +61 411 845 092 E sam@plasmaleap.com www.plasmaleap.com

Booth	Organisation
06	**Siemens** 885 Mountain Highway, Bayswater, VIC 3153 Australia T +61 1300 369 515 E industryservice.au@siemens.com www.siemens.com.au
04	**SONOSYS Ultraschallsysteme GmbH** Daimlerstrasse 6, 75305 Neuenbuerg, Germany T +49 7082 791840 E info@sonosys.de www.sonosys.de
07	**Spirax Sarco** 14 Forge Street, Blacktown, NSW 2148 Australia T +61 1300 774 729 (SPIRAX) E info@au.spiraxsarco.com spiraxsarco.com/global/en-au
02	**Tetra Pak Marketing** Level 2, 5 Burwood Road, Hawthorn, VIC 3122 Australia T +61 3 8561 3800 www.tetrapak.com
11	**The Dallas Group** 13A Monterey Road, Dandenong South, VIC 3175 Australia T +61 3 9706 9965 E magnesol@dallasgrp.com www.magnesol.com
09	**Unifiller Asia Pacific** 100 Park Road, Rydalmere, NSW 2116 Australia T +61 408 243 553 E wilhelmh@unifiller.com www.unifiller.com

Exhibition Floor Plan

Foyer, Level 1

Melbourne Convention and Exhibition Centre



The exhibition is located in the Foyer on Level 1 of the Melbourne Convention Centre, and will be open during the following hours.

Monday 23 September 2019	0730-1915
Tuesday 24 September 2019	0830-1700
Wednesday 25 September 2019	0800-1700
Thursday 26 September 2019	0830-1330

Social Program

Welcome Reception

Date:	Monday 23 September 2019
Time:	1715-1915
Venue:	Exhibition, Foyer, Level 1, Melbourne Convention and Exhibition Centre
Dress code:	Smart casual
Cost:	Included in full congress registrations
	Additional tickets are available from the Registration and Information Desk for $80 per person

As the first official social event of the Congress, the Welcome Reception provides you with the opportunity to relax and enjoy the company of colleagues and friends.

Gala Dinner

Date:	Wednesday 25 September 2019
Time:	1900-2300
Venue:	Aerial, 17 Dukes Walk, South Wharf
Dress code:	Smart casual
Cost:	$145 per ticket (includes a 3-course meal and beverages)
	Additional tickets are available from the Registration and Information Desk for $145 per person

A time to unwind, the Gala Dinner will be held at Aerial, only a short walk from the Melbourne Convention and Exhibition Centre. Enjoy delicious food and wine, breathtaking views of the Yarra River and panoramic city views, and the company of fellow delegates during this relaxing and entertaining evening.

General Information: A-Z

Abstracts

Abstracts are available via the app.

Accommodation Directory

Adina Apartment Hotel, Northbank

550 Flinders Street, Melbourne VIC 3000
T +61 3 9246 0000

Crown Metropol

8 Whiteman Street, Southbank VIC 3006
T +61 3 9292 6211

Crown Promenade

8 Whiteman Street, Southbank VIC 3006
T +61 3 9292 6688

Crowne Plaza Melbourne

1-5 Spencer Street, Melbourne VIC 3005
T +61 3 9648 2777

Holiday Inn Melbourne on Flinders

575 Flinders Lane, Melbourne VIC 3000
T +61 3 9629 4111

Novotel South Wharf

7 Convention Centre Place, South Wharf VIC 3006
T +61 3 9058 0444

Pan Pacific South Wharf

2 Convention Centre Place, South Wharf VIC 3006
T +61 3 9027 2000

Travelodge Southbank

9 Riverside Quay, Southbank VIC 3006
T +61 3 8696 9600

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All Customer Service desks are able to assist with printing and scanning. A business centre is located in the Melbourne Convention Centre.

Certificate of Attendance

Certificates of attendance will be emailed to delegates after the Congress.

Cloakroom

The cloakroom is located near the Melbourne Convention Centre Customer Service desk. Luggage and other items can be stored here. Items are not held overnight and must be picked up before the facility closes.

Continuing Professional Development

Members of Engineers Australia will be awarded one (x1) hour of CPD per hour of Congress sessions.

Daily Catering

Daily morning and afternoon teas, and lunches will be served in the exhibition in the Foyer of Level 1 of the Melbourne Convention Centre.

Delegate List

A copy of the delegate list has been emailed to delegates prior to the Congress in the pre-arrival letter. The delegate list contains the name, organisation, state and country of registered delegates, speakers, sponsors and exhibitors. Delegates will not appear on the list if they have elected to withhold their name.

Dietary Requirements

Every effort has been made to cater for delegates who have specified dietary requirements at the time of registering. Please make yourself known to a venue staff member at catering times and functions in order to obtain your meal. If you did not provide this information at the time of registering, please advise the staff at the Registration and Information Desk.

Disclaimer

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Evaluation

We welcome your feedback and we ask that you complete a short electronic survey shortly after the Congress. Details will be issued to you at the conclusion of the Congress.

Language

The official language of the Congress is English.

Mobile Telephones

As a courtesy to speakers and other delegates please ensure your mobile phone is switched off during Congress sessions.

Name Badge and Lanyard

All delegates will receive a name badge upon registration. This badge is the official pass and must be worn for security purposes and to obtain entry to all Congress sessions, the exhibition, relevant social functions and associated activities. Entry to anyone not wearing their name badge will be refused.

Non-Smoking Policy

The Melbourne Convention and Exhibition Centre has a 'No Smoking' policy within all areas of the venue. Congress attendees may smoke outdoors within the designated areas.

Photography

Unauthorised photography during the Congress sessions is strictly prohibited. Attendees taking photographs may have photos deleted and may be asked to leave.

Prayer Room

A prayer room is available for delegates to use and is located on the Ground Floor near the Customer Service Desk at the Pan Pacific entrance end of the Melbourne Convention Centre.

Privacy Statement

Information requested and provided on the Congress online forms will be used to administer the Congress including accommodation, catering, transport and sponsorship. Data obtained will remain the property of WALDRONSMITH Management and the International Congress on Engineering and Food. For more information on our privacy policy, please visit www.waldronsmith.com.au.

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Monday 23 September 2019	0730-1730
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Wednesday 25 September 2019	0800-1730
Thursday 26 September 2019	0830-1330

Session Q&A

Each room will have Q&A microphones on stands for delegates to ask questions.

Social Media

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Speaker Preparation Room

Speakers are required to submit and preview their presentations at least two hours prior to their session. This can be done prior to daily sessions commencing or during catering breaks.

The Speaker Preparation Room is located in Speaker Room 101 on Level 1 of the Melbourne Convention Centre and will be operational during the following hours:

Monday 23 September 2019	0730-1700
Tuesday 24 September 2019	0730-1700
Wednesday 25 September 2019	0830-1700

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INTERNATIONAL CONGRESS
ON ENGINEERING AND FOOD

MELBOURNE, AUSTRALIA
23-26 SEPTEMBER 2019

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The effect of processing on the kinetics of digestion

Alan MACKIE[1]

[1]University of Leeds, United Kingdom

In many parts of the world the increasing consumption of highly processed foods in combination with an increasingly sedentary lifestyle is leading to a wide range of food related health problems. Risk factors for metabolic diseases such as type 2 diabetes and cardiovascular diseases are strongly associated with the rapid absorption of macronutrients. Food structure plays an important role in defining the extent and rate of nutrient release.

Processing of dairy or cereal based foods can have a significant impact on the rate of nutrient release. In the work presented, we have shown that the processing of the oats can have an impact on gastric emptying and glycaemic response. Porridge was prepared from either oat flakes or oat flour. The flake porridge gave a lower glucose response than the flour porridge and there were apparent differences in gastric emptying in both the early and late postprandial phases. The appetite ratings showed similar differences between early and late phase behaviour. In dairy systems, both in vitro and in vivo experiments have shown that processing can have a profound effect on gastric restructuring and thus digestion kinetics. This has implications for health effects ranging from appetite and obesity to muscle wasting.

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Characterization of sausages elaborated with scabbard fish (*Trichiurus lepturus*) with oregano (*Origanum vulgare*), chickpea (*Cicer arietinum*) and extra virgin olive oil

1*Fuentes Lorenzo, 2 Beltrán Vanessa 3Garay Charlotte

1 Universidad de Cartagena, Facultad de Ingeniería, Programa de Ingeniería de Alimentos
Avenida El Consulado, calle 30 No 48-152, Cartagena –Colombia.
*lfuentesb@unicartagena.edu.co

Abstract. The scabbard fish *(Trichiurus lepturus)* is a semi fats fish which has proteins, minerals and different vitamins. Vitamin C and calcium content are present in high amounts. The objective of the present study was to develop a sausage from meat of scabbard *(Trichiurus lepturus)*, with olive oil as source of omega 3, the physico-chemical, microbiological, sensory and texture characteristics were determined. The proximate composition was determined following the methods of AOAC (2012). The microbiological characteristics were determined according to the norms techniques Colombian 4458, acceptability was sensually evaluated with a non trained panel of 20 panelists, using a hedonic scale to taste, color, odor and texture. Formulations 61.6% (F1), 60.6% (F2), 60% (F3), differed from the sample control with the contribution of olive oil and extract of oregano and chickpea flour. Significant differences were observed (p < 0, 05) at F2 and F3 to F1. The higher polyunsaturated acids content (EPA) was observed in the formulation F3, obtaining the best sensory and nutritional content than other formulations. The proximal content was 15.07% protein, 5.26% fat and 10.37% of carbohydrates. In terms of the characteristic of toughness was higher than in the other formulations, the sausages had good microbiological and sensory quality. These values comply with the standards required by the Codex Alimentarius, it is concluded that the product can be considered as a new alternative in the human diet.

Keywords: Scabbard fish, texture, proteins, sausages

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EFFECT OF THE ULTRASOUND AND MAGNETIC FIELDS ON THE COOKING OF A STICK EMULSION TYPE SAUSAGE OF TUNA MEAT *(KATSUWONUS PELAMIS*) MEAT MAGRA OF PORK AND OLIVE OIL

Lorenzo, Fuentes Berrio (1)*, Manuel Roca Argüelles (2), Víctor M. Gélvez Ordoñez (2) University of Cartagena, *e-mail: lfuentesb@unicartagena.edu.co: (2) Institute of Pharmacy and Food. UH. Cuba: (2) University of Pamplona- North of Santander - Colombia

SUMMARY

The objective of this research was to evaluate the effects of the treatment with Ultrasound (US) / (37 kHz / 26 ° C) and Magnetic Fields (CM) / (4.5 mT / 26 ° C), on the cooking / h of a meat emulsion sausage type with three fundamental raw materials: tuna steak meat, lean pork meat and olive oil, for the application of ultrasound and magnetic field a factorial design of a factor was performed with three levels of exposure time of the treatment and 3 repetitions per level. The results showed that there are statistically significant differences (p <0.05) during all the explosion times of the US and CM treatments, highlighting the application time
5 minutes with the greatest reduction in cooking at all nitrite levels (mg / kg) . Keywords: Meat, cooking, olive oil, tuna, sausage

Comparative performance of proteins and emulsion in adults and the elderly

Uri LESMES[1]

[1]Technion – Israel Institute of Technology, Haifa, Israel

The caloric and nutritional importance of proteins and lipids pose a major challenge in feeding the world today and tomorrow. In light of the irreversible nature of age-related physiological changes, bio-processing and manufacturing could be re-thought to ensure rational design and tailoring of foods to meet the needs of seniors.

This talk will overview in vitro digestion studies has focused on the digestibility of milk proteins and emulsions stabilized by these proteins, as potential delineators of geriatric health and well-being.

First, this work will present an innovative yet generic in vitro elderly digestion model used to compare the digestibility of whey proteins in adults and the elderly. SDS-PAGE and LC-MS/MS analyses will challenge the concept of "slow" and "fast" digesting proteins as well as shed light on the possible generation of bioactive peptides in the gut lumen. Second, we describe how the varying spatio-temporal dynamics of the gastro-intestine of adults and the elderly affect digestibility of protein-stabilized emulsions through competing mechanisms of coalescence versus flocculation. Moreover, we will highlight the important role of gastric lipase on the structural changes emulsions undergo during digestion.

Overall, this talk will present attendees with scientific evidence that could stimulate and facilitate future developments of foods for the elderly population.

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Formulation and processing factors affecting bioaccessibility of polyphenols

Avi SHPIGELMAN[1]

[1]Faculty of Biotechnology and Food Engineering, Technion, Haifa, Israel

It has been reported numerous times that that consumption of fruits and vegetables is associated with a lower incidence of chronic diseases like cancer, cardio-vascular and many others. Often it is suggested that the presence of polyphenolic compounds is the responsible factor for the beneficial effect. Yet while in-vitro studies (or even in animals) constantly present extremely positive results for polyphenols, human studies are often less successful.

Bioaccessibility and bioavailability of these compounds is likely a very limiting issue in the application of those natural compounds for the development of both preventive and treating preparations. The low bioaccessibility is associated with low aqueous solubility, limited intestinal absorption, chemical instability in the preparation or the gastric track, microbial metabolism in the lower intestine and other limitations.

The presented talk will both summarize the current state of the art regarding known parameters affecting the bioaccessibility of polyphenolic compounds followed by presenting the possible effect of the presence of cell wall material in various conditions.

Our results, both in single polyphenol and multicomponent polyphenol model systems, show that polyphenol – cell wall material interactions are strongly affected by the pH, processing treatments and mostly by the structure of the polyphenol. As cell wall material is often co-present with polyphenols in plant-based foods, engineering its interaction with the polyphenols (by formulation and processing) can be used to tailor the polyphenol bioaccessibility.

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Role of food structures in lipid digestibility and absorption

Harjinder SINGH[1]

[1]Massey University, Massey, New Zealand

Lipids are an important source of metabolic energy and essential fatty acids as well as act as carriers of fat-soluble vitamins. The importance of nutrient lipids in the human diet has led to major advances in understanding the mechanisms of lipid digestion and absorption. With these advances has come new recognition that the matrix in which lipids are presented (i.e. food structure) in the diet could influence the rate of lipid digestion and hence the bioavailability of fatty acids. Consequently, there is growing interest in understanding how food material properties can be manipulated under physiological conditions to control the uptake of lipids and lipid-soluble components. The rate of digestion of lipids appears to be important in satiation and subsequent energy regulation. Moreover, clinical studies have shown that the extent and duration of postprandial lipaemia is positively related to the pathogenesis and progression of coronary heart disease.

Lipids in natural foods occur generally as in the form of complex structure in which triglycerides particles are coated with a solubilizing, stabilizing layer or multi-layer of membrane phospholipids and proteins. Breaking down the surrounding structures and releasing the lipid droplets from the cells, seed bodies or whatever locating matrix, will have a profound influence on our ability to digest the lipid and use its components efficiently and effectively. In processed foods, lipids (extracted from plant and animal sources) may also be incorporated within the food matrix in the form of emulsions. This paper will review the current knowledge on the state of lipids in different foods and how these systems are modified as they traverse through the gastrointestinal tract. Greater knowledge and understanding of how the digestive system treats, transports and utilizes lipids will allow the microstructural design of foods to achieve a specific, controlled physiological response.

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Pressurized Fluid Options to Produce Cannabis-Containing Products for the Food Industry

Jose M del Valle, Jerry W King

CFS, Fayetteville, Arkansas, United States

Abstract

The dynamic growth of the cannabis industry – both for traditional *Cannabis* as well *Cannabis sativa L.* (hemp) – is well documented and for hemp-derived-CBD (cannabidiol is projected to be $1.65 billion by 2021. Although the use of "green" processing technology is inherent in commercial practice and imperative for consumer safety, quantitative evaluation of such solvent choices and procedures is lacking and will be reported here. Cannabis-derived extracts are used particularly in infused products and inhalable-delivery systems and can be obtained by hydrocarbon extraction, varying formats of CO_2 extraction; the use of ethanol for extraction and purification, and other processing agents that have GRAS-status. Here the relative "greenness" of such processes and derived products is accessed with the aid of the solubility parameter concept for the major cannabinoid constituents found in extracts, their inclusive "entourage" terpene components, as well as the inclusion-exclusion of lipophilic co-extractives, i.e. – triglycerides, waxes and plant pigments. Particular note will be paid to the use of CO_2 in its dry ice, subcritical, and supercritical states for comminution, terpene isolation, and the extraction of specific ratios of cannabinoids and terpenoids. An assessment of low temperature (<-60^{o}C) and pressure (~300 psi) and inclusion of ethanol for extraction and refining will be provided. Finally, how the above-cited processes are integrated into producing a final product will be illustrated.

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Sustainable production of bio-actives: the mini-biorefinery concept applied food industries

Maria Angela A MEIRELES[1,2]

[1]*University of Campinas, Campinas, São Paulo, Brazil*
[2]*Bioativos Naturais, Campinas, São Paulo, Brazil*

Abstract
Several agro based industries, in special food industries generates an enormous amount of residue or byproducts that up-to-few years back were considered a discard. Being a problem frequently solved considering only the regulatory demands of authorities. Nowadays, the increased demand for technologies that are harmless to the human being and protective of the environment is provoking changes in the food industry. This brought the opportunity of translating the biorefinery concept of fuel-based industries to smaller and frequently multitask processing plants such as for instance the case of condimentary or spice processing industries. Therefore, this talk will focus on the integration and intensification of volatile oil (or essential oil) processing plant translating the biorefinery concept to a mini-biorefinery for sustainable production. References: [1] Debien, I. C. N., Vardanega, R., Santos, D. T., Meireles, M. A. A. (2015). Pressurized Liquid Extraction as a Promising and Economically Feasible Technique for Obtaining Beta-Ecdysone-Rich Extracts from Brazilian Ginseng (Pfaffia glomerata) Roots. Separation Science and Technology, 50: 1647–1657. [2] Meireles & Albuquerque. INPI - Instituto Nacional da Propriedade Industrial. Date: 06/02/2013. [3] Osório-Tobón, J. F., Carvalho, P. I. N., Rostagno, M. A., Meireles, M. A. A. (2016). Process integration for turmeric products extraction using supercritical fluids and pressurized liquids: Economic evaluation. Food and Bioproducts Processing, *98*, 227-235. [4] Vardanega, R., Santos, D. T., Meireles, M. A. A. Production of Biosurfactant from Brazilian Ginseng Roots by Low-Pressure Solvent Extraction with and Without the Assistance of Ultrasound. Recent Patents in Engineering, 2014, *4*, 69-81.

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High Value Products after Processing with Subcritical Water and Supercritical Carbon Dioxide

Marleny D.A. SALDAÑA[1]
[1]*Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5, Canada*
marleny.saldana@ualberta.ca

Abstract
Subcritical water (sCW) and supercritical CO_2 (SC-CO_2) are considered environmentally friendly solvents. Research in my laboratory has intensified on the use of these solvents for the extraction of value-added compounds from Agri-Food by-products and the use of $SCCO_2$ drying to form dried aerogels. In this presentation, some examples of high value products after processing with sCW and SC-CO_2 will be provided. Value-added compounds, such as phenolics, tannins and polysaccharides, were extracted from Agri-Food by-products using sCW within stainless steel reactors at different temperatures, pressures and times. Extracts obtained were evaluated for their phenolic, tannin and carbohydrate contents, and antioxidant activity. Results indicated that temperature was the most important variable using sCW. Also, biomass hydrolysis with sCW assisted by ultrasonication led to nano-cellulose, which was dried by SC-CO_2 to form light aerogels. Results have shown that sCW and SC-CO_2 can be successfully used to produce high value products.

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Supercritical fluid: A green technology to recover/produce bioactive molecules within delivery systems as functional ingredients for industry

Marilena ANTUNES-RICARDO[1], Tomás GARCÍA-CAYUELA[1], José A. MENDIOLA[2], Elena IBAÑEZ[2], Janet A. GUTIÉRREZ-URIBE[2,3], M. Pilar CANO [1,2], **Daniel GUAJARDO-FLORES[1]**

[1]*Tecnológico de Monterrey, Nuevo Leon, Mexico.*
[2]*Institute of Food Science Research (CIAL, CSIC-UAM, Madrid, Spain*
[3]*Tecnológico de Monterrey, Puebla, Mexico.*

Abstract

An enormous worldwide amount of food, agricultural and industrial biological residues makes the recovery of value-added compounds a promising way to reduce residue disposal costs. Supercritical carbon dioxide extraction has been one of the most promising green processes, which also offer the advantage of reducing the unit operations of extraction, fractionating, drying, and stabilization processes into a single step. This presentation will focus on the use of enzymatic hydrolysis and ultrasound in combination with supercritical fluid technology to enhance the selective extraction of bioactive compounds from cactus pear (*Opuntia ficus*), modify the structure of Chili pepper (*Capsicum annuum*) compounds to improve their bioactivity, and to produce microcapsules increasing the bioavailability and bioaccessibility of common bean (*Phaseolus vulgaris*) compounds.

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Assessing the impact on scale-up of "nonidealities" in supercritical CO_2 extraction of solid food materials: Mathematical simulation and experimental verification

José M. DEL VALLE[1], Gonzalo A. Núñez[2]

[1]*Pontificia Universidad Católica de Chile, Santiago, Chile*
[2]*Universidad Ténica Federico Santa María, Santiago, Chile*

Mathematical modeling of SuperCritical (SC) CO_2 extraction of solid substrates usually relies on differential mass balances for thin sections of packed beds where most parameters can be estimated from available data and/or correlations in literature, and where single unknowns are terms describing 1) solute partition between SC-CO_2 and the substrate, and 2) mass transfer within the solid substrate. A robust mathematical model of this type can be used to simulate industrial SC-CO_2 extraction plants with the purpose of assessing the techno-economic feasibility of commercial processes. Usual assumptions of mathematical models of SC-CO_2 extraction for solid substrates are 1) packing of single-size particles, 2) plug-type flow pattern of SC-CO_2, and 3) constant properties of SC-CO_2 in the extraction vessel. To an extent, these assumptions are fulfilled by carefully adjusting experimental conditions at the laboratory scale. To assess the effect of some "non-idealities" (particle size distribution, radial velocity gradients of CO_2, axial pressure gradients, and axial and radial temperature gradients), a mathematical model can be applied to simulate extraction curves of the process, and experiments can be carried out to confirm selected results with the aim of identifying conditions for which corrections are required to properly simulate industrial plants. The justification to undertaking this research agenda is experimental evidence of "non-ideal" extractions at large scale that include radial gradients in extraction yield, and extraction curves differing depending on experimental scale. This presentation will examine the extent of selected non-idealities in extraction curves at different scales, and their potential effect on the mathematical simulation of industrial SC-CO_2 extraction processes.

Asahi 4.0

Anna REID[1]

[1]*Asahi Beverages, Melbourne, Australia*

Abstract
Asahi Beverages manufactures alcoholic and non-alcoholic beverages, and innovative, new-to-market products. It is a leading beverage company in Australia and New Zealand and a member of Asahi Group Holdings, one of Japan's leading beverage conglomerates.

In 2016 Asahi Beverages set a vision to strategically integrate people capability with emerging technologies to build a smarter value chain, calling this “Asahi 4.0” aligned with concepts of Industry 4.0. Since 2016, Asahi Beverages has developed an Industry 4.0 roadmap (people, infrastructure and platform), develop an IT architecture to support this journey and has completed several projects working towards this vision. This presentation looks to share the learnings to date on this journey in this new frontier, including the importance of a multi-disciplinary systemic approach.

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Refrigerated seafreight of food products

David TANNER[1], Nick SMALE[2], Andrew EAST[3]
[1] *Start Afresh Limited, Mount Maunganui, New Zealand*
[2] *Nick Smale Consultancy, Auckland, New Zealand*
[3] *Massey Agritech Partnership, Palmerston North, New Zealand*

Abstract
Food product quality is influenced by the supply chain conditions experienced from the time of harvest/manufacture through to consumption. Highest on the priority list is temperature management. Temperature plays a major role in maintenance or loss of quality, as it strongly influences the rates of food deterioration. Use of refrigeration technologies in the preservation of food is essential for extending shelf-life.

Exporters of fresh, temperature-sensitive products separated from their markets by sea generally have three options for transport of their goods to distant markets; airfreight, stowed in refrigerated containers or placed in the refrigerated hold of a sea-going vessel. Airfreight is generally used for high-value, low volume, short shelf-life products. Refrigerated and non-refrigerated airfreight ‘cans’ are available for this mode. For larger volume produce, with longer shelf-life, airfreight is not generally a viable option. Integral refrigerated container systems have become the system of choice for many fresh food product exporters as they provide a convenient unit, with perceived control of conditions. Larger volume exporters (particularly those in the horticultural and dairy industries, are able to take advantage of a potentially total lower cost option whereby produce is placed in a refrigerated deck of a ship. This option, however, is becoming increasingly more difficult to secure, as the retirement rate of refrigerated cargo carriers is greater than the rate of new vessel builds.

This presentation will cover trends in seafreight, system performance, equipment improvements, packaging implications, physiological needs of the produce, improvements in operation of the equipment and resultant improvements in performance.

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Industry 4.0 and Digitalization in Food and Beverage

Leonie WONG

Siemens Limited, Melbourne, Australia

Abstract
The challenges faced by Food and Beverage manufacturers around productivity, cost pressures and changing consumer demand are driving the need for innovation in the manufacturing space. Industry 4.0 and Digitalization give opportunities for Food and Beverage manufacturers to unlock the potential of their operations. Implementing a digital strategy gives manufacturers the tools to be able to respond quickly, flexibly and cost effectively to current market demands, whilst maintaining top quality. However, this is often a new frontier for many manufacturers with many unknowns. This presentation will uncover what Industry4.0 and Digitalization can mean for your operations, and will address:

- What is Industry 4.0
- What are the common issues faced by Food and Beverage manufacturers
- The current market snapshot and adoption of Digitalization
- Implementation ideas and case study
- The concept of using the Digital Twin in brewing

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Effect of Various Encapsulation Methods on the Stability of Probiotic Bacteria

Moses J.A.[1], Yoha K.S.[2], C. Anandharamakrishnan[2]

[1,2]*Indian Institute of Food Processing Technology (IIFPT), Ministry of Food Processing Industries, Govt. of India, Thanjavur, Tamil Nadu, India*

Abstract
Drying and encapsulation of probiotic bacteria require precise control over process parameters, as these have direct implications on cell viability, powder characteristics, and oral-gastro-intestinal stability. The technology of encapsulation has received considerable attention in recent years, owing to the numerous benefits it offers, particularly in terms of quality retention, release profiles and targeted delivery. Freeze drying is the most commonly adopted method for such applications; however, it is expensive and time-consuming. The focus of this research was to study the feasibility of developing an equally competent alternative approach for encapsulating probiotic bacteria. Four different drying approaches: freeze-drying, spray-drying, spray-freeze-drying and refractance window drying were used to encapsulate *Lactobacillus plantarum*. Physico-chemical parameters of the powder and microbial stability were monitored over a storage period of 90 days. Simulated *in-vitro* digestion studies were conducted to validate the efficacy of targeted release in the intestinal region. Interestingly, promising results were noted for probiotic bacteria dried using refractance window drying. Whilst maintaining quality, the process was cheaper and required lesser drying time as compared to freeze drying. This provides insight for a novel drying approach for probiotic bacteria and research can be taken up to optimize drying conditions for other probiotics as well. Additionally, the developed powder can be consumed as such or can be incorporated into suitable food systems.

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Influence of copper fungicides using in vineyard on the phenolic compound contents, color and antioxidant activity of wine

Xiangyu SUN, Tingting MA, Yulin FANG

College of Enology, Northwest A & F University, Yangling, China

Abstract
Introduction:
Copper (Cu) is one of the heavy metals of greatest concern in the wine industry, mainly due to the long-term use of copper fungicides (mainly the Bordeaux mixture) in vineyard, which caused heavy copper pollution in grape must. In this paper, the effects of copper pollution on the polyphenol contents, color and antioxidant activity of wine, as well as correlations among these factors, were investigated.
Method:
Different concentrations of copper pollution in grape must (low, medium, high) were set up by adding exogenous copper into Cabernet Sauvignon grape must. The effects on phenolic compound contents, the color parameters and the antioxidant capacity of wines were analyzed.
Results:
Copper had clear influences on wine polyphenol contents. At low copper concentrations, the concentrations of nearly all polyphenols increased, and the antioxidant activity values of the wine also increased. When the copper concentration reached the lowest level of the medium copper range (9.6~16 mg/L), most of the indexes also improved. When the copper concentrations reached the latter part of the medium copper range (19.2 and 22.4 mg/L), many of the tested indexes began to decreased. Furthermore, when the copper concentration reached the high ranges (32, 64, and 96 mg/L), the polyphenol contents, CIELAB color parameters, and antioxidant activity of wine were substantially decreased, indicating the need to control increasing copper contents in grape must.
Significance:
With these results, a better understanding of the influence of copper pollution on wine production could be obtained, thereby providing a potential strategy improvement for the copper fungicides using in the wine industry.

Keywords: Copper; Wine; Phenolic compounds; Color; Antioxidant activity; HPLC; CIELAB

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Using ultra-high pressure treatment to stimulate the ageing process of wine

Xiangyu SUN, Tingting MA, Yulin FANG

College of Enology, Northwest A & F University, Yangling, China

Abstract
Wine is usually aged in oak barrels, which is a lengthy process and very expensive and with some risk. In this study, young red wines were treated with ultra-high pressure (UHP) to stimulate the ageing process. The effect of UHP on the chemical properties, the color and sensory quality, the phenolic composition, includes phenolic acids, flavan-3-ols and proanthocyanidins, and the regional and variety phenolic characteristics of wines were studied. After UHP treatment, part of the chemical properties showed evident changes, such as tartaric acid, citric acid and lactic acid. And the sensory quality was improved after treatment. Especially when they treated with 100 MPa for 30min, wine sensory quality got the highest score. Meanwhile, the concentration of phenolic acids increased, while the levels of flavan-3-ols decreased. The content and structure of proanthocyanidins also changed and the tendency was similar to that of natural ageing. In addition, phenolic acids and flavan-3-ols were used to identify the region and the variety of wines, and the accuracy of the discriminant model is 88.9% and 100%, which means the phenolic acids and flavan-3-ols could reflect the region and variety characteristics of wines in general. Meanwhile, after UHT treatment, the accuracy of the discriminant model is 90.1% and 100%, indicating that UHT treatment did not change the region and variety characteristics of wines. In summary, the UHP technology has some chance to instead of oak barrels. With these results, we hope the UHP processing could be used in wine industry as early as possible.

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The effects of processing units on secondary metabolites and functional properties of carrot juice processing

Tingting MA, Chengrui TIAN, Xiangyu SUN

College of Food Science and Engineering, Northwest A & F University, Yangling, China

Abstract
Carrot juice is one of the main products of carrot processing. Usually, the producers paid more attention to the juice yield, solid content, acidity and other routine physical and chemical indices. However, more studies related to the preservation of functional and active components that are beneficial to humans during carrot juice processing have attracted more attention. Therefore, the aim of this study was to systematically investigate the effects of processing units (blanching, enzyme liquefaction, sterilization) on the composition and biological activity of secondary metabolites (carotenoids, essential oil, polyphenols) of carrot juice, and the correlative mechanism of the effects was also discussed in depth. Results indicated that suitable blanching contributed to the dissolution and stability of the carotenoids. While single enzyme treatment or mixed enzyme treatment could significantly raise the contents of the carotenoids in the juice. And high temperature sterilization increased the loss of carotenoids on one hand but, conversely, improved its stability during storage. Compared with fresh carrot juice, blanching and enzyme liquefaction increased the total polyphenol content (TPC) and the antioxidant activity, whereas sterilization decreased of the TPC and the antioxidant activity. For carrot juice essential oil, blanching and sterilization significantly decreased the components of the juice essential oil, whereas enzyme liquefaction had no considerable effect. While the three different processing units showed noticeable differences on the antimicrobial activity of the juice essential oil. This study is expected to aid the development of some methods and provide some parameters that could facilitate carrot juice processing technology.

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Analysis of Nutrition Compositions and Antioxidant Capacity of Kiwifruit (*Actinidia*) in China Market and Their Relationship with Flesh Color and Retail Price

Tingting MA, Chengrui TIAN, Xiangyu SUN

College of Food Science and Engineering, Northwest A & F University, Yangling, China

Abstract
Introduction:
Many reasons underlie consumer selection of kiwifruit, such as the retail price, appearance, flavor, and nutritional qualities. In recent years, consumers have preferentially selected kiwifruit based on the flesh color, which caused huge disparity in prices. But whether the priciest kiwifruit is the most nutritious kiwifruit has not been well investigated.
Method:
Hence, in this study, the nutritional quality and antioxidant capacity of China domestic kiwifruit and imported kiwifruit with different prices and the relationships of retail price among cultivars, nutritional qualities and flesh color were investigated.
Results:
Results showed that cultivar was the main factor influencing nutritional quality, though the product region could also affect the cultivar characteristics to some extent. Additionally, nutritional quality and antioxidant capacity of kiwifruit had no relationship to the product region. What’s more, there was no correlation among the nutrient compositions, antioxidant capacity and retail price of kiwifruit. At the same time, the flesh color was associated with greater commercial value but not higher nutritional quality or antioxidant capacity. Thus indicates to consumers that imported kiwifruit were not all superior to local versions, and the priciest kiwifruit did not equal to the most nutritious kiwifruit, also the color kiwifruit. There still need more research to help consumers to choose kiwifruit.
Significance:
The goal of this study was to determine whether the priciest cultivar is the most nutritious, and to provide some parameters regarding the nutritional quality of Chinese market kiwifruit to aid consumer selection of kiwifruit and producer improvement of economic returns.

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Abstract title: Development and Evaluation of an Experimental Fish Dryer

Authors: Kamaldeen Ayinla, YUSUF*[1], Ajayi OLADIPO[2]
Affiliations: [1,2]Agricultural and Bio-Environmental Engineering Technology Department, Auchi Polytechnic, P.M.B 13, Auchi Edo State, Nigeria.
Corresponding Author *kamyuf@gmail.com

Abstract :In this study, an experimental fish dryer was developed and evaluated. During the design of the dryer, considerations were given to easy mechanism of turning the fish during drying and mechanism to control the drying temperature of the fish. The evaluation of the dryer was carried out by considering drying the fishes in whole and in part (i.e. head, middle and tail) to determine the effects of drum numbers on the drying rate of the fish and the drying efficiency of the dryer. The data obtained for drying the whole fish was subjected to a regression analysis and that of drying of the part was considered as a factorial experiment in a RCBD with drum number as the blocking factor. The drum number has no effect on the drying rate of the whole fish and the drying efficiency of the machine. The regression model and R^2 value for the drying rate obtained were $Y=0.008x+10.97$, $R^2=0.024$ and $Y=-0.406x+81.78$, $R^2=0.014$ respectively. Also, the result of drying the fish in parts reflects that the drum number has a significant effect on the drying rate of the fish in parts but has no significant effect on the drying efficiency of the dryer at 5% confidence limit. The optimum drying rate and drying efficiency obtained during the experiment for the whole fish are 11.04g/h and 82.56% respectively and for the fish in part, the optimum drying rate and drying efficiency are head 4.15g/h, middle 4.17g/h, tail 3.92g/h and head 87.82%, middle 87.81%, tail 90.14% respectively.

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A novel ice encapsulated storage system-field trial on farm for cooling of milk

Refat AL-SHANNAQ[1], **Mohammed FARID[1]**

[1]*University of Auckland, Auckland, New Zealand*

Abstract
Milk quality and safety depend heavily on its processing temperature, including the rate it is cooled and stored in farms. Recently, New Zealand dairy farmers have been instructed to upgrade their dairy-shed milk cooling systems to meet a new legislation (Operational code NZCP1 2017)[1] came into effect in June 2018 for all dairy farms.

A novel ice encapsulated storage system (50kWh) is designed by our team, constructed and installed on a farm (794 Tauhei Rd, Tauhei, Hamilton 3375, New Zealand) with assistance of two local companies, in order to achieve the new milk cooling regulations with minimum expenses. Milk enters the first plate heat exchanger and cooled with farm water source (bore or tap water) from approximately 35^{o}C to around 20^{o}C. The precooled milk then enters a second plate heat exchanger, where a chilled food grade glycol is used as the coolant to lower the milk temperature to the desired temperature before it enters the milk storage vat. The chilled food grade glycol coolant is provided from the novel ice encapsulated storage tank. The ice storage system is capable to cool the milk below the required temperature, 6^{o}C, and has a high potential for commercialization. Saving in electricity cost is expected since the refrigeration unit will be running mostly at night with lower electricity tariff. Milk quality analysis conducted by an independent organization showed significant improvement in milk quality from B/A to A+, following the installation of our ice storage system.

[1] NZCP1: Design and Operation of Farm Dairies, New Zealand Ministry for Primary Industries, 19th May, 2017.

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Effect of HHP Treatment on the Myofibrillar Protein Structure of Cultured Yellow Croaker

Hua YANG[1], Huien ZHANG[1],Xiangyang QI[1],Shaoqian CAO[1],Xingming YANG[1],Jupeng YANG[1]

[1]*Zhejiang Wanli University, Ningbo, China*

Abstract
In this paper, the culture of large yellow croaker as raw material, after high hydrostatic pressure treatment (pressure: 150 MPa, 200 MPa, 250 MPa, 300 MPa, 350 MPa, 400 MPa, 500 MPa, dwell time: 5 min, 10 min, 15 min, 20 min, 25 min, 30 min), by fluorescence spectrophotometry, fourier transform infrared spectroscopy, circular dichroism spectroscopy, laser Raman spectroscopy, scanning electron microscopy The effects of high hydrostatic pressure treatment on the myofibrillar protein structure of cultured large yellow croaker was analyzed and studied. The results showed that the fluorescence and λmax of muscle myofibrillar protein in cultureed yellow croaker fish varied with the pressure and the dwell time. The polarity of the microenvironment of the amino acid residues was enhanced and the tertiary structure of the protein was affected by the hyperbaric pressure. The peak of pressure and dwell time became higher, NH bending and CN stretching vibration occurred in the protein structure, and the structure of protein was affected by EHV. The α-helix content of myofibrillar secondary structure increased with the pressure and dwell time High and gradually reduced; myofibrillar protein secondary and tertiary structures have changed; EHV affect the protein conformational changes and cause protein denaturation, the greater the pressure the greater the degree of degeneration, the longer the dwell pressure, the greater the degree of degeneration, degeneration The degree of a direct impact on the myofibrillar protein microstructure.

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Assessing the inactivation efficiency of Ar/O_2 plasma gas-liquid interaction on *Listeria monocytogene* cells: sublethal injury and inactivation kinetics

Yuanyuan Pan [1, 2, 3], Jun-Hu Cheng [1, 2, 3], Xiaoye Lv [1, 2, 3], Da-Wen Sun [1, 2, 3, 4][1]

[1] School of Food Science and Engineering, South China University of Technology, Guangzhou 510641, China
[2] Academy of Contemporary Food Engineering, South China University of Technology, Guangzhou Higher Education Mega Center, Guangzhou 510006, China
[3] Engineering and Technological Research Centre of Guangdong Province on Intelligent Sensing and Process Control of Cold Chain Foods, Guangzhou Higher Education Mega Centre, Guangzhou 510006, China
[4] Food Refrigeration and Computerized Food Technology (FRCFT), Agriculture and Food Science Centre, University College Dublin, National University of Ireland, Belfield, Dublin 4, Ireland

Abstract

Optical emission spectroscopy (OES) was employed to characterize the reactive species generated in plasma gas-phase, and flow cytometry (FCM) in tandem with fluorescent techniques was utilized to quantificationally detect and assess Ar/O_2 plasma induced damage on *Listeria monocytogene (L. monocytogene)*. Results showed that both the germicidal effect and proportion of sublethally injured cells exhibited a time-dependent behavior, and post-treatment storage further extended the plasma lethality. The cytoplasmic enzymatic activity was reduced, but no considerable leakage levels of intracellular DNA and protein occurred. Incorporating the post-treatment storage for 48 h substantially decreased the intensity of intracellular reactive oxygen species (ROS) ($p < 0.01$) to relatively low level with no chemical residues. Moreover, the inactivation kinetics was well described by Weibull model ($R^2_{NS} = 0.996$, $R^2_{S} = 0.996$). The current study provided valuable information on the inactivation kinetics of *L. monocytogene* and demonstrated the potential applications of plasma-mediated sterilization in liquid foodstuffs.

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The mechanisms of hypoglycemic effect of foxtail millet based on transcriptomics

Xin REN, Ruiyang YIN, Dianzhi HOU, Qun SHEN*

College of Food Science and Nutritional Engineering, China Agricultural University, Beijing 100083, China

Abstract text

Our previous animal experiment have proved that foxtail millet feeding significantly improved the blood glucose metabolism in high fat diet and STZ-induced (HFD/STZ) diabetic rats. To further clarify the mechanisms of the hypoglycemic effect of foxtail millet, the difference on liver transcriptional profiles between diabetic rats, normal rats and foxtail millet feeding rats were investigated. The results shown that 4 weeks of foxtail millet feeding in this study could mitigate negative variations of liver transcriptional profile in HFD/STZ diabetic rats. Specifically, foxtail millet feeding activated the insulin-stimulated PI3K/AKT signaling pathway by up-regulating expression of IRS, PI3K and AKT in liver, which will inhibit gluconeogenesis by down-regulating expression of G6P, FBP and PEPCK, and stimulate glycolysis by up-regulating expression of GK and PK subsequently. Moreover, foxtail millet feeding inhibited NF-κB signaling pathway and reduced expression of inflammatory factors, which will weaken the inhibition of insulin signaling pathway and improve blood glucose metabolism ultimately.

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Effect of digestion on the immunoreactivity and proinflammatory properties of recombinant peanut allergen Ara h 1

Yang Tian[1,2] Huan Rao[1,2], Wenhui Fu[1,2], Sha Tao[3], Wen-Tong Xue[1,2*]

[1] Beijing Advanced Innovation Centre for Food Nutrition and Human Health, College of Food Science and Nutritional Engineering, China Agricultural University, Beijing, 100083, People's Republic of China
[2] College of Food Science and Nutritional Engineering, China Agriculture University, Beijing, 100083, People's Republic of China
[3] College of Information and Electrical Engineering, China Agricultural University, Beijing 100083, People's Republic of China
**Corresponding author: Professor Wen-Tong Xue.*

Abstract
Ara h 1 is one of the major allergens in peanut, peptides formed in the digestion process of Ara h 1 could induce allergic symptoms and cause local inflammatory. The mechanism of intestine epithelial immune need to be clarified. Here we explored the effect of digestion on the immunoreactivity and proinflammatory properties of recombinant Ara h 1(rAra h 1). rAra h 1 was purified from *E.Coli BL21 (DE3) plysS* cells and treated (or untreated) with heat, digestion were performed by pepsin. Caco-2 cell models were utilized to study the influence of digested peptides on the interleukin-8 (IL-8) secretion and nuclear factor kappa B (NF-κB) signaling. According to the results, in the early period of digestion, both native and heated rAra h 1 were degraded and lost the IgE reactivity. But the secretion of proinflammatory cytokine IL-8 were increased in Caco-2 cells incubated with digested rAra h 1. Q-PCR and Western-blot revealed that the regulation of cytokines was mediated through the NF-κB pathway. Therefore peptides from digested rAra h 1(heated or unheated), has the capacity to activate the Caco-2 cells via the NF-κB pathway. Our findings help to elucidate the immunoreactivity and proinflammatory properties of digested rAra h 1.

Phenolic variability of Hass avocado peel (*Persea americana* Mill*.): the size matters.*

Igor TRUJILLO-MAYOL[a], Carlos L. CESPEDES-ACUÑA[b], Julio ALARCON-ENOS[b].
[a] *Food Engineering Department, Universidad del Bío-Bío, Av. Andrés Bello 720. PO Box 447, Chillán, Chile.*
[b] *Laboratorio de Síntesis y Biotransformación de Productos Naturales, Facultad de Ciencia, Universidad del Bío-Bío, Chillán Chile.*
Email: igor.trujillo@gmail.com, ccespedes@ubiobio.cl, jualarcon@ubiobio.cl

Introduction: Avocado fruits are different in size (Schaffer, Wolstenholme, & Whiley, 2013), as a result of biotic and abiotic stressors that also induce phenolic synthesis (Trchounian A., 2016). Peels are the first fruit protection (Roby, Harbertson, Adams, & Matthews, 2004) thus, provide information about the cultivar.
Objectives, materials and methods: the aim was to correlate the total phenolic, flavonoid content (TPC and TFC), antioxidant capacity, individual phenolics and the activity of phenylalanine ammonia lyase and chalcone synthase in avocado peel from three statistically different in size avocado groups (small "S", medium "M" and large "L").
Results: TPC, TFC, antioxidant and enzymatic activity were found higher in the S group. The content of phenolic acids was lower in L while; quercetin was higher compared to S and M, in which (-) epicatechin was found upper. Positive correlations ($p<0.001$and $p<0.05$) were observed between TPC, TPF, DPPH, and enzymatic activity, conversely, were negatively correlated ($p<0.001$) to avocado size.
Conclusion: The outstanding phenolic content and enzymatic activity of avocado peel from small fruits remark the importance of the food systems metabolism to increase the bioactiveness of the commodities without affecting the productivity.

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Trchounian A., M. P. and N. S. (2016). . Plant-Cell Stress Responses, 1–386.

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Identification of aroma-active compounds of mango juices and analysis of the effect of processing methods on aroma profile

Wentao ZHANG[1,2], Pan DONG[1,2], Fei LAO[1,2], Jiayi LIU[1,2], Xiaojun LIAO[1,2], **Jihong WU[1,2,*]**

[1]*College of Food Science & Nutritional Engineering, China Agricultural University, Beijing, China*
[2] *National Engineering Research Centre for Fruit and Vegetable Processing, Beijing, China*

Abstract
Volatile components, especially the aroma-active components impact the aroma profile of fruits strongly. Hence, studying the dynamics of aroma-active components in mango juice would help to deeply understand and control the aroma determinants in different mango processing methods. Four mangos from Sichuan province, China were chosen in this work. The volatiles and aroma-active components of four mango juices were identified by solid phase microextraction-gas chromatography-mass spectrum/olfactometry and odor activity value (OAV). In addition, aroma compounds were further investigated in fresh, pasteurization and high hydrostatic pressure (HHP) processing mango juices. Finally, the electronic nose and electric tongue was applied to discriminate the overall aroma of different treatments.
Sixty-seven components were identified in four cultivars including monoterpenes, lactones, aldehydes, alcohols, and acids. Twenty-two aroma compounds were characterized as the most important contributors to mango aroma profiles by OAV and frequency detection analysis, such as β-myrcene, (E)-2-hexenal, (E)-2-nonenal, (Z)-3-hexenol, geraniol, (E)-β-Ionone, ethyl butyrate, and γ-lactone. Data also showed that pasteurization diminished C9 key aroma compounds significantly ($p<0.05$), such as (E,Z)-2,6-nonadienal and (E)-2-nonenal. HHP processing had an important effect on terpeny aroma compounds. For example, 3-carene, terpinolene and caryophyllene increased significantly ($p<0.05$) while β-myrcene and D-limonene decreased significantly. Furthermore, we found that fresh juice, pasteurized juice and HHP juice could be distinguished efficiently by electronic nose and electronic tongue. It is an important method to distinguish different juices.
This work is of great significance for flavor quality of mango juice processing and authentic identification by volatile components and aroma active components.

The Use of Rutin Hydrate Pickering Particles to Combat Lipid Oxidation in Food Emulsions

John NOON[1], Tom MILLS[1], Ian NORTON[1]

[1]*University of Birmingham, Birmingham, United Kingdom.*

Abstract
Lipid oxidation (LO) is a major concern in the food industry, as it can lead to numerous negative effects in foods including: formation of unwanted compounds, loss of nutritional value, as well as changes to taste, texture and appearance. The increased usage of unsaturated fats in foods to help combat major health issues such as obesity and heart disease does, for all its benefits, make foods more susceptible to LO. The problem of LO is further amplified when using Oil-in-Water (O/W) emulsions, due to their large interfacial areas (between oil and water phases) which provide numerous sites upon which LO reactions can take place.

The use of Rutin Hydrate (RH), a natural and potent antioxidant compound, as Pickering particles for the stabilisation of O/W emulsions provides a potential solution to this problem. RH was investigated for its ability to provide O/W emulsions with both physical stability, through its ability to act as Pickering particles, as well as oxidative stability, through using a variety of antioxidant mechanisms to combat LO.

Results have shown that RH is able to produce O/W emulsions (with average D[3,2] droplet diameters of ~11µm) which were stable throughout the duration of study (14 days). RH stabilised emulsions were shown to be significantly more effective at combatting LO than Polysorbate 20, a conventional emulsifier. It was also found that the location of Rutin Hydrate, whether it was situated at the interface of O/W emulsions or in the continuous phase, had no significant impact on LO.

APPRAISAL OF COMMON PRACTICES CONSTITUTING MISUSE AMONG FARM TRACTOR OPERATORS IN NIGERIA

E .O. Atanda[1,2], O.M. Unuigbe[1] and O. Ajayi [1]
1. Department of Agricultural & Bio-Environmental Engineering Technology, School of Engineering Technology, Auchi Polytechnic, P.M.B. 13, Auchi, Edo State, Nigeria.
e-mail: olugbenga_ atanda@yahoo.com; unuigbeom@gmail.com; oladipo aj@yahoo.com
2. Formerly at Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC), Federal Department of Agriculture, P.M.B. 636,
Akure, Ondo State, Nigeria.

ABSTRACT
The study presents common practices constituting misuse among farm tractor operators employed in agricultural mechanization establishments/organizations, educational and research institutions, local government councils as well as privately owned mechanized farms in Southern Nigeria. Information gathering was accomplished through the use of Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC) benchmark assessment form between years 1993 to 2009 and also from year 2010 to date. Additional information were also gathered from trainees (mostly tractor operators) during teaching and practical sessions while the lead author was formerly serving as a Tractor Resource Officer and subsequently Head, Training and Manpower Development Department between years 1993 to 2009 at Agricultural Mechanics and Machinery Operators' Training Centre (AMMOTRAC), Akure in Ondo State, Nigeria. The information gathered from trainees during both benchmark assessment and training periods were compiled and analyzed to determine common practices constituting various misuse among tractor operators. Operators' practices constituting different misuses were subsequently classified based on tractor systems like cooling, electrical, hydraulic, lubrication, transmission and brake, air-intake and exhaust systems. Other misuse determined was based on tractor operation related activities. The effects of different types of misuse on the tractor operation, maintenance, repair and on the operators were discussed. The study observed that cases of farm tractor misuse among tractor operators will have some serious implications on the present and future utilization of farm tractors in Nigeria, if they were not reduced to the bearest minimum. Some suggested corrective measures aimed at eliminating different types of tractor misuse among tractor operators in Nigeria are also presented in the paper.

Keywords: Tractor, Misuse, Tractor Operators, Maintenance, Trainees

ASSESSMENT OF EROSION PROBLEMS: CASE STUDY OF AUCHI, EDO STATE IN NIGERIA

E.O. Atanda[1], M.A. Enaboifo [2] and D. A.Okodugha[3]

1. Department of Agricultural and Bio-Environmental Engineering Technology, School of Engineering Technology, Auchi Polytechnic, P.M.B. 13, Auchi, Edo State, Nigeria.

2. Department of Crop Science, University of Benin, Benin, Edo State, Nigeria.

3. Department of Civil Engineering Technology, School of Engineering Technology, Auchi Polytechnic, P.M.B. 13, Auchi, Edo State, Nigeria.

e-mail: olugbenga_atanda@yahoo.com; michael.enaboifo@uniben.edu; aluyahbaba@yahoo.com

ABSTRACT

Soil erosion has become a great ecological treat to lives, properties and particularly the washing away of agricultural soils. It has a social and psychological impact which makes it very difficult to access when extreme events occur. In order to enhance a suitable environment devoid of soil erosion menace, the study examines the factors that cause erosion, socio-economic impacts and control measures to erosion in Auchi, Etsako West Local Government Area of Edo State, Nigeria. The study involves oral interview during field visits and the use of structured questionnaires to elicit information. In carrying out the survey, Auchi was divided into five quarters for easy administration of the questionnaires to the respondents. A total number of 250 questionnaires were served, out of which 215 questionnaires were retrieved at the end of the study which indicates 86% success rate. The questionnaires were compiled and analyzed using descriptive statistics, which include frequency and percentages. The study revealed that soil erosion has a very severe impact on the socio-economic life and activities of the residents in Auchi particularly with respect to destruction of properties, farmlands, roads, displacement of peoples as well as the resultant psychological effect. Different factors were attributed to the cause of soil erosion in the study area amongst them are lack of or poorly constructed drainages, poor physical planning such as building houses and other structures contrary to urban and regional planning rules and regulations, poor handling of erosion control projects in the pasts, bad soil characteristics and topography of the town were identified. Also individual and community efforts at reducing erosion problem yielded no results as suggested measures to be adopted by government in controlling soil erosion include design and construction of drainage systems during execution of roads, continuous studying of the erodibility properties of soils in the study area, rain harvesting to reduce overland flow as well ensure storage for other purposes and award of erosion control contracts to qualified contractors for execution. In addition, areas prone to erosion should be marked as waterways or water paths where erection of buildings or other structures should not be allowed.

Keywords: Soil, Erosion, Auchi, Study area, Causes

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Production of dried apple snacks incorporated with *Bacillus coagulans*

Andrêssa M.M.T. GALVÃO, Sueli RODRIGUES, **Fabiano A.N. FERNANDES**

Universidade Federal do Ceará, Fortaleza, Brazil

Abstract
This work developed a process combining ultrasound pre-treatment and fluidized bed drying to produce dried apple snacks containing the probiotic *Bacillus coagulans*. The use of fluidized bed enabled drying apple cubes at low temperatures (30 to 50 ^{o}C), and the incorporation of the probiotic at the final stages of the drying process. The apple cubes were pre-treated in a bath ultrasound to induce the formation of microscopic channels in its tissue structure increasing the water apparent diffusivity during fluidized bed drying, resulting in a shorter drying time. The probiotic was sprayed on the apple cubes mixed with a coating solution comprised of PEG 400 and hidroxyethylcelulose (HEC) to improve adhesion to the apple snack surface and to protect the microorganism from heat. Response surface methodology (RSM) was used to evaluate the optimal combination of ultrasound pre-treatment and fluidized bed drying, studying the effect of ultrasonic pre-treatment time (10 to 30 min) and drying temperature (30 to 50 ^{o}C) on the total processing time and water apparent diffusifity. The optimal coating solution that ensured better surface coating was determined by RSM varying the concentrations of PEG400 (50 to 200 μL/L) and HEC (50 to 150 mg/L). The probiotic apple snack was produced using the optimal process and coating solution ensuring high viability of *Bacillus coagulans* in the final product.

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Quality improvement of fresh-cut vegetables employing fine bubble water for washing and disinfecting materials

Toshinori TAKEI[1], Masashi MORIMOTO[1], Kotaro SUZUKI[1], Masachika TAKASHIO[1]

[1]*Zensho Laboratories of Food Technology, Zensho Holdings Co. Ltd., 2-18-1 Konan, Minato-ku, Tokyo 108-0075, Japan*

Abstract

Fresh-cut vegetable is a ready-to-eat product increasingly demanded globally by consumers because of the health benefits and convenience associated with its consumption.

For its production, chlorinated water (up to 200 ppm of chlorine) is routinely applied to disinfect the surface of vegetables, and it is required to remove the residual chlorine completely from the product. These conventional procedures might be resulted in the mechanical damage and lost of cell fluids of vegetables, and more over the excess water consumption. To produce more tasteful products economically, we tried introduction of the fine bubble technology developed recently. International Standard Organization started to give the concrete definition of fine bubble (ISO 20298-1:2018, 21255:2018 and others), which make us possible to determine the effect of bubbles in the fresh-cut vegetable industry scientifically.

Fine bubble water employed to the production started from washing and disinfecting the whole cabbage and so on, and we concluded that fine bubble water realized in the reduction of disinfectant and rinsing water necessary, and it was also confirmed that the improvement of the quality of fresh-cut cabbage, for example, microbial stability for shelf life, color, texture, aroma and flavor, nutritional quality comparing to the product conventionally prepared without bubble water.

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Fermentation and microbial source affect the physicochemical properties, citric acid, total phenolics and antioxidant activity of nonalcoholic finger millet malt beverage

Henry O. UDEH[1], Kwaku G DUODU[2], **Afam I. O. JIDEANI**[1]
[1]*Department of Food Science and Technology, University of Venda, Thohoyandou, South Africa*
[2]*Department of Food Science, University of Pretoria, South Africa*

Abstract
The effect of fermentation and microbial source on physicochemical properties and citric acid content, phenolic compounds and antioxidant activity of two finger millet (FM) malt flours were investigated using sorghum as an external reference. Grains were malted, mashed and fermented using the grain microflora and *Lactobacillus fermentum*. A fermentation-time dependent decrease in pH of the beverages, with a corresponding increase in sugar content were noted. Similar decrease was recorded for the viscosities of the beverages. A decrease in the citric acid content with fermentation time was noted with *Lactobacillus fermentum* for the FM beverages. The phenolic compounds found in the FM beverages were protocatechuic acid, catechin and epicatechin. Fermentation-time dependent decrease in the total phenolics of the beverages was observed. The beverages exhibited 2, 2-diphenyl-1-picrylhydrazyl, 2, 2′-azinobis-3-ethylbenzthiazoline-6-sulfonic acid radical scavenging action and iron reducing activities, which were significantly ($p < 0.05$) reduced at 96 h fermentation for both microbial sources. The 24 h fermented beverage retained a higher amount of total phenolics and had higher antioxidant activity. The study show that FM could be utilised as a functional grain in the production of nonalcoholic beverage with important phenolic compounds for health promotion and wellness.

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Recent Development of Radio Frequency treatments for Pasteurizing Agricultural Products

Shaojin WANG

College of Mechanical and Electronic Engineering, Northwest A&F University, Yangling, Shaanxi 712100, China

Abstract

Recent pathogen incidents have forced agricultural product industry to seek alternatives for postharvest pasteurizations of agricultural products. Radio frequency (RF) has been identified as one potential treatment method to replace chemical fumigations and other conventional thermal methods because it is relatively easy to apply and leave no chemical residues. RF equipment is commercially available today, and is commonly used by the baking industry for final drying of crackers and by the other industries. It involves the direct transfer of electromagnetic energy into bulk materials, providing fast and volumetric heating. This presentation introduces the RF heating principle and systems, explores the difference between free running oscillator and 50 □ systems, and finally demonstrates some recent developments and applications of RF systems for pasteurization of agricultural products, including thermal death kinetics of targeted pathogens as influenced by heating rate, CA conditions and heating rates, RF heating uniformity improvements using computer simulation, and development of practical RF pasteurization process.

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Effects of moisture contents on extruded meat alternatives made from Maillard-reacted beef bone hydrolysate and plant proteins

Jie Hong CHIANG[1, 2], Allan HARDACRE[1], Michael PARKER[1]

[1]*School of Food and Advanced Technology, Massey University, Palmerston North, New Zealand*
[2]*Riddet Institute, Massey University, Palmerston North, New Zealand*

Meat analogues are designed to have the same sensory properties to meat but are made from plant proteins. However, meat analogues exhibited weak aroma and almost tasteless which resulted in low market success. Therefore, the addition of Maillard-reacted beef bone hydrolysate to the mixture before extrusion can produce meat alternatives with high aroma and taste quality, yet fibrous texture is still observed. Previous work studied on the interactions between meat and plant proteins to form meat alternatives using a twin-screw extruder. Literature stated that fibrous structure was observed in meat analogues at 55-60% moisture content. In this study, the objective was to investigate the effects of moisture contents on the physicochemical properties of extruded meat alternatives. Meat alternatives were extruded at maximum barrel temperature of 170°C, water feed rate of 3.6 kg/h, and different feed rate of 1.8, 2.2, 2.6 and 3.0 kg/h to obtain moisture contents of 49, 52, 56 and 60%, respectively. Meat alternatives at 52%MC showed the highest degree of texturisation (2.59±0.28). Fibrous microstructure was observed for meat alternatives at 49%MC and 52%MC, multiple segmented layers accompanied with some fibrous microstructure was observed for meat alternatives at 56%MC, and no fibrous microstructure was observed for meat alternatives at 60%MC. Chemical bonding results suggested that a large amount of aggregated proteins were linked with hydrogen bonds. Disulphide bonds were the key force in the formation of fibrous structure of meat alternatives. Overall results showed that different moisture contents in meat alternatives affected the textural and structural properties significantly.

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Mass transfer during displacement of milk protein concentrates from spiral wound membranes with water

Ingrun KIEFERLE[1], Ulrich KULOZIK[1]

[1] *Technical University of Munich, Freising, Germany*

Abstract

Prior to chemical cleaning, membrane plants equipped with spiral wound modules (SWM) are rinsed with water to displace the product. In this process, the minimum possible mixed phase volume and thus high mass transfer rates are aspired. This is the case if the advective transport is predominant over dispersive phenomena, which prolong the residence time of the product. For the flow in SWM, though, the quantification of these two transport components is not readily possible. However, we could estimate the Péclet numbers for the displacement of milk protein concentrates from SWM. This dimensionless number corresponds to the ratio of the advective to the dispersive transport rate. We determined the Péclet numbers based on the residence time distribution of the milk protein concentrates in SWM registered by means of a turbidity sensor and by subsequently applying the so-called plug flow with dispersion model. It turned out that the Péclet numbers increase with the concentrate viscosity and take values in the range of 10 to 70. The corresponding Reynolds numbers take values between 10 and 230 for the concentrate and between 170 and 480 for the rinsing water. Hereby, high Péclet numbers can be assigned to low Reynolds numbers et vice versa. This means that the displacement of milk protein concentrates at a high water volume flows is favourable with regard to the mixed phase volumes. Our results are based on experimental data collected with SWM on an industrial scale and thus provide information about realistic processes.

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Extrusion based Food Layered Manufacturing of casein-whey protein mixtures differing in pH, protein content and denaturation parameters

Kilian DAFFNER[1], Saumil VADODARIA[1], Ian NORTON[1], Tom MILLS[1]

[1]*University of Birmingham, Birmingham, United Kingdom*

Abstract
3D-Printing of food (also called Food Layered Manufacturing, FLM) allows for creation of complex and novel shapes and designs, personalized nutrition and fast production of small amounts of customized dishes. Moreover, no storage - and less distribution costs make the whole process much more sustainable than the current mass production.

Since several years, different types of food were 3D-printed by researchers all over the world, e.g. chocolate, cake frosting, meat purees, dough, hydrocolloids and more. To date, FLM of dairy materials was conducted using different types of feed materials including processed heated cheese, sodium caseinate combined with pectin, sucrose and starch as well as cold acidified milk concentrates.

Goal of the current study is to find edible and printable formulations of dairy materials for extrusion based 3D-Printing including a full phase transition. By changing pre-process parameters (denaturation temperature, - time and – pH) and formulations parameters (protein type, - content and pH) cold-acidified samples are gelled via a heating step (pH-T route). Formulations undergo a phase transition in a nozzle or a printing bed, from sol (tan δ = 90 °) to gel, and are deposited layer by layer. Parameters like the phase transition temperature as well as the aggregation rate help to characterize formulations regarding their printability. Printed gels are post-characterized via different measurements including rheology, CLSM or syneresis to better understand their microstructure.

Investigation of market failures in agriculture: case studies on intellectual property rights

Camille AOUINAÏT[1,2], Danilo CHRISTEN[2]
[1]*Swiss Federal Institute of Technology, Lausanne, Switzerland*
[2]*Agroscope, Conthey, Switzerland*

Agricultural firms have to cope with different types of market failures like information asymmetry and ill-defined property rights (Bohman et al., 1999). Intellectual Property Rights (IPR) are a mean to address market failure (Garnsey et al., 2011). To what extent do trademarks complement or substitute other appropriation tools like patents? The paper addresses this question thanks to an identification of innovation needs of small firms in stone fruit production in Switzerland.
Two case studies on IPR mechanisms were conducted. The findings indicated a poor use of patents in the sector. Food traditional production is not the intended sector for patents' use. Nonetheless, extended potentialities exist in new process technologies, logistics, value chain organization and distribution systems. The regional trademark is highly recognized by consumers through origin criteria but not quality differentiation. Competition through imports, retailers' trademarks and political load are substantial hindering factors. To foster trademark position, diverse strategies should be designed like adapted segmentation and marketing mix revision. The study highlights marketing and management strategies to be pursued that could benefit all value chain actors like cross-sectoral synergies to create positive spillover for the entire supply chain.

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Milk protein fractionation by crossflow microfiltration
– how low-frequency pulsation can ease the fouling dilemma

Maria WEINBERGER[1], Ulrich KULOZIK[1]

[1]*Technical University of Munich, Freising, Germany*

Abstract
Milk is a foodstuff rich in proteins. Its two major proteinaceous components are caseins and whey proteins. By separating both from each other, an increase in value is achieved. The most gentle separation process available is crossflow-microfiltration, not causing any enzymatic or thermal stress on the proteins. Thereby, the membrane retains the caseins, which are assembled in micellar structures, while the smaller whey proteins can permeate through the pores. However, retained proteins can block pores and deposit on the membrane, also known as membrane fouling, which leads to a reduced permeate volume flow and whey protein transmission, i.e. a poor filtration and separation efficiency. Current technologies provide an only unsatisfactory fouling prevention. Thus, there is a need of new fouling prevention approaches in crossflow filtration.

High-frequency pulsation of the crossflow has been described to improve the long-term flux in microfiltration [1, 2]. However, the influence on deposit layer structure and protein transmission remains unknown. We show how low-frequency pulsating crossflow can be applied in order to improve protein transmission and therefore separation efficiency. Our data states that frequency and amplitude of the pulses, besides the already thoroughly investigated transmembrane pressure, highly influence the transmission gain on the one hand and the flux on the other hand. We therefore propose a molecular model that describes the deposit layer loosening under pulsating conditions. Exemplarily, we show this effect on milk protein fractionation by crossflow-microfiltration. However, this approach is also applicable for other food and non-food separation tasks.

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Extraction of proteins from *Tenebrio molitor* and *Gryllodes sigillatus* and evaluation of their potential as future protein source

Léa WICK[1,2], **Martin MONDOR**[1,*], Hélène DROLET[1], Louis-Philippe DES MARCHAIS[1], Sébastien VILLENEUVE[1], Cynthia LAFOND-LAMBERT[1] and Akier Assanta MAF[1]
[1]: Saint-Hyacinthe Research and Development Centre, Agriculture and Agri-Food Canada, Saint-Hyacinthe, Quebec, Canada
[2]: Département de génie biologique, IUT de Nancy-Brabois, Vandoeuvre-lès-Nancy, France

*: Corresponding author: tel. 450-768-7915; e-mail: Martin.Mondor@agr.gc.ca

Food Security: Poster presentation

In this work, *Tenebrio molitor* and *Gryllodes sigillatus* were evaluated for their potential as future protein source. A factorial design (pH: 7, 8.5 and 10; temperature: 22°C and 50°C) was carried to extract the proteins. Resulting extracts were freeze dried and analyzed for protein and fat contents, and protein recovery was estimated. Extracts with the highest protein recovery were then characterized for their functional properties (solubility; fat adsorption capacity (FAC)), and bread making potential. Protein content (NX4.76) of the extracts ranged between 21.99-31.56%, for *T. molitor* and between 36.19-40.28%, for *G. sigillatus*, while their corresponding fat content ranged between 41.49-49.72%, and 13.01-15.25%. Protein recovery was found to be the highest at pH 10; 22°C for *T. molitor* (16.61±0.59) and at pH 10; 50°C for *G. sigillatus* (19.20±3.47). Solubility profiles of insects extracts showed minimum solubility for pH between 4 and 5 (*T. molitor*: 35%; *G. sigillatus*: 40%). For all pH range, solubility of insects extracts was found to be lower than for whey and pea proteins. On the other hand, *T. molitor* and *G. sigillatus* extracts showed a FAC of 214.3±5.9% and 328.6±12.2%, respectively, compared to 138.3±8.9% and 204.1±5.0%, for whey and pea proteins. Substitution of wheat flour with 10% of insects extracts induced a decrease in the loaf specific volume (cm^3/g) compared to unsubstituted flour (Control: 4.74; *T. molitor*: 3.94; *G. sigillatus*: 3.80). However, this should still be considered as satisfactory by consumers. In conclusion, both insect species studied have potential to be used as future functional protein source.

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High voltage electrical discharges in extractions of bioactives from Oregano leaves (*Origanum vulgare* L.): process control and impact on antioxidative properties of extract

Marinela NUTRIZIO[1], Nadica MALTAR-STRMEČKI[2], Predrag PUTNIK[1],
Danijela BURSAĆ KOVAČEVIĆ[1], Farid Chemat[3], Francisco Barba[4], Kristina Vugrinec[1],
Anet REŽEK JAMBRAK[1]

[1] *Faculty of Food Technology and Biotechnology, University of Zagreb, Zagreb, Croatia*
[2] *Rudjer Boskovic Institute, Division of Physical Chemistry, Laboratory for Magnetic Resonances, Zagreb, Croatia*
[3] *Université d´Avignon et des Pays du Vaucluse, Avignon, France*
[4] *University of Valencia, Valencia, Spain*

Abstract
According to UN Agenda 2030. there is great concern of future trends in environmental protection, food production, health, water etc. Extractions are commonly considered as to be energy consuming and solvent consuming processes.
High voltage electrical discharge-plasma (HVED) is one of new promising green techniques and “green” solvent can be selected using computer approach by COSMO-RS. Plasma generator IMP-SSPG-1200 was used for extractions (Impel group, Zagreb, Croatia). Optimization of processing extraction parameters (argon and nitrogen gases for generation of plasma, voltage – 15kV, 20kV and/or 25kV), frequency (100Hz), pulse duration (400 ms) and treatment times (3 and 9 min) was done using software STATGRAPHICS Centurion XV StatPoint (STATPOINT TECHNOLOGIES, INC., Warrenton, Virginia, USA). Oregano prepared by pharmacopeia (1g per 50mL of solvents (water or water/ethanol (75/25 v/v; 50/50 v/v) was treated by HVED. Extraction process was controlled by analytical methods (determination of amount (yield) of total phenolic compounds, antioxidant properties by EPR (electronic paramagnetic resonance) method, DPPH; FRAP; near infrared spectroscopy (NIR), FTIR and differential scanning calorimetry (DSC), and investigate changes during and after extraction process. Process follows 6 principles of “green” extraction through development an equipment for generating HVED plasma; effectiveness of extraction of bioactive compounds from Oregano and increased yield by optimization of the process parameters. Results showed increased yield of obtained extracts, increased antioxidant activity of extracts, and no changes in DSC and FTIR.

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Emerging pulsed electric field process development for the bio-based industry

Leandro BUCHMANN[1], Robin BLOCH[1], Lukas BÖCKER[1], Wolfgang FREY[2], Christian GUSBETH[2], Iris HABERKORN[1], Markus NYFFELER[3], Paolo S. RAVAYNIA[1], Alexander MATHYS[1]

[1]*ETH Zurich, Zurich, Switzerland*
[2]*KIT, Karlsruhe, Germany*
[3]*Armasuisse, Bern, Switerland*

Abstract
The food and bio-based industry are urged to find novel solutions to ensure sustainable, healthy and safe product manufacturing in the future. Abiotic sub-lethal stress induction via nanosecond pulsed electric field (nsPEF) treatment might be a viable process to increase the efficiency of cellular agriculture and thereby enables a sustainable and economically viable production of safe and nutritious food and bio-based products in the future.

Effects of physical and chemical fluid properties on PEF treatment homogeneity were investigated using the non-invasive Ultrasound Doppler velocity profiling for continuous PEF system characterization and control, which enabled tailored nsPEF processing. The *Arthrospira platensis* suspensions were nsPEF treated in a repetitive way to increase intracellular effects. The biological response was analyzed by single cell impedance spectroscopy (EIS) in combination with a proteomic shotgun analysis. Statistical analysis was conducted by an independent T-test at a confidence interval of 95%.

Application of nsPEF to highly proliferating cells in a repetitive process resulted in a statistically significant increase in cell growth ($p=0.009$). Besides the increase in biomass, economically important pigments were increased. The EIS analysis revealed no changes in the cell morphology of *A. platensis*, whereby the intracellular alteration of cells due to nsPEF was affirmed. The proteomic analysis of the treated *A. platensis* revealed the upregulation of the Na-Ca exchanger/integrin-beta4 ($p = 0.0069$) and the elongation factor TU ($p = 0.0073$). The proteomics result corresponds well with the observed macroscopic biomass increase. Integrin signaling to a Ras-like protein is strongly related to increased cell proliferation.

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A nutrikinetic model linking broccoli processing conditions to ITC bioavailability

Matthijs DEKKER and Teresa OLIVIERO

Food Quality and Design Group, Wageningen University, Wageningen, The Netherlands

Mathematical modelling of digestion can be a valuable tool to understand the effects of processing conditions on the kinetics of liberation, absorption, distribution, metabolism and excretion (LADME) of food components. Like in pharmacokinetic modelling, simple empirical, black box, models (one- or two-compartment models) can be used to fit *in vivo* data in order to derive kinetic parameters like e.g. the bioavailability, maximum plasma concentration, elimination half-life. More meaningful parameters can be obtained by using physiological based models instead to see the effect of e.g. food digestion on the release and absorption of food components with potential health benefits.
In this presentation a physiological based nutrikinetic model of the gastrointestinal tract is presented and demonstrated on the modelling of experimental data from an *in vivo* intervention study[1] with differently processed broccoli products containing variable amounts of myrosinase activity. The model can describe the observed ITC excretion profiles based on physiological relevant parameters describing the small intestinal transit time, plant and colonic enzymatic conversions of glucosinolates into ITC. The potential and the challenges of using this modelling approach to link food design aspects to nutrikinetic parameters that are relevant for the health benefits of food products will be discussed.

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Technical Review of Shea Butter Processing Methods and Product Utilization along the Supply Chains including Potential for Improved Techniques

Adesoji Matthew OLANIYAN[1], Olawale Elijah AJALA[2]

[1]*Federal University, Oye Ekiti, Nigeria*
[2]*University of Ilorin, Ilorin, Nigeria*

Abstract
Shea (*Vitellaria paradoxa*) butter is used in food, cosmetic, pharmaceutical, medical and energy industries for vegetable oil and other food supplements, soaps and pomades, drug ingredients, ointments and biodiesel respectively. Due to its high nutritive and medicinal values, shea butter is eaten by people and applied as ointment to aching parts of the body. Recently, a lot of foods, pharmaceutical and industrial products have been developed using shea butter as raw material. In this study, different methods of processing shea from fruit harvesting through kernel pretreatments for butter extraction and post-extraction utilization were reviewed and evaluated with a view to propose improved techniques along the supply chains. Processing operations are in three stages which include: (i) shea fruit processing for shea kernel recovery; (ii) shea kernel processing for shea butter recovery; and (iii) shea butter processing to various industrial products notably biodiesel. In the first stage, processing operations include shea fruit parboiling, washing, drying, shelling and winnowing to recover the kernel, and kernel drying. In the second stage, different methods of shea butter extraction were reviewed and evaluated and the areas that need improvement along the chains were elucidated. Lastly, esterification and transesterification processes using as substrate shea butter obtained from traditional hot water floatation (wet extraction) method, improved dry (mechanical) extraction method and solvent extraction method were critically reviewed. This study brings to light the need to emphasize quality control along the processing line from shea fruit processing to shea butter extraction in order to ensure high quality product.

Keywords: Shea (*Vitellaria paradoxa*) butter, extraction methods, product utilization.

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Improving product quality in local rice processing through design and integration of small scale parboiling and drying devices

Adesoji Matthew OLANIYAN[1], Taiwo Maruf AYODEJI[2], Nonzo Dickson ANI[2], Mayowa Kehinde ADARAMOLA[2]

[1]*Federal University, Oye Ekiti, Nigeria*
[2]*University of Ilorin, Ilorin, Nigeria*

Abstract
Important unit operations in local rice processing include parboiling, sun-drying, milling, cleaning and packaging with parboiling and sun-drying being the most tedious. Existing traditional method of parboiling can be improved upon by application of steam to treat raw rice instead of using boiling water as in the existing method. In local rice processing, drying determines product quality and reduction in weight and volume of product thus minimizing packing, storage, and transportation costs. The traditional sun-drying method is unhygienic, labour-intensive, inefficient and unsustainable. In this study, a small scale parboiling and drying units were designed, built and integrated into rice processing in the rural communities. The parboiling unit consists of the parboiling chamber which was lined internally with perforated pipes for water infiltration, and a ventilated heat chamber filled with charcoal to supply heat energy for the parboiling process. The drying unit has five major functional parts, which are the heating chamber, heat exchanger, suction unit, distributor and the drying chamber. Major design considerations for both units included technical simplicity, ease of operation and maintenance, and techno-economic status of the smallholder rice processors. The parboiling and units were tested by using the former for parboiling freshly harvested paddy rice and the latter for drying the parboiled paddy rice. Proximate analysis of the parboiled and dried rice samples were carried out and results obtained were compared with those of traditional parboiling and sun-drying methods. The satisfactory performance of both devices is an improvement over the existing method of rice parboiling and drying.

Keywords: Drying unit, parboiling unit, processing, paddy rice, unit operations.

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Hypoallergenic and low protein ready-to-feed (RTF) infant formula by high pressure pasteurization: A novel product.

Md Abdul WAZED[1], Mohammed FARID[1]
[1]*Dept. of Chemical and Materials Engineering, University of Auckland, New Zealand*

Abstract

Infant milk formula (IMF) is designed to mimic the composition of human milk (9-11 g protein/L), however, standard protein content of IMF (15 g/L) is still a matter of controversy. Burgeoning demand of low protein infant formula, especially in Asia, resulted mainly from paediatric obesity. Excessive protein rises stress on kidneys, implicates overweight and later develops symptoms of the metabolic syndrome in infants. On the other hand, despite having numerous functional and nutritional roles on human health, beta-lactoglobulin (β-Lg) is considered as a major reason of cow milk allergy to the infants. The β-Lg content in cow milk is 3-4 g/L whereas, interestingly, it is not present in human milk. In this aspect, to modify protein composition, increasing the ratio of alpha-lactalbumin (α-Lac) to β-Lg would be an imperative approach to come up with a hypoallergenic IMF with low protein content. Such a formula would ensure the necessary balance of essential amino acids as 123 and 162 amino acid residues are available in α-Lac and β-Lg respectively. Hence, this study considered pasteurized form of ready-to-feed (RTF), a new product, to retain heat-sensitive bioactives and other components. Therefore, the comparative effects of high pressure processing (HPP) under 300-600 MPa at 20-40°C and HTST pasteurization (72°C for 15 and 30 s) were investigated. The highest ratio of α-Lac to β-Lg was achieved after HPP (600 MPa, ~40°C for 5 min) which potentially explains the synergistic effect of HPP at higher temperature to manufacture a hypoallergenic pasteurized RTF formula with low protein content.

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Progressive freeze-concentration and its application to new food products

Osato MIYAWAKI[1], Takahiro INAKUMA[2]

[1]*Ishikawa Prefectural University, Ishikawa, Japan*
[2]*Shinshu University, Nagano, Japan*

Abstract

Progressive freeze-concentration (PFC) forms a single ice crystal in the system so that the system is much simpler as compared with the conventional method of suspension crystallization (SC) for freeze-concentration, in which many small ice crystals are formed. The concentrate by PFC, as well as SC, retains the original profile of components after the concentration, which is much different from other methods of concentration like distillation and reverse osmosis.

PFC was successfully applied to concentrate various fruits juices and the concentrates could be fermented to produce new type fruits wines without chaptalization. Among fruits juices, melon and water melon were included. These juices were known to be difficult for their high thermal sensitivity. PFC was also applied to concentrate fermented alcoholic drink like Japanese sake. In this case, the concentrate retains the similar flavor profile with the original fermented product. This provides an entirely new method for the concentration of alcoholic drink as compared with the conventional distillation, which changes flavor profile completely from the original fermentate. PFC was also applied to concentrate natural flavors, which was recovered from the distillate in the conventional distillation process of fruits juices.

The new food products described above became possible only by PFC, for its high flexibility in the operation mode and the production scale as compared with SC, which is applicable only to large-scale continuous production.

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Update on engineering aspects of electron beam irradiation of fresh produce

Rosana MOREIRA[1], Elena CASTELL-PEREZ[1]

[1]Texas A&M *University, College Station, TX, USA*

Abstract

Fresh produce do not receive a lethality step to inactivate pathogens during processing and there is the potential internalization of pathogenic organisms into the core of fruits and vegetables. Furthermore, irregular surfaces are havens for bacterial colonization. A process to develop precise irradiation treatment plans for fresh produce using electron beams and engineering principles and to evaluate the factors affecting accurate determination of radiation D10 values is described and validation of calculated dose assessed using low and high energy e-beam accelerators and gamma-rays demonstrated for several food items.. Growth and mobility data within samples are used for simulation of irradiation protocols. Sensitization strategies including Modified Atmosphere Packaging and washwater treatments are evaluated. Incorrect irradiation setup leads to under and over-dosage at different regions of the food sample resulting in serious safety and quality problems. Type of inoculum medium, oxygen levels, tissue exposure, and irradiation set-up affect the D10 value calculation. Just a slight misplacement of the sample around the e-beam causes drastic changes on the irradiation effect, resulting in erroneous D10 values. Critical parameters in the planning of irradiation treatment of fresh produce using electron beams include the area of sample exposed to the source and dose calculation. Calculation of dose and dose distribution within the sample using Monte Carlo techniques is precise and consistent. Recommendations on radiosensitization strategies are provided to help determine the optimal e-beam treatment to ensure safety (pathogen decontamination) and quality (minimal detriment) of fresh produce. Thoughts on future direction of irradiation research are presented.

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Hurdle technology for effective electron beam irradiation of fresh produce

Elena CASTELL-PEREZ[1], Rosana MOREIRA[1], BAsri Omac[1]
Texas A&M *University , College Station, TX, USA*

Abstract

The quality of washwater applied in fresh produce handling operations including pH, nitrate, dissolved organic carbon (DOC) and alkalinity, impact the efficacy of irradiation treatments by affecting the number of hydroxyl radicals ($^{\cdot}OH$) produced from radiolysis of water. This study examined the effect of washwater quality on the decontamination efficacy of e-beam irradiation against *Salmonella* Typhimurium ATCC 13311. The combined effect of e-beam plus and hydrogen peroxide (H_2O_2) treatments was also investigated since there is no information on this hurdle technology for water disinfection in the fresh produce industry. Calcium carbonate, nitrogen-nitrate standard solution, Suwannee River fulvic acid (FA) standard II, and hydrogen peroxide solution (50% wt) were prepared in DI water with 1.0 mM phosphate buffer (PB). H_2O_2 in solution was measured using drop wise titration with a standard Hach hydrogen peroxide test kit. 150 µl of bacterial suspension were placed in sterilized vials for electron beam irradiation treatment using a 1.35 MeV Van de Graaff accelerator (0.15-0.75 kGy). Although changes in pH (5.5, 7.2, 8.5) and alkalinity did not affect ($P>0.05$) the inactivation rate in aqueous solutions, the addition of nitrate decreased ($P < 0.05$) the D_{10}-average values by 6.21% and 11.72%, respectively, suggesting that the dissolved oxygen in buffer solution is not sufficient to react with all hydrated electrons formed from water radiolysis. The D_{10}-values also decreased by 8.28% and 11.03% when fulvic acid was added. Addition of hydrated electron scavengers to washwater has great potential to reduce the risk of contamination in fresh produce washing lines.

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Renewable heating above 100°C for use in food processing

Don J. CLELAND[1], Richard J. LOVE[1], James R. NEALE[2], Martin J. ATKINS[2]
[1] Massey University, Palmerston North, New Zealand
[2] University of Waikato, Hamilton, New Zealand

Abstract
In the food processing industry most process heating above 100°C is via steam from fossil fuel boilers. Most of this process heating is for air drying operations. The Paris climate change agreement is driving the need to decarbonise. Simple heat recovery is limited above 100°C because most hot streams such as dryer exhausts are cooler. Biomass boilers are often constrained by the amount of waste biomass available near to major food processing sites. Heat pump (HP) systems driven by renewable electricity have the potential to provide such heating with low carbon and at greater efficiency (COP>1) than direct electrical resistive heating (COP=1). However, few HP systems operate at >100°C due to the practical constraints of capital cost, equipment availability and reduced efficiency particularly as the HP temperature-lift increases. Some specific opportunities for new and novel HP systems that arise from the current constraints will be explored. It will be shown that HPs could be feasible for dryer air heating to above 150°C and towards about 200°C using heat recovery from dryer exhaust air. Any residual air heating could be achieved renewably by electric heating, high temperature solar collectors combined with storage, small scale biomass boilers or combinations of such options.

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Food Logistics and the Supply Chain (Arial, 12pt font, bold, left aligned, Sentence case)

Authors (Arial, 10pt font, First name, Surname in CAPITALS, separate authors with a comma and affiliations numbered in superscript. Show presenting author in bold text.)
e.g.
Rodolfo GARCÍA-FLORES[1], Pablo JULIANO[2]

Affiliations (Arial, 10pt font, italics, superscript number, Organisation, City, Country)
e.g.
[1]*CSIRO Data61, Goods Shed Level 1, 710 Collins St., Docklands, Australia*
[2]*CSIRO Food and Agriculture, 671 Sneydes Road, Werribee, Australia*

Abstract text (Arial, 10pt font, single spaced, left aligned)

Abstract
Food production and distribution is currently undergoing dramatic changes. On one hand, it is expected that food consumption will continue to grow for at least the next 40 years, driven by a growing population and rising incomes and contributing to the economies of many countries by providing a large number of jobs at each stage of the supply chain. On the other hand, this increase in food demand will be constrained by scarcer resources, more attention to food security, and changing dietary habits.

In this talk, we will present an overview of the work CSIRO is carrying out to increase the efficiency of food supply chains in order to reduce the amount of food loss for a number of products, in particular for broccoli and other vegetables. This work involves, first, the application of comprehensive surveys to produce a snapshot of the horticultural industry in the eastern states of Australia at present, and second, the design of supply chains as to consider the optimal location of facilities where the fresh produce that would otherwise become loss, is processed to become valuable products like food supplements, flour or snacks. The results of the survey are used to inform the supply chain models and, at the same time, make forecasts of the likely outcomes given a number of plausible economic scenarios.

Investigation of market failures in agriculture: case studies on intellectual property rights

Camille AOUINAÏT[1,2], Danilo CHRISTEN[2]
[1]*Swiss Federal Institute of Technology, Lausanne, Switzerland*
[2]*Agroscope, Conthey, Switzerland*

Agricultural firms have to cope with different types of market failures like information asymmetry and ill-defined property rights (Bohman et al., 1999). Intellectual Property Rights (IPR) are a mean to address market failure (Garnsey et al., 2011). To what extent do trademarks complement or substitute other appropriation tools like patents? The paper addresses this question thanks to an identification of innovation needs of small firms in stone fruit production in Switzerland.
Two case studies on IPR mechanisms were conducted. The findings indicated a poor use of patents in the sector. Food traditional production is not the intended sector for patents' use. Nonetheless, extended potentialities exist in new process technologies, logistics, value chain organization and distribution systems. The regional trademark is highly recognized by consumers through origin criteria but not quality differentiation. Competition through imports, retailers' trademarks and political load are substantial hindering factors. To foster trademark position, diverse strategies should be designed like adapted segmentation and marketing mix revision. The study highlights marketing and management strategies to be pursued that could benefit all value chain actors like cross-sectoral synergies to create positive spillover for the entire supply chain.

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Structure modification of potato slices to reduce oil absorption in deep-fat fried chips

ROSANA MOREIRA[1], Paulo F Da Silva[1]
[1]Texas A&M University, College Station, TX 77843-2117.

This study evaluated pre-treatments (soaking, dehydration, enzyme activation, sonication) associated with the calcium ion impregnation in potato tissue to enhance cellular-structure integrity during frying.

Optimization of ultrasound parameters was performed to deliver Ca^{+2} ions to the potato slices tissue. At the maximum soaking $CaCl_2$ concentrations ($50x10^3$ ppm) and the longest time (30 min), sonicated samples showed a decrease of 43% in oil content when compared to the control. Response surface methodology estimated an oil content of 0.21 kg oil/kg DM for potatoes pre-treated in a $CaCl_2$ (50.0 $x10^3$ ppm) solution for 16.5 minutes (non-sonicated), and 0.16 kg oil/kg DM in a $CaCl_2$ (50.0 $x10^3$ ppm) solution for 23 minutes (sonicated). Sonication made samples whiter in color and tougher to brake than the controls. Higher $CaCl_2$ concentrations yielded darker samples, higher bulk and solid densities, and higher degree of shrinkage for S/NS samples.

The highest oil-content reductions were: 26.5% for "soaking" in $CaCl_2$ (20000 ppm / 30 min), 19% for "dehydration" in ethanol (70% v/v) + $CaCl_2$ (10000 ppm) for 2 minutes, 8.8% for "thermal treated" (50.0ºC/30min) + $CaCl_2$ (10000 ppm), 14.9% for "sonicated-assisted thermal treated" (50.0ºC/30min) + $CaCl_2$ (10000 ppm), and 30.2% for "sonicated-assisted soaking" in $CaCl_2$ (20000 ppm / 30 min). Sensory evaluation of control, non-sonicated, and sonicated samples showed "texture", "flavor", and "overall quality" were different ($p < 0.05$) with sonicated samples scoring higher.

Results show the potential of sonication technique as a pre-treatment to reduce oil absorption of potato chips during deep-fat frying.

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From small computers to big data, food process analytical control and beyond: A brief history of process analytical technology and case studies from the NZ diary industry

Brent YOUNG[1], Wei YU[1], David WILSON[2]

[1]*University of Auckland, Grafton, Auckland, New Zealand*
[2]*Auckland University of Technology, Auckland Central, Auckland, New Zealand*

Abstract
The term “Big Data” characterised by volume, velocity, variety and veracity, as well as value, is rapidly gaining attention, both by vendors providing novel information technology solutions, and manufacturers wondering how best to take advantage of these new offerings. While the application of big data is not unusual in the dairy industry, to date it has been primarily restricted to the management of the dairy herds using genetics to increase milk production. The application of big data mining techniques and analytics to dairy manufacturing is still relatively new. This presentation will highlight both the advantages and suggest some cautions of using big data approaches for real time quality control in the industrial production of milk powder.

A unique dataset was constructed to compare three large scale plants of different designs, overcoming significant challenges in alignment of disparate data sources, across six years of production. Models were clearly able to differentiate plant and process changes, and by appropriate weighting of unusual results, were able to predict functional test results, especially the production of off-spec product. These models can be used in real-time to significantly lower the likelihood of producing powder that will fail customer functional tests, and therefore substantially reduce cost of quality failure

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Sustainability of refrigerated facilities

Don J. CLELAND[1], Richard J. LOVE[1], Todd B. JEKEL[2], Doug T. REINDL[2]
[1] Massey University, Palmerston North, New Zealand
[2] Industrial Refrigeration Consortium, University of Wisconsin, Madison, WI, USA

Abstract
Improving sustainability is becoming a key business strategy and is essential for the future of human-kind. This paper analyses sustainability of refrigerated facilities and methods and metrics to assess sustainability. It also compares refrigeration with other methods for preservation with a focus on sustainability. Application of life-cycle carbon foot-printing to a case study refrigerated storage facility shows the importance of minimising product losses, refrigerant choice and/or leakage reduction, reducing energy use or using renewable energy, and the embodied footprint in the facility (particularly concrete and metal used for structures).

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New Zealand insights towards a new era of food engineers

Richard H. ARCHER[1], Don J. CLELAND[1]
[1] Massey University, Palmerston North, New Zealand

Abstract
The Food Industry is facing rapidly changing consumer attitudes and business models driven by modern communications and information systems. Amidst this change, the NZ food export industry is shifting from volume (commodities and ingredients) to value (e.g. consumer products, health and wellness attributes) while husbanding its social licence to operate, particularly around animal welfare and environmental concerns. Our Food Engineers need a framework in which to navigate this complex and dynamic world. They must first understand consumer and health needs, then the food structures necessary to convey the properties required, and finally the process needed to form those structures. The Food Engineer of tomorrow will need to preserve more of the parent material structure, deal with less refined raw materials and be seen to process less severely. They can afford less waste and less resource. Yet students entering university programmes increasingly come with limited familiarity with the concrete world. Further, they will move into a world where knowledge is cheaply available and judgment is in short supply. We will describe New Zealand responses to these challenges via two examples: increased project-based learning in undergraduate engineering and a nation-wide research programme "Food Industry Enabling Technology". We hope these examples will give insights into developing Food Engineers for the food sectors of the world.

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Pulsed Electric Field Use in Food Industry – Application Examples and Equipment Design

Stefan TOEPFL

Elea GmbH, Quakenbrück, Germany

Abstract

Since the first reports of pulsed electric field (PEF) impact on plant, animal and microbial cells in the 1960s numerous applications in food and bioprocessing have been investigated. A low energy requirement, the continuous operability and short processing times are major advantages in comparison to conventional processing techniques.

Enhancing drying rates of plant products by 20 to 40 % allows a reduction of drying times and a capacity increase of existing drying equipment. Due to its effect on product structure PEF is industrially applied in French Fries and snack industry. A smoother cut surface, improved product quality and reduced fat uptake are major benefits in addition to energy savings.

Besides its impact on plant cells also an inactivation of microbial cells can be achieved. In particular for heat sensitive media the product quality can be significantly improved. At present the technique is applied for shelf life extension of freshly squeezed fruit and vegetable juices. But also a preservation of liquid egg or infant formula can be obtained while retaining functional and nutritional value.

The presentation will give an overview of current industrial use and possible applications. The equipment design as well as technical requirements and commercial experience will be discussed exemplarily.

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Mechanisms of bacterial retention and infiltration into leafy greens during water film evaporation

Mohsen RANJBARAN[1], **Ashim K. DATTA**[1]

[1]*Biological and Environmental Engineering Department, Cornell University, Ithaca, NY 14850, USA*

Abstract

Evaporation of a water film at a leaf surface is a process that frequently happens as leafy greens move from field to fork. As surface water evaporates, capillary forces generated by the surface tension of water can push microorganisms present in water toward the leaf surface, facilitating their adhesion to the substrate surface and infiltration into the leaf openings and crevices. Therefore, this pathway can play a strong role in the infiltration of leafy greens by pathogenic bacteria before and during minimal processing chain. Despite the mentioned risk, there is no study concerning the sole effect of evaporation on the bacterial infiltration into fresh produce. In this work we model transport of bacteria within an evaporating sessile droplet at a leaf surface. The model includes fluid flow within the droplet and gas phase, gas-water interface tracking during evaporation, transport of vapor in the gas, passive and active transport of bacteria within water, and heat transfer. The model results for bacterial distribution and infiltration are validated by conducting drop evaporation experiments on patterned Polydimethylsiloxane (PDMS) and real leaf surfaces. Our results indicate that evaporation can cause internal flows within the droplet that can move and accumulate bacteria close to the leaf surface. The model is further used to study the effects of the most important factors contributing in the infiltration of bacteria into the leaf openings and providing practical food safety recommendations.

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Plant stomatal defense against bacterial infiltration: a mechanistic model

Mohsen RANJBARAN[1], **Ashim K. DATTA**[1]

[1]*Biological and Environmental Engineering Department, Cornell University, Ithaca, NY 14850, USA*

Abstract

Leafy-greens are among the most contaminated food products to human-pathogenic bacteria. Stomatal openings regulate gas exchange between the leaf interior and outside environment. However, they can serve as gates for infiltration of bacteria into the leaf tissue. Each pore is controlled by a pair of guard cells that function in response to many abiotic (e.g., light, humidity, etc.) and biotic (e.g., microbe associated molecular patterns (MAMPs)) stimuli. In this work, we develop a novel mechanistic mathematical model for the stomatal shape change in response to various stimuli. The model includes light-driven transport of K^+, Cl^-, H^+, malate^{2-} ions into the guard cells, water inflow to the guard cells as a result of water potential difference created across plasma membrane due to accumulation of K^+, Cl^-, and malate^{2-} ions, and finally, large deformation of the hyper-elastic cell wall due to turgor pressure. In addition, transport of abscisic acid (ABA) hormone is modeled, which regulates the rate of ion transport into the cells at various environmental conditions. We show that as human pathogenic bacteria, such as *Escherichia coli,* contact the guard cell walls, the perception of the MAMPs by the plant triggers ABA biosynthesis within the guard cells that stops the H^+ pump at the plasma membrane (membrane depolarizes to higher than -100 mV) and leads to outflow of water from guard cell and stomatal closure. The model is validated for the size of the stomatal opening at various environmental conditions using available confocal images with maximum deviation of ±0.9 μm.

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Three Sisters: From Canadian First Nations ancestral knowledge to innovative modern food processing technologies

Sébastien VILLENEUVE[1,*], Stéphane GARIÉPY[2], Martin MONDOR[1], Marie Thérèse CHARLES[3], Axel DIEDERICHSEN[4], Carl BÉLEC[3] and Michel GROS-LOUIS[1,2]
[1]: Saint-Hyacinthe Research and Development Centre, Agriculture and Agri-Food Canada, Saint-Hyacinthe, Quebec, Canada
[2]: Quebec Research and Development Centre, Agriculture and Agri-Food Canada, Quebec City, Quebec, Canada
[3]: Saint-Jean-sur-Richelieu Research and Development Centre, Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, Quebec, Canada
[4]: Saskatoon Research and Development Centre, Agriculture and Agri-Food Canada, Saskatoon, Saskatchewan, Canada

*: Corresponding author: tel. 450-768-7969; e-mail: Sebastien.Villeneuve@canada.ca

Food Security: Poster presentation

Among Native Americans, the group of plants consisting of maize, squash and beans is called the “Three Sisters.” Intercropping these species improves plant health, increases productivity and requires less fertilization input. The focus of this project was to broaden the understanding of ancestral lineages of maize, squash and beans, and of derived food ingredients. Information was gathered from scientific and historical literature, interviews and conversations with Indigenous peoples, and workshops to identify ancestral processing know-how. Scientists at Agriculture and Agri-Food Canada have developed to enhance maize nixtamalization, a process from which the product is used in making Native American food. The extraction of functional components from squash and the processing of beans into bioproducts was achieved. The bioactive compound content, which is beneficial to human health, was evaluated as well as the functionality and attributes of derived ingredients. With respect to knowledge transfer, Indigenous partners were closely involved in the project to ensure a good balance between proposed practices and processes and needs of Indigenous communities. Seeds have been collected in various communities, and agreements have been established to ensure the protection of Indigenous rights with regard to the genetic material. In the medium and long term, the project involving the characterization and production of the Three Sister crops will have positive social, cultural and economic impacts on First Nations. Over time, we could see an improvement in the use of agricultural land on Indian reserves and their surroundings, and local, community and private agricultural and agri-food businesses could emerge.

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Inactivation of *Listeria innocua* in ground meats by ohmic heating at different voltages

Evelyne GUÉVREMONT[1], Martin MONDOR[1], Sonia LAFLEUR[1], Sabrina BERGERON QUIRION[1], Mohammad Reza ZAREIFARD[1], Hélène DROLET[1], Sébastien VILLENEUVE[1]

[1]: Saint-Hyacinthe Research and Development Centre, Agriculture and Agri-Food Canada, Saint-Hyacinthe, Quebec, Canada

*: Corresponding author: tel. 450-768-7969; e-mail: Sebastien.Villeneuve@canada.ca

Advances in Food Process Engineering: Poster presentation

The objective of this study was to determine the impact of ohmic heating (OH) treatments on a microbial contamination of ground meats by *Listeria* spp.. The OH system consisted of a Teflon cylinder cell, two Titanium electrodes, two fiber optic thermometers, a variable frequency AC power supply, a data logger and a PID controlling system. Pork and poultry meats (50 g) were contaminated with *Listeria innocua* ATCC 33090 at 5 log ufc/g. Treatments applied were a frequency of 10kHz and different voltages (10, 15 and 20V) to reach up 80^{o}C internally. The microbial population in both meat types was impacted similarly by the treatments. There was no significant lost on the microbial population (0.24 log ufc/g) when the meat was exposed to OH for half of the time (50%) required to reach 80^{o}C whereas a higher bacterial decrease was observed at 75% of the cooking time (2.42 log ufc/g). Treatments at 80^{o}C (100%) showed a reduction ≥4.02 log ufc/g. For both meat types, the final microbial population was not function of the applied voltage. The Weibull model was used to fit the data and it provided an acceptable fit of the data for all conditions resulting in a model that could be used by the industry. Results indicated that OH could be a suitable alternative to process solid food products but further research is required to confirm the safety of the end product and to extend its application.

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Current Situation, Challenge and Prospect of 3D Food Printing in China

Min ZHANG[1], Zhenbin LIU[1]

[1]*State Key Laboratory of Food Science and Technology, Jiangnan University, 14122 Wuxi, Jiangsu, China*

Abstract:
Four main 3D food printing technologies are: Extrusion Technology, Inkjet Printing Technology, Binder Jetting Technology and Selective Sintering Technology. According to the research and application status of 3D food printing, it is still in its infancy. The current main research works focus on the following directions: 1) The Relation between Material Characteristics of Different Food Material Systems and 3D Printing; 2) Improving the Internal Structure and Texture Characteristics of Food by 3D Printing Technology; 3) Simulation, optimization and modeling of 3D printing process; 4) 3D Printing of Colored Foods. In China,the 3D food printing faces various challenges in software development, equipment R&D, scale application and so on. It also faces challenges from food safety and technology. 3D printed foods in China have broad application prospects in special nutritious foods, chocolate candy, children's foods and elderly foods, food surface design, personalized catering and other fields.

Keywords: 3D Food Printing;Current Situation; Challenge; Prospect

Dynamic gauging for studying rapidly swelling or shrinking layers

Jheng-Han TSAI, Georgina CUCKSTON, Bart HALLMARK, **D. Ian WILSON**
Department of Chemical Engineering and Biotechnology, University of Cambridge, UK

Abstract
Materials which swell or shrink rapidly on contact with liquid arise in many food processing systems, ranging from coatings which swell as they hydrate to soiling layers which swell or shrink on contact with cleaning solutions. Quantifying the initial rate and extent of this swelling can be challenging, particularly when the layers are soft and the solutions opaque. The technique of fluid dynamic gauging was developed to allow the thickness of such layers to be monitored *in situ* and in real time, and Wang *et al*. (2016) recently presented a version which can operate aseptically with no net input of liquid. Their device was not able to make measurements directly after the layer contacted the liquid and this paper reports how a change in configuration allows data to be collected soon after the layer is immersed.

The concept is demonstrated using (i) gelatin layers, which swell or shrink depending on the pH and ionic strength of the aqueous solution, and (ii) a range of food soiling deposits, where understanding the effect of pH and surfactant concentration is desired for designing cleaning protocols.

Computational fluid dynamics simulations of the gauging flows show good agreement with the experimental data, allowing the stresses imposed by the gauging liquid on the surface being gauged to be calculated. This allows the strength of the layer, or changes in strength, to be determined *in situ*.

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Textural properties and microstructural characterization of fresh-cut pumpkin (Cucurbita pepo) subjected to high hydrostatic pressure treatment

Xinna HU[2,3,4], Tao MA[2,3,4], Huan KANG[2,3,4], Xiaosong HU[2,3,4], Yi SONG [1,2,3,4*], Xiaojun LIAO[1,2,3,4]

[1] *Beijing Advanced Innovation Center for Food Nutrition and Human Health, China Agricultural University, Beijing, China*
[2] *College of Food Science and Nutritional Engineering, China Agricultural University, Beijing, China*
[3] *National Engineering Research Center for Fruits and Vegetables Processing, Beijing, China*
[4] *Key Laboratory of Fruits and Vegetables Processing, Ministry of Agriculture, Beijing, China*

Abstract
High hydrostatic pressure (HHP) processing is an emerging technology which can preserve the quality of texture as well as extend the shelf life of minimally products. Numbers of studies revealed that high pressure could alter the initial mechanical properties of plants. However, changes of microstructure and morphology have not been fully investigated as well as the relationship between textural properties and microstructural characterization. Researches in this area could provide theoretical guidance for the further application of HHP in the food industry.
Fresh-cut pumpkin slices subjected to HHP (100 MPa, 200 MPa, 300 MPa, 400 MPa, 500 MPa and 600 MPa) treatment were investigated with an aim to trace the textural and microstructural changes compared with untreated and heated ones. The treatment efficacy was evaluated by texture profile analysis and combinational microscopy techniques including TEM and confocal imaging. Results showed that the texture of pumpkin was jointly influenced by pressure-triggered alteration on cell morphology, membrane integrity and pectin properties. Samples with HHP treatment can better maintained original properties than those heated on color parameter, hardness, relative electrical conductance and degree of pectin esterification, among which moderate pressure (300~400 MPa) exerted more positive effects.
The findings implied the possibility of HHP technology on providing high quality of target product during the preservation period and provide a new aspect of technology about fruits and vegetables processing.

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Effect of water state on microwave thawing of frozen food

Kota KAWAURA, Shin KIMURA, Yushi KOMICHI, Manabu WATANABE, Osato MIYAWAKI, Toru Suzuki

Tokyo University of Marine Science and Technology, Tokyo, Japan

Abstract

In microwave thawing of frozen food, the dielectric properties are largely different between water and ice, which substantially affects heating process. In food, the state of water is classified into two categories; nonfreezable water (bound water) and freezable water.

Firstly, the microwave heating of bound water was analyzed. A rice powder sample containing only bound water, which was confirmed by DSC, was prepared. This sample was effectively heated by microwave showing that the bound water is heated by microwave.

Then, glucose and dextran solutions with concentration at 10, 20, and 30 % were prepared as food model. In the microwave heating of these samples at unfrozen state, no substantial difference was observed in the heating process in spite of the difference in solute and concentration among samples.

In frozen state, however, the heating processes by microwave were much different among these solution samples. In frozen state, the part of the freezable water temperature-dependently changes to frozen water, which is substantially not heated by microwave. Frozen water content, as ice fraction, as a function of temperature was estimated form the literature data for these glucose and dextran solutions.

An index was proposed for the initial heating rate of frozen solution sample in consideration of ice fraction as a function of temperature. This index could effectively predict the differences in microwave heating process of glucose and dextran solutions at various concentrations and temperatures.

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Food engineering vision and strategy towards 2050

I. Sam SAGUY

The Robert H. Smith Faculty of Agriculture, Food & Environment, The Hebrew University of Jerusalem, Rehovot, Israel

Abstract

Recent global surveys of food engineers (FEs) projected the need for curricula changes and possible integration with other academic programs. Moreover, the majority of the FEs surveyed preferred other domains for their higher education. Unabated and exponential advances in science, technology and innovation, combined with globalization and the increase roles of Millennials and Z-generation created mounting significant challenges and opportunities. These challenges (e.g., 10-billion people by 2050, aging, food safety/security, global warming, greenhouse gases, finite resources) call for a paradigm shift and reassessment of the food engineering profession. The shift should include symbiosis of a multidisciplinary vision, novel strategy and curricula. The repurposing changes should aim at enhancing food engineering future, augmenting its societal impact, fencing away adjacent domains, and ensuring its strides in pursuing breakthroughs and excellence. Moving beyond current framework, FEs 2050 vision should embrace both basic and applied research and a proactive role in integrating advanced information and digital tools (e.g., artificial intelligence, Internet of Things, big data, deep learning). Open innovation, start-up mind-set, 4-helix partnerships and collaborations with all the ecosystem stakeholders and domains (e.g., medicine, computer science, nutrition, biotechnology, life sciences) should be adopted. New business models and consumers partnerships are also essential. The new curricula should also cover evolving topics (e.g., health and wellness, bioavailability, *Enginomics*, sustainability, nutrition, consumer science). Promoting novel skills (e.g., creativity, time/people management, communication, entrepreneurship, social responsibility, ethics) and enhanced employability are essential. FEs 2050 horizon is exceptionally promising and the time is ripe for embarking on this exciting journey.

The marketing of Carrots and the advantage of using Bottle water and used plastic materials in the Federal Capital Territory Abuja Nigeria.

Michael OKE,

Michael Adedotun Oke Foundation, Federal Capital Territory, Nigeria

Abstract

In the Agricultural sectors the used of bottles, plastic, nylons cannot been overemphasize, due to the important of used in respect of the packaging, transportation and marketing strategies wise, which promote effective marketing and adding value to promote profitability and increase sales of an average sellers and encourage buyers and also reducing the weight that will make it easily transported and protect the shelf life of an average crop in the Agricultural sectors.

This paper therefore study a marketers that have being using bottle water in the strategies of prolonging the shelf life of an average carrots. Some of the marketers use the water inside too cool the carrots in which is going to preserve the self-life and some of the nylon are laying down in which they use to displayed some of the products in the markets which promote profitability and encourage more buyers to get close to the customers and various questions were ask from the buyers and sellers. Pictures were taken too support findings. This paper therefore stressed for effective means of marketing and technology development in areas of preservations and prolonging the life shelf of the carrots.

Keywords: Marketing, Carrots, Bottle water, plastic, Federal Capital Territory.

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Proton Relaxation studied by Low-field NMR as a Tool to Monitor Frying Oil Quality

Mohamed Al-KHUSAIBI[1], Nasser AL-HABSI[1], M. Shafiur RAHMAN[1]

[1]*Department of Food Science and Nutrition, College of Agricultural and Marine Sciences, Sultan Qaboos University, P. Box 34, Al-Khod 123, Oman*

Abstract

Intermittent frying results in degradation of oil and formation of compounds that diminish the fried food quality and reported to have negative health effects. The conventional methods currently used to assess the degree of oil abuse are costly, time consuming and involving several chemicals. Nuclear magnetic resonance (NMR) technology has been widely investigated as one of the rapid, safe, non-invasive and non-destructive analytical methods. This work aims to investigate the possibility of using low-field NMR to study the degree of oil abuse. Intermittent frying was carried out at 185°C using sunflower oil. Frying was done every 15 minutes for 5 hours per day for 12 days. Oil samples were taken at the end of each day for analysis. Samples were analyzed for peroxide value (PV), free fatty acids (FFA), and Low-field ^{1}H NMR. The results of LF-NMR clearly showed three different bound proton types; weakly, medium and strongly bound protons. The results showed a decrease in the pre-exponent relaxation of medium-bound (T_{21}) and weakly-bound (T_{22}) proton. These medium- and weakly-bound protons might be linked to the unsaturated fatty acids that breakdown during frying. On the other hand, there was no significant changes in the strongly-bound proton which might be linked to saturated fatty acids. A good correlation was found between PV and FFA and the weakly and medium bound protons while no correlation was found with the strongly-bound proton relaxation. Proton relaxation measured by LF-NMR can be considered a good tool to monitor frying oil quality.

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Process, structure and property relationships in food powder agglomeration and performance

Edgar CHAVEZ MONTES[1], Juan Manuel MARTINEZ ALEJO[2], Hector LOZANO[2], Jean-Claude GUMY[1], Rodolfo PINAL[2] & M. Teresa CARVAJAL[2]

[1]Nestlé Research & Development Orbe, Orbe, Switzerland
[2]Purdue University, West Lafayette, IN, USA

Abstract
During processing and handling of food powders, particle interactions inevitably occur, often leading to cohesiveness and undesirable agglomeration, with consequences on performance such as powder flow, dispersibility, dissolution, stability and overall quality of the final product.

In this study, the use of physicochemical and surface analytical characterization techniques such as Inverse Gas Chromatography (IGC) or X-ray photoelectron spectroscopy (XPS) provided information on particle-property modification resulting from processing. These particle-property attributes resulting from different unit operation conditions were examined in relation to their effect on performance features associated with changes taking place at the surface.

Interfaces and surfaces provide the primary framework for particle cohesion-adhesion interactions, including the dependence of such interactions on surface roughness, solid-state properties and humidity conditions. Collective input from the physicochemical, thermodynamic, visual and rheological methods provide information on the nature and impact of agglomeration at different length scales.

Processed materials such as commonly used ingredients, starch and lactose, and beverage powders such as coffee and chocolate, were used for this study. This presentation discusses the use of multi-parametric information, derived from various experimental analytical tools, to obtain information on the structural diversity and evolution associated with the processing of powders. The study covers food relevant materials, including the impact of processing on overall powder performance.

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Effect of Processing on the Angle of Repose of Different Rice (*Oryza sativa*) and Sorghum (*Sorghum bicolor*) Germplasm

Chijioke OSUJI[1], Ngozi IDIKA[1], Kingstine ALOZIEM[1]

[1]*Federal University of Technology, Owerri, Nigeria*

The processed and unprocessed samples of rice and sorghum grains of newly released germplasm (varieties) were evaluated for differences in angle of repose. Separate batches of different varieties of rice and sorghum were processed by soaking, boiling and malting after which they were dried. The dry untreated samples served as control. Static angle of repose (AoR) was measured using the method described by Iieleji and Zhou (2008). The malting and boiling treatments generally increased the AoR of the rice samples. The soaking and drying of the rice samples did not significantly affect the AoR. Whilst the Notore O.P. showed the most significant changes (31^o – 39^o) for rice; the Faro 62 rice variety maintained an angle of repose of 35^o for all its samples. But sorghum samples were generally reduced by the AoR for the sorghum samples. Only the unknown red sorghum variety recorded an insignificant increase in AoR after boiling. The AoR is used for design of grain feed entry hoppers. The AoR obtained for all the rice samples ranged from 31^o to 40^o but the sorghum samples ranged from 24^o to 28^o. The changes in AoR was probably due to the effect of the grain interaction with moisture as reported by Saiedirad *et al*. (2008) and Abdul-Rasaq *et al*. (2011).

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Effect of heating and freezing on the physical properties of bean sprout

Kana JODO, Tomomi KUBO, Osato MIYAWAKI, Toru SUZUKI

Tokyo University of Marine Science and Technology, Tokyo, Japan

Vegetables are known to be susceptible to substantial changes in physical properties by heating and/or freezing. In this paper, various methods were applied to analyze the mechanism of the change in physical properties of bean sprout in heating and/or freezing.

From the impedance analysis, the Cole-Cole arch, representing the intactness of the cellular structure of bean sprout, drastically changed by freezing or the heat treatment at the temperature higher than 50 ^{o}C, showing that the substantial change in cellular structure occurred. Dynamic elasticity measured by reed vibration method showed that the elasticity of bean sprout largely decreased by freezing or the heating at the temperature higher than 50 ^{o}C, corresponding to the change in cellular structure.

Bean sprouts were soaked in physiological saline and the optical absorbance (A_{264}) was measured in the solution at 264 nm in heating process. Then, A_{264} began to increase at the temperature higher than 50 ^{o}C suggesting the beginning of cellular disruption.

Transversal tensile analysis was also applied to measure the change in texture. In this case, the frozen and/or heated samples at the high temperature showed smooth curves before breakage while the fresh sample showed a zigzag curve representing the freshness in texture.

In conclusion, the change in physical properties of bean sprout by freezing and/or heating was proved to be strongly related to the change in the cellular structure. From the transversal tensile analysis, the difference in texture between the fresh sample and the treated samples were clearly distinguished.

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Effect of *Lactobacillus rhamnosus* and *Lactobacillus helveticus* on release of physiologically active peptides during Cheddar cheese ripening

Lu LIU[1,2], Xiaodong LI[1,2], Mingqi ZHAO[1,2], Lina WANG[1,2], Xiuxiu ZHANG[1,2], Hongda ZHANG[1,2]

[1]*Food College, Northeast Agricultural University, Harbin, China*
[2]*Key Laboratory of Dairy Science, Ministry of Education, Northeast Agricultural University, Harbin, China*

Abstract
This study aimed to evaluate probiotic for their capability to produce Cheddar cheese enriched in physiologically active peptides. The effect of Lactobacillus rhamnosus and Lactobacillus helveticus on production of angiotensin-converting enzyme (ACE)-inhibitory and antioxidant peptides during Cheddar cheese ripening at 4℃ for 240 days was investigated. The water-soluble extracts (WSE) of Cheddar cheese showed the highest activity was fractionated by ultrafiltration and gel filtration chromatography and characterized by LC-MS analysis. Results demonstrated that cheeses made with probiotic were significantly higher in biological activity than those without probiotic during the whole ripening and reached the maximum at the end of period ($P < 0.05$). The molecular weight of physiologically active peptides of cheeses with probiotic was <1000 Da and the length was 5-10, mainly derived from β-CN. These peptides mainly had high content of hydrophobic amino acid residues and most of the C-terminus of these peptides contain Val, Ala, Phe or Pro residue might exert the higher activity of ACE-inhibitory and antioxidant. The findings would contribute to understand the impact of probiotic on release of ACE-inhibitory and antioxidant peptides during Cheddar cheese ripening and also provide an insight into how dairy products as potential natural sources of physiologically active peptides.

Cleaning walls by intermittent impinging jets

Melissa CHEE[1], Nene YAMASAKI[1], Yi Han Justin NG[1], Julien LANDEL[2], **D. Ian WILSON**[1]
[1] *Department of Chemical Engineering and Biotechnology, University of Cambridge, UK*
[2] *School of Mathematics, University of Manchester, UK*

Abstract
Impinging water jets are widely used by cleaning-in-place systems to remove residual product or soiling layers from the internal surfaces of process equipment. The liquid spreads out radially from the point of impingement as a fast moving film until a point where it changes thickness, similar to a hydraulic jump. The forces imposed on the soil are largest within the radial film, and it has been suggested that these can be enhanced while using less water by using intermittent jets, whereby the flow is turned on and off, generating a series of regular accelerations.

This hypothesis was investigated by using an interrupter plate to disrupt and reimpose a jet impinging on a Perspex wall. A range of interruption periods were investigated, straddling the time taken for the jet to form the jump. The flow patterns were captured on high speed video and the formation time compared with the theory presented in Chee *et al*. (2019). Refinements to the theory are proposed.

Cleaning by intermittent jetting was then studied using a number of soil materials representing a range of viscoplastic behaviours (tomato ketchup, toothpaste and petroleum jelly). Viscoplastic soils are studied as their yielding behaviour presents challenges in cleaning. The effect of jetting period/formation time, soil thickness and soil type were investigated and the observed rates of cleaning compared with the model by Wilson *et al*. (2014) for cleaning by a steady jet.

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Food Structure Engineering: The Product Design Principles Revisited

M. Azad EMIN

Karlsruhe Institute of Technology, Karlsruhe, Germany

Abstract

The increasing awareness of the impact of diet on human health, environment, and well–being has been compelling the food industry to undergo a major concept revolution, by shifting from traditional foods to sustainable and functional food products. The key challenge in designing such products is the processing of sustainable and health-promoting ingredients into complex food systems using efficient, safe, and robust methods without sacrificing the appeal and convenience character of the food. This difficult task demands a revisit of the product design principles to determine and focus on the major engineering challenges to be solved.

In this presentation, these principles and the corresponding challenges will be discussed and demonstrated by using extrusion technology as an example, as this technology has been gaining an ever-increasing attention due to its flexibility to process a wide range of raw materials to desired product characteristics and functional properties.

To utilize the potential of extrusion process, we have developed an approach and tools which may practically enable the food research to analyse this process at a mechanistic level and characterize the decisive process parameters crucial for complex food design and scale-up purposes. The approach is based on the fractionation of the processing steps into interrelated sections and defining the according dynamic process functions, such as process-rheology-structure relationships. This contribution will focus on this approach and the corresponding tools developed with respect to the design of sustainable and functional food systems.

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Synergetic inhibitory effects of ultrasound and nisin/carvacrol against germination, outgrowth and vegetative growth of spores of *Bacillus subtilis* ATCC6633 in laboratory medium and milk

Lihua FAN[1], Donghong LIU[1]
[1] *Department of Food Science and Nutritio, Zhejiang University, Hangzhou, Zhejiang, China*

Abstract
Spore-forming bacteria are an aggravating problem for the food industry due to spore formation and subsequent returning to vegetative state during food storage, thus posing spoilage and food safety challenges. Thus, alternative strategies to the conventional thermal processing technology to increase palatability of processed foods while meeting the bacterial spore inactivation standards are currently required. The study evaluated the synergetic inhibitory effects of ultrasound and nisin/carvacrol on spore germination and outgrowth, and subsequent growth of vegetative cell of *Bacillus subtilis* in laboratory medium and milk. Ultrasound (3.33 W/mL, 15 min) pretreatment and nisin (0.01%, 0.02%) or carvacrol (0.05%, 0.1%) synergistically inhibited spore germination and outgrowth, and vegetative growth of spores in laboratory medium, while no such inhibitory effect was observed in milk even with a 10-fold higher concentration (1%) of nisin. Flow cytometry analysis showed the germination efficiencies of ultrasound stressed spores with nisin/carvacrol (67.23% and 30.45%, respectively) was comparable to that of unstressed spores (95.10%). These results quantitatively revealed the inhibitory effect of the stress conditions, and was confirmed by phase-bright spore images. In general, the current work identified the combined ultrasound-carvacrol treatment as an effective strategy to control spores and vegetative cells of *B. subtilis* in laboratory medium and milk during abusive storage.

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Pulsed Electric Field Systems and Applications

Michael KEMPKES
Diversified Technologies, Inc., Bedford MA USA

Pulsed Electric Field (PEF) processing uses short, high voltage pulses to electroporate cells for a wide range of applications. There are growing markets for PEF application to plant cells, where the plant tissue is modified for a variety of applications, including drying, cutting / slicing, and extraction of juices and valuable compounds.
PEF treatment of vegetative material has two major impacts, which can save time and energy in processing. First, when the plant cell membranes are ruptured, intra-cellular material is released into the tissue. This material is primarily water, but includes desirable compounds produced by the plants (lipids, flavonoids, vitamins, etc.), which are now accessible within the tissue, rather than being trapped within the cell. This effect can be used to speed drying, or enhance extraction of material from the plant tissue itself. Second, this liquid supports the cell walls. After electroporation, the release of intra-cellular material reduces this internal pressure, which softens the plant material – similar to the changes seen in cooking, freezing, or enzymatic activity. This impact can be used for multiple applications in food processing, most successfully in the processing of potatoes for French fries and chips.
Treating plant cells requires with PEF requires significantly less energy than killing microbes, which enables very high throughputs with conventional PEF systems, and allows treatment of whole products and slurries rather than just liquids. This paper provides an overview of PEF applications for fruits, vegetables, and other materials, including their pulsed power requirements and examples of commercial systems.

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Transcriptomic analysis reveals key genes related to antioxidant mechanisms of fruits quality improving by trypsin during storage

Xin LI [1, 2, 3, 4], Xueru LIU [1, 2], Haonan JING [1], Yong YIN [1], Huichun YU [1]

[1] *College of Food and Bioengineering, Henan University of Science and Technology, Luoyang, 471023, China;*

[2] *State Key Laboratory of Cotton Biology, Henan University, Kaifeng 455000, China;*

[3] *Key laboratory of Desert and Desertification, Chinese Academy of Sciences, Lanzhou, Gansu, 730000, China.*

[4] *Ministry of Education Key Laboratory of Cell Activities and Stress Adaptations, Lanzhou University, Lanzhou 730000, China*

Abstract: It has been revealed that trypsin scavenges superoxide anions and improves the storage quality and shelf life of pitaya in our previous works. Strikingly, the preservation effect of trypsin on pitayas is due not to its antibacterial or antifungal activity but to its superoxide scavenging activity. This hypothesis is further confirmed by the dynamical cross-correlation maps of trypsin compounds generated by ProDy which showed that the effect of trypsin on the storage quality of pitaya was closely associated with the stability of the structure. Moreover, trypsin significantly decreased the production of superoxide anions and hydrogen peroxide and decreased the levels of cell permeability and membrane lipid peroxidation. The activities of major antioxidant enzymes, except that of ascorbate peroxidase (APX), related to the scavenging of either superoxide anions or hydrogen peroxide were significantly improved by trypsin treatment. Comparison of transcriptome profiles of pitaya treated with trypsin with control revealed that many genes, especially genes related to antioxidation were up or down-regulated following trypsin treatment. In addition, the result of protein–protein interaction network indicates a synergy among the antioxidant enzymes and suggests that the synergistic effect of trypsin with antioxidant enzymes, particularly SOD, can regulate the levels of endogenous active oxygen species, reduce malondialdehyde content, improve cell membrane integrity, alleviate cell damage and delay fruit ageing.

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Screening of mixed surfactants based reverse micellar system for Lactoperoxidase extraction from whey

Shwetha KARANTH[1], Regupathi IYYASWAMI[1]

[1]*National Institute of Technology, Karnataka, India*

Growing health concerns prompts the food industry to switch towards biopreservatives. Bovine Lactoperoxidase, a minor whey protein, is used as an antimicrobial in cosmetic, food and pharmaceutical preparations. However, conventional techniques for Lactoperoxidase purification like chromatography and membrane separation suffers from a number of drawbacks. Industries are in pursuit of reliable,cheap and scalable methods. The present work investigates food grade non-ionic and ionic surfactant blends for lactoperoxidase liquid-liquid extraction. The method involves selective phase transfer of Lactoperoxidase from whey to reverse micelles and back into a fresh aqueous medium at appropriate conditions. Reverse micelles were prepared by mixing Tween, Span and Triton series surfactants individually with AOT to improve the extraction efficiency. Complete Lactoperoxidase solubilization was achieved with reverse micelles formed by 100mM AOT and 20mM Tween 80 at pH8 and it was back extracted into fresh aqueous phase containing 1M KCl at pH10. Purification fold up to 1.24 was achieved. Improved activity and extraction efficiency was observed in all the reverse micelles formed by the non-ionic surfactants mixed with AOT than with the system formed by AOT alone. The aqueous phase (whey) from forward transfer can be further used to fractionate other whey proteins.

References: Chuo, S. C. et al. (2014) ‘A new method of extraction of amoxicillin using mixed reverse micelles,’ Colloids and Surfaces A: Physicochemical and Engineering Aspects. Elsevier B.V., 460, pp. 137–144.

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Sustainable food security for all: opportunities to enhance nutrition and decrease food waste in resource-limiting settings

Robyn ALDERS[1,2,3]

[1]*Development Policy Centre, Australian National University, Canberra, Australia*
[2]*Kyeema Foundation, Maputo, Mozambique;*
[3]*Centre for Global Health Security, Chatham House, London, UK.*

Abstract
Achieving sustainable food security in support of human and planetary health is among the greatest challenges facing humanity today. Even with our current population, over 10 per cent of people globally are undernourished and approximately 30 per cent are deficient in key micronutrients. These problems are more prevalent in resource-limiting settings and may be unevenly felt within households, frequently affecting young children, women of reproductive age and the elderly.

Heavy reliance on monotonous cereal-based diets is a major factor contributing to global malnutrition. Why were staples such as maize, rice and wheat the focus of so many food security programs in the 20th century? Perhaps their relative ease of storage and transport made them attractive; it certainly was not primarily because of their nutritional value. Engineering and food technology have a vital role to play in ensuring sustainable production and utilisation of agricultural, livestock and marine resources. Technologies that facilitate equitable distribution of nourishing food, regenerative agriculture and reduce food waste (e.g. by reducing aflatoxin contamination of grains and nuts and efficiently and safely conserving perishable nutritious foods such as vegetables and non-muscle components of carcasses) are vital to meeting future food requirements.

Moving forward, interdisciplinary teams bringing engineering and food technology together with nutritional physiology (human and animal), agroecology, value chain management, economics and other social sciences are required to ensure that our food systems can be tailored to meet the requirements of people of differing ages, genders, reproductive states, health circumstances, cultures and in varying geographies.

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Design of an automatic pumpkin-mud drying system

Yi-chich CHIU[1], Zhi-Kai LIN[2], Li-Wen ZHONG[1], Chi-Hui CHEN[1]
[1]*National Ilan University, Yilan, Taiwan*
[2]*Wangshan Leisure Farm, Yilan, Taiwan*

Abstract
The objective of this research was to design an automatic pumpkin-mud drying system, which can dry the pumpkin-mud to form the continuous pumpkin thin slices. The dry pumpkin thin slices can be grinded as pumpkin powder and that can be easily used for food ingredients. The drying system is composed of four units: feeding, drying, discharge and control. A programmable logic controller was applied to control the sequences of processing and to regulate the drying temperature and rotation speed of the feeding wheel and drying wheel. The feeding unit includes peristaltic pump, satellite coating wheels and drum type drying wheels. The pumpkin-mud is fed by using the peristaltic pump, and then the pumpkin-mud was coating on the drum type draying wheel by using satellite wheel, the spacing between satellite wheel and drum type draying wheel which can be adjusted to get the well pumpkin-mud adhesion thickness. The drying unit uses the electric heater to heat the coal oil inside of the drum type drying wheels, the heat flux transfers to the surface of drum type draying wheels and then dry the pumpkin-mud. The discharge unit includes side scraper and discharging tray. The dray pumpkin thin slice is scratched down from the surface of drum type draying wheels and fallen to the discharging tray. The tested results showed that the drying capacity reaches about 1155.1g/h of pumpkin slice. Consequently, the developed automatic pumpkin-mud drying system can save the labor usage and shorten the drying time for pumpkin drying processes.

In-situ real-time measurement of respiration rate of fresh produce using newly developed modular respirometer

Nandita KESHRI[1,2], Ingo TRUPPEL[1], Werner B. HERPPICH[1], Martin GEYER[1], Cornelia WELTZIEN[1,2], Pramod MAHAJAN[1]

[1]*Leibniz Institute for Agricultural Engineering and Bioeconomy, Potsdam, Germany*
[2]*Technical University of Berlin, Germany*

Abstract
Monitoring respiration as rates of either O_2 consumption or CO_2 production is an important tool to optimise the design of packaging systems or to maintain optimal conditions inside storage systems for fresh produce. Maintaining proper storage condition and real-time measurement of respiration rates of fresh produce can help reduce the global horticultural wastage. Currently, respiration rates are mostly measured by gas chromatography or headspace gas analysers. Both these methods are manual and lacks the ability for real-time monitoring. Given the weakness, a compact and modular respirometer based on a respiration measuring sphere (RMS88) was developed, which consisted of one O_2 (0 %-25 %) and two CO_2 sensors (0 %-0.5 % and 0 %-5 %) for continuous real-time monitoring of gas concentrations and respiration rates of fresh produce. The developed respirometer was analysed to measure in-situ real-time respiration rate of fresh produce stored inside a chamber (190 L). The respirometer kept inside the chamber used a pump arrangement to flush the gas sample (flow rate of 5 L/min) from chamber to respirometer for 1 h at regular intervals. The developed respirometer was programmed to take measurements of O_2 and CO_2 concentrations and transfer the data wirelessly to a terminal program on PC. All the data was processed in the terminal program to calculate respiration rate and respiratory quotient of fresh produce stored inside. Such wireless and portable system was shown to be a powerful tool to measure respiration rate and RQ of fresh produce in real-time. Due to its compact, mobile and modular design, the RMS88 offers great potential to be incorporated in storage systems or to develop an intelligent storage system.

Keywords: In-situ, respiration rate, real-time, respirometer, fresh produce O_2 and CO_2 sensor.

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Holistic Sustainability Assessment of Global Food Systems- challenges, needs and available tools

Alexander MATHYS[1] **,** Abhishek CHAUDHARY[1,2]

[1]*ETH Zurich, Zurich, Switzerland*
[2]*Indian Institute of Technology (IIT) Kanpur, India*

Food systems are at the heart of at least 12 of the 17 Sustainable Development Goals (SDGs). The wide scope of the SDGs call for holistic approaches that integrate 'siloed' food sustainability assessments. Here we present a first global scale analysis quantifying the status of national food system performance of 156 countries, employing 25 sustainability indicators across seven domains: nutrition, environment, food affordability & availability, sociocultural wellbeing, resilience, food safety, and waste.

We assess the nutritional quality of average national daily diet taking into account >25 essential nutrients and several nutrients of health concern in the consumed food items and their daily dietary reference intakes and maximum reference values respectively. Next, we compile the environmental footprint of national diets through literature review and through recently proposed approaches in life cycle assessment. The results show that high-income nations score well on most indicators, but poorly on environmental, food waste and health sensitive nutrient intake indicators. Transitioning from animal foods towards plant-based foods would improve indicator scores for most countries. Our nation-specific, integrated nutrition-environmental quantitative assessment of global food systems can help policy-makers to set improvement targets on specific areas and adopt practices while keeping track of the other aspects of sustainability.

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Emerging food processing techniques to target more sustainable food systems

Alexander MATHYS[1]

[1]*ETH Zurich, Zurich, Switzerland*

Emerging food stabilization techniques cover process-product-operation interactions, where selected examples of innovative thermal, electro-magnetic, mechanical and combined preservation processes will be introduced.

Current thermal process solution could cover a broad range of application already. Besides these established solutions, micro process engineering as a process intensification tool enables an ultra-short thermal treatment of foods within milliseconds (ms) using very high surface area- to-volume ratios. The innovative application of ultra-short pasteurization and sterilization at high temperatures, but with holding times within the range of ms would allow the preservation of liquid foods with higher qualities.

Electro-magnetic based nano second pulsed electrical field (nsPEF) and low energy electron beam (EB) enables an efficient use of biomass in food production. The application of emerging continuous process concepts could enable the gentle microbial control of liquid foods with nsPEF and low water activity foods with low energy EB, while keeping their organoleptic properties.

During mechanical high pressure processing in batch, focused investigations on the property changes within pure water and more complex systems, such as microorganisms, enabled a detailed understanding of the respective process-product-operation interactions.
After studying spore inactivation in very detail, classical high pressure preservation could be optimized through combined thermal and mechanical processes such as high pressure thermal sterilisation as well as continuous ultra-high pressure processing up to 450 MPa as innovative multi hurdle technologies.

Holistic life cycle sustainability assessment, aligned with the introduced process innovations, can evaluate the suggested solutions on a multi parameter base, in terms of improved food production sustainability.

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Impact of sound attenuation on ultrasound-driven yield improvements during olive oil extraction

Miguel AMARILLO[1], Nicolás PÉREZ[1], Florencia BLASINA[1], Adriana GAMBARO[1], Alessandro LEONE[2], Roberto ROMANIELLO[2], Xin-Qing XU[3], Pablo JULIANO[3]

Affiliations
[1]*Universidad de la República, Uruguay*
[2]*Universitá di Foggia, Italia*
[3]*Commonwealth Scientific and Industrial Research Organization, Australia*

Abstract
High frequency ultrasound can enhance olive oil extractability industrially. However, the ultrasound attenuation phenomena and their implications on extractability, are not well understood. This work evaluated the ultrasound attenuation effects on the oil extraction efficiency, while providing deeper insights into the physics behind the ultrasound extraction in a heterogeneous medium. Olives from Arbequina variety were collected and processed into a paste using standard olive crushers. Sound pressure distribution was characterized in a high frequency ultrasound reactor, carrying 3 kg of water or paste, by using a novel indirect contact hydrophone device at 0.4 MHz or 2 MHz. A through-transmission ultrasonic technique was applied to determine attenuation profiles throughout the reactor and coefficients in paste at the central frequency peak of each transducer, with various paste to water ratios and reactor sizes in a reactor with a 14.5 cm transducer to wall distance. Among the various effects evaluated, an emission frequency of 0.4 MHz improved extractability of 10.4 % compared to 2 MHz that gave a of 2.0 % (kg oil/100 kg oil in paste) improvement. The attenuation profiles corroborated these findings with attenuation coefficients of 3.9 and 5.3 dB/cm measured near the respective frequencies. Even though no sound pressure levels in paste were detectable beyond 9 cm from the transducer at both frequencies, oil extractability improvements were observed with this set up but at lesser extent than at shorter distances. This research suggests that attenuation affects the standing wave oil trapping separation mechanism. A microstreaming driven mechanism is proposed for larger scale systems.

Keywords: olive oil, ultrasound, attenuation, standing waves

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Performance evaluation of a new dry-peeling technology with sequential direct flame and catalytic infrared heating for tomatoes

Zhongli PAN, Irving RABASA, Chandrasekar VENKITASAMY
University of California – Davis, Davis, CA, USA

Abstract

To improve the sustainability of tomato peeling by reducing water use and wastewater generation, a dry-peeling technology using catalytic infrared (CIR) emitters or electric emitters as heating sources was successfully developed in our previous studies. The current research is a continued development of the technology by using sequential direct flame and catalytic infrared (SDFCIR) heating to reduce the overall heating time by taking the advantage of high temperature of flame. The direct flame (DF) heating before the CIR heating allows to quickly heat the shoulder area of the tomatoes, achieve more uniform surface temperature and improve the peelability. The objective of this study was to evaluate the peeling performance of the new dry-peeling system. The system consists two heating sections of the DF burners and CIR emitters with automatic control of tomato residence time under different heating sections. The peeling performance of heated tomatoes was evaluated by determining the peeling easiness, peeling removal, peeling loss, color and firmness and compared with lye peeled tomatoes. The SDFCIR heating of tomatoes for 220 s with 65 s of DF and 155 s of CIR resulted in high peeling performance with 5.12±0.78 of peeling easiness, 99.66±0.38% peeling removal, 13.03±2.40% peeling loss and 0.47±0.05 of Hue°. The surface temperatures of tomatoes were 84.8±10.3°C and 105.5±5.9°C after DF and CIR heating, respectively. It has been concluded that the SDFCIR dry-peeling system can be used to significantly increase the throughput to produce high quality peeled product without using water and chemicals compared to CIR alone.

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How do dry heating treatments at different pH alter the interfacial activity of whey proteins?

Danilo C. VIDOTTO[1], **Guilherme M. TAVARES[1]**

[1]*University of Campinas, Campinas, Brazil*

Abstract

Whey proteins are widely used as ingredients in food industry because of their nutritional value and techno-functional properties. Whey protein isolate powders (WPI) are composed of more than 90% of protein (mainly beta-lactoglobulin and alfa-lactalbumin) and residues of lactose, fat and minerals. When submitted to different processes such as heat treatments, whey proteins may undergo structural changes, which affect their techno-functional properties like solubility and interfacial activity. Dry heating (DH) is a thermal treatment applied to powders that can induce controlled Maillard reaction. In this study, commercial WPI (94% of protein) with and without added lactose was rehydrated and adjusted at different pH (3, 5, 7 and 9). WPI dispersions were then frozen and lyophilized. Samples were dry-heated at 60 and 80□C for 48 hours and then analyzed according protein structure and some techno-functional properties. Although the water activity of the powders was less than 0.1, browning indexes and free lactose contents indicated the consumption of the reducing sugar by Maillard reaction, as expected. In addition, DH treatments diminished protein solubility of samples dry-heated at pH 9, distinguishing from other samples that were almost completely soluble. DH at 80□C reduced emulsion capacity of the proteins. Nevertheless, the applied treatments do not affect foaming capacity and drainage. This research certainly contributes to understand how emerging treatments may positively or negatively affect WPI techno-functional properties.

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A KECA identification method based on GA for E-nose data of six kinds of Chinese spirits

Yong YIN, Yanfang WANG, Xiaopeng SHEN, Huichun YU, Xin LI
College of Food & Bioengineering, Henan University of Science and Technology, Luoyang 471023, China

Abstract: In order to improve the correct identification rate of six kinds of Chinese spirits using electronic nose (E-nose), the kernel entropy component analysis (KECA) identification method based on genetic algorithm (GA) for these E-nose data was proposed, and the effects of different selection methods for kernel parameter of a kernel function (radial basis function, RBF) on the identification of the six kinds of spirits were explored in depth. Firstly, three feature parameters of these E-nose data including integral value (INV), relative steady-state average value (RSAV) and wavelet energy value (WEV) were extracted, respectively; and the three feature parameters were employed to represent these E-nose data together. Secondly, when the RBF was selected as kernel function, the concrete operation of two kernel parameter selection methods were given, the two selection methods were the matrix similarity measure based on Euclidean distance and the GA, and the corresponding kernel parameters were 16.8608 (matrix similarity measure) and 67.9039 (GA), respectively. Finally, according to the values of the obtained two kernel parameters, the identification effects of KECA method based on the GA and the matrix similarity measure for the six kinds of spirits were studied. The results show: when the first 125 kernel entropy components were selected, the correct identification rate of the six kinds of spirits based on the GA was up to 98.81 %, while the correct identification rate based on the matrix similarity measure was only 91.67 %; when the first 200 kernel entropy components were selected, the correct identification rate based on the matrix similarity measure was increased to 98.81 %. Therefore, the kernel parameter determined by GA is significantly better than that of matrix similarity measure. This shows that the KECA method based on the GA is suitable for the identification of the six kinds of Chinese spirits by E-nose.

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Pasteurization effects of food model during vacuum freeze drying combined with high frequency dielectric heating

Atsushi MUTO[1], Ken-ichiro SUEHARA[1], Takaharu KAMEOKA[1], Kazuhiko KAWAMURA[2], **Atsushi HASHIMOTO[1]**,

[1]*Mie University, Tsu, Japan*
[2]*Chubu Electric Power Co., Inc., Nagoya, Japan*

Abstract

This study presents the development of a pasteurization method during vacuum freeze drying (FD), which is popular as a drying method with less deterioration in quality of foods. We experimentally showed that the FD time could be shortened by using high-frequency (HF) dielectric heating. In addition, the plasma generation was observed between the electrodes, and it was thinkable that microorganisms could be killed during the FD process. In this study, the pasteurization of bacteria within a food model during the FD process were performed by focusing our attention on the influences of bacterial types and the distance from the surface.

Staphylococcus aureus spread on the surface of frozen agar as the food model died 2 hours after the start of drying, and spore forming cereus bacteria were sterilized 6 hours after the start. The proposed method was effective not only for the pasteurization of vegetative cells but also for that of spore forming bacteria. Additionally, the number of bacteria on the surface of the food model fell the most quickly, and the pasteurization time of bacteria close to the bottom took the longest. Furthermore, the sample temperature was kept at approximately -25 °C during pasteurization, and the bacterial death behavior was not due to the thermal effect. These results suggested that bacteria could be killed by plasma generated in the voids due to the descent of the drying front. Therefore, this study play a very important role in pasteurization during FD and process design of high quality dried foods.

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Plasma Functionalized Water: From bench to prototype for fresh food safety

Uta SCHNABEL[1, 3], Mathias ANDRASCH[1], Jörg STACHOWIACK[1], Oliver SCHLÜTER[2], Paula BOURKE[3], Jörg EHLBECK[1]

[1]Leibniz Institute for Plasma Science and Technology, Greifswald, Germany
[2]Leibniz Institute for Agricultural Engineering and Bioeconomy, Potsdam, Germany
[3]College of Sciences and Health, Technological University Dublin, Dublin, Ireland

Fresh-cut produce like lettuce may contain a very high microbial load, including human pathogens. Therefore, the need for antimicrobial agents at post-harvest stages to prevent microbial growth is evident. Sanitation steps based on non-thermal plasma (NTP) opens up innovative food processing possibilities by application at different points along the food chain; for production, modification, and preservation, as well as in packaging of plant- and animal-originated food. Plasma differs from the gaseous state of matter by a certain amount of free charge carriers caused by ionization processes of the gas atoms and molecules due to the supply of energy.
This talk describes innovations resulting in a pilot scale fresh produce processing system based on cold plasma functionalized water. The primary focus was on antimicrobial efficacy in line with the importance of food safety to the fresh produce processing sector. The treatment of natural products with changing parameters (size, surface, water content) is challenging for the design and optimization of cold plasma processes. To overcome these challenges, a specific plasma process based on microwave plasma operated with compressed air was established to deliver plasma processed air (PPA) as the antimicrobial agent to process water. This served to functionalize the water (PTW) with antimicrobial properties.
To successfully scale up the application, an understanding of the antimicrobial properties, the chemical composition of PTW and the food quality characteristics of color and texture was developed. The optimized PTW production and decontamination process was implemented into pilot-plant scale lettuce-washing thus demonstrating the industrial scalability and applicability.

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Antidiabetic properties of lentil (*Lens culinaris* L.) extracts obtained from fresh, germinated and enzymatically hydrolyzed grains

Anna Luisa CASARIN[1], **Ruann DE CASTRO[1]**

[1]*University of Campinas, School of Food Engineering, Department of Food Science, Sao Paulo, Brazil*

Abstract

Lentil is an important legume for human consumption and it is a source of nutrients and minerals, as well as natural antioxidants, such as the phenolic compounds. The modification of plant matrices using germination and enzymatic treatment has promising results by improving the nutritional and biological properties of these substrates. Thus, this work evaluated the effects of germination, enzymatic hydrolysis and the association of the two processes on the antidiabetic properties of lentil extracts, in which the inhibition ability of α-amylase and α-glycosidase were assessed. The results showed that the enzyme inhibition ability of the lentil extracts was positively affected by germination and enzymatic hydrolysis. Samples of germinated and fresh lentils treated enzymatically presented increment up to 60% and 40%, respectively, in the capacity of α-amylase inhibition. The extracts obtained from the combined processes (germination and enzymatic hydrolysis) has a growth of approximately 17% in α-glycosidase inhibition, when the samples were treated with a binary mixture of the commercial enzymes α-amylase (Termamyl) and cellulase (Optimase). The maximum inhibition levels of α-amylase and α-glycosidase activities were 94% and 45%, respectively. It was possible to conclude that the enzymatic treatment of fresh or germinated lentil samples considerably improved their antidiabetic properties.

Linking ultrasonic damping of chocolate to its rheological properties

Lucas GROB[1], Konstantina PAPADEA[1], Peter BRAUN[1], Erich J. WINDHAB[1]

[1] *Laboratory of Food Process Engineering, Swiss Federal Institute of Technology Zürich (ETH), Zürich Switzerland*

Efficient process control is one essential tools of modern production. Shaping process loops allows overcoming seasonal and raw material fluctuations. In confectionery production, proper crystallization and cooling are essential processing steps to control as they determine the final properties of the product (e.g surface gloss and snap).
In the past decades, the so-called “Detachlog” system has been developed and configured. Its patented technology[1] detects noninvasive the detachment behavior of confectionery product via the damping of the ultrasonic amplitude. The characteristic density change during solidification affects the surface-to-surface interaction of the solidifying material (e.g chocolate or confectionery products) with the conveying molds. The development of such an amplitude is recorded from filling of the mold until the final detachment of the chocolate tablet. Additionally the temperature is plotted; this inline tempercurve is to measure the temper degree of the chocolate and to serve as a measure for the polymorph induced in the chocolate. Estimating noninvasively the temper degree of chocolates can be beneficial on controlling the temper unit.
The objective of this study is to link the damping of the ultra sound throughout the crystallization process of chocolate with rheological properties, more over the amount of seed crystals within the chocolate. The development of the viscosity and ultrasonic damping were recorded with a Rheometer in a plate-plate setup. A linear relationship was found between both factors. Pilot-scale measurements revealed similar behavior and suggest that cooling conditions also affect the damping.

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High Gas-barrier Polymer Packaging for Advanced Food Processing Technologies

Shyam SABLANI

Washington State University, Pullman, WA, United States of America

Abstract

High gas-barrier ethylene vinyl alcohol (EVOH)- and metal-oxide coated polyethylene terephthalate (PET)-based multilayered polymeric films have provided a suitable alternative to foil-based packaging for shelf-stable food products with extended shelf-life. Multilayer polymeric film-based packaging is also compatible with advanced microwave and high-pressure processing technologies. Structural properties of polymer packaging are generally able to withstand these processes and remain stable during extended storage. This presentation will highlight some of the efforts being made for the design and development of high gas barrier polymer packaging, mechanisms of barrier changes in EVOH and metal oxide coated PET-based films subjected to sterilization processes, and influence of barrier properties on shelf-life of food products.

Revaluation of globe artichoke bracts (*Cynara scolymus*) discarded industrially by obtaining an extract with antiproliferative activity.

Carmen SOTO-MALDONADO[1], John JARA-QUEZADA[1], Cristian TORRES-ALARCON[2], María Elvira ZUÑIGA-HANSEN[2,1].

[1]*Centro Regional de Estudios en Alimentos Saludables, Valparaíso, Chile.*
[2]*Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile.*

Abstract
Globe artichoke (*Cynara scolymus*) is a Mediterranean vegetable recognized by the presence of different bioactive compounds, such as phenolic antioxidants and dietary fiber. Its marketing is in fresh form or processed in canned form. In the latter process only about 30% of the vegetable is used, generating a large amount of waste, mainly bracts. This fraction of the artichoke still is rich in dietary fiber and antioxidants, such as chlorogenic and dicaffeoylquinic acids, which are recognized for their benefit in the treatment of diseases related to oxidative stress such as cancer. In this work, industrially discarded artichoke bracts, containing an antioxidant activity (ORAC method) of 44,858.9 µmol Trolox equivalent/100 g dry bracts, were extracted using a hydroalcoholic solution, obtaining an extract that, when freeze-dried, presented an activity of 106,376.5 µmol Trolox equivalent/100 g dry extract. The antiproliferative activity of this extract was evaluated by means resazurin method using breast cancer cell lines (MCF-7), colon cancer (CaCo2), and fibroblasts as control (healthy cells). The results show that the antioxidant extract is effective in reducing the viability of MCF-7 cells to 37% when the concentration thereof is 500 ppm; in the case of CaCo2 cells they are affected in the presence of 750 ppm of extract, observing a viability of 47%. While, fibroblasts cells maintain their viability (100%) up to 1500 ppm, when its value decrease close to 50%, which also demonstrates the selectivity of action of the extract, and the feasibility to valuate these discards.
Acknowledgement: Project CONICYT R15F10006.

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Discrimination of Fresh and Frozen-thawed Beef Based on Ultrasound Imaging

Zongbao SUN, Tianzhen WANG, Xiaobo ZOU*, Xiaojing YAN, Liming,LIANG, Junkui LI, Xiaoyu LIU

School of Food and Biological Engineering, Jiangsu University, Zhenjiang, China

Abstract
Fresh beef is more expensive than frozen-thawed beef for its good quality and taste. Some unscrupulous traders labeled frozen-thawed beef as fresh beef for sale. The feasibility of using ultrasonic imaging technology to analyze and identify fresh and frozen-thawed beef was studied in this paper. Firstly, the texture, microstructure and some physical and chemical indexes of the fresh and frozen-thawed beef were collected to analyze their differences. Secondly, a total of 60 ultrasound images of fresh and frozen-thawed beef were collected by ultrasound imaging system. Twenty texture characteristic value defined by grey level cooccurrence matrix were collected. Then, Principal Component Analysis for data dimension reduction was used, and linear discriminant analysis(LDA) and support vector machine(SVM) were used to discriminate the samples. The result showed that there were significant differences in texture index, L value and cooking loss between fresh and frozen-thawed beef. These differences combined with microstructural images showed that the tissue structure of frozen-thawed beef was damaged and the internal texture was poor. The ultrasound images of fresh and frozen-thawed beef showed significant differences, which could be well explained by the above studies. The texture features of the ultrasound image of fresh and frozen-thawed beef were significantly different. Both LDA and SVM had good discriminant results, especially LDA. when the principal component numbers were five, the precision rates of calibration set and prediction set of LDA were both 100%. The results showed that it was feasible to distinguish the fresh and frozen-thawed beef by using ultrasound imaging technology.

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Impact of smoking methods on flavor and physicochemical properties of sliced bacon

Jie GUO[1], Qiong WANG[2, 3], Conggui CHEN[1], Hai YU[2], Baocai XU[1, 3,*]

[1] *Hefei University of Technology, Hefei, China*

[2] *Yangzhou University, Yangzhou, China*

[3] *Yurun Group, Nanjing, China*

Abstract ：The aim of this study was to prepare sliced bacon through the process of wood smoke, liquid smoke and paper smoke. The volatile compounds of three kinds of smoked sliced bacon were determined by solid phase microextraction, gas chromatography-mass spectrometry, odor activity value, electronic nose and electronic tongue, which combined with sensory characteristics, overall odor, overall taste, free amino acids, physicochemical properties and microbiological indicators were evaluated. The 59 volatile compounds were identified from three smoked sliced bacon. 44 volatile compounds in wood smoke, 32 volatile compounds in paper smoke and 46 volatile compounds in liquid smoke, which belonging to 10 aldehydes, 10 phenols, 13 ketones, 8 alcohols, 12 hydrocarbons and 6 other compounds. Most abundant volatile substances in sliced bacon samples were aldehydes (45.05-53.92%), which mainly imparts the flavor of the bacon fat, fruit and baked goods. There were 7 essential amino acids and 9 non-essential amino acids in the three kinds of smoked bacon, the difference was not statistically significant ($P>0.05$). The variation trend of the total number of three kinds of smoked bacon colonies was relatively consistent, but the total number of wood smoked colonies and water content were lower, and the salt content and L* value were relatively high. The overall flavor, the main flavor compounds and volatile flavor substances of liquid smoked bacon were the closest to wood smoke and the odor was relatively stable, which can be applied to industrial production.

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Role of oral processing in *in vitro* digestion: a case study of bread

Jing GAO[1,2], Eileen Yi Ning TAN[1], Sherlene Hui Ling LOW[1], Yong WANG[3], Jian YING[3], Zhizhong DONG[3], Weibiao ZHOU[1,2]
[1]*Food Science & Technology Programme, National University of Singapore, Singapore*
[2]*National University of Singapore (Suzhou) Research Institute, Suzhou, China*
[3]*Nutition & Health Research Institute, COFCO Corporation, Beijing, China*

Abstract
Food structure plays an important role in its digestion. The original food structure is dramatically altered during mastication. Bolus structure has a profound impact on the subsequent enzymatic hydrolysis of macronutrients in the food and the release of end products during gastrointestinal digestion. This study investigated the role of oral processing and bread structure on bolus formation and kinetics of starch digestion using an *in vitro* digestion model. Three types of bread (i.e. baked bread, steamed bread and baguette) were artificially “chewed” using four oral processing methods (i.e. cutting, cut-and-pestle, blending and grinding). The level of ‘oral processing’ was quantified as the amount of artificial saliva absorbed, size of bolus particles and bolus texture. Obtained boluses were subjected to the INFOGEST digestion model and the kinetics of glucose release was followed over a 6-hour period of intestinal digestion. Results showed that the blending method produced bolus with small particle size, high saliva impregnation efficiency and soft texture. Higher mixing efficiency between saliva and bread particles from the pressing action led to a more cohesive bolus. The impact of bolus structure on starch digestion was bread-type dependent. Among the three types of bread, baguette had a higher rate of starch hydrolysis due to its porous structure. Results of this study demonstrated that the oral stage of conventional *in vitro* digestion protocol had a direct impact on the predicted glycemic potential of starchy food and it should be revisited and carefully designed to reflect differences in the extent of oral processing observed in the population.

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Heterotrophic microalgae as a sustainable source of highly technofunctional proteins

Lutz GROSSMANN[1], Jörg HINRICHS[2], Jochen WEISS[1]

[1]*University of Hohenheim, Dept. Food Physics and Meat Science, Stuttgart, Germany*
[2]*University of Hohenheim, Dept. Soft Matter Science & Dairy Technology, Stuttgart, Germany*

Abstract

In foods, protein-rich microalgae are currently mainly used in two ways: (*i*) as dietary supplement, and (*ii*) as a whole cell ingredient, being a value giving component without any technofunctionality (inactive filler). However, proteins from microalgae may have unique technofunctional properties in foods, which go beyond their nutritional value. It is suggested that heterotrophic (without light) cultivation is a more sustainable and cleaner process compared to phototrophic (with light) cultivation. For these reasons, a protein extraction process to obtain less-refined proteins and the technofunctional properties of the obtained protein extracts from two heterotrophically cultivated microalgae (*Chlorella protothecoides* and *Chlorella sorokiniana*) were studied.
The minimal processing approach yielded in less-refined protein extracts with a protein content of 37 – 39 wt%. The proteins showed an unusual high solubility in water in a broad pH-range (e.g. proteins of *Chlorella protothecoides* showed a solubility of >84 % in the pH-range 2 to 12), which might be useful in formulation protein-enriched foods at low pH-values. Moreover, promising emulsifying properties were obtained for proteins of *Chlorella protothecoides* and *Chlorella sorokiniana* with a high pH- and salt stability. Lastly, proteins of *Chlorella sorokiniana* acted as gelation agent, which is a unique property to structure viscous foods. The obtained results were linked to the composition of the extracts, showing that the interplay between proteins and carbohydrates is a crucial parameter in terms of technofunctionality. These results suggest that extracted microalgae proteins are a highly functional food ingredient, which might be used in foods more often in the future.

ICEF13 ABSTRACT TEMPLATE

In Pursuit of the World's Best Steak – Advanced Robotics and X-ray Technology to Transform an Industry

Christian RUBERG[1]
Darryl HEIDKE[2]
Sean STARLING[3]
Richard APPS[4]
Andrew ARNOLD[5]
Graham GARDNER[6]
Graham TRAFFONE[7]
[1]*Meat and Livestock, Sydney, Australia*
[2]*Scott Automation and Robotics, Dunedin New Zealand*
[3]*Murdoch University, School of Veterinary and Life Sciences, Murdoch, Western Australia*
[4]*JBS Australia Ltd*

Abstract

Australia is progressing towards being the world's preferred supplier of premium red meat, but it is challenged by having a high cost structure. In response, Meat and Livestock Australia, the processing industry, and key technology providers have spent the last 14 years developing and implementing robotic automation supported by advanced real time sensing technology such as x-ray imaging.

This paper outlines the investment strategy behind collaborating with the world's leading companies, and successfully integrating: meat science, industrial robotics, medical imaging, and airline security systems, into Australian beef and sheep meat supply chains.

These world-first systems that were initially implemented in lamb processing feature: robotic cutting, dual energy x-ray,machine vision sensing, laser sensing, and full carcase traceability. The beef processing sector is now set to benefit from the learnings and progress in lamb processing. These innovations have moved Australia into first place for advanced red meat processing automation, and have delivered in some cases an under 2 year capital payback with an up to 25% improvement in boning room productivity. Unexpectedly, the key pay-back is not labour savings, accounting for only 15% of the benefit, but an increase in carcase value due to precise, clean, and repeatable cutting lines. In addition to cutting lines, the objective eating quality data, for instance intramuscular fat also known as marbling, will through improved genetics and livestock husbandry assist the whole 'paddock-to-plate' supply chain to optimize its offering to increasingly discerning consumers. The future of meat processing may also benefit from artificial intelligence algorithms, exo-skeletons, and augmented vision systems.

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Activation and conformational changes of chitinase induced by ultrasound

Furong HOU[1], Xiaobin MA[1], Lihua FAN[1], Danli WANG[1], Tian DING[1,3], Xingqian YE[1,2,3], Donghong LIU[*1,2,3]

[1] *College of Biosystems Engineering and Food Science, Zhejiang University, Hangzhou 310058, China*

[2] *Fuli Institute of Food Science, Zhejiang University, Hangzhou 310058, China*

[3] *Zhejiang Key Laboratory for Agro-Food Processing, Zhejiang R&D Center for Food Technology and Equipment, Hangzhou 310058, China*

Abstract

The effect of ultrasound on chitinase activity and conformational changes was investigated in this study. Results revealed that ultrasound did activate chitinase with a maximum enhancement of 19.17% compared with the untreated chitinase. Furthermore, an increase of V_{max} and a decrease of K_m after sonication were obtained, illustrating that the affinity between chitinase and substrate was intensified. No obvious effect of the tolerance to most metal ions was exhibited whether sonicated or not ($p > 0.05$), which could be attributed to the insensitivity of chitinase to metal ions from *Streptomyces griseus*. The conformational changes of chitinase were analyzed by circular dichroism (CD), Fourier transform infrared (FTIR), Raman and fluorescence spectroscopy. Results indicated that α-helix was the primary component of chitinase secondary structure. The activation of chitinase induced by ultrasound was presumably due to the decrease of tryptophan on chitinase surface and the increase of β-sheet and random coil in chitinase secondary conformation. All of these conformational changes made chitinase more flexible and regular, which were helpful for the activation of chitinase. In brief, ultrasound is a possible way to activate chitinase to enlarge its application in food industry.

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Fish Protein Hydrolysates: Application in Deep-fried Food and Food Safety Analysis

Shan He[1,2], Chris Franco[2], Wei Zhang[2]

[1]*School of Chemistry and Chemical Engineering, Guangzhou University, China*
[2]*Center of Marine Bio-products Development, Flinders University, Australia*

Abstract
Four different processes (enzymatic, microwave-intensified enzymatic, chemical, and microwave-intensified chemical) were used to produce fish protein hydrolysates (FPH) from Yellowtail Kingfish for food applications. In this study, the production yield and oil-binding capacity of FPH produced from different processes were evaluated. Microwave intensification significantly increased the production yields of enzymatic process from 42% to 63%. It also increased the production yields of chemical process from 87% to 98%. The chemical process and microwave-intensified chemical process produced the FPH with low oil-binding capacity (8.66 g oil/g FPH and 6.25 g oil/g FPH), whereas the microwave intensified enzymatic process produced FPH with the highest oil-binding capacity (16.4 g oil/g FPH). The FPH from the 4 processes were applied in the formulation of deep-fried battered fish and deep-fried fish cakes. The fat uptake of deep-fried battered fish can be reduced significantly from about 7% to about 4.5% by replacing 1% (w/w) batter powder with FPH, and the fat uptake of deep-fried fish cakes can be significantly reduced from about 11% to about 1% by replacing 1% (w/w) fish mince with FPH. Food safety tests of the FPH produced by these processes demonstrated that the maximum proportion of FPH that can be safely used in food formulation is 10%, due to its high content of histamine. This study demonstrates the value of FPH to the food industry and bridges the theoretical studies with the commercial applications of FPH.

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Abstract
Sustainability of the Food Supply System; Energy, Water and Waste
Dennis R Heldman
Endowed Professor of Food Engineering
The Ohio State University

Future efforts on sustainability of the food supply chain must focus on the improvements in efficiency of energy use, reduced demands for fresh water and a reduction in food waste. There are numerous studies describing the amounts of food waste that occur throughout the food supply system. In developed countries, these wastes are as high as 40% of the raw materials produced. In the U.S., food waste that occurs after the product is delivered to the final consumer are estimated at 21 to 27% of raw food products and ingredients. These food wastes represent significant the significant amounts of energy and fresh water required to produce, manufacture, store, and deliver high quality food products to the consumer.

This presentation will focus on two broad objectives: (1) defining the quantities of energy and water lost as a result of food waste, and (2) a discussion of the scientific challenges to reducing food waste. Although energy and water are wasted due to inefficiencies at all stages of the food supply chain, the magnitude of the waste associated with food waste is cumulative and is most significant at the stage when the product is delivered to the consumer. There are numerous technical challenges to reducing food waste throughout the food supply chain, but the waste that is most evident is food waste encouraged by code date applied to food packages. Real-time shelf-life indicators can overcome the deficiencies associated with code dates and reduce food waste, as well the corresponding wastes of energy and water in the food supply system.

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Survival of *Lactobacillus casei* in low pH fruit juices.

Araceli OLIVARES[1], Ma. Elvira Zúñiga[12].

[1] *Centro Regional de Estudios en Alimentos Saludables - CREAS. Placilla, Sector Curauma, Valparaíso, Chile.*
[2] *Pontificia Universidad Católica de Valparaíso - PUCV. Valparaíso, Chile*

Abstract

One "probiotic" definition is: "A preparation of a product containing viable, defined microorganisms in sufficient numbers, which alter the microflora (by implantation or colonization) in a compartment of the host and by that exert beneficial health effects in this host". The minimum concentration of live probiotic bacteria to exert this effects should be around 10^6 - 10^7 CFU/mL at the expiry date of the product.
The aim of this study was to use microencapsulation technique (using sodium alginate) to confer protection from the acidity of non-dairy product, specifically low pH fruit juice.
Pineapple, raspberry and orange juice pH obtained were 3.28, 2.75 and 3.45, respectively. Natural fruit juices were prepared from fresh fruits. They were used directly from the juice extractor and citrus juicer container, then was pasteurized at 72°C by 90 s.
40 mL of fruit juice was mixed with 4 g of microencapsulated *Lactobacillus casei* (2.3 x 10^7 CFU/g spheres) and maintained in refrigeration conditions (4°C) during 4 weeks. At the end of storage period more than 60 % of microcapsules were recovered from pineapple and orange juice with more than 90% of viability (respect to the initial). Therefore, the microcapsules that remained intact in the juice did not decrease their content of *Lactobacillus*, which confirms that sodium alginate be able to protect them. On the other hand, some probiotics released from microcapsules to media (juice fruit) use media to grow and increase *Lactobacillus* content and get closer to suggested value in the final product.

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Extrusion processing modifies the microstructure and *in vitro* digestibility of broken rice

Wenhan YANG, Xingqian YE, **Jinhu TIAN***
Zhejiang University, Hangzhou, China
* Corresponding author: Jinhu Tian

Abstract
During rice dehulling and polishing, about 14% of the rice will be broken. How to utilize those low-value broken rice effectively is a critical issue for the rice industry. In this study, extrusion technology was used to restructure the broken rice. The morphology, molecular structure and digestibility of intact, broken and extruded rice were investigated with scanning electron microscopy (SEM), X-ray diffraction (XRD), Fourier transform infrared (FTIR) as well as a simulated *in vitro* gastrointestinal digestion model. The extruded rice showed a rough surface with more crinkles than that of the intact and broken rice, while XRD and FTIR analysis indicated that the extrusion processing decreased the crystalline structure of broken rice and transformed its diffraction type from an A-type to a mixture of B- and V-types. The equilibrium starch hydrolysis (%) and kinetic constant of broken rice was significantly higher than that of the extruded rice, 80.90 %, 6.42×10^{-2} (min^{-1}) and 76.10%, 2.91×10^{-2} (min^{-1}), respectively. Our results indicated that extrusion processing could modify the microstructure and digestibility of rice effectively, and could be an optional way to produce staple rice with lower digestibility.

Keywords: broken rice, extrusion, crystallinity, microstructure, *in vitro* digestibility

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A new aspect of food rheology on postprandial stage

Yukiharu OGAWA[1], Olaniyi Amos FAWOLE[2], Takahisa NISHIZU[3], Jinhu TIAN[4], Sunantha KETNAWA[1], Jaspreet SINGH[5]

[1]*Chiba University, Matsudo, Japan*
[2]*Stellenbosch University, Stellenbosch, South Africa*
[3]*Gifu University, Gifu, Japan*
[4]*Zhejiang University, Hangzhou, China*
[5]*Massey University, Palmerston North, New Zealand*

Abstract
The rheological property is usually recognized as one of the most important parameters to evaluate food qualities on processing and eating. It has been studied by both mathematical and empirical approaches using novel technologies. Meanwhile, food digestibility is currently spotlighted due to its health impact. Although it is generally considered that a foodstuff is completely changed to a fluid at the gastric digestion stage, food matrix, particularly plant-based food matrix, remains its structural formation at least at the early small-intestinal digestion stage. The indigestible portion of digesta like cell wall matrix usually shows rheological attributes such as viscoelasticity and it could connect to the bioaccessibility of digestive enzyme and the bioavailability of nutrients in the matrix. A simulated in vitro digestion model which mimics the human digestive tract is an appropriate device to produce the mimicked digesta and digested fragments. It can also produce the digested samples through the simulated digestion. To measure the rheological attributes of soft materials like digested fragments, some novel technologies such as the resonance ultrasound spectroscopy can currently be applied. Thus, the combination of those devices and techniques could examine the change of rheological properties of digesting samples that would concern with the kinetics of nutrients during digestion. A new aspect of rheological properties connecting to nutritional attributes of plant-based food will be suggested and discussed. The trial approaches for applying mathematical modeling to the evaluation of rheological properties of digesta will be attempted as well.

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Influence of whey protein isolate-gum Acacia conjugate on the physicochemical stability and in vitro bioaccessibility of β-carotene emulsion

Weijun CHEN[1], Donghong LIU[1, 2,] *, Jianwei ZHOU[3]

[1]*College of Biosystems Engineering and Food Science, Zhejiang University, Hangzhou, China*
[2]*Fuli Institute of Food Science, Zhejiang University, Hangzhou, China*
[3]*Ningbo Institute of Technology, Zhejiang University， Ningbo, China*

Abstract
Due to its good emulsifying properties, whey protein isolate (WPI) is extensively used in oil-in-water emulsions based delivery systems. However, the stability of proteins stabilized emulsions is easily influenced by the environmental conditions (such as pH, ionic strength, temperature and so on). Previous reports have proved that Maillard based reaction could improve the characteristics and functionalities of proteins. So the focus of this work is to evaluate the effect of WPI-gum Acacia (GA) conjugates prepared by different methods (dry heating and ultrasound Maillard reaction) on the physicochemical stability and bioaccessibility of β-carotene emulsions in the gastrointestinal tract. Mean size of β-carotene emulsions stabilized with WPI-GA conjugates (about 300 nm) were significantly higher than that stabilized with WPI (239.6 nm). However, the conjugates stabilized β-carotene emulsions showed improved stability to environmental stresses (ionic strength, heating, freeze-thaw treatment and UV light), lower β-carotene degradation rate during storage at 5, 25, 37 and 55 ℃ and higher bioaccessibility in vitro digestibility. For the β-carotene emulsions stabilized with WPI-GA conjugates obtained from dry heating and ultrasound Maillard reaction, the former exhibited better thermal stability and higher bioaccessibility in vitro digestibility, while the latter showed better redispersibility and β-carotene retention during storage. The information obtained in this study will facilitate the development of food-grade delivery systems for protecting chemically labile lipophilic bioactive compounds and their better application in functional foods.

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Opportunities and challenges in application of forward osmosis in food processing

Navin K RASTOGI

Department of Food Engineering, CSIR-Central Food Technological Research Institute, Mysore - 570 020, INDIA. A constituent laboratory of Council of Scientific and Industrial Research, New Delhi

Abstract
Food processing and preservation technologies must maintain the fresh like characteristics of the food while providing an acceptable and convenient shelf life as well as assuring safety and nutritional value. Besides, the consumers demand for highest quality convenience foods in terms of natural flavor and taste, free from additives and preservatives necessitated the development of a number of membrane based non-thermal approaches to the concentration of liquid foods, of which forward osmosis has proven to be most valuable. A series of recent publications in scientific journals have demonstrated novel and diverse uses of this technology for food processing, desalination, pharmaceuticals as well as for power generation. Its novel features, which include the concentration of liquid foods as at ambient temperature and pressure without significant fouling of membrane made the technology commercially attractive. This review aims to identify the opportunities and challenges associated with this technology. At the same time, it presents a comprehensive account of recent advances in forward osmosis technology as related to the major issues of concern in its rapidly growing applications in food processing such as concentration of fruits and vegetables juices (pomegranate, grape, pineapple, red raspberry, orange, tomato Juice and red radish juices) and natural food colorants (anthocyanin and betalains extracts). Several vibrant and vital issues such as recent developments in the forward osmosis membrane and concentration polarization aspects have also been addressed. The asymmetric membrane used for forward osmosis poses newer challenges to account both external and internal concentration polarization leading to significant reduction in flux. The recent advances and developments in forward osmosis membrane processes, mechanism of water transport, characteristics of draw solution and membranes as well as applications of forward osmosis in food processing have been discussed.

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Emerging technologies for designing novel foods

Navin K RASTOGI

Department of Food Engineering, CSIR-Central Food Technological Research Institute, Mysore - 570 020, INDIA. A constituent laboratory of Council of Scientific and Industrial Research, New Delhi

Abstract

Consumers' demand for the highest quality convenience foods in terms of natural flavor and taste, free from additives and preservatives necessitated the development of a number of non-thermal approaches to processing of plantation products, out of which high pressure and pulsed electric field have proven to be the most valuable. In recent years, there has been a significant increase in the number of scientific papers in literature demonstrating novel and diversified uses of these technologies – thus these technologies can be considered as new and prominent emerging technologies. Destruction of microorganisms, inactivation of enzymes at low or moderate temperatures without changing organoleptic and nutritional properties, as well as recent commercial success stories show that these technologies have a great potential, which can be used for the development of diversified value-added food products with exciting opportunities for industry such as products with novel physicochemical and sensory properties. The effect of high-pressure technology and pulsed electric field on the quality and safety of foods will be discussed. A brief account of the challenges in adopting these technologies will also be included.

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Extrusion: a tool for Food Innovation

Gilles MALLER

Clextral, Firminy, France

Twin-screw extrusion was first introduced to the plastic industry in the 1950's and then transitioned to the food industry in the early 70's to precook flours and process flat crispy bread.

Since then, this technology has been leveraged in the food and feed areas and has been key to the global development of mainstream food products including breakfast cereals and snacks, additionally, pet food and fish feed. Extrusion is also a key tool in the ingredient industry, for instance, to make encapsulated flavors. Today, hundreds of food items are produced using twin-screw extrusion technology.

Extrusion remains at the forefront of innovation today and two current examples will be discussed:
- Protein fibration: or how to make truly meat-like products from pea, soy, or other protein-rich seeds, to cater to the rapidly growing market for plant-based meals;

- EPT™ or Extrusion Porosication Technology: an innovative drying process where a twin-screw extruder is connected to a spray dryer to dry high solid materials while conferring unique properties to the powder.

We can see that whilst twin-screw extrusion has become a well-used technology in many industries, it is still a unique and exciting tool to develop new products and processes.

Free radical detection in water and herb extracts after processing by high voltage electrical discharges and high power ultrasound

Shikha OJHA[1], Marinela NUTRIZIO[2], Nadica MALTAR-STRMEČKI[3], Brijesh TIWARI[1], **Anet REŽEK JAMBRAK[2]**

[1] *Teagasc - Irish Agriculture and Food Development Authority, Department of Food Biosciences, Carlow, Ireland*
[2] *Faculty of Food Technology and Biotechnology, University of Zagreb, Zagreb, Croatia*
[3] *Rudjer Boskovic Institute, Division of Physical Chemistry, Laboratory for Magnetic Resonances, Zagreb, Croatia*

Abstract
Formation of radicals by nonthermal processing can be good in order to inactivate microorganisms, for wastewater treatments, for dyes destruction, for oxidative processes, chemical synthesis, formation of plasma activated air (PAA) or water (PAW), but on the other hand it can deteriorate quality of some food products, extracts etc. In this study, the influence of sonification of water on the formation and stabilization of hydroxyl radicals has been investigated by Electron spin resonance (ESR) spectroscopy and spin-trapping method. Sonication was done using ultrasonic processor (S-4000, Misonix Sonicators, Newtown, Connecticut, USA), set at 600 W, 20 kHz, 12–260 µm with different probes. Probes of 1.6 mm and 6.4 mm were used in order to observe influence of different ultrasound power on formation of hydroxyl radicals. Ultrasonication was carried out with 50, 75 and 100 % amplitude, for 1, 3 and 5 min. High voltage electrical discharge-plasma (HVED) is one of new promising green techniques for extractions. Plasma generator IMP-SSPG-1200 (Impel group, Zagreb, Croatia) was used for extractions of bioactive compounds from herbs in different solvents. Optimization of processing extraction parameters (argon and nitrogen gases for generation of plasma, voltage – 15kV, 20kV and/or 25kV), frequency (100Hz), pulse duration (400 ms) and treatment times (3 and 9 min) was done using software STATGRAPHICS. Results showed that number of radicals is increasing with treatment time and increase in amplitude, and the reduction in their number is smaller at samples stored at 4°C after treatments, than for those stored at room temperature after treatments. For extracts, radical scavenging activity of extract was monitored. The remaining DPPH radicals, expressed as a percentage, showed that is some treatment runs, especially with nitrogen there was less % of left DPPH radicals in samples that means that phenolic compound form extracts chemical bonded with DPPH.

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Impact of Temperature Fluctuation on Relative Humidity and In-package Condensation of Strawberries Packed Under Modified Atmosphere and Humidity Packaging

Graziele GROSSI BOVI, Pramod MAHAJAN
Department of Horticultural Engineering, Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), Potsdam, Germany

Strawberries are perishable commodities due to its high respiring and transpiring rates. Improved packaging could enable shelf-life extension of strawberries; nevertheless, water vapor evolution inside fresh produce packages often limits product´s shelf-life due to condensation. This excess water represents a threat to the product quality and safety as it stimulates growth of microbial activity resulting in reduced shelf-life. In this context, this research work targets to evaluate the performance, under fluctuating temperature, of two innovative approaches for modified atmosphere and humidity packaging (MAHP) of strawberries. The moisture regulation systems for MAHP tested were: i) the use of enhanced water vapour permeable films (NatureFlex and XTend) and ii) the use of humidity controlling cellulose pads with different amounts of fructose (0, 20, and 30%). Mass loss of strawberry, in-package condensation, water absorbed by pads, and water transmitted through packaging material were quantified after 5 d of storage under fluctuating temperature. Results showed that both strategies were effective in reducing condensation as compared to control samples. The use of NatureFlex film, however, led to higher mass loss (3.68%) as compared to other strategies (0.6-1.7%). In addition, results also evidenced how adequate temperature control plays an import role in the regulation of humidity in fresh produce packaging as it affected humidity directly.

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Crack in rusks: modelling and simulation of stress and displacement fields

Jean-Yves MONTEAU[1,2], Luc GUIHARD[1,2], Alain LE BAIL[1, 2]

[1]*GEPEA UMR CNRS 6144, Nantes, France*
[2]*Oniris, Nantes, France*

Abstract
Crack during storage is a recurrent problem in the dry cereal products industry (rusks, biscuits, crackers...). The aim of this work is to understand how mechanical stresses develop during storage. For this purpose, a model was developed with Comsol Multiphysics to visualize the changes of the water content and of the stress and displacement fields during one week of storage. The parameters required for the modelling are in particular the mass diffusivity, the hygrometric expansion coefficient, the Young's modulus and the Poisson's ratio of rusk. Specific measurement methods were developed to obtain these data such as a dilatation bench and observation of the material undergoing compression test. A first model was developed assuming an isotropic material. The results showed that the water content is almost equalized throughout the rusk over one week of storage. A second model including the presence of cells in the structure showed that the stresses tend to be higher around the cells. The rusk tends to shrink during storage with small strain. The calculated stress reach high values close to the rupture stress. As a conclusion, rusk breakage seems to be closely linked to the cellular structure of the crumb of the bread used to produce rusk. The mitigation of rusk crack requires a good control of the uniformity of the cellular structure of the crumb without large cells.

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Food supply chains as cyber-physical systems: a path for more sustainable personalized nutrition

Sergiy SMETANA, Kemal AGANOVIC, Volker HEINZ
German Institute of Food Technologies (DIL e.V.), Quakenbrück, Germany

Abstract

Current food system evolved in a great degree because of development of processing technologies: people learned to bake bread long before the advent of agriculture; salting and smoking supported nomad life styles; canning allowed for longer military marches, etc. Food processing technologies went through evolution and optimization and rely on minor fraction of energy comparing to initial prototypes. Emerging processing technologies (high-pressure, pulsed electric fields, ohmic heating, shockwave) and novel food systems (cultured biomass, 3-d bioprinting, cyber-physical chains) try to challenge the existing chains by developing potentially more nutritious and sustainable food solutions. However, new food systems rely on low technology readiness levels and estimation of their potential future benefits or drawbacks is a complex task mostly due to the lack of integrated data. The research is aimed to develop an algorithm for the design and assessment of novel food production chains based on cyber-physical approaches and developed conceptual sustainability assessment models.

The study indicates that cyber-physical nature of modern food is a key for the engineering of more sustainable paths for novel food systems (cultured foods, urban agriculture, personalized nutrition). Implementation of machine learning methods to the collection, integration and analysis of data associated with biomass production and processing on different levels (from molecular to global) led to the precise analysis of food systems and estimation of upscaling benefits as well as negative rebound effects associated with societal attitude. Moreover, such data-integrated assessment system allows transparency of chains, integration of environmental and nutritional properties, construction of personalized nutrition technologies.

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PREDICTING THE CRYSTALLISATION OF SUGAR IN RAISINS: STATE-DIAGRAM CONSTRUCTION

Bhesh BHANDARi[2], Deepa DAHAL[2], Tuyen TRUONG[2], Sergio ALMONACID[1,3], Paulina URRUTIA[1], María Elvira ZÚÑIGA[1,4] and **Lorena ALVAREZ**[1.]

[1] Centro Regional de Estudios en Alimentos Saludables-CREAS-, Valparaíso, Chile
[2]University of Queensland, Brisbane, Australia
[3] Universidad Técnica Federico Santa María, Valparaíso, Chile
[4] Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile

Keywords: Crystallisation, sugar in raisins, state diagram

Abstract
Crystallization of sugars in raisins is a well-noticed phenomenon. This defect makes the fruits look mouldy or having infested by insects although this is purely due to the crystallization sugar.
Sugar crystallization is a major problem in exportation of raisins and these results show that the problem is mainly due to storage and transportation conditions. The state of diagram is key to stablish a mechanism to control crystal growth rather to avoid its initial nucleus formation.

The aim of this study was to experimentally determine the state-diagram and the isothermal sorption of three varieties of raisin (Flame, Thompson, Golden).

The thermal transition of the different samples was estimated by Differential Scanning Calorimetry (DSC1, Mettler Toledo). Tg varied from -20 to -60°C at a water activity of 0.25 and 0.7, respectively, and non-significant differences were found among all three varieties ($p<0.05$). The water activity of raisins was 0.51, 0.56, and 0.54 for Flame, Thompson and Golden, respectively, corresponding to a Tg of -37, -42, and -41°C, respectively. Tg values were adjusted to Gordon-Taylor model, giving a k value of 2.45, 2.54, and 2.26 for Flame, Thompson and Golden, respectively.

Raisin variety does not affect significantly their Tg, obtaining values close to -40°C for the final products. Storage and transportation temperature varies from 15 to 30°C approximately, consequently, rubbery state could not be avoided. The state of diagram will allow to stablish a mechanism to control crystal growth rather to avoid its initial nucleus formation.

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Pathways to reducing water-scarcity impacts from Australian food consumption

Brad RIDOUTT[1], Danielle BAIRD[2], Kimberley ANASTASIOU[2], Gilly HENDRIE[2]

[1]*Commonwealth Scientific and Industrial Research Organisation (CSIRO) Agriculture and Food, Clayton South, Victoria, Australia*
[2]*CSIRO Health and Biosecurity, Adelaide, South Australia, Australia*

Abstract
Water scarcity is a major global environmental concern, identified in Target 6.4 of the United Nations Sustainable Development Goals, and the food system is a critically important intervention point, being responsible for around 70% of global freshwater use. In this study, life cycle assessment was used to model the water-scarcity footprints of 9,341 individual Australian adult diets obtained through 24-hour recall as part of the most recent Australian Health Survey. In addition, a diet quality score was calculated for each of these diets. Our objective was to identify pathways toward healthier diets with lower water-scarcity impacts. Dietary water-scarcity footprints averaged 362 L-eq person^{-1} day^{-1} and were highly variable (sd. 218 L-eq person^{-1} day^{-1}), reflecting the diversity of eating habits in the general community. The potential to reduce dietary water-scarcity impacts is therefore large, although the opportunity to intervene through amended dietary guidelines is not straightforward due to the large variations in water-scarcity footprint intensity between individual foods within a food group, and the inability of consumers to identify lower water-scarcity footprint products without additional food labeling. Reductions in the water-scarcity footprint of Australian food consumption are likely best achieved through reductions in food waste, technological change to improve water-use efficiency in food production, as well as the implementation of product reformulation and procurement strategies in the food manufacturing sector to avoid higher water-scarcity footprint intensity ingredients.

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Innovations in Recyclable Polymers

Claire SAND, Ph.D.[1 2 3]
[1] Owner, Packaging Technology and Research
[2] Adjunct Professor at Michigan State University
[3] California Polytechnic University

The circular economy is the focus of much packaging innovation. Recent circular economy goals established by CocaCola, Kraft Heinz, McDonalds, Danone, Nestle, Unilever, and many other food companies relate to the amount of their packaging that will be recycled or the amount of recycled content that will be used in their packaging. American Chemistry Council's (ACC) Plastics Division has announced two ambitious goals: that 100% of plastic packaging is recyclable or recoverable by 2030, and 100% of plastic packaging is reused, recycled or recovered by 2040. European plastics manufacturers are committed to ensuring high rates of reuse and recycling with the ambition to reach 60% for plastic packaging by 2030 with a goal of 100% reuse, recycling and recovery of all plastics packaging at European level by 2040. The circular economy requires recyclable and reusable packaging. However, concern with migration of non-intentionally added and intentionally added substances limits the use of recycled plastic in direct food contact, especially for the polyolefins (Geueke et al., 2018). And, recycling has unintended environmental costs (Zink & Geyer, 2018). Thankfully, to enable recycle-ready clean polymers, innovations in design, material science, and chemical recycling can provide economically effective solutions. And, packaging that enables separation of different packaging components for easy sorting, adhesives to assist with the separation of multilayer flexible packaging at recyclers, and compatabilizers to ease sorting woes. These polymer science and package systems solutions will be shared.

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Techno-economic analysis of the enzymatic production of dairy oligosaccharides for nutritional supplements

Masih KARIMI ALAVIJEH[1], Sandra E. KENTISH[1], Anne S. MEYER[2], Sally GRAS[1]

[1] *Department of Chemical Engineering, The University of Melbourne, Melbourne, Australia*
[2] *DTU Bioengineering, Technical University of Denmark, Kongens Lyngby, Denmark*

Abstract

Functional oligosaccharides that can mimic those found in human milk are of great value to the infant formula market. There is a lack of published data, however, describing the large-scale production of such compounds. In this study, the economic feasibility of an enzymatic synthesis process for the production of a key building block of human milk oligosaccharides, N-acetyllactosamine (Galβ(1-4)-GlcNAc; LacNAc), from dairy derived lactose was evaluated. Processes were simulated based on the use of either of the three thermostable β-galactosidases from *Bacillus circulans* (BgaD-D), *Thermus thermophilus* HB27 (Ttβ-gly) or *Pyrococcus furiosus* (CelB) to catalyze LacNAc synthesis from lactose (a donor) and N-acetylglucosamine (GlcNAc) (an acceptor). Two downstream processing options, based on chromatography and selective crystallization techniques, were also designed and compared. While the enzyme CelB has greater stability at higher temperatures, this enzyme gives a lower LacNAc yield (5.4%), leading to significant capital investment. Project profitability improved if the unreacted GlcNAc was recovered when the price of GlcNAc was over $10 per kg. For the design based on BgaD-D, the replacement of chromatography with selective crystallization reduced the minimum selling price of LacNac from $5 to $2 per gram. Reducing the acceptor to donor ratio (from 10 to 4) and increasing the lactose concentration (from 17 to 200 g/L) also led to a reduction in the process costs by between 5% and 25%. In particular, the use of lactose concentrations greater than 100 g/L avoided the need for a concentration process prior to crystallization.

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Continuously distributed glass transition and caking of maca (*Lepidium meyenii Walpers*) powder

Alex Eduardo ALVINO GRANADOS[1], Yoshio HAGURA[1], Kiyoshi KAWAI[1]

[1] *Graduate School of Biosphere Science, Hiroshima University, Hiroshima, Japan*.

Abstract

Maca (*Lepidium meyenii Walpers*) is a functional tuber that is mostly processed into an amorphous powder. Hence, it is expected that its physical stability can be controlled based on the glass transition temperature (T_g). Although maca is an outstanding food source, its glass transition and related properties have not been reported. Therefore, the water sorption, glass transition, and caking of maca were investigated. Maca powder was vacuum-dried and equilibrated at various water activity (a_w) at 25°C. Water sorption isotherm was evaluated gravimetrically. T_g was investigated by differential scanning calorimetry (DSC). Mechanical relaxation was studied in a texture-meter under 80 N compression for 3 min at 25 °C. For caking, equilibrated samples were vacuum-dried and sieve-shaken in a 1.4 mm mesh. Hardness of dry cakes was evaluated as a maximum fracture force in a texture-meter. A broad endothermic shift reflecting contentiously distributed glass transition was detected from DSC thermogram, and thus T_g^{onset} and T_g^{offset} were evaluated. Furthermore, each critical water activity (a_{wc}) was determined as the a_w of which T_g becomes 25°C. The a_{wc} determined by T_g^{onset} was validated by mechanical relaxation measurement. Hardness of the cakes increased above a_{wc} determined by T_g^{offset}. Degree of caking drastically increased at a higher a_w than a_{wc} determined by T_g^{offset}. Taking the fact that maca showed contentiously distributed glass transition into account, it is thought that stickiness required for the caking of maca powder will have gradually increased with increase in a_w.

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Technical-scale extraction of bovine αS-, β- and κ-casein using decanter technology

Thomas SCHUBERT1, Remko BOOM2, Jörg HINRICHS1, Zeynep ATAMER1

1University of Hohenheim, Institute of Food Science and Biotechnology, Department of Soft Matter Science and Dairy Technology, Stuttgart, Germany
2Wageningen University, Laboratory of Food Process Engineering, Wageningen, Netherlands

Abstract
The isolation of individual casein fractions are of growing interest because of their multifunctional applications and clean-label status. The different fractions of caseins (αs-, β- and κ-) deliver a wide range of bio- and techno-functional properties, most notably β-casein as a precursor for a variety of bioactive peptides. Though several isolation and purification methods are available, there is still need for improvement, especially on a technical scale. The proposed separation processes mostly use batch separation techniques. The aim of this study was to develop a continuous process for the fractionation of caseins. The use of a decanter enables continuous separation and has the advantage of a relatively simple scale up.
The fractions were obtained from micellar casein powder by means of selective precipitation (1) and the separation process was performed using a temperature-controlled decanter centrifuge. The separation process of the fractions was optimized by changing the operational parameters of the decanter (e.g., weir bore inner diameter, rpm, differential speed, flow rate).
A method for the technical-scale isolation of casein fractions from micellar casein is described in detail and the reproducibility of the method is assessed. Using micellar casein, a purified β- casein fraction can be obtained at a large scale via the proposed method outlined in this study. A
purity of up to 95 % for the β-casein fraction and purities of up to 61 % and 54 % for αs- and κ-casein can be achieved, respectively. Further work is in progress to optimize these fractions of αs- and κ-casein.

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Application of air nanobubble water for the improvement of microalgae culture

Jiangyu ZHU[1], Minato WAKISAKA[1]

[1]*Graduate School of Life Science and Systems Engineering, Kyushu Institute of Technology, Kitakyushu, Japan*

Abstract

Microalgae are microscopic algae widely distributed in water ecosystems, and has extensive application in food, supplement and pharmaceutical fields. However, their slow growth rate is considered as a major limitation to achieve commercial large-scale cultivation. Air nanobubble water technology is a novel and promising tool to overcome some of the microalgae's exploitation limitations as the air bubbles with long lifetime has a variety of physiological and biochemical functions and inside contains sufficient dissolved oxygen. In addition, nanobubble water (NBW) technology is cost-effective and environmentally friendly given that no additional chemicals and other non-renewable resources are used. In this research, effect of NBW on the growth and metabolism of different microalgae, including *Haematococcus lacustris*, *Botryococcus braunii* and *Arthrospira platensis* was investigated. The result demonstrated that the growth of *H. lacustris* and *B. braunii* was increased by NBW and the highest promotion ratio was up to 44% and 26%, respectively. For *H. lacustris*, the astaxanthin content in the NBW treatment group was also improved compared to the control group. As the main product of *B. braunii*, the proportion of lipids in dry matter of NBW treatment groups was decreased, but the total lipids production was still significantly higher than that of the control group. However, there was no substantial variation in the growth of *A. platensis*, indicating that the effect of NBW on microalgae varies from species to species. In general, NBW might be the potentially effective tools to promote the growth of microalgae in the future.

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The rheology of partially crystalline palm kernel oil with regard to a dynamically enhanced membrane foaming application

Kim MISHRA[1], Damien DUFOUR[2], Erich J. WINDHAB[1]

[1]*Laboratory of Food Process Engineering ETHZ, Zürich, Switzerland*
[2]*Ubertone, Schiltigheim, France*

Abstract
In a first step, the influence of shear rate during crystallization on the rheological and morphological properties of partially crystalline palm kernel oil was investigated by using the in-line ultra sound velocimetry – pressure difference method and polarized light microscopy. In a second step, the partially crystalline palm kernel oil was foamed by using a dynamically enhanced membrane foaming apparatus. Within the investigated solid fat content range of 0.5 – 14% the system behaved like a suspension and was fitted with the Krieger-Dougherty[1] model. The fitted intrinsic viscosity [η] matched qualitatively with the crystal morphology. With increasing shear rate crystal morphology changed from spherical to needle like and the intrinsic viscosity [η] increased. A critical crystal concentration Φ_{ccc} for the formation of a yield stress τ_0 was observed. The yield stress τ_0 as function of the solid fat content was fitted with the model proposed by Marangoni and Rogers[2] by varying the primary particle size *a* which decreased with increasing shear rate during crystallization. Foams produced close to the critical crystal concentration Φ_{ccc} showed highest gas fractions Φ_g whereas the number weighted mean bubble size $x_{50,0}$ was only dependent on the acting shear stresses τ during bubble dispersion.

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Determining the level of freshness of vegetable oils by means of optical spectroscopy and volatile analysis

Alain CLÉMENT[1], **Martin MONDOR**[1,*], Hassan SABIK[1], Carole McKINNON[1], Hélène DROLET[1], Louis-Philippe DES MARCHAIS[1], Sébastien VILLENEUVE[1]

[1]: Saint-Hyacinthe Research and Development Centre, Agriculture and Agri-Food Canada, Saint-Hyacinthe, Quebec, Canada

*: Corresponding author: tel. 450-768-7915; e-mail: Martin.Mondor@agr.gc.ca

Engineering Properties of Food and Packaging: Poster presentation

Vegetable oils have been used for a long time as a food ingredient. They range, in commercial and nutritional value from refined low cost commodities to high value cold pressed oils with specific aromas. The quality of vegetable oils relates to its organoleptic value and its freshness. But vegetable oil loses its quality through time due to unavoidable oxidation, leading eventually to rancidity. Optical spectroscopy methods were used to determine the level of freshness of canola oil. It was found that simple auto-fluorescence measurements made at six excitation wavelengths allowed for a quantitative assessment of the level of oxidation (r^2_{CV}= 0,95). Results are obtained in one minute, as compared to three hours for the reference method (Rancimat™). The method was extended to other types of vegetable oils, either refined or first pressed, including soybean, corn, sunflower, olive, peanut, or commercial blends. It was found that a rapid assessment of vegetable oil freshness can be obtained. It is very robust to the type of oil (r^2_{CV}= 0,91), allowing for the determination of three categories: 'rancid', 'slightly oxidized', and 'fresh'. A volatile analysis by GCMS was done on a number of vegetable oil samples that were fresh or oxidized in a controlled manner. Few volatiles, like D-limonene or sulcatone (citrus smell) were identified in fresh refined oils. First press canola oil, however, contains large amounts of pleasant smells from 1 hexanol or ethyl acetate. In the process of oxidation, these compounds disappear and acetic acid, and various aldehydes (like hexanal) are produced.
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Porifera forward osmosis technology and applications

Olgica **BAKAJIN**[1]

[1]*Porifera, Inc., San Leandro, CA, United States*

Abstract

Porifera's PFO Membrane systems can concentrate streams with high osmotic pressures and suspended solids in food and beverage processing, including; fruit juice, coffee, and dairy process streams. Porifera's innovations include a new high flux, high selectivity forward osmosis (FO) membrane combined with a new element and system designs that are ideal for FO processing. Our non-thermal membrane technology can create concentrates where most membrane processes fail, while maintaining the product's original flavors and colors. The advantages of Porifera's PFO technology include low head-loss, reduced footprint, and both co-current and counter-current processing. Porifera has also developed FO membrane systems with draw recovery for high osmotic pressure processing, competing with thermal evaporators. This talk will provide latest information on Porifera's PFO technology and applications, and discuss results of Porifera's recent commercial activities in food and beverage processing.

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ICEF13

Manipulation of water droplet size in structuring novel water-in-oleogel system

Yuxuan HUANG[1], Jayani CHANDRAPALA[1], **Tuyen TRUONG**[1]

[1]*School of Science, RMIT University, Melbourne, Australia*

Abstract

Edible oleogels possess solid-like structure in which a three-dimensional network of food related biopolymers entraps liquid oil within. This work aimed to develop a novel water-in-oleogel system where water droplets having different sizes and aqueous components were dispersed into oleogels. The oleogels were prepared via gelation of vegetable oil (85 % w/w) with monoacylglycerols (5 % w/w). Water phase (10 % w/w) containing either sodium caseinate, whey protein isolate or lactose was added into liquid oleogel samples prior to their setting. Stabilisation of water droplets was achieved with hydrophobic emulsifiers whereas varying water droplet size was obtained by using different homogenization techniques. All resultant water-in-oleogel samples were characterized in terms of hardness, rheological behaviour, thermal properties, microstructure, crystal size/morphology and oil leakage using texture analyzer, rheometer, DSC, confocal laser scanning microscopy, polarized light microscopy and oil loss test, respectively. In general, the water droplet size and the aqueous components influenced measured properties of the water-in-oleogel samples. The sub-micron water droplet size improved the physical properties of the water-in-oleogel with increased hardness and rheological moduli. The water droplet size and dynamics of water confined in the differentiated-sized water-in-oleogels were also studied using low field nuclear magnetic resonance. Measurements on spin-spin transverse relaxometry (T_2) showed that smaller water droplet size caused a significant reduction of free water mobility as reflected by shorter T_{23} relaxation times. The knowledge gained from this study can be beneficial to design and structure various low-fat food matrices.

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Examination of Curry Sauce Excluding Wheat and Dairy Products

Naomi SHIBATA-ISHIWATARI[1], Akari KOUGO[1]

[1]*Gifu University, Gifu, Japan*

Abstract

The incidence of food allergies has increased in recent years. Wheat and dairy products are used as a thickener in various sauces. Here, we aimed to examine a substitute thickener of curry sauce without wheat and dairy products.

In standard curry sauce, wheat and margarine are used. In this study, potato starch (PS) or corn starch (CS) was used as the substitute thickener. Changes in viscosity were measured when the temperature of each sample decreased (45-60 ºC). We examined the thickener which mixed PS and CS, because the temperature dependency of both the PS and CS sauce was different from the standard. From the Arrhenius plot, we calculated the activation energy and frequency factor of the various mixed sauce. Then, it turned out that the activation energy of mixed sample could be estimated based on the mixing ratio and the activation energies of the PS only sauce and the CS only sauce. The calibration curve of the pre-exponential factor by inserting the activation energy of mixed sample was constructed, because there was not regularity about it of the mixed sample. The prediction value of viscosity which was calculated using the estimated parameters was almost same as the experimental value in various mixing ratios. Furthermore, when mixed in the ratio of 15% PS and 85% CS, the temperature dependency accorded with standard sauce.

Converting the viscosity of the substitute thickener into a mathematical formula may contribute to food safety and food selection for individuals with food allergies.

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Why are fruit juices homogenized?

Andreas HÅKANSSON[1], Ulrich KOPPMAIER[1], Eva TORNBERG[1], Fredrik INNINGS[1,2]

[1]*Lund University, Lund, Sweden*
[2]*Tetra Pak Processing Systems, Lund, Sweden*

Fruit drinks such as tomato juice and apricot nectar are often produced by diluting a concentrate (puree) with water (and sometimes adding sugar), followed by mixing and high-pressure homogenization at an intermediate pressure (~15 MPa). Producers claim that the homogenization increases consumer acceptance but the exact effect is quite unclear. Despite the wide use of homogenization on fruit juices, the topic has received little scientific interest.
The objective of this study was to investigate the effect of homogenization of fruit juice concentrate based juices (tomato and apricot) at different homogenizing pressures (5 – 30 MPa) using a HPH designed to be similar to the production-scale machines [1]. Characterizations included particle size determination (light diffraction and microscopy), rheological investigations and use of a hedonic sensory panels. It is concluded that homogenization reduces the size of the cell wall fibers; a relatively low pressure (5-10 MPa) is enough for breaking the cells. The yield stress and apparent viscosity of the suspension increases with the applied homogenizing pressure. This is interpreted as an effect of the higher surface to volume ratio for these smaller fibers, thus creating more possibilities for entanglement and network formation, as has been suggested previously for similar systems [2]. The sensory panel report an increased hedonic liking for the homogenized juices compared to the homogenized. However, the liking was reduced if using too high homogenizing pressure. The results indicate high-pressure homogenization of fruit juices can improve liking by increasing the mouthfeel.

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The fluid mechanics of mayonnaise mixers – the effect of stator slot width

Andreas HÅKANSSON[1], Hans Henrik MORTENSEN[2], Fredrik INNINGS[1,2]

[1]*Lund University, Lund, Sweden*
[2]*Tetra Pak Processing Systems, Lund, Sweden*

Abstract
Rotor-stator mixers (RSMs) are used for emulsion formation in food processing, e.g. in mayonnaise formation. The batch RSM consists of a set of rotor blades mounted inside a slotted static stator screen submerged in a tank. The rotor draws in fluid axially and accelerates it tangentially. When the fluid meets the stator screen it is re-directed radially and forms a turbulent jet extending out from the stator screen slots [1]. Rotor and stator designs differ between manufacturers and each manufacturer offers a range of stator geometries. Despite long industrial use, the fluid dynamics of RSMs is poorly understood.
In this study, the flow in the rotor-stator region was measured using 2D PIV for four stator slot widths (2.2 – 6.4 mm). A sub-grid scale modelling approach was used to estimate local dissipation rates of turbulent kinetic energy [2]. The total shaft power draw of the rotor increases with decreasing slot width. This is expected since decreasing the slot width increases the wall friction and increases the total flow through the stator screen [3]. However, the local dissipation rate of TKE is found to be substantially higher for the wider gaps. This can be understood from the velocity field. The wider gaps give rise to a larger recirculation zone inside the slot and, therefore, a narrower radial jet and steeper velocity gradients. In conclusion, the wider slots give rise to a lower total power-draw and higher levels of local dissipation rates of TKE, and are therefore more beneficial for mixing and dispersion.

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Efficacy of low energy X-ray irradiation in inactivating mono- and co-cultures of Listeria monocytogenes and Pseudomonas fluorescens on different food-contact-surfaces and its modeling

Hongfei ZHANG[1], Xinyi PANG[1], Hon Luen SECK[2], Weibiao ZHOU[1]
[1]*Food Science & Technology Programme, National University of Singapore, Singapore, Singapore*
[2]*A*STAR Singapore Institute of Manufacturing Technology, Singapore, Singapore*

Abstract
Low energy X-ray possesses a high linear energy transfer effect and correspondingly a high relative biological effect, which has potential to inactivate biofilm cells. This study assessed the inactivating kinetics of low energy X-ray against mono- and co-cultures of *Listeria monocytogenes* (Lm) and *Pseudomonas fluorescens* (Pf) biofilm cells on three different food-contact-surfaces (polyethylene, acrylic, and stainless steel). The results indicated that the level of biofilm formation of mono- and co-cultures of Lm and Pf was higher on the rougher and more hydrophilic surface (i.e. stainless steel) than those on the smoother and more hydrophobic surfaces (i.e. polyethylene and acrylic) ($p < 0.05$). The mono-cultured Lm exhibited higher resistance than the corresponding mono-cultured Pf, regardless of surface type. Furthermore, co-culture had enhanced the biofilm resistance of both Pf and Lm.Various kinetic models for the inactivation process were investigated, including: (i) first-order model, (ii) Shull model, and (iii) Weibull model. From the R^2 values and AIC analysis results, the first-order model provided a more accurate fit for the inactivation curves of the mono-culture of both Pf and Lm on the polyethylene and acrylic surfaces, while Weibull model was the best for those of the co-cultures of Lm and Pf on all the three surfaces. This study demonstrated that low energy X-ray can serve as an effective method to inactivate mono- and co-cultures of Lm and Pf. The applicability of table-top low energy X-ray source to sterilization applications is highlighted.

Keywords: Low energy X-ray irradiation; *Listeria monocytogenes*; *Pseudomonas fluorescens*; biofilm; food-contact-surface

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Thermal Characteristics and Proton Mobility of Date-Pits and Hemicellulose Extracted from Date-Pits

Nasser Al-Habsi*, Muna Al Mawali, and Mohammed Shafiur Rahman
Department of Food Science and Nutrition, College of Agricultural and Marine Sciences, Sultan Qaboos University, P. O. Box-34, AlKhod-123, Muscat Oman, *E-mail: habsin@squ.edu.om

Abstract
Date-pits contains dietary fiber including cellulose, hemicellulose and lignin, and its proper utilization as high value product requires understanding of physiochemical and structural characteristics. Differential Scanning Calorimetry (DSC) and Low Field Nuclear Magnetic Resonance (LF-NMR) were used to measure thermal characteristics and proton mobility, respectively. The DSC thermogram of date-pits powder showed three endothermic peaks, first one due to the melting of oil, second one after glass transition shift, and third ones for solids-melting. Extracted hemicellulose showed three endothermic peaks, two before solids-melting and third one was for the solids-melting. However, glass transition shift could not be traced in the case of hemicellulose. This could be due to very rigid amorphous structure of the hemicellulose beyond the thermal simplicity of the glass transition. The proton relaxation showed 3 types of proton from their relaxation time as strongly-bound (T_{2b}), moderately-bound (T_{21}) and weakly-bound (T_{22}). These relaxation times were analyzed as a function of temperature. In the case of T_{2b}, the relaxation time increased sharply from -80 to -60^{o} and remained constant (i.e. date-pits: -25?? and hemicellulose) followed by a maximum peak. In the case of T_{21} date-pits showed one plateau and one maximum peak, whereas hemicellulose showed 3 maximum peaks. This study showed that macroscopic relaxation in DSC was completely different from the microscopic proton relaxation. Further studies need to be performed to explore the types of structural relaxations in thermal and its relation to the proton relaxation.

Analysis of dynamic changes in metabolites in green soybeans (*Glycine max* (L.) Merr.) under modified atmospheres by statistical methods

Yoshio MAKINO[1], Atsushi NISHIZAKA[1], Masatoshi YOSHIMURA[1], Itaru SOTOME[1], Kenji KAWAI[2], Takashi AKIHIRO[3]

[1]*The University of Tokyo, Tokyo, Japan*
[2]*Belle Green Wise Co., Ltd., Nagoya, Japan*
[3]*Shimane University, Matsue, Japan*

Abstract
Modified atmosphere packaging (MAP) is a promising postharvest technology to prolong freshness of horticultural products. Meanwhile, presenters have been found that some kinds of functional metabolites were accumulated in the tissue of the products under hypoxic conditions created by MAP. In the present study, changes in metabolites in the products under modified atmospheres was investigated by metabolomics combined with principal component (PC) and cluster analyses.

Green soybeans (*Glycine max* (L.) Merr.) were sealed in a pouch with six (normozia) or one (low O_2/high CO_2) perforations of 6 mm ∅ and stored at 25°C for 10 d. In-package O_2/CO_2 concentrations, mass and hue angle of samples were measured during storage. Specific metabolite concentrations were measured over time during storage using Gaschromatograph-Mass spectrometer.

Oxygen concentrations in pouches with six and one perforations were 19.0 and 10.5–14.0%, respectively. CO_2 concentrations in pouches with one and six perforations were 1.6 and 6.7–8.7%, respectively. Mass retention rate and hue angle of the samples stored under low O_2 and high CO_2 were higher than those under normoxia. These results agreed with the many reports previously published on MAP. Therefore, the samples were suitably prepared for investigating the effects of modified atmospheres on dynamic changes in metabolites.

According to the results from PC analysis, concentrations of some kinds of amino acids and fatty acids in the samples stored under low O_2 and high CO_2 were higher than those under normoxia. Metabolomics suggests that MAP was effective for retaining these nutrients by depressing respiration in green soybeans.

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Thermal relaxations, glass transition and water activity of food powder blends

Takumi MOCHIZUKI[1], Kiyoshi KAWAI[1], Yrjö H. ROOS[2]

[1]*Hiroshima University, Hiroshima, Japan*
[2]*University College Cork, Cork, Ireland*

Various dehydrated foods contain amorphous solids and a number of food powders are manufactured using mixing of ingredients with varying water activities, a_w. Therefore, it is important to understand water migration in mixing of ingredients with varying water activities. The present study used a maltodextrin (DE 20, Maltrin M200) to obtain calorimetric glass transition temperature (T_g) data using Differential Scanning Calorimetry (DSC). Samples were equilibrated at room temperature in vacuum desiccators over saturated salt solutions; CH_3COOK (a_w = 0.225), $Mg(NO_3)_2$ (a_w = 0.529), $NaNO_2$ (a_w = 0.654). Equilibrated maltodextrin samples were used at various mass fractions for blending and blend storage after mixing at room temperature. Blends of different initial a_w were monitored for T_g. In 1st scan, blends with M200 at a_w 0.225 gave two separate enthalpy relaxations. These relaxations were similar to those of individual blend components. Additionally, as the mixing ratio increased, relaxation of a_w 0.654 and relaxation of a_w 0.529 shifted to the higher temperature and relaxation of a_w 0.225 shifted to lower temperature. This was caused by water migration. In an immediate rescan, there was an endothermic glass transition and temperatures for onsets and offsets in the1st scan and 2nd scan agreed. These results showed that individual relaxation behavior or mix components were retained until translational mobility and water migration were activated during heating to above T_g. Consequently, mixed food ingredients can retain their individual noncrystalline structures until glass transition of both components occurs as a result of thermal or water plasticization.

Pasteurization of different food and beverages by thermosonication

Filipa SILVA[1,2], Alifdalino SULAIMAN[3], Elham MILANI[4], EVELYN[5]

[1]*University of Auckland, Auckland, New Zealand*
[2]*Universidade de Lisboa, Lisbon, Portugal*
[3]*Universiti Putra Malaysia, Serdang, Malaysia*
[4]*Chemistry and Chemical Engineering Research Center of Iran, Tehran, Iran*
[5]*University of Riau, Pekanbaru, Indonesia*

Abstract

In this study a showcase of results obtained at University of Auckland is presented. The simultaneous application of ultrasound combined with heat, thermosonication (TS), to inactivate key microorganisms and enzymes in specific foods and extend their shelf-life was carried out.

Milk and beef slurry containing *Bacillus cereus* bacterial spores were processed in pulse mode at 0.33 W/mL-70°C. The following foods were TS with continuous energy supply: orange juice containing *Alicyclobacillus acidoterrestris* bacterial spores at 20.2 W/mL-78°C, beef slurry containing *Clostridium perfringens* bacterial spores at 0.33 W/g-75°C, beer containing *Saccharomyces cerevisiae* yeast ascospores at 16.2 W/mL-60°C, strawberry puree containing *Byssochlamys nivea* mould ascospores at 0.33 W/mL-75°C, apple juice containing *Neosartorya fischeri* mould ascospores at 0.33 W/mL-75°C. In addition the polyphenoloxidase (PPO) fruit browning enzyme inactivation in strawberry, apple and pear purees was investigated for 1.3 W/g-72°C.

The recommended six log reductions in *B. cereus* spores were achieved after 2.16 and 17.6 min TS at 70°C in beef slurry and milk, respectively, with a log linear inactivation pattern. Regarding beer, a minimum pasteurization of 15 pasteurization units was obtained after TS for 2.5 min at 60°C. The process was not effective against *A. acidoterrestris* and *C. perfringens* in beef slurry, even after 60 min. The TS caused activation shoulders in the two moulds' spores followed by a rapid decrease in numbers. The PPO enzyme TS inactivation in fruits was linear in the three fruits. Overall the results demonstrated the benefit of using ultrasound assisted heat processes as opposed to thermal process alone, since TS resulted in higher microbial and enzyme inactivation.

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Continuous pulsed electric field decontamination of liquid whey protein formulations – influence of process parameters and media properties on inactivation efficiency

Felix SCHOTTROFF[1], Maximilian GRATZ[1], Anna KROTTENTHALER[1], Nicholas B. JOHNSON[2], Matthieu F. BÉDARD[2], Henry JAEGER[1]

[1]Institute of Food Technology, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria

[2]Nestec Ltd, Nestlé Product Technology Centre Nestlé Nutrition, Konolfingen, Switzerland

Abstract

Pulsed electric field (PEF) treatment offers distinct benefits for the gentle preservation of heat sensitive products, by enabling lower treatment temperatures. As milk-derived protein solutions are important, yet distinctly sensitive compounds, e.g. for dietary supplements or infant formulae, a gentle PEF preservation concept was developed, with a focus on industrial applicability.

Thus, *Listeria innocua* was suspended in different formulations including 2 and 10 % whey protein isolate, a vitamin premix, and two different pH levels (4 and 7). The continuous PEF process was designed using inlet temperatures of 20–40 °C, and a maximum outlet temperature of 58 °C, applying different PEF conditions. Reference trials were carried out by conventional thermal treatments (glass capillaries) and continuous Ohmic heating. Inactivation levels were determined and product quality was assessed (Immunoglobulin M and G levels; Vitamin A and C concentrations). Kinetic modelling was performed by developing a specific D-value concept for PEF treatments, and compared to the Weibull approach.

Results showed an inactivation of up to 6.51 $\log_{10}$ cycles of *L. innocua* with limited or no impact on the concentration of selected heat sensitive bioactives (<5 %). The efficiency of the inactivation decreased with increasing protein concentrations and pH values. Differentiation of thermal and electric field effects revealed a maximum of 1 $\log_{10}$ thermal inactivation at the highest PEF treatment intensity. The traditional D-value concept was successfully transferred to model PEF inactivation kinetics.

Thus, the study can contribute to the industrial implementation of PEF treatment for the gentle preservation of heat-sensitive protein solutions.

Increased inactivation of bacterial endospores by ohmic heating

Felix SCHOTTROFF[1,2], Taras PYATKOVSKYY[2], Kai REINEKE[3], Peter SETLOW[4], Henry JAEGER[1], Sudhir SASTRY[2]

[1]*Institute of Food Technology, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria*
[2]*Department of Food, Agricultural and Biological Engineering, The Ohio State University, Columbus, USA*
[3]*GNT Europa GmbH, Aachen, Germany*
[4]*Department of Molecular Biology and Biophysics, University of Connecticut, Farmington,USA*

The eradication of bacterial endospores requires severe treatments, also distinctly infringing product quality. The combination of heat and electric fields during Ohmic heating was shown to be able to help overcome this issue by increasing spore inactivation.

A mechanistic approach was carried out, using spores of wild-type *Bacillus subtilis*, and isogenic mutants, lacking specific parts known for their contribution to heat resistance: small-acid soluble proteins, coat, outgrowth enzyme SleB, SleB and dipicolinic acid (DPA).

The spore suspensions were treated in small glass capillaries (L=40mm, d=1.5mm), which were conductively and non-conductively sealed. Identical temperature histories (80–120°C) and immediate cooling were applied. Plate counts, DPA release, and TEM images were used to determine the physiological state of the spores after Ohmic and conventional heat treatments.

Inactivation levels of 3-6 $\log_{10}$ were determined, with a more pronounced effect of Ohmic heating, compared to conventional thermal treatment for most strains (Δlog up to $3\log_{10}$). Mutants lacking compounds related to the core showed a behavior more similar to thermal inactivation ($\Delta<1\log_{10}$).

Thus, results indicate an effect of the electric field on the spore core, whereas other spore components may even protect the spores against the treatment. As the combination of both, heat and electric field, is necessary to achieve enhanced spore inactivation, it was hypothesized that the initiation of a heat-induced activation makes the spore susceptible to the electric field.

The obtained insights help to understand spore inactivation by electrotechnologies and enable efficient process design, aiming at maximum inactivation, product safety and quality.

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Improved inactivation of spoilage enzymes in fruit and vegetable products by ultrasound combined with thermal processing

Alifdalino SULAIMAN[1], Filipa SILVA[2]

[1]*Universiti Putra Malaysia, Serdang, Malaysia*
[2]*University of Auckland, Auckland, New Zealand*

Abstract

The undesirable activity of enzymes naturally present in plant based foods can cause food quality deterioration during storage and limit its shelf life. These endogenous enzymes can be very resistant to thermal and non-thermal preservation processes used by the fruit and vegetable products industry. Therefore in addition to pathogenic/spoilage microorganisms, the enzymes can also be used as criteria for the design of appropriate food pasteurization processes.

Ultrasound technology is known to break up proteins, starches and other large biopolymers such as enzymes, and can affect the protein and enzyme functionality. The damage of protein structure by ultrasound is desirable since it results in enzyme inactivation. The rapid formation and collapse of bubbles change the enzyme's environment, such as temperature, pressure, shear stress and pH. This is good for enzyme inactivation, as it denatures the enzyme protein, causing enzyme conformational changes and decrease of enzyme activity.

A review of the use of power ultrasound alone and combined with heat (thermosonication, TS) and pressure (manothermosonication, MTS) to inactivate enzymes naturally present in fruit and vegetable products. The most relevant plant enzymes studied were pectin methylesterase (PME), polygalacturonase (PG), polyphenoloxidase (PPO) and peroxidase (PRO). First the enzyme inactivation kinetics will be reviewed. After, several examples demonstrating the advantage of TS/MTS in comparison to thermal process alone for enzyme inactivation will be presented at the same processing temperature. Results of enzyme residual activity (RA) for different treatments (thermal, TS, MTS) and ultrasound conditions (specific acoustic power and processing time) will be resumed.

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Surface modification of cellulose nanofibers for developing packaging film for food products

Balunkeswar NAYAK[1], Suriyaprakaash LAKSHMIBALASUBRAMANIAM[1]
[1]*School of Food and Agriculture, University of Maine, Orono, Maine, United States*

Abstract
Cellulose nanofiber (CNF) has excellent mechanical and film forming properties. However, CNF has a poor water vapor barrier and swells through the absorption of moisture resulting in decreased overall barrier property. The objective of this study was to modify CNF to impart hydrophobicity to it and prepare films with acceptable mechanical strength. CNF films that were premade was modified with fatty acids viz., lauric and palmitic using the acyl chloride forms of the respective fatty acids with pyridine as a catalyst at a temperature of 110°C. The modified CNF fibers and CNF films were analyzed using FT-IR and thermogravimetric analyzer to determine the success of modification. The degree of substitution, hydrophobicity and tensile strength was determined using titrimetric methods, sessile drop methods and tensile strength testing, respectively. Confirmation of modification of CNF films and fibers were determined using FT-IR and TGA curves. The percent acylation determined using titrimetric method was 20% (lauric acid) and 10.7% (palmitic acid). The contact angle of water droplet was 118.72° and 105.37° for lauric and palmitic acid modified CNF indicating that the modified CNF is indeed hydrophobic. Films formed using modified CNF fibers had poor tensile strength, while CNF films that were prepared and then modified retained approximately half of the tensile strength of pure CNF films. The results showed that CNF fibers when made into a film and then modified using fatty acids could potentially be used as a novel renewable packaging material.

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Emerging Technologies for Extraction of Bioactive Compounds from New Zealand Manuka tree leaves (*Leptospermum scoparium*)

Noor AL-SAUD[1], Kaveh SHAHBAZ[1], Mohammed FARID[1]
[1]*Dept. of Chemical and Materials Engineering, University of Auckland, New Zealand*

Abstract
The native species of New Zealand flora have a significant number of health-promoting components contributed by the geographic isolation and great UVB light level. *Leptospermum scoparium* (Manuka) is small indigenous shrub belonging to the family of Myrtaceae, which is equivalent to tea tree (*Melaleuca alternifolia*) in Australia. Māori and the early settlers used the bark, leaves, seeds, and flowers for therapeutic preparations. Moreover, the oil is rich in bioactive terpenes which scientifically proven to have potential activities in different areas includes antimicrobial, anti-inflammatory, anti-acne, antiviral, UVB skin protection, herbicidal, antioxidant and anti-aging. The essential oil is produced from the leaves by steam distillation. By prolonging the period of distillation (up to 5 h), maximum extractable bioactive can be achieved.
Nevertheless, production of Manuka oil is considered of high value compared to Australian tea tree oil due to the heavy oil components (sesquiterpenes). Recently, deep eutectic solvents (DES) as promising green solvents have attracted more attention in the extraction of bioactive compounds. DESs are considered as biodegradable, easy to handle, nontoxic with high selectivity towards the target compounds.
Moreover, DESs can be used as a solvent during extraction and also as a formulation medium. In this manner, DES can be incorporated into cosmaceuticals, pharmaceutical, and industrial application. In this study, different types of DESs were prepared and utilized for extraction of bioactive terpenoids from manuka in a single extraction step, and the potential activities of the extracts were investigated.

Influence of blanching on the physicochemical and antioxidant activity of freeze-dried pomegranate arils (cv. Wonderful)

Adegoke Olusesan ADETORO[1], Alemayehu Ambaw TSIGE[1], Olaniyi Amos FAWOLE[1], Umezuruike Linus OPARA[1, 2]

[1]*Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Horticultural Science, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa.*

[2]*Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Food Science, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa.*

ABSTRACT

Drying is vastly used in food industry, since it allows prolonged shelf-life of products by inhibiting enzyme activity and growth of microorganisms. Freeze-drying technique is preferred for drying heat sensitive products, however, its major drawbacks are long drying time and low rehydration capacity. Blanching can be applied prior to conventional drying techniques as it lowers drying time and improves drying process, resulting to intermediate moisture product. In this work, the effects of blanching (90°C 30s, 90°C 60s, 100°C 30s, 100°C 60s and control) on the moisture ratio, drying rate, physicochemical attributes and antioxidant activity of dried arils were investigated. Blanching treatment significantly reduced drying rate by 38%, thus conserved energy. Untreated arils had the lowest effective moisture diffusivity (2.40×10^{-7} m^2/s) compared with treated arils (3.28×10^{-7} - $4.36 \times 10^{-7} m^2/s$). Colour measurements such as redness (a*) was retained as a result of blanching. Blanching condition (90°C 30s) showed the best colour retention (a*; 28.7 ± 2.28) compared to unblanched arils (a*; 38.5 ± 5.07). Furthermore, physicochemical attributes such as total soluble solids and titrable acidity, as well as antioxidant capacity were retained in blanched samples. For instance, blanching at 90°C had the highest anthocyanin content (30s & 60s) and radical scavenging activity (60s), while the highest ferric reduction antioxidant power (FRAP) was observed in sampled blanched at 100°C 30s.

Keywords: Punica granatum, arils, blanching, freeze-drying, physicochemical properties

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The future of meat: sustainably meeting future demand with plant-based and cell-based meat

Liz SPECHT[1]

[1]*The Good Food Institute, Washington, D.C., United States*

Abstract
Global demand for meat is expected to rise by nearly 70% in the next 30 years, and yet livestock cultivation already occupies such a large fraction of habitable land that current meat production methods will be unable to meet this demand. Furthermore, the most efficient meat production methods – those that involve intensive, industrialized systems – are plagued by a host of harms such as severe environmental pollution and public health risks. Despite increasing consumer awareness of these limitations and harms, meat consumption per capita was higher in 2018 than in any previous year — both globally and in the United States. Simply advocating for less meat consumption has not proven tractable, at least until the appearance of compelling alternatives. The solution is to develop technologies for making delicious and price-competitive plant-based meat and cell-based meat that satisfies consumer demand while exhibiting a fraction of the resource burden of conventional meat production. While consumer demand for these products has surged in recent years – as have the number of startup companies that have emerged to commercialize them – this sector is still relatively nascent from a technology development standpoint. This talk will explore the state of the plant-based meat and clean meat industries with a particular focus on specific areas of need within the technological landscape where an influx of creative minds and concerted resource allocation seems best poised to advance the field.

Scaling plasma technology for the food industry

PJ CULLEN[1]**,** Kevin KEENER[2]

[1]*University of Sydney, Sydney, Australia*
[2]*Iowa State, Ames, USA*

Abstract
Cold plasma has been identified as a promising technology for a wide array of applications in the food industry. The potential applications include: microbial decontamination, pest control, toxin elimination, food and package functionalisation and many others. A wide variation of discharges in the form of corona, spark or arc can be formed in gas or liquid media using pulsed power with various kinds of reactor configurations; all with important technological wide applications. However, the majority of studies reported to date have been at laboratory scale. Recent technological advances have resulted in it becoming possible to realise uniform plasmas of higher density in larger volumes. This paper discusses the status and challenges of transferring the technology to food the industry. Scaling approaches are discussed for the most widely tested plasma designs including plasma jets and DBDs. The benefits and challenges of using atmospheric air as the inducer gas is discussed along with the potential of employing current MAP food gases. Design approaches to facilitate the required processing throughputs are discussed including retention of plasma species and in-package plasma technology. The importance of effective process control and validation of the processing technology are outlined. The most likely food products and applications for early adoption of plasma technology are discussed.

Selection and breakage functions of foods during human mastication

Muhammad HOW[1,2], Eli-GRAY STUART[2], Marco MORGENSTERN[3], Jim JONES[2], John BRONLUND[1,2]

[1]*Riddet Institute, Palmerston North, New Zealand*
[2]*Massey University, Palmerston North, New Zealand*
[3]*New Zealand Institute for Plant & Food Research, Lincoln, New Zealand*

Abstract
Selection and breakage functions are commonly used in industrial processes to model the particle size reduction during comminution. Similar methods can also be used to predict the particle size distribution of food during human mastication. Mechanistic models have been presented in the literature describing the selection function of the food particle being subjected to breakage during mastication. The input parameters of the model, the number of breakage sites (n_b) and particle affinity factor (O_1) are obtained from conducting one chew experiment using different size and numbers of particles. A relationship between the number of selected particles vs offered particles are attained on which damaged, and non-damaged particles are distinguished by visual inspection. However, this approach is time-consuming and prone to human error. Hence, an alternative method to obtain the selection function input parameters is necessary. We hypothesised that the n_b and O_1 values could be determined by relating the total occlusal area of the teeth with the projected area of food particles of various sizes as measured with a fast optical method. To validate this fast method four subjects were recruited and their total occlusal area obtained by image analysis of a chewing gum. The selection and breakage functions of two test foods for four subjects were determined with both the traditional and the new fast methods using single-chew experiments. This presentation will show the difference in model predictions using both sets of input parameters when compared against data for the same subjects for multiple chews to swallow point.

Hydration kinetics and nutrient loss with increased temperature for two popular seed bean (*Phaseolus vulgaris*) varieties

Lavaraj DEVKOTA[1], Lizhong HE[1], Jocelyn MIDGLEY[2], Victoria HARITOS[1]
[1]*Department of Chemical Engineering, Monash University, Melbourne, Australia*
[2]*Simplot Australia Pty. Ltd., Melbourne, Australia*

Abstract

Seed beans are an important source of dietary protein and contribute a major portion of the human diet across the world. However, bean consumption is limited by long hydration and cooking times. While hydration softens beans sufficiently for cooking and reduces anti-nutritional components, increasing the hydration temperature accelerates these processes. An optimal time-temperature condition for hydration is desired that limits loss of mass and heat labile nutrients. This work investigated the effect of temperature (30-80°C) on the hydration behavior and kinetics of two commonly consumed red beans. Physico-chemical and microstructural analyses revealed both beans to be similar but, surprisingly, their hydration behaviors differed. Small Red Bean hydration followed a sigmoidal shape curve (to 70°C) while Red Kidney Bean hydration followed a downward concave shape suggesting different mechanisms of water uptake. The hydration behaviors for Red Kidney and Small Red Beans were modelled using Peleg (R^2≥0.97) and sigmoidal (R^2≥0.99) models, respectively. Water uptake rate increased, while equilibrium moisture content decreased for both beans with increasing temperature. A simplified model was developed for small red beans which can predict hydration as a function of temperature and time (R^2=0.97). Increasing temperature from 40°C to 50°C caused a steep increase in mass loss from ~2% to ~10 wt.%. FTIR characterization of the dehydrated solid showed the presence of polyphenols, starch and soluble fibers. In conclusion, bean hydration behavior is characteristic for each bean variety and possibly determined by interaction of components in the seed, and hydration above 50°C caused loss of valuable bean nutrients.

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MRI measurement of moisture distribution inside root vegetables during microwave-vacuum drying for a relation to shrinkage

Takaharu TSURUTA[1], Shohei MIYATAKE[2], Ryota ISHIBASHI[2], Hirofumi TANIGAWA[1]

[1]*Kyushu Institute of Technology, Kitakyushu, Japan*
[2] *Graduate School of Kyushu Institute of Technology, Kitakyushu, Japan*

Abstract
Drying shrinkage is one of important topics in foods processing. We propose the microwave-vacuum drying method for a high-quality drying with a short drying time. Controlling the microwave irradiation to keep the material at room temperature enables a less shrinkage and a rapid drying compared to the traditional drying methods. In this study, three kinds of root vegetables, radish, carrot and potato, are selected as cylindrical samples with different initial moisture content, we have also done the warm-air drying together with the microwave vacuum drying to understand the drying and shrinkage characteristics. Experimental measurements are focusing on the shrinkage deformation as well as the moisture distribution inside the materials. MRI measuring technique was used to observe the distribution of moisture contents inside the materials. The images of the moisture distribution indicated clearly that the central part of samples was dehydrated faster than the outer region. To clarify the mechanism of deformation due to shrinkage of food structure, we have measured the glass transition temperature with a Differential Scanning Calorimeter DSC. The results indicate that the central part causes the glass transition due to lowering the moisture content. The central core with hardness results in the less shrinkage compared to the case of warm-air drying. On the other hands, because that radish and carrot have lower glass transition temperatures, the room-temperature drying is not able to get the glass state even if the lower moisture content, which results in the shrinkage as same as the volume of dehydrated water.

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Simulation on Thermal Sterilization of Liquid Canned Foods Containing Headspace Based on COMSOL Multiphysics

Shuhang Chen[1], Jianwei Zhou[2], Donghong Liu[1],Yi Liu[1]

[1]*Zhejiang University, Hangzhou, China*
[2]*Ningbo Institute of Technology, Ningbo, China*

Abstract
Two kinds of two-dimensional axisymmetric models simulating the thermal sterilization process of pure water and 1.0% CMC solution were established based on COMSOL Multiphysics software.The temperature changes simulated by different model at the same positions in the can were compared by wireless temperature sensor to verify the accuracy. The different performances of velocity field, temperature field and lethality field simulated by the two models were analyzed with 1.0% CMC solution cans. The results shows that the model which considering the headspace can better characterize the physical field changes during liquid canned food sterilization. On this basis, the relative pressures in 1.0% CMC cans at different headspace heights and different holding temperatures were analyzed by the model with the headspace. The higher the temperature, the smaller the headspace height and the greater the relative pressure inside the can.Manufacturers can determine the pressure of different cans in each stage of the sterilization process to control the pressure of the sterilization tank and the maximum withstand pressure of the can, so as to avoid the deformation of cans during sterilization.

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The application of the E-nose coupled with ICA and wavelet energy threshold method in the vinegar discrimination

Huichun YU, Yuzhen ZHAO, Xin LI, Yong YIN*
College of Food & Bioengineering, Henan University of Science and Technology, Luoyang 471023, China

Abstract: The drift of gas sensors will remarkably decrease the robust detection ability of electronic nose (e-nose), in order to enhance long-term robust discriminant ability of the e-nose in the vinegar samples discrimination, a drift of gas sensors elimination method was proposed based on independent component analysis (ICA) coupled with wavelet energy threshold. Firstly, ICA is used to decompose the electronic nose signal, obtain independent signal components, and the drift signal and other error information are independent signal components. Secondly, some independent components were selected according to the magnitude of the wavelet energy of each independent component, in this step the independent signal components contains drift signal and other error information are not selected. Finally, the e-nose signals were reconstructed using these selected independent components. The results show that six kinds of vinegar have been discriminated very well by the linear discriminant analysis (LDA), and indicating the suitability of this method to improve long-term robust discriminant ability of the e-nose.

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Applications of State Diagram in Food Engineering: Past, Present and Future

Mohammad Shafiur RAHMAN[1]

[1]*Sultan Qaboos University, Muscat, Oman*

Abstract

A state diagram shows the phases or states of foods as a function of solids or water content and temperature. The main advantage of drawing a map is to help understanding the complex changes when the solids content (or water content) and temperature of foods are changed. The recent state diagram is based on the glass transition line, freezing curve, maximal-freeze-concentration conditions, solids-melting line and water-vapor line. Two fundamental concepts, water activity and glass transition are widely used to determine the stability of foods during processing and storage. Both concepts have their advantages and limitations when apply in different physical and chemical changes in foods. In the literature it was emphasized that a combination of water activity and glass transition concepts could be a powerful tool in predicting food stability. Recently, water activity and glass transition concepts are combined in the state diagram by plotting BET monolayer as a function of temperature. It is now advanced with macro-micro region concept considering 13 micro-regions to determine different states or phases of foods. The current applications of the macro-micro region concept based on state diagram will be discussed by presenting different chemical and physical changes during processing. The issues of its applications in solving food-engineering problems will be discussed considering examples, such as drying, baking, and chemical reactions. Finally, current challenges will be highlighted with its need to apply in solving more complex food engineering problems.

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Development of selective heating method by ohmic heating with surface-temperature control

Toshifumi UDO[1], Haruo TOMITA[2], Mika FUKUOKA[1], Noboru SAKAI[1]

[1]*Tokyo University of Marine Science and Technology, Minato-ku, Tokyo, Japan*
[2]*Osaka Gas CO.,LTD. Konohana-ku, Osaka, Japan*

Abstract
A selective heating method by ohmic heating has a great advantage to introduce into food industry, either heating or cooling on the surface of sample, which would make other types of pre-cooked food, such like centrally-heated meat products without surface cooking so as to reduce drip loss and texture degradation, or even could make a product firstly heated on its surface with heat carrier. On this study, we designed and developed an innovative ohmic heating instrument combined with a chiller on its titanium electrodes. We selected beef as sample to demonstrate this novel method. 20kHz of alternative currents frequency was chosen and applied. Temperature history, thermal images, and weight loss, rheological parameters were also obtained. It was confirmed that this method selectively heated the center of the sample while keeping the surface part as raw. The overview of the sample seemed raw beef, even though the center portion was properly cooked, being surrounded by the raw beef. This ohmic heating system is simpler and can be applied no matter what sample was chosen. Overall, this study is proposing a new technique of ohmic heating, and it would have a great potential in food industry to produce an innovative, valued product in the future.

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Ultrasound-assisted thawing of mango pulp: effect on thawing rate, sensory and nutritional properties

Yi LIU[1], Shuhang CHEN[1], Donghong LIU[1,2,3*]

[1]*College of Biosystems Engineering and Food Science, Zhejiang University,Hangzhou, China*

[2]*Fuli Institute of Food Science, Zhejiang University, Hangzhou, China*

[3]*Zhejiang Key Laboratory for Agro-Food Processing, Zhejiang R&D Center for Food Technology and Equipment, Hangzhou, China*

Abstract：Sensory and nutritional properties of mango pulp thawed by ultrasound with different intensities (0, 0.037, 0.074 and 0.123 W/mL) were studied. Thawing time decreased significantly ($p<0.05$) as ultrasonic intensities increased. Higher intensity helped preserve carotenoids (β-cryptoxanthin and β-carotene). However, according to sensory evaluation, texture and aroma deterioration was found at high-intensity of 0.123 W/mL. This might be due to higher viscosity and dimethyl sulfide content based on results of volatile compounds by GC-MS and rheological properties of mango pulp. Ultrasonic thawing treatment at 25℃reduced thawing time by 51-73% when compared with that at 4℃, and retained 26.5-58.5% more total phenol and 8.7-11.0% more total carotenoid content in mango pulp. In short, a higher ultrasonic intensity (0.074-0.123 W/mL) and temperature of 25℃contributed to higher thawing efficiency and better nutritional quality. The results demonstrated that ultrasound processing could serve as a potential alternative to conventional thawing processing of mango pulp.

Drop break-up in rotor stator mixers

Fredrik INNINGS[1,2], Andreas Håkansson[2], Dragana Arlov[1] Hans Henrik Mortenssen[1],

[1]*Tetra Pak Processing Systems AB, Lund, Sweden*
[2]*Lund University, Lund, Sweden*

Abstract
Liquid-liquid emulsions can be created using different mixing techniques and the equipment used for processing has a large impact on the final emulsion. Rotor-stator mixers are one of the most commonly used mixers today with multiple application areas[1]. In industrial mixing and emulsification, the droplet size is a key parameter, since it influences both the stability and quality of the final food product. In this study we have studied the drop break up from many angels; We have performed PIV measurements to investigate the flow in the rotor/stator region as well as conducted CFD simulations of the same regions. The drop break-up have been studied both in batch and in in-line mode where the inline mode permits investigations on the effect of a defined number of passages on the drop size distribution and also of the flow rate. In batch mode we have used mixers from laboratory to industrial scale and studied the effect of energy input, viscosity and surface tension. We can now predict the final drop size and we can explain the fairly large difference in efficiency between industrial batch and in-line systems.

[1]Zhang, J., Xu, S., & Li, W. (2012). High shear mixers: A review of typical applications and studies on power draw, flow pattern, energy dissipation and transfer properties. *Chemical Engineering and Processing: Process Intensification*, *57*, 25-41.

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Relationship between Solids Content and Viscosity after Evaporating Soymilk Prepared in a Laboratory

Makoto SHIMOYAMADA[1], Akari ISHIYAMA[1], Hayato MASUDA[1], Shintaro, EGUSA[2]

[1]*University of Shizuoka, Shizuoka, Japan*
[2]*Marusan ai Co. Ltd., Okazaki, Japan*

Abstract
Soymilk is made from imbibed soybean seeds and has milky appearance and taste. Several commercial items imitating bovine milk have been developed from soymilk, such as yoghurt-like fermented soymilk, cream, etc. To mimic condensed milk, soymilk, which was prepared from different varieties of soybean and by different processes, was evaporated under reduced pressure. Viscosity of evaporated soymilk samples was exponentially increased with increase in solids content. When two kinds of commercial soymilks were evaporated at 55, 65 and 75 °C of water bath, all soymilk samples showed two separate regression curves depending on solids content. The regression curve at higher solids content was steeper than the other one at lower solids content. When raw soymilk prepared in a laboratory without heat treatment was evaporated at 55 and 65 °C, concentrated soymilk showed two curves like the commercial soymilk. However, the raw soymilk evaporated at 75 °C showed only one curve differing from other samples. Heating of the raw soymilk showed two regression curves even at 75 °C. β-conglycinin is known to be denatured over 70 °C, so partially denatured β-conglycinin is considered to have an important role in this difference.

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Status of Rice Food Security of Small Farmer Households under Intermediate Level of Mechanization in Kampar Region, Indonesia

Ujang PAMAN[1]
[1]*Universitas Islam Riau, Pekanbaru, Indonesia*

Abstract

Rice is the most important staple food in Indonesia and it has become a key indicator of food security across the country. In Kampar Region, most small farmers are facing challenges to meet their rice food security due to shrink farm size and stagnate rice productivity. This paper attempts to recognize the status of rice food security of small farmer households under intermediate level of mechanization in Kampar Region, Indonesia. Surveys were conducted in two districts: Bangkinang and Kuok of Kampar region and took time from April to June 2018. A total of 50 small farmers (25 small farmers from each districts) were purposively selected for samples. Data were collected through personal interview and analyzed using descriptive – quantitative techniques. The average of rice production was 1,376 kg with cultivated area of 3,699 m^2 on average. Based on the rice production and per capita rice consumption of 114.6 kg/year, about 60% of small farmers could fulfill a rice food need as long as 12 months or more. However, about 40% of small farmers could fulfill the rice food need less than 12 months and even 20% of them could only suffice for less or equal to 6 months. It was also found that it was required about 487 m^2 to fulfill the annual per capita rice consumption under the present rice productivity of 3,75 ton/ha.

Influence of protein source on the functionality and the digestibility of infant formulas

Linda LE ROUX1, Françoise NAU2, Raphaël CHACON1, Didier DUPONT2, Romain JEANTET2, Olivia MENARD2, Amélie DEGLAIRE2

1Sill Dairy International, Plouvien, France
2 STLO, INRA, Agrocampus Ouest, 35042, Rennes, France

Infant formulas (IF) are the only source of nutrition for infants who cannot be breastfed from their mothers. There is currently a growing interest for these sensitive products, in order to control more carefully their quality and design their composition with regard to sustainable development concern. The aim of this work was to study how a partial substitution of dairy proteins by plant proteins influenced the functionality and the digestibility of IF.
Three IF were developed with identical composition, except that 50% of the proteins were whey proteins in the “reference IF”, and pea or faba bean proteins in the “plant IF”. Homogenization and drying steps parameters were investigated at a semi-industrial scale (IF flow rate around 100 kg.h-1). The process influence was assessed through the IF microstructure using confocal microscopy, and the protein digestibility using a dynamic *in vitro* digestion model.
The results showed that the emulsion structure differed depending on the protein type source that did not lead to the same stabilization of the fat droplets. It simultaneously affected the viscosity of the IF and consequently the drying parameters. Last, differences in terms of protein hydrolysis rate were observed mainly during the gastric phase compared to the end of the digestion.
This study provides new insights on the impact of the substitution of protein source in IF. It showed that plant protein sources could be good candidates for dairy proteins substitution in IF, both from a processing and nutritional point of view.

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Global Challenges and Opportunities to Inspire Food Engineers – Millennials Era to Digital Generations

Yrjö H. ROOS
University College Cork, Cork, Ireland.

Abstract

Millennials Food Engineers have entered their careers while digital generations, generation Z, are influencing consumer trends and prepared for leading the industry tomorrow. Social changes have strongly altered food industry and academic research. Modern society requires special Food Engineering skills needs focusing on integration of health, nutrition, safety, materials science, modelling, sustainability, social responsibility and innovation. Conversely, Food Engineers are challenged by an enormous impact of global social pressures, communications, information flow and consumer trends. These include climate change, population growth, personal nutrition and dietary habits, social media and virtualization, healthy choices and online shopping while traditional Food Engineering may be limited to regulatory and undervalued areas. The focus of Food Engineering is shifting from unit operations and processing to product engineering and understanding human internal unit operations (e.g., digestibility, gastric aspects, targeting, bioavailability), health and wellness (e.g., medicine, brain, biology, biota, pro- and prebiotics, nanotechnology, biotechnology), nutrition (e.g., personalization, prevention, satiety), modeling (e.g., virtualization, big data, internet opportunities), food safety, consumer choices, expectations and protection, and social responsibility. This is the time to convince Food Engineers and other disciplines of the important role of Food Engineering as a discipline covering the entire food chain from 'field to flush'. Such an important task needs to include the Generation Z Food Engineers already in training as guided by present leaders of Food Engineering in academia and industry.

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Unmanned ingredient handling and processing with robotics in bakery and prepared food

Authors
Jake NORMAN[2], Mark SWAINSON[3], Kjartan Gudmundsson[4]

Abstract
Food manufacturing faces a perfect storm of rising labour costs, flat line productivity and food deflation. Advanced technology and robotics can address these issues yet to date the deployment of robotics in the preparation, handling and processing of raw materials has been very limited.

Research under two Innovate UK projects shows the labour cost of handling ingredients can be as high as 5% of turnover per annum in prepared food businesses and 1% in bakery.

This seminar will highlight the work undertaken by APRIL Robotics and the University of Lincoln to develop fully automated ingredient handling and processing systems. The use of robotics has enabled unmanned manufacturing of complex food products in bakery and prepared food businesses.

We will share insights including:

1) Full segregation of allergens with no shared contact surfaces or pipes (unlike pneumatic conveying & traditional cooking skids)

2) Reduced ingredient usage from improved accuracy (+/-1g)

The project seeks to resolve the major issues effecting productivity, food quality, food safety and waste within traditional manufacturing processes.

A multidisciplinary research team including Computer Science, Machine Learning, food science and technology worked together on the project.

A full-scale demonstrator was built at the National Centre for Food Manufacturing for full testing of food products.

The Innovate UK collaborative project started in September 2017 and is due for completion in August 2019.

Link to project details: https://gtr.ukri.org/projects?ref=102778

[2] APRIL Robotics part of Olympus Automation Ltd. UK

[3] University of Lincoln, UK

[4] University of Lincoln, UK

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Food Materials Science Importance in Food Process and Product Engineering

Yrjö H. ROOS
University College Cork, Cork, Ireland.

Abstract
Food Materials Science and phase transitions of different orders are often the basis of food processing and successful stabilisation of food ingredients and foods. Several food processes are based on understanding changes in food component properties and materials state during changes in pH, water content or temperature. Structuring of food solids occurs at high solids contents and food solids properties need to be taken into account in various unit operations. For example, food freezing results in separation of ice and vitrified solutes may protect entrapped components. Spray drying of formulated solids may provide innovative solutions for protection of volatiles and structures for long shelf life foods. Such processes may consider solid and liquid states of food materials which can be modulated using solid and liquid phases and effects of pH, temperature, hydrophilic, hydrophobic and other molecular characteristics of formulation materials to achieve desired processability, stability and delivery properties in multicomponent systems. Simple state diagrams are available to characterise single and binary components behaviour in freezing, extrusion and dehydration, but many innovative processes require more detailed data for component mixtures to achieve product stability. Food product engineering may also benefit from structural relaxations characterisation as a tool to control unit operations and storage stability. Furthermore, the state of solids may have a significant impact on product sensory characteristics and release of desired functional components.

Modification of functional and rheological properties of apple pomace via extrusion

Vera SCHMID1, Heike P. KARBSTEIN1, M. Azad EMIN1

1Karlsruhe Institute of Technology, Karlsruhe, Germany

Abstract

In recent years, the increased consumer awareness and demand for natural, health-promoting, and sustainable foods has driven the research for alternative resources. With this, by-products from fruit and vegetable processing, such as apple pomace, have gained significant attention as novel and economic sources of dietary fibers and phytochemicals. In addition to its nutritional value, apple pomace has a range of functional properties such as water binding, gelling and thickening properties. Therefore, it can be used not only to fortify but also to structure food products and beverages. However, depending on the application, the apple pomace must often be modified to achieve the desired functionality in foods. Recently, extrusion processing has gained significant attention due to its ability to modify biopolymers in a flexible, environment- friendly, and sustainable manner.

In this contribution, we will present the influence of extrusion conditions on the water binding and absorption, as well as thickening properties of apple pomace. Thereby, we will discuss the impact of screw speed, water content, and barrel temperature on the viscosity of aqueous dispersion of apple pomaces. The results will be discussed regarding the role of cell wall structure and components. The outcome provides a better understanding of thermomechanical modification of cell wall polymers in apple pomace and its impact on functional and rheological properties. This information is essential for designing functional ingredients and innovative food formulations.

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Laser-Induced Breakdown Spectroscopy: From Mars rover to food safety

PJ CULLEN[1]**,** Carl Sullivan[2]

[1]*University of Sydney, Australia*
[2]*Dublin Institute of Technology, Ireland*

Abstract
Laser-induced breakdown spectroscopy (LIBS) is famous as the laser technique employed on the Mars rover to analyze the planet's surface. However, the technology holds huge potential for the food industry for the rapid characterisation and identification of food products, ingredients and contaminants. Methods commonly used for the investigation of mineral composition and the authentication of the geographical origin of biological samples are based on atomic, nuclear and mass spectroscopy techniques. LIBS is an atomic technique which offers multi-elemental analysis, fast response, remote sensing, little to no sample preparation, low running cost and ease of use making it a promising technique for the food sector. In this paper we introduce recent progress and applications of LIBS as an efficient and reagent-free, at or on-line tool capable of replacing traditional time-consuming analytical methods for assessing the quality and composition of food products. Examples are provided for mineral analysis of high risk food such as infant formula but also heavy metal detection of foods such as arsenic contact of seafood. The limits of detection for elements within food matrices are discussed. The potential of the technology for mapping elements in biological tissue is explored through LIBS imaging. Finally, the challenges and applications of using the technique for liquid foods such as beer and milk is discussed.

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Prediction of liquid loss from frozen and thawed cod by hyperspectral imaging

Kathryn E. WASHBURN, Svein Kristian STORMO, **Torstein SKÅRA**

Nofima AS, P.O. Box 6122, 9291 Tromsø, Norway

Abstract
Quality evaluation of fish products is frequently limited to spot checks, due to challenges in assessing quality of all the products in a rapid, objective, and consistent manner. Methods to quickly evaluate quality of fish have been the focus of much research, as there are numerous advantages for both sellers and buyers. A possible proxy for quality assessment, particularly for frozen fish, is liquid loss, which in addition to affecting yield, is correlated with undesirable sensory attributes such as package exudate, dry mouthfeel and tough texture.

This study evaluated whether hyperspectral imaging of fresh, frozen and thawed packaged fillet portions could predict liquid loss of the samples. Vacuum packaged cod loins were split into two groups; one was kept chilled and the other was subjected to different freezing and thawing, i. e. samples were frozen and thawed either rapidly or slowly, giving rise to different levels of liquid loss.

Multivariate analysis of the hyperspectral imaging data on the chilled samples could predict drip loss with good accuracy for samples that underwent no further processing. Also, analysis of data from hyperspectral images on frozen or thawed samples showed a good ability to predict their liquid loss. These results indicate that hyperspectral imaging is a promising method for non-invasive quality monitoring of cod products in different processing states. In addition, whereas previous research had been unable to predict sample processing protocols, improvements to the hyperspectral imaging technology now enable the separation of samples based on freezing and thawing procedures.

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Mayonnaise production in rotor stator mixers

Fredrik INNINGS[1,2], Björn Bergenståhl[2], Dragana Arlov[1], Ulrika Brintje[1]

[1]*Tetra Pak Processing Systems AB, Lund, Sweden*
[2]*Lund University, Lund, Sweden*

Abstract
Mayonnaise is an oil in water emulsion with a high oil content where egg is used as the emulsifier to stabilizes the oil droplets. As every home chef knows the skill of the chef determines the quality of the mayonnaise, and the same goes for industrial produced mayonnaise.[1] The objective of this study was to increase the knowledge of industrial mayonnaise production. The approach was to produce mayonnaise with a pilot high shear rotor-stator mixer and vary mixing and recipe parameters to evaluate their impact on oil droplet size and the mayonnaise quality.

The results show that several parameters have an impact on the properties of mayonnaise. Variations in the recipe showed that oil content, emulsifier content and type of emulsifier have a great influence on the properties of mayonnaise. From the mixing parameters it was concluded that both mixing time and mixing speed during the emulsification has an impact on the texture and droplet size of the mayonnaise. The theory about colloidal glass can successfully be used to explain the complex system of mayonnaise and how the texture are built up. It was found that not only the flow in the rotor/stator region affected the result but also the flow in the tank. Catastrophic breakage (phase inversion) was also studied and the parameters affecting it were identified and quantified.

[1]Moslavac, T., Pozderović, A., Pichler, A. (2011). Influence of process parameters and composition of the oil phase on rheological properties of mayonnaise. *MESO: prvi hrvatski časopis o mesu*, *13*(2), 101-101.

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On the length-dependent milk protein deposit layer in hollow fiber membranes

Roland SCHOPF[1], Ulrich KULOZIK[1]

[1]*Technical University of Munich, Chair of Food and Bioprocess Engineering, Freising, Germany*

Usually, ceramic tubular membranes are used for milk protein fractionation due to their high durability and resistance to harsh operating conditions. Also, spiral wound membranes (SWM) are in use because of their high membrane area per module. These membranes are either costly or difficult to clean. A possible alternative are hollow fiber membranes (HFM), rarely used in the dairy so far. However, deposit formation due to the casein retention results in a flux decline and in a decrease of separation efficiency. The open question is whether the variation of local pressure and flow conditions has a higher impact on the change of the deposit layer structure as compared to ceramic tubular membranes and SWM.

The experiments were carried out with lab-scale HFM (0.2 µm PES). In order to assess the length-dependent deposit layer formation, five membrane modules of 30 cm were installed in series. Flux, pressure drop and protein transmission for each module can be analyzed separately.

The deposit layer resistance shows a deposit reduction from the membrane inlet to outlet. This leads to a reduction of the transmission and consequently to a decrease of the separation efficiency. The deposit layer can be assumed to be thicker or more compact at the system´s inlet due to the higher transmembrane pressure. The whey protein mass flow shows that there is an optimum in the efficiency of fractionation at lower transmembrane pressures.

HFM are a suitable alternative to ceramic tubular membranes and SWM operating at appropriate pressure drop and crossflow velocity conditions.

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High speed extrusion of food paste – optimizing the die entry angle

Patrick WILMS1, Reinhard KOHLUS1
1University of Hohenheim, Stuttgart, Germany

Abstract
The production of food pastes often includes a dosing step that involves high speed extrusion through dies of varying geometry. During this extrusion, the high volume fraction of solid fillers not only leads to high operating pressures, but it also greatly increases the risk of jamming, thereby blocking production lines and increasing machine downtime. The jamming risk is thought to increase with increasing shear rate as particles are not allowed to relocate within the bulk and
thus form a rigid percolating network.

The internal shear during extrusion is often induced by a confinement as it introduces extensional flow and thereby forces internal rearrangement. Although extensional flow has received considerable attention in the polymer industry, the large particle size of the components (>100 micron) in food pastes prevent the use of conventional (capillary) analysis and thus requires a different approach. By adapting an Instron Universal Testing System (bench-top) and a custom built pilot-scale high-speed ram extruder, the influence of the die entry angle as a function of filler volume fraction, filler shape and extrusion speed, is measured over a large range of shear rates
(1 - 500 s^{-1}). Special effort is put into differentiating between the different flow regions (slip, shear and plug). The experimental outcome is used for parameter estimation and provides our input parameters for simulations of the paste flow. By manipulating the die entry angle, with a special focus on slip maximization, the overall pressure drop can be minimized and the jamming risk reduced.

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Dielectric properties of mango pulp (*Mangifera indica* L.) and mango nectar for microwave heating at 915 and 2450 MHz

Tiago A. B. B. CAVALCANTE1, Carlos H. CAMPOS1, Carmen C. TADINI1,2, Jorge A. W. GUT1,2.

1*Dep. Chemical Eng., Escola Politécnica, University of São Paulo, São Paulo, Brazil*
2*FoRC - Food Research Center, University of São Paulo, São Paulo, Brazil*

Abstract

The study of dielectric properties is important to understand the interaction of microwave electromagnetic energy with foodstuffs. These properties help to adequately design microwave heating processes. Continuous flow microwave heating is an emerging technology for the pasteurization of liquid foods. The aim of this research was to study the dielectrics properties (relative electrical permittivity and dielectric loss factor) and electrical conductivity of mango pulp and nectar to contribute with applications in microwave pasteurization. The pulp and nectar were obtained from mango Palmer variety, marketed at São Paulo (SP, Brazil). Three commercial brands of mango nectars were also analyzed. The dielectric properties of samples were obtained with a network analyzer and an open-ended coaxial cable for the range of 200 to 3000 MHz between temperatures 20 and 120 °C with a thermostatic capsule. The values were obtained for commercial frequencies (915 and 2450 MHz) and the results were correlated with temperature. The penetration depth was also calculated. The relative electric permittivities decreased with temperature and values were similar among all samples. The effects of temperature on the dielectric loss factor indicate that at 915 MHz ionic loss predominates and that at 2450 MHz dipolar loss predominates as heating mechanisms due to influence of salt and water content. The penetration depth was different between samples and depended on temperature. It was possible to obtain the change of the dielectric properties and the penetration depth as the temperature raised which is useful information for the design of applicator tubes on microwave heating processes.

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Predicting freshness quality and shelf-life of strawberries using visible and near-infrared spectroscopy technology

Fernando MENDOZA, Yessica BUTENHOFF, Hanna NYKÄNEN, Tomas ÅHLMAN, Urban WÄHLBY

AB Electrolux, Global Advance Food Preservation, Stockholm, Sweden

Abstract

Strawberry senescence has a direct impact on market price and its accurate assessment and prediction are of main importance to increase competitiveness and prevent food wastage. The aim of this study was to develop sensing models for automatically predicting the freshness quality and shelf-life of strawberries under different storage conditions based on visible and near-infrared spectroscopy (Vis-NIRS, 400–1,700 nm) data.

A total of 1,050 high-quality strawberries were stored in five-different controlled refrigeration conditions (varying from 2–6°C±0.5°C, 40–80%±5% RH). Strawberry sampling was conducted daily for 14 days, and during each sampling time 25 units (five from each environmental condition) were randomly selected for Vis-NIRS testing. After scanning, five-quality traits: water content, firmness/softness, sweetness, acidity and sensory quality scores were measured and used as reference values for modelling. Vis-NIR data was processed/selected for chemometric analyses based on: quantitative partial least square (PLS) for predicting the five-quality indices; and qualitative discriminant analysis (DA) for identifying unacceptable, acceptable and premium qualities in order to estimate shelf-life. The experiment was run three times and the analysis included two independent test sets for model calibration and validation. PLS models were developed for each storage condition and when all data is considered together.

These results showed that all quality indices and shelf-life can be well predicted from the Vis-NIRS signals with correlation coefficients higher than =0.890. An ANOVA analysis showed that most of the PLS model results were not significantly (P>0.05) different from the corresponding reference values, and all correlate well particularly with the sensory scores (R>0.910). The Vis-NIR method provides robust chemometric models to assess multiple strawberry freshness indices and to estimate shelf-life, simultaneously, during its circulation in the supply chain.

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Screw extrusion based 3D printing of soy and pea protein mixtures

Patrick SCHÜÜRMANN[1], Jens SCHRÖDER[1], Volker LAMMERS[1]

[1]*German Institute of Food Technologies (DIL e.V.), Quakenbrück, Germany*

3D food printing is an emerging technology that is capable to design food with tailored textures and nutritional value. Compared to conventional processes, 3D printing comes along with other advantages such as process flexibility and simplification. Selected foods were already successfully used for the printing process, particularly chocolate and pasta. However, the range of natively printable materials is restricted due to specific requirements of the printing process. Especially rheological characteristics - the viscosity and flowability as well as yield stress and shape stability - are crucial for the printability. To overcome this material based limitations, a 3D printer was combined with a twin- screw extruder. This system allows continuous printing and specific thermal and mechanical treatment of the substrates to influence their process behavior and material properties. The 3D printer was used with soy and pea protein mixtures. Different substrates with varying protein water ratio were characterized by measurement of viscosity, yield stress, thixotropy and differential scanning calorimetry. Correlation between the material properties and printed structures are made to obtain further information about the printability of plant based protein. The gained information can be used to optimize the screw based 3D printing and to create foods with new textures and applications. Particularly continuous printing of plant based proteins represents an innovative approach creating meat- like structures.

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Biosourced foam structuration process studied by high speed imaging in microfluidic devices

Dominique DELLA VALLE[1], Julian SEPULVEDA[1, 2], Catherine LOISEL[1, 2], Alain RIAUBLANC[3], Agnès MONTILLET[2]

[1] *ONIRIS, Nantes, France*
[2] *GEPEA, Nantes, France.*
[3] *INRA, Nantes, France*

Abstract
Usually, microfluidic devices are used to produce monodispersed emulsions, in creeping flow conditions, where the drop size is controlled by the channel size. The present work aims to study the production of stable food foams in such systems, at higher flowrates than those commonly encountered in microfluidic applications. The aqueous foaming solutions are prepared from Xanthan gum [0.2-0.5 %] (Ketrol AP from Kelco) is used as thickening agent, and protein isolate [3%] (Protinav 95 from Lactalis France) as surfactant. Gas (N_2)-liquid flow is implemented in two microfluidic devices with submillimetric channels (600 µm square section) encountering or not an enlargement section (1000 µm x 600 µm). The biphasic flow pattern is observed at high Reynolds numbers (500-5000) with a high speed imaging system, designed to capture the gas bubbles shape with a sufficient accuracy at the process velocities, till $20 m.s^{-1}$.

As a first step, gas break-up mechanisms along the channels are identified. Depending on the flow dynamics, the gas breakup can take place mainly by three mechanisms: tip-dropping (binary splitting), tip-streaming (detachment of small drops at the bubble tip), and ligament fragmentation (surface instabilities). In the present case, elastic turbulence provides an additional contribution to govern the gas fragmentation.

The second step is focused on the determination of the bubble size distribution inside the channels, and at the outlet for the end product. A wide range of viscosities and flowrates are investigated, in order to propose scaling laws for the industrial production of foams by these innovative systems.

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Starting food process modeling from molecular scales

Moritz KINDLEIN1, Ekaterina ELTS[1], **Heiko BRIESEN[1]**

[1]*Chair of Process Systems Engineering, Technical University of Munich, Freising, Germany*

Abstract
Food processing happens on a wide range of time and length scales. As a consequence, physically meaningful mathematical modelling and simulation of these processes has to be done on multiple scales. Many phenomena that govern properties and processing behavior of food result from the molecular composition and – according to the title – this study gives examples of how to start food process modeling from the molecular scale. We exemplify the benefits of molecular dynamics simulations by presenting recent studies from our group towards the molecular understanding of the behavior of chocolate especially with respect to the addition of lecithin.

At first, different phospholipids, which are the main molecular components of lecithin, are characterized in terms of their strength of interaction with crystalline sucrose, as phospholipids need to adsorb on sucrose surfaces in chocolate to influence its rheology. Non-equilibrium, all-atom molecular dynamics simulations are used to determine the detachment work of several phospholipids from a crystalline sucrose surface.

Secondly, coarse-grained molecular dynamics simulations are performed to calculate lecithin concentration-dependent structures in chocolate. The results provide a mechanistic explanation of the undesired increase of yield stress after adding an excessive dose of lecithin and suggestions for improvement are presented.

Thirdly, cocoa butter immobilization, which is hypothesized to be one reason of the high viscosity of chocolate, is investigated. It is shown that specific molecular interactions are responsible for the immobilization phenomenon.

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Impact of temperature combined with bipolar membrane electroacidification on selective separation of whey proteins

Claudie ASPIRAULT[1], Alain DOYEN[1], Laurent BAZINET[1]

[1]*University Laval, Quebec, Canada*

Abstract
Whey is a co-product generated from the dairy industries that has the potential to be valorized due to its high-protein value. Separation of the two major whey proteins, α-lactalbumin and β-lactoglobulin, improves their respective nutritional and functional properties but this separation step is complicated by the fact that both proteins have close molecular weight and isoelectric point. One way to overcome this problem is to modify the pH of the protein solution to promote the selective aggregation and precipitation of one of the proteins of interest. However, these methods require large volumes of chemical products, making it problematic on an environmental point of view. Bipolar membrane electrodialysis (EDBM) is a greener process that provides acidification and demineralization of a solution at the same time. This research presents the impact of different pre-heating temperatures (20, 50, 55 and 60 °C) of a whey protein solution containing 10 % of proteins combined with EDBM pH modification (6.0, 5.4, 5.0 and 4.6) and ionic strength decrease induced on the efficiency of EDBM process for the separation of the major whey proteins. Preliminary tests have shown that proteins denaturation stage might be an important factor influencing efficiency of the separation: an increase of the heating temperature from 50 to 60 °C increased by 5 times the precipitation rate of α-lactalbumin whereas it was only 2 times higher for β-lactoglobulin. Furthermore, EDBM acidification allowed higher precipitation and selectivity of protein in comparison with chemical acidification due to the induced decrease in ionic strength.

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Brewer spent yeast protein hydrolysate as an emulsifying agent

Gabriela VOLLET MARSON[12], Rafaela POLESSI SATURNO[1], Eliana Marcela VÉLEZ-ERAZO[1], Miriam DUPAS HUBINGER[1]

[1]School of Food Engineering, *University of Campinas, Campinas, Brazil*
[2]*University of Montpellier II, Montpellier, France*

Abstract
The brewer spent yeast presents in its composition proteins with technological and functional properties. These yeasts are the second largest waste in the brewing industry, although they are still mostly underutilized in animal feed. The emulsifying capacity of the brewer's yeast protein hydrolysate was accessed through a fractional factorial design (2^{4-1} with 3 central points). Emulsions composed of yeast precipitate (YP), yeast protein concentrate obtained through membrane filtration technology (YPC) and sunflower oil were produced using an ultrasonic probe (69 to 120 W) coupled to a water bath (4 °C). The influence of protein concentration (1.5 - 6%), oil concentration (10 - 20%), pH (5.5 - 7.5), and the ratio of proteins from concentrate to precipitate (10 - 45%, m/m) were evaluated on emulsion stability, regarding Turbiscan instability index, droplet size distribution, apparent viscosity and zeta potential. The experimental design was able to explain minimum 99.8% of the data for all responses, being protein concentration the most influential factor, followed by pH, oil concentration and YP and YPC proportion. Higher protein concentration resulted in smaller droplets size, lower Turbiscan instability and higher viscosity. A smaller amount of sunflower oil resulted in smaller droplet size. Higher YP proportions resulted in higher apparent viscosity. Emulsions containing 3.8% protein (27.5% YPC and 72.5% YP), 15% oil at pH 6.5 were more stable, resulting in the lowest Turbiscan instability index (0.9 ± 0.2), intermediate apparent viscosity (54.3 ± 0.6 mPa. s) and most of the droplets with a size between 1 and 10 µm.

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Production of concentrated brewer spent yeast protein hydrolysate with a low content of RNA

Gabriela VOLLET MARSON[12], Rafaela POLESSI SATURNO[1], Eliana Marcela VÉLEZ-ERAZO[1], Miriam DUPAS HUBINGER[1]

[1]*University of Campinas, Campinas, Brazil*
[2]*University of Montpellier II, Montpellier, France*

Abstract

Yeast-based by-products are an attractive option as a source of proteins due to their availability, nutritional composition and environmental perspective, but their application may be hampered by its ribonucleic acid content (RNA). Brewer spent yeast (BSY) is the second most relevant by-product from the brewing industry and consists of the yeast cells collected after fermentation. This work objective was to produce a high protein and low RNA BSY hydrolysate (BSYH) through enzymatic hydrolysis and ultrafiltration (UF) using regenerated cellulose membranes. Enzymatic hydrolysis was performed using a mixture of Alcalase™, Protamex™ and Brauzyn® (pH 7.0, 50 °C) in an automatic titrator. BSYH was centrifuged and the supernatant was used as feed for the UF in a 10 kg mol^{-1} molecular weight cut-off membrane. BSYH at pH 8 was concentrated to a volumetric concentration factor of 1.5 in a cross-flow mode system (7.7 10^{-3} m^2) operating at 50 °C and 12 bar. The total solids, crude protein and RNA contents of BSYH feed, retentate and permeate were determined. The UF procedure resulted in a total solids and crude protein retention factors of 56 and 54%, respectively. RNA was mostly permeated (retention factor of 25%) through the regenerated cellulose membrane. With a permeate flux of 18.1 ± 2.7 kg m^2 h^{-1}, BSYH solids and proteins were 41 and 43% higher after concentration, respectively, while RNA content was 12% lower. The ultrafiltered BSYH concentrate had a total solids content of 12%, of which 48% consisted of crude proteins and less than 2% were RNA.

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Non-thermal processing of açaí (*Euterpe oleracea* Mart) berry

Maria de Fátima Dantas LINHARES[1], Thatyane Vidal FONTELES[1], Fabiano A.N. FERNANDES[2], **Sueli RODRIGUES**[1].

[1]Federal University of Ceará, Food Engineering Department, Fortaleza, Brazil
[2] Federal University of Ceará, Chemical Engineering Department, Fortaleza, Brazil

Abstract

Açaí berry (*Euterpe oleracea* Mart*)* is an Amazon super-fruit with a high antioxidant capacity due to the high-bioactive anthocyanins and other bioactive compounds. The fruit is consumed in different ways such as meal complement, protein bars, ice-creams, juices and combined with granola and banana. By law, the berry is bleached before processing to avoid Chagas disease. The fruit pulp, which is highly perishable, is usually diluted in water, pasteurized and frozen. In the present study, we evaluated the effect of low-pressure cold plasma (nitrogen gas) and high-power ultrasound processing on the açaí juice quality, regarding the anthocyanins and phenolic content, the antioxidant activity. Plasma processing changed the nitrogen flow rate (10 to 30 L/min and processing time 5 to 15 min). Ultrasound processed changed the potency density (75 to 373 W/cm^2) and processing time (2 to 10 min). The anthocyanins were expressed as cyanindin3-O-glucoside, phenolics were expressed in gallic acid, and the antioxidant activity was determined using ABTS, DPPH and FRAP protocols. Plasma processing increased the phenolic content and slightly decreased the anthocyanin content. Ultrasound processing resulted in a slight increase in phenolics and anthocyanins. The antioxidant activity was dependent on the processing conditions and increased up to 45 % for plasma processing and up to 40% for ultrasound processing. Thermal processing (90 ^{o}C/ 1 min) resulted in phenolic compounds decrease of 40% and anthocyanins decrease of 90 %. According to the results, low-pressure plasma processing and ultrasound were better to keep the bioactive and antioxidant capacity of açaí juice.

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Food industry in the digital era: virtual tools, smart systems and connectivity

Francesco MARRA

University of Salerno, Department of Industrial Engineering, via Giovanni Paolo II, 132, 84084 Fisciano SA Italy

Abstract

The whole industrial sector is moving nowadays toward connectivity, smart systems and virtual tools, though most of the players in food manufacturing and processing are still not familiar with key-words such as big-data, computational power, business-intelligence-capabilities, human-machine interaction, robotics, internet of things, artificial intelligence.

This talk is then aimed to explore some of the potential that the digital revolution can bring along the food chain and especially in the food processing industry. The most promising virtual tools and methodologies to be applied in design and management of equipment for the food industry, innovative and/or optimized food processes, new food products, connectivity apps, smart systems are identified and discussed. Especially, the speaker will share his vision on the reliability and capability of some of such tools to lower production costs and to increase the process/product profitability. Case studies on how such tools can provide innovations in the food industry will be discussed too.

The digital era framework offers unique opportunities for the food industry and for the future food engineer careers and mandates adequate research and development to overcome emerging challenges: will Food Engineers be the ferrymen able to massively introduce and drive the fourth industrial revolution in the food industry ?

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Non-centrifugal cane sugar production: Heat transfer study to optimize the use of energy

Fabián VELASQUEZ[1], Sebastián ESCOBAR[1], John ESPITIA[1], Ricardo LOPEZ[1], Jader RODRIGUEZ[1]

Corporación Colombiana de Investigación Agropecuaria - Agrosavia. Centro de Investigación Tibaitatá – Kilómetro 14 vía Mosquera Bogotá, Mosquera, Colombia

Non-centrifuged cane sugar (NCS) is a concentrated product obtained through the evaporation of water contain from sugarcane juice in open heat exchangers (OE). The heat supplied to the evaporation stages is obtained from the cane bagasse through the thermochemical process of combustion, where the thermal energy released is transferred to OE by the flue gas. Therefore, the optimization of energy usage becomes essential for the proper design of the production process. For optimize the energy use, it is necessary modeling and simulation of heat transfer between the combustion gases and the juice and to understand the major mechanisms involved in the heat transfer. The main objective of this work was simulate heat transfer phenomena between the flue gas and open heat exchangers using Computational Fluid Dynamics model (CFD). The simulation results were compared to field measured data. Numerical results about temperature profile along the flue gas pipeline at the measurement points are in good accordance with field measurements. Thus, this study could be of special interest in design NCS production process and the optimization of the use of energy.

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Emulsion containing sacha inchi (*Plukenetia volubilis* L.) oil stabilized by nonionic surfactants and sodium alginate

Klycia SILVA[1], Ana Gabriela CARVALHO[1], Renata RABELO[1], **Miriam HUBINGER**[1]

[1]*University of Campinas, Campinas, Brazil*

Abstract

Sacha inchi oil (SIO) presents about 82% polyunsaturated fatty acids and important micronutrients, as tocopherol and phenolic compounds. The presence of these compounds makes this oil an interesting alternative to be applied in foodstuffs and cosmetics products. This work investigated the production of emulsions containing SIO in order to promote its protection against lipid oxidation, and for a possible combination with other encapsulation methods. Oil in water emulsions were prepared using sodium alginate (2wt%) and polysorbates (Tween 20 and 80 at concentrations of 0; 0.5 and 1.0wt%) as encapsulating and stabilizer agents, respectively. Emulsions were characterized in relation to droplets mean diameter and size distribution, optical microscopy, ζ-Potential, creaming index and rheological behavior and the physical properties of the phases were evaluated by interfacial tension. Emulsions showed high electronegativity (≈ -80 mV) and pseudoplastic behavior. Control emulsions (0.0wt% polysorbates) displayed low kinetic stability with increased SIO concentration (45; 60 and 75% in relation to total solids) and droplets size and span values ranging from 3.61 to 2.41μm and 2.20 to 0.81, respectively. After polysorbates addition, especially the 1.0wt% Tween20, emulsions showed significant increase in kinetics stability with decreasing of droplet size (1.74 to 1.80μm) and span (0.81 to 0.85). This fact occurred due to interfacial tension reduction (from 13 to 7 mN/m) on the surface of SIO drops promoted by surfactants (1.0wt% Tween20). Results showed that emulsification process using 1.0wt% Tween20 was an efficient method for SIO encapsulation.

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The positive impacts of postharvest interventions in food security: a value chain perspective

Silvia ESTRADA-FLORES[1], Suzie NEWMAN[2]

[1]*Food Chain Intelligence, Queretaro, Mexico*
[2]*Plant & Food Research New Zealand, Auckland, New Zealand*

Abstract
Postharvest interventions in aid projects are linked to increased financial sustainability of smallholder enterprises, lifting of communities from poverty, improved food security, and decreased environmental impacts through waste avoidance and better use of resources. More recently, the introduction of value chain theories has led to significant advances in the development of inclusive (i.e. gender, ethnic) horticultural chains.
This presentation discusses some positive outcomes observed from postharvest interventions in international development projects, including:

- Product quality interventions, which aim to enhance nutritional and marketable quality of fresh and processed products. The outcomes include switching smallholders from subsistence horticulture to semi-commercial and fully commercial activities, and the improvement of human welfare through the provision of nutritive and safe produce for both household and commercial consumption.
- Storage interventions, which target postharvest loss reduction through improved postharvest treatments, and storage and transport conditions. The key economic outcome observed is an increase in smallholder profitability through increased marketable produce. There are also important environmental benefits on the avoidance of food waste.
- Utilization and marketing interventions, which encourage new product development and market diversification, value creation through product differentiation, and smart use of by-products. The economic benefits include more profitable market alternatives and opening new revenue stream through the use of by-products. The environmental benefits are waste avoidance and opportunities to open circular economies by reusing waste to generate fertilisers or energy.

To frame this presentation, we will discuss some results observed from projects developed in South East Asia and Africa.

Synergistic effect of high pressure processing and two spice extracts on quality and shelf life of low-salt sausage during storage

Mei XU[1], Pan HUANG[1], Conggui CHEN[1], **Peijun LI**[1], **Baocai XU**[1]
[1] *Hefei University of Technology, Hefei, China*

Abstract
This study explored the effect of high pressure processing (HPP, 400 MPa) and two spice extracts, 0.05% cinnamon and 0.05% clove, alone or in conjunction, on quality and shelf life of low-salt sausage during storage at 4 ± 1°C. The results showed that the spice extracts could retard lipid and protein oxidation of the low-salt sausages ($P < 0.05$), while accelerated oxidation was found in the samples treated with HPP ($P < 0.05$). The sub-lethal lactic acid bacteria of the samples treated with HPP was observed to grow and be the predominant microbial flora at the end of storage, howerver, the growth was inhibited when the two spice extracts were added ($P < 0.05$). The low-salt sausage treated with HPP and the spice extracts had the longest (24-day) shelf life. It is revealed that the combined use of HPP and the two spice extracts is a promising strategy to improve the quality and extend the shelf life of low-salt sausage.

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Pulsed electric field treatment of red wine: inactivation of *Brettanomyces* and potential hazard caused by metal ion dissolution

Sanelle VAN WYK[1], Filipa SILVA[1], Mohammed FARID[1]

[1]*University of Auckland, Auckland, New Zealand*

Abstract

Brettanomyces yeast concentrations as low as 10^4 cfu/ml can have devastating effects on wine quality. To combat *Brettanomyces* contamination, sulphur dioxide is added throughout wine production. However, this can have negative effects on wine quality and cause adverse effects on consumers. A promising alternative non-thermal technology to inactivate *Brettanomyces* and preserve wine is pulsed electric fields (PEF). The effect of PEF processing conditions, *B. bruxellensis* yeast strain and alcohol concentration on *B. bruxellensis* inactivation in red wine, as well as whether PEF treatment could have a harmful effect on wine through the release of metal ions was investigated. Electric field intensity was found to have a greater impact on inactivation than specific energy, with 31, 40 and 50 kV/cm treatments resulting in *B. bruxellensis* D-values of 181.8, 36.1 and 13.0 μs, respectively. At 50 kV/cm, a temperature rise of almost 10 °C, doubled inactivation to 3.0 log reductions. Yeast strain and alcohol concentration were also shown to influence inactivation, even though cell size comparisons of the three yeasts tested proved inconclusive. Overall, PEF treatment of wine was shown to be a possible preservation alternative for the wine industry. After PEF treatment, the wine produced remained safe for human consumption, with Fe, Cr and Ni ions contents well below dangerous levels.

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Non-thermal preservation of wine using high pressure processing and pulsed electric fields

Sanelle VAN WYK[1], Filipa SILVA[1], Mohammed FARID[1]

[1]*University of Auckland, Auckland, New Zealand*

Abstract

Brettanomyces bruxellensis is a concern for the wine industry worldwide, capable of spoiling wine and causing undesirable sensory properties. Sulphur dioxide is widely used in the wine industry to prevent microbial spoilage. Nevertheless, this preservative can cause adverse effects in consumers. Consequently, the wine industry is interested in finding alternative methods to reduce SO_2 levels, while maintaining wine quality. The objectives of this study were therefore to determine the viability of using non-thermal technologies including high pressure processing (HPP) and pulsed electric fields (PEF) for *B. bruxellensis* inactivation in wine and the effect on wine quality parameters including colour density, total phenolic content, pH and volatile phenol concentration directly after processing and during storage. It was also important to ensure that PEF treatment has no harmful effect on wine through the release of metal ions. HPP treatment at 400 MPa for 5 seconds achieved > 6.0 log reductions of *B. bruxellensis*. PEF treatment produced wine safe for human consumption, with metal ion contents well below dangerous levels. No significant difference between the overall sensory quality of HPP vs untreated wines and PEF vs untreated wines were found after being stored for a year. SO_2 and PEF treatments had no significant effect on wine quality, while the colour and phenolic quality of HPP treated wine deteriorated after six months of storage. HPP and PEF proved to be viable alternatives for the inactivation of *B. bruxellensis* in wine, with the potential to reduce the industry's reliance on sulphur dioxide.

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Comparison of Simulated Digestion for the Phenolic Composition and Antioxidant Activity in Different Cultivars of Lychee Pericarp

Dongxiao SU[1], Qingzhu ZENG[1], Zhuohui XU[1], Shan HE, Yang YUAN

School of Chemistry and Chemical Engineering, Guangzhou University, Guangzhou, P.R. China

Abstract
Lychee pericarp is rich in phenolic and has good antioxidant activity. The effects of simulated gastric (SGF) and intestinal fluid (SIF) digestion on the contents, composition, and antioxidant activities of the phenolic substances in the pericarp of different lychee cultivars were investigated. Compared with distilled water (DW) treatment, the total phenolic content (TPC) and total flavonoid content (TFC) in the pericarp of different lychee cultivars decreased after SGF digestion. The TPC and TFC of lychee pericarp also decreased after SIF digestion. However, the TPC in three cultivars increased. The SGF and SIF also had different effects on the FRAP and ABTS antioxidant activities of different lychee cultivars. The SGF digestion decreased the ABTS antioxidant capacity of lychee pericarp but enhanced the FRAP value of some lychee cultivars. However, the SIF digestion decreased the FRAP antioxidant activity of different lychee cultivar pericarps but enhanced the ABTS antioxidant capacity of lychee. The HPLC results showed that lychee pericarp had relatively high contents of procyanidin B2 and procyanidin A2. After SIF digestion, caffeic acid and isoquercitnin could not be detected in any of the lychee varieties. However, quercetin-3-rutinose-7-rhamnoside and isoquercitrin were increased after SGF digestion. Lychee pericarp could be used as an inexpensive functional food ingredient.

3D simulation of oxidation reactions in real deep-fryers: interactions with anisothermal oil flow and design

Maxime TOUFFET[1], Mohamed Hatem ALLOUCHE[2], Paul SMITH[3], Olivier VITRAC[1]

[1]*UMR 1145 ''Food Processing and Engineering'' INRA, AgroParisTech, Université Paris-Saclay, 91300, Massy, FRANCE*
[2]*UMR 6303 CNRS-Université de Bourgogne France-Comté, F-21078, Dijon, FRANCE*
[3]*Cargill R&D Centre Europe, Havenstraat 84, B-1800, Vilvoorde, BELGIUM*

Batch deep fryers rely on a simple multi-millenary design. Innovative designs should minimize heating time, oil volume, oil abuse, lingering smell and finally oil uptake. New engineering approaches have been explored through several collaborative research programs. This communication reports the coupling between the anisothermal oil flow and oxidation reactions of triacylglycerols during initial heating and holding time. The key phenomena were analyzed by coupling 3D heat and flow simulation in an Eulerian frame with a Lagrangian description of transports and reactions. After a fast transient period, oxidation reactions are controlled by the dissolution rate of oxygen at the oil bath surface, where it is converted into hydroperoxides within a diffusion layer of a few millimeters thick [1]. The lifetime of hydroperoxides (~30 min) is longer than the vertical mixing time (~1 min), so that they can be dispersed by advection and eddy diffusion. As the decomposition of hydroperoxides (LOOH) is strongly endothermic, the fate of LOOH (decomposition or accumulation) is controlled by the residence time in the different regions of the deep-fryer. The speciation of breakdown products depends on the local temperature. Only the decomposition close to the surface contributes to the propagation of the radicalar mechanism. In the bulk, stable polymers are favored and accumulate near hot surfaces. The predictions were validated by comparing with local measurements of oxidation products [2].The effects of different designs are illustrated to evidence the possibilities of innovation.

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Influence of oil and protein type on the particle properties of model infant formulas

Guilherme de Figueiredo FURTADO, Ana Gabriela da Silva CARVALHO, Miriam Dupas HUBINGER

University of Campinas, Campinas, Brazil

Abstract
Considering the frequent need to develop new formulations that contain functional appeal to meet the scientific and technological demands, the objective of this study was to evaluate drying performance and physicochemical properties of model infant formulas composed of different types of oils and proteins. Formulations containing 20, 30, 30 and 40 g L-1 protein, oil, lactose and maltodextrin, respectively, were prepared using either whey protein isolate (WPI), whey protein hydrolysate (WPH), WPI+Lactoferrin (LF) or WPH+LF. The oil phase was composed of high oleic sunflower oil (HOSO), or a mixture of HOSO with medium chain triacyclglycerols (MCT) or coconut oil (CO). Emulsions were prepared in a double stage high pressure homogenizer (30/5 MPa, 2 cycles). Powders were produced by spray-drying emulsions (inlet temperature of 170 °C) to an average final moisture content of approximately 1.5% and average water activity of 0.13. The extent of powder build-up on the dryer wall decreased for formulations containing LF and these powders showed higher encapsulation efficiency (above 70%). In addition, these formulations presented a slightly orange appearance due to the presence of LF, which was evidenced by the slightly higher b* values of the color analysis. Addition of MCT or CO oil also yielded a higher encapsulation efficiency. Additionally, differences in wettability, microstructure and particle size were linked to the emulsifier system and oil type used. Inclusion of LF and MCT in the formulation showed to be promising ingredients for the development of functional infant formulas.
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Gentler and kinder processing of goat milk: Effect of high pressure processing on its quality

Alifdalino SULAIMAN[1], Sangitha NARAYANAN[1], Nor Nadiah Abdul Karim SHAH[1], Siti Mazlina MUSTAPA KAMAL[1]

[1]*Universiti Putra Malaysia, Serdang, Malaysia*

Abstract
Fresh goat milk spoilt in a short time due to bacterial spoilage. The common heat pasteurization is usually employed to increase its shelf life. With the increasing consumer interest for minimally processed fresh goat milk with high nutrient and quality, high pressure processing (HPP) could provide a gentler and kinder alternative to pasteurized goat milk.

This research studied the safety and quality (colour, rheological properties, total soluble solids, pH and microbiological analyses during storage) of goat milk processed by HPP (200 to 600 MPa) and thermal treatment (60 to 80˚C) at 5 to 15 min. Storage study for 30 days at 25˚C and 4˚C were also carried out to evaluate the shelf life of the processed goat milk.

HPP processed goat milk retained a stable viscosity and total soluble solids than thermal treated milk which declines during extensive heat treatment and storage period. Similar effect on total colour different was observed for HPP processed (600MPa, 10 min) and thermal processed (80, 10 min) goat milk. The refrigerated (4˚C) HPP (600 MPa, 10 min, RT) goat milk product was seen to give comparable result in term of safety to the thermal pasteurized (70˚C, 15 min) milk, where both can be stored at 4˚C for 10 days with minimal detection of microbial growth.

In conclusion, HPP goat milk provide a good alternative to traditional thermal pasteurization in terms of shelf life and quality with subsequent refrigeration.

Forward Osmosis for Dairy Processing – A Pilot Scale Study on Milk and Whey Concentration

Novel Approaches to Dairy Processing

George CHEN[1], Anna ARTEMI[2], Judy LEE[2], Sally GRAS[1,3], Sandra KENTISH[1]
[1] The ARC Dairy Innovation Hub, Department of Chemical Engineering, The University of Melbourne, Parkville, Victoria 3010, Australia
[2] Department of Chemical and Process Engineering, University of Surrey, Guildford, Surrey GU2 7XH, United Kingdom
[3] The Bio21 Molecular Science and Biotechnology Institute, The University of Melbourne, Parkville, Victoria 3010, Australia

Abstract

Concentration and drying are the most energy intensive processes in dairy processing, demanding ~25% of the total energy consumption. As milk and whey powders are the main spray dried products manufactured by the dairy industry, there is a great interest in increasing the total solids concentration prior to drying by means of less energy consuming unit. Forward osmosis (FO) is an emerging membrane technology that can potentially be applied as a pre-concentration step for powder production, as it is reported to be more energy efficient and less susceptible to fouling compared to conventional membrane concentration processes such as reverse osmosis (RO).

The concentration of milk and whey was studied at a pilot scale using FO membranes with an installed membrane area of 24 m^2. A draw solution of NaCl was used to mimic the potential brine streams available in a dairy processing plant, avoiding the need for the regeneration of a synthetic draw solution. A concentration factor of 2.5 was achieved for both the skim milk and fresh whey. Operating parameters such as temperature, transmembrane pressure, and draw solution concentration were investigated to optimise the concentration process. A cleaning protocol was established for recovering the membrane performance after milk and whey concentration. The energy required for milk and whey concentration using only the FO step was found to be much lower than that required by RO. This pilot scale study provides useful information to advance FO technology and accelerate the commercialization of this technology in dairy processing.

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Effect of cooking on aroma profiles of Chinese foxtail millet (*Setaria italica*) and correlation with sensory quality

Shuang BI[1,2,3,4,5], Aojidong WANG[2,3,4,5], Xinxing XU[1,2,3,4,5], Dongsheng LUO[1,2,3,4,5], Wentao ZHANG[1,2,3,4,5], Qun SHEN[2,3,4,5], Jihong WU[1,2,3,4,5]*

[1]*Beijing Advanced Innovation Center for Food Nutrition and Human Health, Beijing, China*
[2]*College of Food Science and Nutritional Engineering, China Agricultural University, Beijing, China*
[3]*National Engineering Research Center for Fruit & Vegetable Processing, Beijing, China*
[4]*Key Laboratory of Fruit & Vegetable Processing, Ministry of Agriculture, Beijing, China*
[5]*Beijing Key Laboratory for Food Non-thermal Processing, Beijing, China*

Abstract
The effects of roasting, boiling, and freeze-drying after boiling on volatile aroma compounds in three varieties of Chinese foxtail millet (Setaria italica), namely, Jingu 21, Fenghonggu and Dongfangliang were determined. During boiling significant ($p < 0.05$) increases in the contents of several unsaturated aldehydes, alcohols, and benzene derivatives were observed, unlike roasting that mainly increased in the contents of pyrazines. Freeze-drying after boiling decreased complexity of flavors with a reduction in the contents of volatile compounds. Descriptive sensory analysis showed that the maximum intensity of ‘popcorn-like’ and ‘smoky’ odors was observed for roasted samples, whereas boiled and pre-boiled-freeze-dried samples were characterized by ‘boiled rice’ and ‘boiled potatoes’ odors, respectively. A correlation of odor-active profile data with descriptive sensory analysis clearly established the role of pyrazines such as 2-ethyl-3,5-dimethylpyrazine in contributing to the ‘popcorn-like’, ‘boiled beans’, and ‘smoky’ odors, whereas dienals such as (E,E)-2,4-decadienal were responsible for the ‘boiled rice’ aroma.

Recent advances in the radio-frequency tempering and thawing of frozen foods

Yvan LLAVE

Niigata Agro-Food University, Niigata, Japan

Abstract
It has been reported that when a frozen food is radio-frequency (RF) heated, some small regions thaw first, due to special nonuniformities of heating, absorbing much more power than the rest of the frozen regions. This situation leads to thermal runaway heating[1], which causes nonuniform temperature distributions, significant drip losses and may results in bacteria growth and product quality degradation. However, in recent years some solution's approaches to these problems have been published. This presentation summarized some of the most relevant and novel application studies; dielectric properties data in the RF band; and novel mathematical simulation models developed to achieve uniform heating. Applications of RF tempering or thawing of frozen foods included blocks of beef meat blends, lean beef, shrimp, and tuna fish, chicken breast, and cylindrical pork sirloin. Simulation models have been predicted heating pattern, electric field distribution, pressure profiles, and moisture content distributions in batch and continuous RF process. Experimental and simulation works have been focused on electrodes applicator position, electrodes shape and size, which showed to be successful on shortening processing time and improved the RF's ability to penetrate deeper into food products, which is preferable for tempering and thawing purposes. Improvements in temperature uniformity has been reported by using translational and rotational movement of the food product, electrode vertical movement, adjustment in electromagnetic potential, lowering the temperature in the cavity, and using two-cavity systems due to the changes in the electric field distribution. The data described herein are valuable for the development of RF thawing systems.

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Pepper seed oil extraction by pressure-assisted, ultrasound-assisted and conventional solvent methods

Liang ZHAO[1], Yan MA[1], Xiaojun LIAO[1]

[1] *College of Food Science and Nutritional Engineering, China Agricultural University, Beijing, China; National Engineering Research Centre for Fruit and Vegetable Processing, Beijing, China; Key Laboratory of Fruit and Vegetable Processing, Ministry of Agriculture and Rural Affairs, Beijing, China*

Abstract

The aim of this study was to optimize pressure-assisted extraction (PAE) parameters of pepper (*Capsicum annum L.*) seed oil (PSO) using response surface methodology (RSM) and compare the chemical composition and characteristics of PSO by PAE, ultrasound-assisted extraction (UAE) and conventional solvent extraction (CSE). The gas chromatograph method was used for determine the composition of fatty acids. The methods of Association of Official Analytical Chemists (AOAC) were used to analyze the phospholipid content, acid value, iodine value, peroxide value, saponifiable and unsaponifiable values of the extracted PSO. The optimized PAE parameters were 370 MPa at 50°C for 5.7 min, which could achieve the extraction percentage of 83.0%. For UAE, similar percentage of extraction need ultrasonic power of 200 W at 50°C for 50 min; and for PSO, needs 50°C for 6 h. The results indicated that PAE is the most efficient extraction method compared with UAE and CSE. What's more, PAE could retain higher level of unsaturated fatty acids (82.36%), γ-tocopherol (8.04 mg/100 g), characterized with lower acid value (3.89 mg KOH/g), peroxide value (1.47 mmol/kg) and higher iodine value (130.80 gI/100g), and displayed superior antioxidant capacity. The available data are provided for evaluation and application of PAE in oils extraction industry and PAE could be a more efficient and time-saving technique to extract higher quality PSO.

Keywords: Pepper seed oil, Pressure-assisted extraction, Ultrasound-assisted extraction, Conventional solvent extraction, Chemical composition

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The formation and stability of carbon dioxide nanobubbles designed for potential applications in food processing

Khanh PHAN[1], Tuyen TRUONG[1,2], Bhesh BHANDARI[1]

[1]*School of Agriculture and Food Sciences, The University of Queensland, Queensland, Australia*
[2]*School of Science, RMIT University, Melbourne, Australia*

Abstract
Bulk nanobubbles (NBs) which are ultrafine gas-filled cavities (< 500 nm in size) possess unique properties such as remarkable stability in water, high internal pressure, extremely large surface/volume ratio and high gas dissolution ability. These properties of NBs can provide promising benefits to food product quality and processability. This work aimed to investigate the formation and stability of CO_2 bulk NBs in water for intended applications in food processing. The NBs were generated by injecting CO_2 gas and distilled water through a commercial venturi-type NBs generator. The CO_2 gas gauge pressure applied were 300, 350 and 400 kPa, whereas two different levels of water pressure (100 and 200 kPa) were used. Size measurement via dynamic light scattering technique indicated that generated CO_2 NBs were in nano-size range (190-530 nm) depending on the CO_2 and water pressures used. Their existence lasted for more than 7 days with a good repeatability of size distribution. Zeta potential of the formed NBs varied from -8 to -19 mV, indicating their stability in the aqueous medium. Concentration of CO_2 in water containing the NBs also increased (> 2000 ppm) significantly when compared with the water only samples. Besides, when a surfactant (Tween 80) was used in the system to produce NBs, the mean size of NBs was significantly ($p \leq 0.05$) decreased to lower than 100 nm. These findings highlight some new fundamental understanding on the generation and physical characteristics of CO_2 NBs which can have potential applications in food processing that need to be further explored.

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Radio frequency for innovative thermal processing – mathematical modeling for process optimization and industrial scale-up

Ferruh ERDOGDU[1], Francesco MARRA[2]

[1]*Ankara University, Ankara, Turkey*
[2]*University of Salerno, Salerno, Italy*

Radio frequency (RF) assisted heating of foods has been used as innovative thermal processing from thawing to pasteurization – sterilization processes. Its recent industrial focus has been the continuous tempering-thawing of frozen commodities due to its potential to reduce quality losses encountered in conventional processing. With rapid and volumetric heating behavior, it is possible to achieve this process quicker than conventional approaches with minimized risk of quality losses. However, its efficiency depends upon various factors, such as geometrical features of the product and physical configuration of the RF system. Furthermore, the operation mode, either in batch or continuous, affects the temperature (non-)uniformity and heating rate. Considering the recent studies in the field, the research in this area has been rather focused on the applied mathematical modeling for process design and optimization. Therefore, the objectives of this study were to demonstrate the background in RF processing based on mathematical modeling approaches for process design and optimization with industrial scale – up and examples given for various food processing operations from tempering – thawing to pasteurization. This study hence dealt with the engineering aspects of RF processes, covering the analysis of transport phenomena involved, set-up and use of virtual tools for design and optimization.
A short review of the literature with innovative nature of RF application for various food processing from thawing to post-harvest processing and pasteurization – sterilization were also addressed with unsolved issues - needs for further research at industrial and academic sides.

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The Effect of Fermented-Milk Containing Probiotic *Lactobacillus casei* Strain AP on the Concentration of Monocyte Chemoattractant Protein-1 (MCP-1), Blood Glucose, and Lipid Profiles in Obese People

Anggeria Oktavisa DENTA[1], Sunarti SUNARTI[1,3], **Widodo WIDODO[1,2]**

[1]*Graduate School of Biotechnology, Universitas Gadjah Mada, Yogyakarta, Indonesia*
[2]*Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta, Indonesia*
[3]*Departement of Biochemistry, Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta,Indonesia*

Abstract
Obesity and hyperglycemia can increase the concentration of Monocyte Chemoattractant Protein-1 **(**MCP-1), which may, in turn, trigger various diseases. Healthy fermented-milk products may be developed from *Lactobacillus casei (L. casei)* AP, a local probiotic strain from Indonesia. Since this strain has never been tested on humans, our study aims to examine the effect of *L. casei* AP local probiotic fermented-milk products on the concentrations of MCP-1 and the blood glucose and lipid profiles in obese people. We administered *L. casei* AP fermented-milk products to our obese subjects and measured their concentrations of fasting blood glucose, total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides using diagnostic systems kits. We then tested their MCP-1 concentrations with ELISA. Our data showed that *L. casei* AP fermented-milk products decreased MCP-1 concentrations and reduced fasting blood glucose to a nonsignificant concentration (p>0.05). The administration of *L. casei* AP fermented-milk products to lipid profiles significantly reduced total cholesterol, LDL cholesterol, and triglyceride concentrations (p<0.05), while the increase in HDL concentration was not significant (p>0.05). It is concluded that *L. casei* AP probiotic fermented-milk can reduce the concentrations of MCP-1 and fasting blood glucose and improve lipid profiles in obese people.

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Turning Phytates into a natural Iron delivery system

EDWIN HABEYCH[1], NICOLA GALAFFU[1]
[1]*Nestlé Research Center (Micronutrient Group), Lausanne, Switzerland*

Abstract
Micronutrient malnutrition affects billions of people's lives around the world, causing many adverse effects on human health, not all of which are clinically evident. Iron deficiency anaemia (IDA) is the biggest nutritional deficiency worldwide.

IDA arises when physiological requirements cannot be met by iron absorption from the diet due to low intake and/or low bioavailability. Nutritional factors in the diet like phytic acid or ascorbic acid can contribute reduce or enhance iron absorption respectively.

Phytic acid (PA) is known as anti-nutrient for minerals due to its natural capacity to form insoluble complexes with minerals. However, under certain conditions, these complexes can be solubilized, given to phytic acid the potential to be used as natural delivery systems for iron.

In this work, a soluble formulation of iron:PA complexes was developed with the use of amino acids and hydrolyzed protein showing high stability in sensitive foods such as the one containing polyphenols and high iron bioaccessibility in Caco-2 cells *in-vitro* model.

One of the developed compounds was tested for iron absorption in a randomized, controlled, single blind, cross-over study using three stable labelled isotope in healthy Swiss adult women (n=22) in interventions with and without the addition of an inhibitory meal rich in phytate. Iron absorption was assessed by means of erythrocyte incorporation 14 d after consumption of the labelled test meals.

Tested iron:PA complex was confirmed to be 2x to 5x more bioavailable than ferric pyrophosphate (a common fortificant used in food), eventually leading to a more effective fortification of condiments.

Towards heuristics for food product design

Simon LAWTON[1,2], Serafim BAKALIS[2], Timothy FOSTER[2], Christopher KOH[3]

[1] *PepsiCo Global R&D, Leicester, UK*
[2] *The University of Nottingham, Nottingham, UK*
[3] *PepsiCo Global R&D, Plano, Texas, USA*

Abstract

Traditional means of product development involves the selection of ingredients and processing method, followed by optimisation for the most desired attributes, within the constraints of process capability, which inevitably leads to compromise some way along the development pathway.

We suggest an alternative approach to identify the required product / process parameters, using a heuristic approach that correlates dimensionless properties of the product and process to define a design space. Such an approach has the benefit of starting with the definition of the required product attributes, allowing an unconstrained selection of processing technology, and additionally aids in the identification of "white spaces" where process or product innovation may enable competitive advantage.

To define the design space, a dimensional analysis is first conducted to identify dimensionless numbers characterising the product and correlate these with known process dimensionless numbers characterising heat and mass transfer to define the product-process interactions. We then seek to identify overlap between the individual target product attribute design spaces to identify the true process-product design space for product development.

Such an approach can be used to highlight the range of different product attributes that can be derived from the same starting substrate, by varying factors such as product geometry and heat transfer to the product surface.

The Design Space approach will be introduced using flavour generation as a case study, using a potato snack as an example where very different final products can be derived based on the geometry and applied heat transfer coefficient to illustrate its use.

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System engineering approach to design solutions for humanitarian food security situations

Dominique BOUNIE[1], **Jay SELLAHEWA[2]**

[1]*University of Lille, Villeneuve d’Ascq, France*
[2]*CSIRO Agriculture and Food, North Ryde, Australia*

Abstract

Humanitarian crises (natural disasters, man-made crises) raise complex food security concerns where many multi-dimensional and sometimes conflicting issues have to be taken into account. In such contexts, providing safe, nutritious, good quality and culturally accepted food in the right quantity at the right time in the right place is of utmost importance. This requires a double paradigm shift: first, by focusing on beneficiaries’ needs and not on donors’; and second, by designing solutions tailored for the different phases of the entire humanitarian continuum, i.e. not only for relief but also for prevention and rehabilitation.

Functional Analysis (FA) - a system engineering method - may be usefully applied for designing technical solutions appropriate to any humanitarian food product, process or service. At each of their life cycle steps, FA aims first to identify the specific functions and constraints needed by the users (beneficiaries), then to characterise them precisely in terms of appraisal criteria, levels and flexibility (external FA), and finally to design the solution best suited to these specifications (internal FA). Reverse FA aims to improving existing solutions by examining functions and constraints that are unsatisfactory or not addressed, and by adapting the corresponding solutions accordingly.

Such functional methods strongly differ from the more traditional ones where preset exogenous solutions are forcedly transferred and imposed to users (beneficiaries) who, most of the time, do not adopt them in the long term. The different examples presented here demonstrate how food engineering methodologies could contribute to food security in a humanitarian context.

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Modeling of Ohmic Heating Patterns of Ketchup Using Computational Fluid Dynamics Codes

NAFISEH ZAMINDAR[1], NAYYERE GHOLIPOUR SHAHRAKI[1], MOHAMMAD HOJJATOLESLAMI[2]

[1]Isfahan (Khorasgan) Branch Islamic Azad University, Isfahan, Iran
[2]Shahrekord Branch Islamic Azad University, Shahrekord, Iran

Abstract

In this research numerical model of ohmic heat transfer of ketchup was developed by Fluent software. Thermophysical properties of the sample were defined as a function of temperature and applied for modeling. A three dimensional geometry of ohmic cell was designed and meshed (nodes with distance of 1, 1.2 and 2 mm) through Ansys Workbench. Boundary conditions, basic equations, computational methods and mesh study were determined through Fluent. Grid independence, temperature and velocity profiles, the slowest heating zone, pasteurization value (F_{value}), heating rate and energy calculations were studied. Simulation showed there was no significant differences between three grids from the beginning to the end of heating stage ($p \leq 0.05$). Pilot-scale validation of the model was performed according to laboratory experiments in thermocouple location (x = 0, y = -1.4, z = -5 cm) from the beginning to the end of heating stage at three voltage gradients of 9, 12 and 15 V/cm and 60 Hz frequency. There was no significant difference between predicted and experimental temperatures using t-test ($p \leq 0.05$). Cold spots and over processing were not created. The time required to heat the sample from 25 to 90 °C was 70, 60 and 50 s and the ohmic heating rates were 1.3, 1.5 and 1.8 °C/s at voltage gradients of 9, 12 and 15 V/cm, respectively.

Effect of Immersion Ohmic Heating on Thawing Rate and Properties of Frozen Tuna Fish

NAFISEH ZAMINDAR[1], SHAHNAZ FATTAHI[1]

[1]*Isfahan (Khorasgan) Branch Islamic Azad University, Isfahan, Iran*

Abstract
In present study, the application of immersion ohmic heating (OH) was examined to improve thawing of frozen tuna fish cubes. The experimental tuna cubes (3 × 3 × 3 cm) were subjected to three different voltages (40, 50 and 60 V) with three different concentrations (0.3, 0.4 and 0.5 % w/v) of brine solution. The parameters associated with the quality of tuna such as thawing time, thawing rate, thawing loss, cooking and total losses, centrifugal loss, lipid oxidation, texture and color, during ohmic heating thawing (group 1) were investigated, and compared with the conventional still air thawing, water thawing at 27°C and 40°C (group 2). The results showed the application of ohmic heating significantly decreased the thawing time. The results of group comparisons showed that thawing and total losses in group 1 was significantly lower than group 2. The highest 2-thiobarbituric acid (TBA) and the lowest tissue strength were observed in group 1 ($p \leq 0.05$). Thawing loss in conventional methods (air and water thawing) was 2.24 times higher than the ohmic treatments. Ohmic treatments did not have any significant effect on water holding capacity of samples.

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Evaluation of Antimicrobial Release from Biodegradable Films, Foreseeing Application as Food Packaging Material

Samar ELSHAMY [1], Isao KOBAYASHI [1,3], Kunihiko UEMURA [1,3], Mitsutoshi NAKAJIMA [1,2,3], Marcos A. NEVES[1,2,3], †marcos.neves.ga@u.tsukuba.ac.jp

[1]*Tsukuba Life Science Innovation Program (T-LSI), University of Tsukuba, Tsukuba City, Japan.*
[2]*Faculty Life & Environmental Science, University of Tsukuba, Tsukuba City, Japan.*
[3]*Food Research Institute, NARO, Tsukuba City, Japan.*

Abstract

Foodborne outbreaks are a considerable problem that occurred worldwide, either in developed or developing countries. It may affect both the national economy and food industry, as one accident of foodborne outbreak may lead to enormous economic losses[1]. Therefore, we must think innovatively and to find a solution to decrease the losses either through preventive measures or products that can enhance both food safety and quality.

For this reason, we are proposing the biodegradable films incorporated with natural active antimicrobial agents as a smart food packaging to protect food against a wide variety of food poisoning microorganisms and consequently extend the shelf life of the food products and improve the food safety, besides protecting the consumer's health.

Based on our previous experiments, by using chitosan films incorporated with essential oils EOs nanoemulsions as natural antimicrobial agents. The obtained results showed excellent film properties as well as a significant antimicrobial activity against gram-positive and gram-negative bacteria which indicates an innovative, promising product that can release natural active antimicrobial agents to the food surface causing inhibition to the bacterial growth, extending shelf life and enhance the food safety.

For the sake of the film's elaboration, foreseeing its application as food packaging material. We are working to find the scientific explanation, trigger's factors and understanding the kinetic mechanism of the EOs nanoemulsions release from the chitosan film to the food surface.

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Continuous process using protein-carbohydrate matrices for structuring and encapsulation

Mackenzie M. HANSEN, Yrjö H. ROOS

Food Technology, School of Food and Nutritional Sciences, University College Cork, Ireland

Encapsulation requires entrapment of sensitive bioactives with structure-forming food components to enhance protection and delivery. In the present study, an encapsulation matrix was developed using whey proteins and sugars for controlled hardening and vitrification of wall materials. A concentrated mix of WPI and sucrose in water as gelling and glass-forming ingredients, respectively, was used to form stable particles. Using a peristaltic pump, liquid flowed continuously through silicon tubing and formed droplets. Rapid solidification of protein occurred when droplets were submerged in heated, stirred oil at 100°C; drops were then harvested for vacuum oven drying. Solutions were characterized by viscosity and flow tests to gather densities, flow rates, surface tensions, drop weights, and estimated droplet sizes. Glass transitions and other changes in state were recorded using differential scanning calorimetry. Dried drops were characterized for porosity, hardness, diameter, water activity, and solids content. Microstructures were analyzed with optical, confocal scanning laser, and scanning electron microscopy. Analysis determined that drops comprised of 40% WPI and 10% sucrose by weight possessed optimum structuring qualities. The continuous process was adapted to encapsulate anthocyanins from blueberry concentrate; changes in feed and drop characteristics were evaluated. Oil uptake into drop structures was quantified, and methods were developed to quantify anthocyanins in feeds and drops. Solid structures formed after undergoing heat-induced protein gelation, drop expansion prior to network collapse with water loss, and sucrose glass formation during drying. This study provides insight into systematic materials-based preparation and use of high solids-concentrated dispersions, demonstrating an alternative encapsulation technology.

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Characterization of the Major Aroma-active Compounds in Raspberry Juice during High Hydrostatic Pressure Processing

Wentao ZHANG[1,2], Xinxing XU[1,2], Shuang BI[1,2], Fei LAO[1,2], Xiaojun LIAO[1,2], Jihong WU[1,2,*]

[1]*College of Food Science & Nutritional Engineering, China Agricultural University, Beijing, China*
[2] *National Engineering Research Centre for Fruit and Vegetable Processing, Beijing, China*

Abstract
Raspberry and its products were welcomed due to the unique flavor and rich nutritional value. Flavor, particularly in aroma, affects product choice, acceptance and consumption directly. To understand the dynamics of aroma determinants in raspberry juice during high hydrostatic pressure (HHP) processing, the major aroma-active compounds were identified in fresh juice followed by their changes under 200, 400 and 600 MPa for 10 min. The volatile compounds present in fresh raspberry juice were isolated by headspace solid-phase microextraction and analyzed by gas-chromatography mass spectrometry. A total of 94 volatile compounds were detected in different raspberry juice. Odor activity value (OAV) was calculated and detection frequency analysis (DFA) was also used to discriminate the potential main contributors to overall raspberry aroma profile. Comparative analysis between OAV and DFA identified 12 components as major aroma-active compounds, namely, hexanal, (Z)-3-hexenal, (E)-2-hexenal, (Z)-3-hexen-1-ol, eucalyptol, 1-octen-3-ol, theaspirane, linalool, beta-damascenone, dihydro-beta-ionone, alpha-ionone and beta-ionone. Both of them showed up-regulated tendency in response to pressure intensity. Only when the pressure reached 600 Mpa, significant difference on hexanal, (E)-2-hexenal, (Z)-3-hexen-1-ol, alpha-ionone and beta-ionone could be observed. Theaspirane, linalool and beta-damascenone were found to increase significantly after HHP treatment. However, (Z)-3-hexenal had no significant change during HHP processing unlike other three C_6 compounds. Principal component analysis suggested that treatment below 400 MPa was closer to fresh juice relatively.

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Pulsed Electric Field Equipment for the Food Industry

Luis REDONDO[1], Duarte REGO[2], Marcos PEREIRA[2], **Filipa SILVA[3]**

[1]*Instituto Superior de Engenharia de Lisboa - ISEL, Lisbon, Portugal*
[2]*EnergyPulse Systems - EPS, Lisbon, Portugal*
[3]*Universidade de Lisboa, Lisbon, Portugal*

Abstract

The application of pulsed electric fields, PEF, for enhancing the mass transfer of valuable inner cellular content and for inactivation of microorganisms is a scientific demonstrated technique for food and biomedical applications, based on the electroporation phenomenon. However the use of this process in the industry has encountered several difficulties due to the industrial requirements and the lack of technological suitable equipment with the energy efficiency, flexibility, cost, size and reliability to meet the industrial demands.

A new set of monopolar and bipolar semiconductor based modulators, from the modular Marx generator topology, up to 20kV, 400A and 10.5kW was designed for the food industry, with flow rates from 20 t/h. Application in the mass transfer and inactivation processes will be described, as well as the associated treatment chamber.

Examples of the operation of these equipment's in several applications, such as in the apple juice, wine, and olive oil industries, as well as, the microalgae cultures, showed that the application of PEF to the industry is a valuable tool. The difficulties encountered at the industrial level and the solutions to circumvent these will be described. In addition, the requirements put by these loads to the PEF systems will be evaluated and solutions encounter shall be discussed in order to achieve the best performance.

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Blueberry cuticular wax removal promoted by mechanical motion

Gonzalo A. MARTINEZ-HERMOSILLA, Alice King

Department of Chemical and Bioprocess Engineering, Massey University, Palmerston North, New Zealand

Abstract
One important factor that influences blueberry quality post-harvest is the presence of cuticular bloom, a natural wax on the fruit skin. The wax acts as a barrier against dehydration, stops diseases, reduces decay and at the same time, it is desired for customers as a sign of freshness. Unfortunately, the wax is easily lost during mechanical handing due to rubbing, brushing or dropping. A simple rotating drum system was used to subject berries to surface-fruit and fruit-fruit contact. Experiments were carried out to measure the amount of wax removal from the fruit as a function of time, rotational speed and berry loading in the drum. During the experiment, the blueberries were video recorded and image analysis was conducted to estimate their motion. A mathematical model was developed to predict the quantity of cuticular wax removed from blueberries surface depending on mechanical motion. The model was based on two parts; the motion of the blueberries in the drum, and the wax removal due to this motion. The results indicated that the model was able to be used to predict the amount of cuticular wax removed for a treatment time of from 0 to 5 min at rotating speeds up to 24 rpm. The model can be used to optimise the design conditions of the handling systems to minimise the risk of wax removal, to provide optimal processing conditions to ensure fruit quality is not compromised.

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Application of the genetic algorithm for smart packaging optimisation

Gonzalo A. MARTINEZ-HERMOSILLA, John E. Bronlund

Department of Chemical and Bioprocess Engineering, Massey University, Palmerston North, New Zealand

Abstract
Packaging design involves trading off a wide range of different functionalities, including considerations of strength, volumetric efficiency, product cooling, handling and other factors. One way to design packaging and combine all of these functionalities is by implementing genetic algorithms. This technique mimics the mechanism of biological evolution in order to find optimum performance within a population of designs. For a given design, each selected functionality is modelled and the performance is scored. Averaging these scores, the overall performance of the design can be estimated. Based on this overall score, the optimum design is selected. In this presentation, two case studies are presented; optimisation of pallet load and optimisation of hand-holes shape and position. For the pallet load optimisation, the problem consisted in finding the optimum box dimensions for a given mass of product in order to maximise volumetric efficiency and provide stability of pallet stacks. The hand-hole optimisation looked for the optimum shape and position of hole to minimise deformation on lifting and maximise the box compression strength. The routine successfully found optimum designs for the two cases in a relative short time. The approach taken is an adaptable methodology, so any other functionality can be used as the basis for optimisation.

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Subcritical water extraction of bioactive compounds from kānuka (*Kunzea ericoides*) leaves

Sinemobong ESSIEN[1]**,** Saeid BAROUTIAN[1], Brent YOUNG[1]
[1]*The University of Auckland, Auckland, New Zealand*

Abstract
The consumption of natural bioactive compounds has gained a lot of attention in recent times. These compounds are used in the development and production of functional foods, nutraceuticals, and fragrances. Kānuka is a native New Zealand medicinal plant and a source of functional and bioactive compounds. Subcritical water extraction was employed in order to obtain high value extracts from kānuka leaves. It is an excellent alternative to conventional solvent extraction and it is an environmentally friendly technique for extracting a wide spectrum of compounds from plants. The effects of extraction temperature (150-210°C), solids content (15-35 g/L), and duration of extraction (up to 40 min) on the antioxidant content and activity of the extract were investigated in this study. The highest of total phenolic and flavonoid contents (210 mg GAE and 25 mg CAE/ g dw respectively), radical scavenging activity, and reducing power were obtained at an extraction temperature of 170°C, an extraction time of 10 min and a 15 g/L solid content. The results indicate higher extraction yield (over 20%) and bioactivity (up to fivefold) for subcritical water extraction in contrast to conventional solvent extraction using ethanol.

PERFORMANCE OF MECHANIZED BIOINDUSTRY BASE SAGO PALM IN CENTRAL MALUKU, INDONESIA

Ridwan. RACHMAT [1], Agus BUDIYANTO [1], Irpan B. JAMAL [1] and Rein E. SENEWE [2]

[1] *Indonesian Centre for Agricultural Postharvest Research and Development (ICAPRD), IAARD-Ministry of Agriculture, Jakarta 12540, Indonesia*
[2] *Indonesian Institute for Agricultural Technology Assessment for Maluku,Indonesia*

Abstract

Sago (Metroxylon Rottb.) in Central Maluku generally grow on the riverbank or region with high enough water resources such as swamps and the tree can grow up to 30 meters height. To ensure the availability of high raw sago quality, then the sago palm demands of the market are still high, it was needed by steps improving the skill of sago producers in Central Maluku that was getting decreased while demand of sago was getting increased to fulfill needs of food and non-food energy not only in Indonesia but also in the world. This time sago plants are still naturally, so that aspect of upstream demanded a change in the culture of dependency naturally be based sago results cultivation / regeneration. Currently marketing only in the form of Tumang / wet sago, so the efforts to increase value-added needs to be done to improve the sago community's ability to process not only to be wet sago but also up to sago processing such as noodles, papeda and other popular snack. , therefore capacity building of sago producers was important to do and needed a precise strategy. Developing a mechanized model of bioindustry base sago palm conducted at Waraka Village, Teluk Elpaputih District, in Central Maluku prefectures have been increased significantly the optimized benefit of sago producers. Increasing the competitiveness skill required of sago producers who had good skill. The results of mechanization in bioindustry development based sago significantly growing the local wisdom spirit enforcement for the society in (1) the optimized producers of sago to benefit, (2) mindset changing up of the labors by increase the importance awareness of sago management. Additionally, the performance of bio industry base sago in Central Maluku as the processing center has been definitely changed the status quo of create jobs, increased the marketing access to better food diversification and to accelerate the realization of food security.

Keywords: Sago, tumang, bioindustry base sago, value added,

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Effect of native fat globule size on foaming properties of milk

Thao M. HO[1], Bhesh R. BHANDARI[1] and Nidhi BANSAL[1]

[1]*The University of Queensland, Brisbane, Australia.*

Abstract

In the dairy industry, foaming properties of milk are of great importance for many products, typically cappuccino-style drinks, due to the essential contribution of foam to appearance, volume, texture and mouthfeel of these products. It is well-known that homogenisation markedly improves foaming properties of milk. But whether the fat globule size reduction or the alteration of fat globule membrane composition, both which are induced by homogenisation, plays a role in the enhancement of foaming properties of milk is unknown. In this study, effect of size of native fat globules on foaming properties of milk was evaluated. In order to produce milk samples containing native fat globules with varied size (0.8, 2.6, 3.7, 4.7 and 5.5µm), separating cones of commercial cream separator were modified, and combination of various fractionation and separation stages was utilized. All milk samples were standardized to 3.5% fat content (w/w). Results showed that the surface tension of milk samples was independent of fat globule size while viscosity and absolute zeta potential values increased with an increase in fat globule size. Foamability of milk samples was only improved when fat globule size was less than 2.6µm. Although the average size of air bubbles in foam increased with an increase in fat globule size, foam stability was not determined by fat globule size. On the other hand, reducing fat globule size by homogenization revealed that the size reduction of fat globules controlled foamability while the alteration in fat globule membrane composition determined foam stability.

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Fractionation of lactoferrin and immunoglobulins from whey by an Electrodialysis with Filtration Membrane process

Qiuyue WANG, George CHEN, Sandra KENTISH

University of Melbourne, Melbourne, Australia

Abstract
Isolation of high-value minor proteins (lactoferrin (LF) and Immunoglobulin (Ig)) directly from whey without pre-treatment is a major challenge for the dairy industry. Immunoglobulins link various parts of the cellular and humoral immune system. Bovine lactoferrin (LF) has been reported to have anti-bacterial, anti-oxidant and anti-carcinogenic properties and used as an ingredient of infant nutritional formula. However, the large-scale utilisation of Ig and LF requires a cost-effective purification process. In this work, an electrodialysis with filtration membrane (EDFM) approach is investigated where BSA and LF are separated using a filtration membrane across which an electrical current is applied. Different coagulant baths have been studied for the preparation of the poly vinyl alcohol filtration membrane using phase inversion. A bath with 80% ethanol proved to be the best choice. A range of voltages and treating time have been investigated within the electrical cell. The results show that the filtration membrane prepared in-house used in the EDFM process can offer a high BSA flux and high rejection for LF and Ig. The separation of LF and Igs from a simulated whey solution can be realized. The Igs flux of those membrane is about 1.62 $g \cdot m^{-2} \cdot h^{-1}$ but the lactoferrin flux of all membranes is very low. This suggests that further optimization of the membrane and operating conditions is required to realize the separation of LF and Igs from each other.

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The use of Pulsed Electric Fields technology for carrot texture modification on human oral processing and *in vivo* bioaccessibility of β-carotene

Sze Ying LEONG[1,2], Dafu DU[1], Indrawati OEY[1,2]
[1]*Department of Food Science, University of Otago, Dunedin, New Zealand*
[2]*Riddet Institute, Palmerston North, New Zealand*

Pulsed Electric Fields (PEF) technology involves exposing plant tissue, placed between two electrodes, to very short (microseconds) and high voltage pulses. PEF-treated plant tissues can experience major microstructural changes and become more porous, leading to textural properties modification. Since food structure plays important role towards digestibility, this study explored the impact of textural properties of cooked carrots manipulated by a PEF pre-treatment on *in vivo* human mastication behaviour and β-carotene bioaccessibility from the resulting bolus.

Prior to blanching (>95^{o}C, 5 min), a batch of Nantes carrots was PEF-treated (ELCRACK HVP5, Germany) at electric field strengths between 0.3 and 1.9 kV/cm (300 ppm $CaCl_2$ as processing medium) and untreated carrots were prepared concomitantly as control. The hardness of each cooked sample was evaluated using texture analyser (n=10) and by human subjects (n=6) to orally process them in duplicate. Carrot bolus were collected after human mastication and immediately subjected to simulated *in vitro* gastrointestinal digestion before comparing β-carotene bioaccessibility between individuals.

PEF-treated carrots did not experience drastic texture softening upon blanching due to enhanced strengthening of carrot cell wall through formation of cross linkages between pectins and calcium ions. Results also showed that texture manipulation through PEF exerted subtle impact on the way human disintegrated the blanched carrots without compromising their β-carotene bioaccessibility.

The ability of PEF technology in modifying the inherent structural properties of plant tissues offers opportunity to the better design plant-based foods for controlling their degree of breakdown while facilitating *in vivo* release of macro- and micro-nutrients during digestion.

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The use of Dimensional Analysis – *Modeling the Direct Expansion Process*

Dennis FORTE

Dennis Forte & Associates Pty. Ltd., Wodonga, Australia.

Abstract

Direct Expansion (often associated with the Extrusion Cooking Process is a highly dynamic process with many changes, both chemical and physical, occurring to the formulation. It is these changes that lead to the development of many of the physical characteristics which define some of the important Finished Product Attributes. It is known that different Formulations will exhibit a different Degree of Expansion (DOE) under the same Process Conditions.

Dimensional Analysis is a useful and powerful tool for studying complex phenomena, such as Extrusion and often finds application as a preliminary step in the scale-up of industrial processes.

The Buckingham- Theorem is used to develop a mathematical Model of the direct expansion process. The proposed equation will (potentially) provide a concise and consistent way of describing the Interactions between the numerous Process Variables and their influence upon the Bulk Density, in a quantitative way.

A series of Extrusion Trials were then completed on a Twin Screw Extruder, using a number of alternative formulations in order to validate the proposed Model.

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Food Excess and By-product Processing 'Ecosystem' Model

Paulomi (Polly) BUREY[1], Sunil PANCHAL[1], Andreas HELWIG[1]

[1]*University of Southern Queensland, Toowoomba, Australia*

Abstract

Horticultural food producers and processors typically have Food Excess and By-products (FE&Bs) generated during their operations, the value of which is underutilised. FE&Bs still often end up in landfill, improperly composted, or given away as animal feed, despite there being no shortage of technical strategies available to deal with this issue. FE&Bs are a rich source of water, bioactive compounds and fibre and could be used to produce high value nutritional and food products, as well as structural enhancements for composite material systems, including packaging. Techno-economics, missing links in the food supply chain to connect FE&Bs to these alternative product pathways, and lack of infrastructure are current hurdles. Investigations are nearing completion to determine the best FE&Bs processing and valorisation 'ecosystem' that approaches viable full circular economy by overcoming these hurdles. Development of such an 'ecosystem' to transform FE&Bs could increase the value of food producers' product, and create new industries. To analyse such a system, we propose here a FE&Bs valorisation model, which takes into account several key influencing factors, including material composition and energy content, transport distance and cost, processing type (mobile or fixed), processing costs and time. The model also examines weighting these factors, based on effort of implementation from an economic viewpoint and/or perception of importance from a social virtue perspective. A simple processing and valorisation ecosystem test scenario is presented, highlighting the benefits of FE&Bs process symbiosis/integration. Australian food production test cases are presented here, but this model could be modified for most situations.

Towards a more food secure world – the role of postharvest technologists and engineers

Suzie NEWMAN[1]
[1]*Plant & Food Research, Auckland, New Zealand*

Abstract
Sustainable Development Goal (SDG) 12 targets sustainable consumption and production. Given that each year, an estimated 1/3 of all food produced – equivalent to 1.3 billion tons worth around $1 trillion – is either wasted or lost through the supply chain. For the developing world - high postharvest losses, poor logistics and infrastructure and distance from market exacerbate this challenge. Trans-disciplinary teams are often needed to address these challenges with postharvest technologists and engineers playing a crucial role in the design and implementation of effective low-cost solutions. Human Centered Design methodologies also ensure that the technology meets the needs of the end-user resulting in greater adoption and uptake of innovations. In this paper, we draw on examples from our international development portfolio in Africa, Asia and the Pacific to illustrate how increasingly postharvest technology and engineering interventions are required to address key supply chain issues to reduce losses and improve quality out-turn. We also explore options to mobilize the food technology and engineering community in food security projects.

Note: this abstract is part of the Session/Roundtable entitled: **Beyond the farm gate: The role of the food engineer in addressing food security and humanitarian situations**

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Pasteurization Of Dehydrated Food Powders With Radio Frequency Heating

Fanbin KONG[1], Samet OZTURK[1], Rakesh K. SINGH[1]

[1]*Department of Food Science & Technology, University of Georgia, Athens, GA, USA*

Abstract
Salmonella outbreaks occurred in low-moisture foods (water activity < 0.6), including dehydrated vegetable powders and spices, have brought attention from food industry and scientific community to develop effective technology for its remediation. Current conventional decontamination methods for food powders, such as steam treatment, irradiation, and fumigation with ethylene oxide, have disadvantages in terms of quality degradation or public health concerns. Radio frequency (RF) heating as an alternative thermal processing technology provides a great chance for pasteurizing dehydrated food powders with reduced heating time and improved food quality. In the past years, we have worked on developing RF heating technology that is suitable for pasteurization of food powders. Dielectric properties of various vegetable powders and spices including corn flour, broccoli powder, and spice seasonings were determined at frequency ranging from 1 to 30 MHz. The RF heating uniformity and temperature profiles of each sample as treated under a RF heating system (27.12-MHz, 6-kW) were obtained. Strategies to improve heating uniformity was explored by investigating the influence of multiple factors including dielectric properties, moisture content, electrode gap and geometry of food on the heating rate and uniformity. Finally, the effectiveness of RF heating on pasteurization of Salmonella and its potential surrogate E. *faecium* was evaluated.

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Argan (*Argania spinosa*) nut shell powder as a source of microfibrillated cellulose: preparation and characterization

Meryem BOUHOUTE[1], Sekove VODO[1], Isao KOBAYASHI[1,2], Mohammed ZAHAR[3], Hiroko ISODA[1], Mitsutoshi NAKAJIMA[1], Marcos A. NEVES[1]

[1]*University of Tsukuba, Tsukuba, Japan*
[2]*NARO Food Research Institute, Tsukuba, Japan*
[3]*Institut Agronomique et Vétérinaire Hassan II, Rabat, Morocco*

Abstract

Cellulose is the most abundant natural polymer in the biosphere, it is composed of a linear chain of 1–4-linked β-D-glucopyranose and is present in all plant cell walls. A new class of plant-based nanomaterial so called microfibrillated cellulose (MFC) is being researched and is derived from cellulose fibers, MFCs detain exceptional rheological properties that could enhance food properties. Argan shell (endocarp protecting argan nut) is a lignocellulosic material representing >48% of total argan oil industry by-products, this material is a potential candidate to prepare MFC due to its high fiber content ~78%. However, knowledge about valorization of this by-product as a source of MFC was never investigated and the material is rather used for combustion by local population. The aim of this study was to investigate the effect of different alkali concentration on cellulose yield to select the most effective pretreatment for cellulose purification. A sample was then selected to prepare MFC using high pressure homogenization while varying the number of passes. High alkali treatment led to a decrease in particle size and the appearance of pores on the surface of alkali treated particles. FT-IR analysis showed the disappearance of peaks attributed to hemicellulose and lignin and results were compared to microcrystalline cellulose (MCC). Aspect ratio and particle size measurements of MFC revealed that high pressure homogenization conditions influence its morphological properties. Our results can lead to a high-end product that could be utilized in the food industry.

Food structure assessment for the optimization of dairy products and manufacturing processes

Lydia ONG[1], Anita PAX[1], Adabelle ONG[1], Mark AUTY[2], Sandra E KENTISH[1], **Sally L GRAS[1]**

[1]*ARC Dairy Innovation Hub, Department of Chemical Engineering, The University of Melbourne, Melbourne, Australia*
[2]*Mondelez International and Reading Scientific Services, Reading, United Kingdom*

Abstract
The ARC Dairy Innovation Hub is a five-year research program co-funded by industry stakeholders, dairy manufacturers and the Australian Research Council. Within this center, the microstructure team are helping manufacturers to better understand the impact of processing variables that can be controlled during food manufacture on the micro/macroscopic properties and quality of food products.

The response of food to shear, compression or tension during manufacture is important, as these properties affect processability, consistency and yield. In the final product, such properties also determine product behavior and they remain important during storage and transport, where changes can alter shelf-life and consumer satisfaction. An understanding of the link between engineering processes or handling and food properties is therefore essential in process development and modification or for reverse engineering products and processes.

This presentation will illustrate the link between process variables and food properties, with a specific focus on Cheddar, Mozzarella and cream cheese. Different methods for assessing product behavior will be compared, including the direct visualization of food stretching and fracture under tension by confocal microscopy. These studies highlight the benefits of a multidisciplinary approach and show how an understanding of food structure, flow and fracture at a micro and macroscale can assist process optimization at industrial scale.

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In Vitro Investigation of the Behavior of Nanocellulose in Human Gastrointestinal Tract and the Influence on Food Digestion

Fanbin KONG[1], Lingling LIU[1]

[1]*University of Georgia, Athens, GA, USA*

Abstract

Nanocellulose (NC) has become a topic of increasing interest due to its potential applications and special characteristics, including its viscous properties and large specific surface area. The objective of this research was to investigate the behavior of three types of nanocellulose, including cellulose nanofibrils (CNF), cellulose nanocrystals (CNC), and TEMPO-CNF (2,2,6,6-tetramethylpiperidine-1-oxyl oxidized CNF), in human gastrointestinal tract and the influence on food digestion and nutrient absorption. Three types of NC showed different behaviors during digestion. In particular, CNF and cellulose were morphologically stable during digestion, while TEMPO-CNF aggregated and CNC formed hydrogels at the gastric phase. The mucoadhesive properties of three types of nanocellulose was investigated in the digestive condition with ex vivo and in vitro assays. The results indicate that nanocellulose shows mucoadhesive properties in digestive tract, where the level of adhesion depends on type of nanocellulose, its concentration and the gastrointestinal section. In the ex vivo flow-through method, three nanocellulose materials showed different levels of retention on porcine gastric and intestinal mucosal surfaces. Fluorescence microscopy confirmed that retention of CNF could be due to entanglement with the mucosal layer, while retention of Tempo-CNF could be due to instantaneous gelling on the mucosal surface. It was also found that all three types of nanocellulose exerted hypoglycemic potential, delayed lipid digestion, and free amino nitrogen (FAN) absorption at high NC concentrations. Viscosity was observed to play a major role in the effects of all three types of NC on food (starch, lipid and protein) digestion and nutrient absorption.

Novel natural emulsifiers derived from biomass-based by-products: case of argan (*Argania spinosa*) nut shell powder

Meryem BOUHOUTE[1], Isao KOBAYASHI[1,2], Mohammed ZAHAR[3], Hiroko ISODA[1], Mitsutoshi NAKAJIMA[1], Marcos A. NEVES[1]†

[1]*University of Tsukuba, Tsukuba, Japan*
[2]*NARO Food Research Institute, Tsukuba, Japan*
[3]*Institut Agronomique et Vétérinaire Hassan II, Rabat, Morocco*

Abstract

Natural ingredients represent an important concern for food industrials in order to satisfy fully aware consumers seeking clean label. Emulsifiers are one of the most utilized ingredients in food formulations and can affect stability of emulsions depending on the type of adsorption at the oil- water interface. Recently, studies reported about the utilization of plant extracts exhibiting surface- activity to stabilize oil-in-water (O/W) emulsions as well as the utilization of microfibrillated cellulose to produce Pickering type emulsions. Argan nut shell is a lignocellulosic material, representing an important by-product of the argan oil industry, it is composed mainly of fibers >78% but also contains low molecular weight compounds in its structure, thus, making it a good candidate to produce natural emulsifiers. In this study, our aim was to use argan nut shell to produce surface- active ingredients and microfibrillated cellulose (MFC) to be utilized separately to stabilize O/W emulsions. Surface-active extracts were prepared using aqueous/ethanol solvent mixtures with increased polarity. MFC was obtained following a two-step process: chemical pre-treatment and mechanical treatment. Oil-in-water (O/W) emulsions were prepared using high-pressure homogenization (HPH) and their physical stability was monitored using droplet size measurements over one-month storage. Our results indicate that derived natural emulsifiers from argan nut shell powder produced physically stable O/W emulsions over time storage with a constant droplet size and a highly negative charge at the oil surface. Surface-activity of aqueous/ethanol extracts and dual wettability of solid MFC particles by water and oil phases will be discussed as the main stability mechanisms.

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Ultrasound-enhanced Mass Transfer in Food Processes

Yang TAO[1]**,** Yongbin HAN[1]

[1]*College of Food Science and Technology, Nanjing Agricultural University, Nanjing, China*

Abstract

In the past few years, the influence of power ultrasound on mass transfer phenomenon during several food processes, including drying, extraction and adsorption processes has been investigated by our group continuously. The mass transfer mechanism in ultrasonic fields has been clarified both experimentally and theoretically. For the extraction and adsorption experiments, ultrasound was mainly used to improve the separation of phenolics from berry-fruit pomace. Meanwhile, a self-designed surface contacting ultrasound facility was utilized to accelerate hot-air drying of various fruits and vegetables. To explore the ultrasound-enhanced mass transfer mechanism, both methodologies of artificial neural network and numerical simulation were employed. In the case of numerical simulation of drying and adsorption, the mass transfer process was addressed as a moving boundary problem due to sample shrinkage and ultrasound induced disruption of absorbents. Besides, the influence of ultrasound on the product quality was also studied by means of different analytical methods. Overall, ultrasound is an efficient tool to enhance the mass transfer during food drying, extraction and adsorption. Experimental analysis coupled with mathematical modeling is effective to explain the mechanism about ultrasonic enhancement of food processes. Together with the improvement of mass transfer process, the quality of final products can also be benefited by ultrasound. More efforts will be put for the scale-up of ultrasonic equipment in our future studies.

Nanomechanical properties by atomic force microscopy on tissue and cell wall of climacteric fruits during its ripening

Stefany CÁRDENAS-PÉREZ[1], Juan Vicente MÉNDEZ-MÉNDEZ[2], **José Jorge CHANONA-PÉREZ[3]**, Artur ZDUNEK[4]

[1] *Chair of Geobotany and Landscape Planning, Faculty of Biology and Environment Protection, Nicolaus Copernicus University, Torun, Poland*
[2] *Centro de Nanociencias y Micro y Nanotecnologías, Instituto Politécnico Nacional, Mexico City, Mexico*
[3] *Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, Mexico City, Mexico*
[4] *Institute of Agrophysics, Polish Academy of Sciences, Lublin, Poland*

Abstract
Atomic force microscope (AFM) can be used in food engineering to evaluate the nanomechanical properties in tissue and cell wall during the ripening of climacteric fruits. The objective was to evaluate the nanomechanical properties of apple tissue (Golden Delicious) as well as mango cell wall (Tommy Atkins) in order to establish its correlation with physicochemical, biochemical and microstructural parameters. Nanoindentation with AFM were carried out to obtain the Young's modulus (E) in apple tissue (AT) and mango cell wall (MCW) during its ripening. These studies were correlated with physicochemical, biochemical, structural properties of the fruits. Firmness (F), °Bx, TSS, enzymatic activity, DRX, imaging with AFM, CLSM and SEM were evaluated by different methods[1,2]. The E of AT and MCW decreased gradually with the ripening time. In both cases, the distribution of E values showed a wide dispersion. In the case of AT, the E values decreased from 0.96 ± 0.42 MPa on day 1 to 0.11 ± 0.06 MPa on day 40. MCW showed be more soft and their E values decreased during the ripening of 2.87 ± 2.40 MPa (day 1) at 0.39 ± 0.16 MPa (day 12). Both materials kept strong correlations with the physicochemical, biochemical and microstructural changes, in particular, fruits F showed a linear correlation. The information derived from this work provides a better understanding of the cellular mechanics in terms of micro and nanostructural changes occurring in the climacteric fruits, which may be useful to improve the quality of the climacteric fruits during the postharvest.

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Evaluation of physical and microstructural properties of mango slices treated with osmotic and microwave drying

Sergio JAUBERT-GARIBAY[1,2], Josué David HERNÁNDEZ-VARELA[2], Stefany CÁRDENAS-PÉREZ[3], José Jorge **CHANONA-PÉREZ[2]**

[1]*Universidad Autónoma de Nayarit, Tepic, Nayarit, México*
[2]*Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, Mexico City, Mexico* [3]*Chair of Geobotany and Landscape Planning, Faculty of Biology and Environment Protection, Nicolaus Copernicus University, Torun, Poland*

Abstract
Mango (Tommy Atkins) is one of the most produced and industrialized fruits worldwide. However, 40% percent of the production can be lost due to inadequate manage during the postharvest. To increase the shelf life many methods had been used. A combination of osmotic dehydration (OD) with microwave drying (MD) appears as innovative process with good potential for quality optimization and a promising possibility to increase the shelf life of mango flesh. This work was aimed to evaluate the cut effect (oval, longitudinal and transversal) in the quality of mango slices as well as the shape, color and cellular changes in fresh (F) and after OD, MD and microwave over processing (MOP). The color and geometric changes were evaluated by a computer vision system (CVS) and cellular changes using confocal laser scanning microscopy (CLSM)[1,2]. Significant changes on the color, morphometric parameters and tissue microstructure were visualized by using both techniques. Results indicated that transversal slices maintain better its color instead of longitudinal slices that present a darker color. The cellular volume decreased in 54.24% from F to OD samples, after MD increases a 10.50%, followed by a decreasing of 16.65% in MOP. MD results show to be an emerging technology capable to preserve sensorial parameters in mango products, due to the rapid heat transfer rates and the minimal damage that occurs in samples. Also, this study provides insight on how fruit cuts affect the drying process, the color, size, shape and cell structure of mango evaluated by CVS and CSLM.

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Performance of quadruple-effect evaporator in sugar juice evaporation process operating in the counter-current flow arrangement

Somchart CHANTASIRIWAN

Thammasat University, Pathum Thani, Thailand

Abstract
The conventional multiple-effect evaporator used for sugar juice evaporation operates in the co-current flow arrangement, in which steam and sugar juice flow in the same direction. More energy efficiency is attained if the multiple-effect evaporator operates in the counter-current flow arrangement, in which steam and sugar juice flow in the opposite directions. In fact, other industrial processes such as desalination and black liquor evaporation processes use this flow arrangement of the multiple-effect evaporator. There are many reasons why the sugar industry adopts the co-current flow arrangement even though it is less energy efficient than the counter-current flow arrangement. The most important reason is the exposure of concentrated juice (syrup) to high-temperature steam, which leads to increased inversion loss and color formation. In this paper, a mathematical model is developed for the simulation of the quadruple-effect evaporator operating in both the co-current and counter-current flow arrangements. Performances of both flow arrangements are compared in order to quantify the advantages and disadvantages of the counter-current flow arrangement. It is shown that inversion loss and color formation, which are the main disadvantages of the counter-current flow arrangement, can be mitigated by using driving steam at a lower pressure without compromising the performance of the evaporator.

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Non-thermal processing of a protein functional beverage using pulsed electric fields: *Escherichia coli* inactivation and effect on proteins

Mona ALZAHRANI[1], Filipa SILVA[1], **Sally ALKHAFAJI[1]**

[1]*The University of Auckland, Auckland, New Zealand*

Abstract

Pulsed electric fields investigations for *Escherichia coli* inactivation suspended in a 70% v/v protein shake beverage was carried out. Square bipolar Pulses at 25, 30, 33, 37 and 40 kV/cm electric field intensities were applied to investigate the effect of different PEF conditions on the microbial population and the proteins relevant to this functional beverage. Four logs reduction in *E. coli* population were obtained with: 10 pulses at 40 kV/cm field intensity, and 25 pulses at 25 kV/cm field intensity. The results indicated that increasing the treatment time or the electric field intensity causes higher inactivation of the *E. coli* cells.
PEF treated whey protein concentrates when compared to the thermally treated, showed less denaturation in proteins, especially for lower electric field intensities (0% denaturation ± 0.007 at 25 kV/cm and 900 Hz, 4.41% denaturation ± 0.008 at 40 kV/cm and 400 Hz). Soy protein isolates manifested high sensitivity toward PEF processing and resulted in denaturation and aggregation in the protein structure.

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Effect of Magnetic Field Coupled with Cold Storage on the Postharvest Quality of Fruits and Vegetables

Zhao Yang[1], Lei Zhang[1], Na Luo[1], Qiujia Deng[1]

[1] *Key Laboratory of Efficient Utilization of Low and Medium Grade Energy, MOE, Tianjin University, Tianjin, China*

Abstract
Based on the mechanism of bioelectromagnetics, the aim of this study was to evaluate the effect of magnetic field on the physicochemical properties of green peppers, spinach and lettuces during cold storage. These vegetables were treated under state magnetic field (5mT) during cold storage (0±0.5℃ or 10±0.5℃, 90±3% RH). The results showed that green peppers treated by magnetic field exhibited higher total soluble solids and ascorbic acid levels than that of control, while alterations in color, respiration rate and relative electrical conductivity were suppressed. Analogously, spinach and lettuces treated with magnetic field had a higher total soluble solids and lower PH than that of control. Furthermore, enzymatic browning of spinach and lettuces treated with magnetic field was effectively alleviated. These results provide important information regarding the application of magnetic field on fruits and vegetables preservation. And indicate that magnetic field treatments may be an alternative to extend shelf life of fresh vegetables through affecting respiration rate and enzyme activity.

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Processing strategies for enhancing the bioactive profile of Brassica vegetables

Netsanet SHIFERAW TEREFE[1], Yanxue CAI[2], Sajad SHOKRI[1,3], Xiyun SUN[1,4], Jian-hui YE[5], Myintzu HLAING[1], Cathy McAULEY[1], Hema JEGASOTHY[1], David BEALE[6], Mary Ann AUGUSTIN[1]

[1]*CSIRO Agriculture and Food, Melbourne, Australia*
[2]*School of Chemical Engineering & Energy Technology, Dongguan University of Technology, Dongguan, China*
3Shiraz University, Shiraz, Iran
[4]*Shenyang Agricultural University, Shenyang city, China*
[5]*Zhejiang University Tea Research Institute, , Hangzhou, China*
[6]*CSIRO Land and Water, Brisbane, Australia*

Abstract
Brassica vegetables are rich sources of phytochemicals such as glucosinolates and polyphenols. Fermentation is known to enhance the accessibility and bioconversion of phytochemicals into their more bioactive forms. Further improvement in the bioactive profile and health promoting properties of brassica vegetables could be achieved when fermentation is combined with innovative preprocessing technologies for inhibiting undesirable reactions such as conversion of glucosinolate precursors into isothiocyanate nitriles instead of the bioactive isothiocyanates. We explored the potential application of fermentation using lactic acid bacteria cultures isolated from the vegetables coupled with mild thermal or ultrasound preprocessing for enhancing the bioactive profile of brassica vegetables. For instance, fermentation alone doubled the yield of sulforaphane, an isothiocyanate that has been shown to have anti-diabetic and anti-cancer effects, in broccoli puree compared to the untreated control. Combining mild heat pretreatment under optimized condition with fermentation further increased sulforaphane yield by ~15 times and resulted in four times more sulforaphane than would be expected based on the extractable glucoraphanin precursor in the raw material, indicating substantial improvement in bioaccessibility and conversion. This presentation discusses our recent findings on the impacts of mild heat and ultrasound preprocessing combined with fermentation on brassica phytochemicals and their derivatives including glucosinolates, isothiocyanates and polyphenols with broccoli and red cabbage as examples. Insights into the underlying mechanisms gained through targeted and untargeted approaches will also be discussed.

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Development of functional powders for improved digestion of dairy products

Qianyu YE[1], Meng Wai WOO[2], Cordelia SELOMULYA[1]
[1] *Monash University, Melbourne, Australia*
[2] *The University of Auckland, Auckland, New Zealand*

Abstract
Over 70% of the world's population have issues in digesting dairy products, known as lactose intolerance, due to the lack of β-galactosidase in the duodenum. Using riboflavin initially as a model for β-galactosidase, this study reports on the preparation of riboflavin-loaded whey protein isolate (WPI) microparticles, using desolvation and spray drying [1]. Ethanol desolvation caused the exposure of embedded hydrophobic amino acids of WPI to riboflavin, facilitating the formation of riboflavin-WPI complexes. The extent of desolvation and crosslinking influenced the morphology of the spray-dried microparticles, while the moisture content of microparticles decreased with desolvation and increased with crosslinking. The modification of WPI conformation upon desolvation was retained in the dry state *via* spray drying. The gastric resistance and release characteristics of microparticles were adjusted by varying the ethanol and Ca^{2+} contents from 0-50% v/v and from 0-2 mM, respectively. The sample from 30% v/v ethanol without calcium crosslinking displayed rapid digestion in less than 30 minutes. The samples from 30% v/v ethanol at 1 and 2 mM Ca^{2+} exhibited excellent gastric resistance and intestinal release. In the next stage of the study, riboflavin was replaced with β-galactosidase, which is a heat-sensitive and acid-labile enzyme responsible for lactose hydrolysis into glucose and galactose in human small intestine. The β-galactosidase-loaded microparticles were generated to protect the enzyme activity from spray drying and proteolysis in the stomach, therefore achieving the targeted release in the duodenum. Potentially the powders can be used as a functional ingredient to improve the digestibility of dairy products.

Reference:
1. Ye, Q., M.W. Woo, and C. Selomulya, *Modification of molecular conformation of spray-dried whey protein microparticles improving digestibility and release characteristics.* Food Chemistry, 2018.

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Encapsulation of curcumin using rice starch modified by 4-α-glucanotransferase: solubility, stability and bioaccessibility improvement

Hyerin PARK[1], Jihyun Kang[1], Shinjoung RHO[2], **Yong-Ro KIM**[1,2]*

[1]*Department of Biosystems and Biomaterials Science and Engineering, Seoul National University, Seoul, Republic of Korea*
[2]*Center for Food and Bioconvergence, Seoul National University, Seoul, Republic of Korea*

Abstract
Curcumin is a polyphenolic compound with anti-cancer, anti-inflammatory and anti-oxidant effects. However, its application in the food industry is very limited owing to its low water solubility and chemical stability. In the present study, 4*α*GTase-treated rice starch (GS) was prepared by treating rice starch with 4-*α*-glucanotransferase (4*α*GTase) for 1 h (1GS) and 96 h (96GS), and the capability of GS to improve the encapsulation efficiency and stability of curcumin by complexation was investigated in comparison with maltodextrin (MD) and β-cyclodextrin (CD). Upon encapsulation with 1GS and 96GS, curcumin solubility increased by 2,241- and 2,846-fold, respectively. UV stability of the encapsulated curcumin with 96GS also improved 1.83-fold and was effective under all pH conditions. The increased stability of curcumin within GS may be attributed to its unique molecular structure and the formation of hydrogen bonds between starch chain and curcumin, as suggested by chromatography and Fourier transform infrared spectroscopy analysis. Moreover, curcumin encapsulated with 1GS exhibited a 11.53-fold increase in bioaccessibility. These results suggest that GS could act as a novel food-grade host material to improve the chemical stability of curcumin.

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Enhancing the activity of superoxide dismutase by high pressure processing

Yang ZHAO[1,2], Zhiqiang HOU[1,2], Weiwei ZHANG[3], Xiaojun LIAO[1,2,*]

[1]*College of Food Science & Nutritional Engineering, China Agricultural University, Beijing, China*
[2]*National Engineering Research Centre for Fruit and Vegetable Processing, Beijing, China*
[3]*Department of Applied Physics, China Agricultural University, Beijing, China*

Abstract
High pressure processing (HPP) is essential in food engineering for its unique function of microbial inactivation and affecting enzyme activity. After HPP (100-500 MPa/0-20 min/30-50 ºC) treatment, the activity of superoxide dismutase (SOD) purified from chestnut rose was increased by 22.23-38.02%. Considering this observation, we further characterized the properties of SOD using physical and chemical methods to elucidate possible mechanisms of the increase. HPP did not have effect on the tertiary and quarternary structures since particle size distribution of SOD maintained constant and no protein aggregates occurred. However, the secondary structure of SOD changed due to an 8.7% reduction of the α-helix fraction, indicating that hydrophobic residues exposed in solution using fluorescence spectra. This study provides some perspectives for using HPP as a novel way to modify the activity of enzymes.

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Food and Agribusiness Engineers – how to play in 2030

Barry MCGOOKIN

Food Innovation Australia

Abstract text (Arial, 10pt font, single spaced, left aligned)

Abstract
With markets, consumers, the environment, and political forces impacting what is produced and where that's sold, engineering support to the food and agribusiness supply chain will have to adapt and adopt to match industry needs, both for manufacturing and across the value chain. By exploring key mega-trends in the food and agribusiness supply chain and their link to global forces of change, this presentation seeks to outline some changes in focus and capabilities for engineers, old and new. With a focus on Australasia, the presentation will explore where key points of need might be emerging and what expectations there are for future skills, including clustered skills which can flex with the rapidly changing landscape. In addition, with multidisciplinary solutions needed for many situations, the presentation will provide an overview of how to approach collaboration and gain the most from the market and deliver with excellence to enhance the success of food and agribusiness in 2030.

<u>Please note that images are not permitted.</u>

Foam performance measurement for beer based on the Helmholtz resonance phenomenon

Takahisa NISHIZU[1], Yuki UEDA[1], Kazutaka INUKAI[1], Nakako KATSUNO[1], Akira ISOE[2], Kazushige HATANAKA[2]

[1]*GifuUniversity, Gifu, Japan*
[2]*Suntory Beer Ltd., Tokyo, Japan*

Abstract

A beer head is an important factor that affects palatability of beer. We have developed a novel acoustical method using the Helmholtz resonance phenomenon to evaluate physical properties of foam. In this study, we examined whether a polytropic index determined by this method is effective to evaluate the beer-foam's properties.

Two types of beer which has different foamability and foam stability were used. A beer foam produced by a foam stability tester (NIBEM-TPH, Pentair Haffmans B.V., The Netherlands) was poured on water in a glass cylinder of a dynamic foam analyzer (DFA100, KRÜSS, Germany) assembled with a custom-made Helmholtz resonator. The changes in size distribution of bubbles and acoustic resonant frequency were measured until all of bubbles were gone. The polytropic indices were calculated by a method reported previously.

The smaller the average size of bubbles in the fixed amount of beer's foam is, the smaller the polytropic index is. As the amount of foam decreased with time, the polytropic index increased. The acoustic loss energy calculated from bubble morphology and size distribution showed a negative correlation with the polytropic index during the bubble decreasing stage. In conclusions, the acoustic method would be useful for evaluating beer-foam's characteristics and monitoring their changes with time.

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Characteristics of Rice Chips Mixed with Green Whole Rice

Sunghyuk BANG[1], Gyiae YUN[1], **Kihwan PARK[1]**
[1]*Department of Food Science and Technology, Chung-Ang University, Anseong, Korea*

Abstract

The chewing and swallowing problems may cause malnutrition, weight loss and some disease for the elderly, and thus it is considered to manufacture snacks, softer in texture and more nutritious. Green whole rice (GWR) is known to have a soft texture and an excellent health benefit. This study was to determine the optimum mixing ratio of rice chips mixed with GWR by evaluating the physiochemical characteristics of chips. White rice, GWR and mixed rice (10, 20 and 30 % of GWR to white rice) chips were prepared with commercial rice puffing machine, and the blade cutting forces, flavors and sugars were evaluated. The nutrient composition was analyzed, and sensory evaluation was performed by elderly people over 65 years old. The hardness of chips was decreased from 1820, 1715, 1651 and 1644 to 887 g as the GWR ratio was increased 0, 10, 20, 30 and 100 %. Among 16 flavor compounds, pyrazine, methylpyrazine and 2,6-dimethyl pyrazine for nutty aroma were detected from the chip with 30 % GWR, 7.87, 63.94 and 21.29 × 10^6 peak area, respectively. Its results were consistent with sensory test scored significantly higher in flavor and taste with mixed rice. The sugar contents of sorbitol, glucose and sucrose were higher than white rice, and the 30% GWR chips contained 23.2 mg/g of dietary fiber. These results suggest that mixed rice chips with 30% GWR would be served as a snack, soft enough to consume and good to supply nutrition with high dietary fiber for elderly.

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Cooking methods altered the nutrition and digestibility of potato

Wenhan YANG, Xingqian YE, Jinhu TIAN*
Zhejiang University, Hangzhou, China
* Corresponding author: Jinhu Tian

Abstract

Potato (*Solanum tuberosum*) is considered as an important carbohydrate in human diet, followed only by rice, wheat, and maize. However, attributing to its high content of rapidly digestible starch, long-term consumption of potato will increase the risk of type-2 diabetes. Domestic cooking (boiling, frying, steaming, etc.) are usually adopted before potato consumption. The chemical and physical modifications that occur during cooking will alter the nutrition and digestibility of potato, which subsequently affected the bioavailability of phytochemicals and the postprandial glycaemic response. In the present study, different cooking methods (boiling, baking, steaming, microwaving, frying, stir-frying, etc.) were performed, the nutrition, phytochemicals, antioxidant activity and starch digestion were evaluated, and results indicated that stir-frying retained only slight levels of the phytochemicals and antioxidant activity, whereas steaming and microwaving were able to retain most of the health-promoting compounds found in raw potatoes. For the digestion rate, the stir-frying and frying showed significant lower digestion rate than that of boiling or steaming during *in vitro* and *in vivo*. Considering the high content of oil during frying, stir-frying could be an optional cooking method for potato processing.

Keywords: potato, cooking, phytochemical, microstructure, digestibility

A new route to develop renewable non-isocyanate polyurethanes for food packaging applications

Mehran GHASEMLOU[1], Fugen DAVER[2], Elena P. IVANOVA[3], Benu ADHIKARI[1]
[1] School of Science, RMIT University, Melbourne, VIC 3083, Australia
[2] School of Engineering, RMIT University, PO Box 71, Bundoora, VIC 3083, Australia
[3] School of Science, RMIT University, Melbourne VIC 3000, Australia

Abstract
Polyurethanes (PUs) are versatile polymeric materials that have shown exceptional properties such as abrasion resistance, thermoplastic behaviour, durability, and toughness. The conventional PUs are synthetised using isocyanate as main starting material. The major drawback associated with isocyanates is their toxicity, and phosgene-based industrial synthesis. In addition, irreversible reaction of isocyanate groups with water often results into unusable byproducts. This can become problematic in industrial practice because it demands many stringent safety protocols during synthesis, transportation, and storage of PU. These drawbacks have motivated on-going research to develop environment-friendly processes that use ecofriendly and non-hazardous materials. Amongst the numerous pathways that have been proposed, the reaction between cyclic carbonates and polyamines is shown to be a promising route leading to formation of non-isocyanates polyurethanes (NIPUs). We report the synthesis of NIPUs by using aminolysis reaction between two cyclic carbonates (ethylene carbonate and propylene carbonate) and three diamines (ethylene diamine, 1,4-butanediamine and 1,6-hexanediamine). We report the synthesis of NIPUs-starch hybrid materials. The reactions will involve mild temperature with help of a catalytic system. The resulting thermoplastic hybrid NIPUs-starch were characterised in terms of physical, mechanical and thermal properties. It is expected that these materials have significant improvements in the abovementioned properties. These starch-NIPUs materials are expected to find broad application in various industries including food packaging.

Particle size-dependent characterization of rice flour-zein composites for gluten-free noodles slit from sheeted doughs

Myeongseon KIM, Im Kyung OH, Sungmin JEONG, **Suyong LEE**

Department of Food Science & Biotechnology and Carbohydrate Bioproduct Research Center, Sejong University, Seoul, Korea

Abstract
Sheeting process for making noodles is preferred since it is possible to use the existing facilities available for the mass production of instant wheat noodles without additional processing establishment. However, the noodle industry has faced substantial technical challenges to prepare gluten-free rice noodles slit from sheeted doughs. Thus, rice flour-zein composites with rice flours haveing different particle sizes (80-100, 100-140, and 140-250 □m) were utilized to generate gluten-free noodles slit from sheeted doughs. Rice flours with small particle size showed high starch damage whereas they had great water hydration properties and high pasting parameters. In addition, the fine particle size contributed to the elastic properties of the rice-zein composites. Furthermore, the thermo-mechanical properties of rice flours were highly dependent on their particle sizes. The ability of zein to generate a viscoelastic protein network at above its glass transition temperature, successfully produced gluten-free rice sheeted doughs regardless of particle size that could be slit into long and thin noodle strands without gluten. The rice-zein noodles with larger particle sizes had a rough surface while the noodle surface became smooth and flat at decreasing particle sizes. The noodle samples with an intermediate particle size (100-140 □m) showed the highest values of hardness, maximum resistance and extensibility to extension that consequently contributed to the reduced cooking loss. The use of rice-zein composites with different particle sizes may be beneficial to food manufacturers from a processing point of view since they can be applied to a wider variety of other gluten-free products.

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Inhibition of biofilm formation of foodborne *Staphylococcus aureus* by the citrus flavonoid naringenin

Xin-An Zeng[1,2*], Qing-Hui Wen[1,2]

[1]*School of Food Science and Engineering, South China University of Technology, Guangzhou 510641, China*
[2]*Overseas Expertise Introduction Center for Discipline Innovation of Food Nutrition and Human Health (111 Center), Guangzhou, China*

Abstract
The formation of biofilm by *staphylococcus aureus* on food contact surfaces is a serious problem for the food industry. In this work, the effect of the citrus flavonoid naringenin on the biofilm formation of *staphylococcus aureus* ATCC 6538 (*S. aureus*) was investigated. Naringenin was found to inhibit the biofilm formation of *S. aureus* at concentrations in the range of 5 ~ 60 mg/L without showing obvious bactericidal activities. The results were confirmed by confocal laser scanning microscopy and scanning electron microscopy which showed that the thick coating of *S. aureus* biofilms became thinner and finally separated into individual colonies when exposed to naringenin. The decreased biofilm formation of *S. aureus* cells may be attributed to decrease in the cell surface hydrophobicity and the exopolysaccharide production that is involved with adherence or maturation of biofilms. Moreover, transcriptional analysis showed that naringenin down-regulated expression of the biofilm-related genes and alternative sigma factor *sigB*. This study provides insight into the inhibitory mechanism of biofilm formation of *S. aureus* cells by naringenin. In addition, this work suggests a potential application of naringenin in the prevention of biofilm formation on industrial food contact surfaces.

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Microalgae for nutraceutical production

Dale D MCCLURE[1], Jonathan NIGHTINGALE[1], John M KAVANAGH[1]
[1]*The University of Sydney, School of Chemical and Biomolecular Engineering, Sydney, Australia*

Abstract
Microalgae can be used to produce a wide range of compounds with applications in the food and nutraceutical industries. Examples include carotenoid pigments, vitamins, phycobilins, sterols and omega-3 fatty acids. Microalgae are particularly attractive sources of these compounds as they can be grown using sustainable feedstocks, grow relatively quickly and produce high concentrations of the desired compounds.

In this presentation we present our results examining the production of lutein. This compound is a carotenoid pigment produced by green algae and plants, and is used in supplements that can benefit macular degeneration. Here we discuss the development and scale-up of a process for lutein production using the microalga *Chlorella vulgaris*. This species has the advantages of a high growth rate, high lutein concentration (8-10 mg g^{-1}) and GRAS status.

Our work growing the microalgae in 5 L photo-bioreactors will be presented; we have examined a range of growth conditions (i.e. light intensities and medium compositions), finding that productivity of the process (1.6 mg L^{-1} day^{-1}) was maximized using high light and high nitrate concentrations. We also examine the scale-up of the process to the pilot (50 L) scale.

Finally, we discuss techniques for the separation of the biomass and the potential fractionation to produce lutein rich extracts. Whole algal biomass or extracts could be readily incorporated into foods or nutraceutical products in order to increase their lutein concentration. Development of such fortified products with health benefits is likely to be important giving increasing health concerns and the aging population.

The application of pulsed electric fields (PEF) in volatile acidity control during wine making substitute for sulfur dioxide (SO_2) addition

Xin-An ZENG[1,2], Debao NIU[1,2]

[1]*School of Food Science and Engineering, South China University of Technology, Guangzhou, China*
[2]*Overseas Expertise Introduction Center for Discipline Innovation of Food Nutrition and Human Health (111 Center), Guangzhou, China*

Abstract
SO_2 is used to limit development of spoilage microorganisms in winemaking, especially acetic acid bacteria (AAB), which are the main cause of the increase of volatile acidity in wine. However, growing consumers demand natural foods without chemical preservatives. Therefore, the aim of this work was to investigate the effect of PEF treatments of *Muscat* must on volatile acidity of wine without SO_2 addition. Results showed that PEF treatments could effectively control the volatile acidity and reduce total acidity and fusel oil content of wine after alcohol fermentation. For example, the volatile acidities of control wine (without SO_2 addition and PEF treatments) and standard wine (SO_2, 60mg/L) were 0.55 and 0.21 g/L, respectively, while the low PEF (8 kV/cm, 1.2 ms) and high PEF (15 kV/cm, 1.2 ms) wine were 0.19 and 0.12 g/L, respectively. This might be ascribed to the inactivation of natural microbiota present in must by PEF and the inactivation of natural AAB (1.2×10^3 CFU/mL) in must treated with high PEF reached 1.28 log. Moreover, total acidity of high PEF wine (3.96 g/L) was lower than that of control wine (5.39 g/L) and standard wine (5.25 g/L). And the fusel oil content of PEF wine (443.04 mg/L) and standard wine (436.92 mg/L) were also much lower than that of control wine (586.46 mg/L). Additionally, PEF treatment could facilitate alcohol fermentation and shorten fermentation time. Therefore, the obtained results indicated that PEF could be a potential alternative to SO_2 use for control of volatile acidity in winemaking.

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Unique surface features in spray dried camel milk powder

Hasan JUBAER[1], Yun XIA[1]**,** Benjamin DAVID[2], Claire SHELLARD[2], Cordelia SELOMULYA[1], Meng Wai WOO[1]

[1]Department of Chemical Engineering, Monash University, Melbourne, Australia
[2]Department of Nutrition, Dietetics and Food, Monash University, Melbourne, Australia

Abstract
Camel milk offers several health benefits and yet has not received substantial research attention, compared to bovine milk, perhaps due to its limited availability around the world. Drying could improve the distribution by preserving the milk. However, very little is known about industrial drying of camel milk and the properties of the powders. The aim of this work was to investigate the properties of spray dried camel milk with reference to bovine milk, since spray drying is one of the most ubiquitous methods of preserving milk. Both bovine and camel milk samples were spray dried in a countercurrent dryer. The powder products were then characterized in terms of their physicochemical and rehydration properties. Camel milk powder exhibited better wettability than bovine milk. Further investigations into the surface morphology via scanning electron microscope revealed relatively large pockmarks (average diameter 2.5 μm) on camel milk powder particles, a feature which has never been reported before. Experimental evidence suggests that these unique pockmarks on the camel milk powder surface led to the improved wettability observed. Deeper understanding of the mechanism leading to the pockmark formation may provide a way to manipulate the surface morphology of various dairy powders to achieve desired properties.

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Effect of xanthan gum on rheological property & bioaccessibility of β-carotene loaded filled hydrogel

Shinjae PARK[1], Seahun MUN[1], Yong-ro KIM[1]

[1] *Seoul National University, Seoul, Republic of Korea*

Abstract

The aim of this study was to examine the effects of xanthan gum on the lipid digestibility, rheological properties, and β-carotene bioaccessibility of rice starch-based filled hydrogels for manufacturing the suitable functional food material. β-carotene was solubilized within lipid droplets of emulsion that were then entrapped within rice starch hydrogels fabricated with different concentrations of xanthan gum. At a low concentration of xanthan gum (< 0.5 wt%), the viscous characteristics of the filled starch hydrogels increased. Furthermore, these hydrogels had a slower rate of lipid digestion than the β-carotene-loaded emulsion. As the concentration of xanthan gum was increased (to 1.0 wt% and 2.0 wt%), the filled starch hydrogels became more elastic gel-like than those without xanthan gum, and also had the fastest rate and highest final extent of lipid digestion. The addition of xanthan gum to the filled starch hydrogel lowered the bioaccessibility of β-carotene to varying degrees, depending on the xanthan gum concentration. Therefore, it has been revealed that the rheological properties of gel have a large correlation with its digestive rate and the presence of xanthan gum can affect the bioaccessibility in small intestinal phase. The results obtained from this study can be useful in designing gel-like food products fortified with lipophilic nutraceuticals.

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Impact of pH and ionic strength on temperature dependent diffusion of micellar bound casein monomers into the serum phase during microfiltration.

Simon SCHIFFER[1], Ulrich KULOZIK[1]

[1]*Technical University of Munich, Freising, Germany*

A reduction of filtration temperature to approx. 10 °C during milk protein fractionation by means of microfiltration (MF) reduces microbiological growth and prolongs plant-operating times. However, lower temperatures come along with a shift in the casein equilibrium in favor of soluble caseins (Ø ~ 10 nm). These have a similar size to whey proteins (Ø ~ 4–8 nm), transmit MF membranes (pore size ~ 0.1 µm) and reduce permeate purity. To improve the MF at low temperatures, it is necessary to understand the effect of pH value and the calcium concentration on serum caseins and filtration properties.

Therefore, the casein equilibrium was studied at temperatures between 6 and 20 °C in 2 °C steps using tempered ultracentrifugation. RP-HPLC was used for a quantification of casein species (αS1, αS2, κ, and β). Besides temperature, effects of a varying pH (6.3–7.3) and calcium concentration (addition of 0.25–20 mM) were investigated. With increasing temperature, soluble casein decreased almost linearly. In contrast to that, an increasing pH value showed little effect on the total serum casein concentration, disregarding a decrease of the minor fractions αS1- and κ-casein. The addition up to 5 mM calcium reduced soluble casein. Higher quantities showed no additional effect. However, at this limiting concentration the serum casein concentration was independent of temperature effects. In a further step, the results were used to optimize the microfiltration of skim milk at low temperatures resulting in long operating times and high purity permeates.

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Up-to-date knowledge on the heat assisted HPP inactivation of bacterial spores in foods

EVELYN[1], Filipa Silva[2]

[1]*University of Riau, Pekanbaru, Indonesia*
[2]*University of Auckland, Auckland, New Zealand*

Abstract

High-pressure processing (HPP) is a food pasteurization technology currently used by industry to inactivate microorganism and extend food shelf-life. Heat assisted HPP (high pressure thermal processing - HPTP or HPP-thermal) is required for the inactivation of specific microbial spores.

A few species/strains of pathogenic/spoilage microorganisms were very resistant to HPTP (≤2.0 log reductions): 900 MPa–110 °C–0.8 min and 827 MPa–84 °C–15 min for *Clostridium botulinum*, 900 MPa–100 °C–2.0 min for *Clostridium sporogenes*; 600 MPa–75 °C–15 min for *Clostridium perfringens*, 620 MPa-90 °C-7 min for *Geobacillus stearothermophilus*. HPTP of *B. coagulans* at 600 MPa–105 °C–0.5 min only resulted in 3.2 log reduction.

Most of the studies carried out with *Clostridium* and *Bacillus* demonstrated non-linearity for the log survivors vs. time in foods after HPTP, well described by the Weibull model. Response surface methodology has also been used to obtain the optimum process parameters for a desired log reduction. The following processing conditions were predicted in milk buffer for six log reductions: 625 MPa–86 °C–14 min for *G. stearothermophilus*, 576 MPa–87 °C–13 min for *Bacillus subtilis*, and 540 MPa–71 °C–16.8 min for *Bacillus cereus.*

To design successful HPTP pasteurization processes, the most resistant spores for a specific food should be used as targets and the non-linearity in the spore survivor curves should be investigated in greater detail.

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Up-to-date knowledge on the HPP inactivation of mold and yeast spores in foods

EVELYN[1], Filipa Silva[2]

[1]*University of Riau, Pekanbaru, Indonesia*
[2]*University of Auckland, Auckland, New Zealand*

Abstract

High-pressure processing (HPP) is a food pasteurization technology currently used by industry to inactivate microorganism and extend food shelf-life. High pressure thermal processing - HPTP (or HPP-thermal) is required for the inactivation of heat-resistant mold spores, whereas only room temperature HPP is required for the inactivation of yeast spores.

Byssoclamys nivea mold ascospores exhibited the highest degree of resistance to HPTP in high-acid foods, in particular in fruit concentrates. Furthermore, a higher resistance of *B. nivea* spores compared to some bacterial spores was reported after 600 MPa, 70–75 °C, and 20 min (2.2 log for *B. nivea* vs. 4.9 log for psychrotrophic *B. cereus*). Room temperature HPP had an effect in only a specific group of less resistant molds: 4.2 log for *Eurotium repens* and 6.0 log for *Penicillium expansum* after 350-500 MPa–15 min. HPP alone at 500 MPa could achieve 6 log reductions of *S. cerevisiae* spores in juices after 0.4 to 1.1 min.

As most of the HPTP log survivors of mold spores showed an upward concavity, the Weibull (*n* between 0.35-0.66) or first-order biphasic models have been used, and careful consideration should be taken to design successful HPTP pasteurization processes. A number of authors used the simple first-order kinetics to describe the inactivation of less resistant mold and yeast spores.

Retail Refrigeration: Making the Transition to Clean Cold

Toby PETERS1,

1*University of Birmingham*

Retail Refrigeration: Making the Transition to Clean Cold

Abstract

The Kigali Amendment and phasing down HFC refrigerants will be a huge step forward for climate change. But more than 80% of the global impact of refrigeration and cooling systems is associated with the indirect emissions of electricity generation to drive the cooling appliances (UNEP TEAP, 2017a).

With cooling energy demand projected to triple by 2050 (University of Birmingham, 2018) as we transition to low-GWP refrigerants, Peters in his report Retail Refrigeration: Making the Transition to Clean Cold argues that we have a collective responsibility to ensure the right long-term solutions are adopted; not only addressing refrigerants, but also maximising overall energy efficiency. To grasp the opportunity, Peters looks at how retailers need to rethink not just their refrigeration systems but thermal management both in-store and even within the wider community, including through district thermal networks and deeper integration with electricity grids. Peters has identified how strategic choices about system architecture and deeper integration with local energy networks could allow supermarkets to make use of negatively-priced excess renewable power or develop new revenue streams.

The report discusses how Governments have a critical role to play in developing total system level approaches; investing significantly more into R&D of sustainable refrigeration and its integration within energy systems, and supporting the development of a clear pathway for sustainable refrigeration, not just low global warming potential (GWP) refrigerants. The report also identifies that with the global growth in cooling, an expanded workforce, with new competencies and certifications, is going to be required.

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Concentration of Coconut Water using Aquaporin-based Hollow Fiber and Tubular Forward Osmosis Membrane

Xuan Tung NGUYEN[1], Simon ALVISSE**[1]**, Guofei SUN**[1]**, Kimball ROELOFS**[2]**, Piotr DLUGOLECKI**[3]**, Jörg VOGEL**[4]**

[1]*Aquaporin Asia Pte Ltd, Singapore*
[2]Berghof Membrane Technology GmbH, Eningen, Germany
[3]Berghof Membrane Technology GmbH, Leeuwarden, The Netherlands
[4]*Aquaporin A/S, Kgs. Lyngby, Denmark*

Abstract

To reduce costs of storage and shipping of coconut water (CW), fresh CW (~5oBrix) is often concentrated by 3 main conventional processes: Reverse osmosis (20o-30oBrix), freeze- concentration (~50oBrix) and vacuum/thermal evaporation (>60oBrix). The potential for higher profit margins and possibilities of creating new CW formulations motivate manufacturers to look for alternative technologies that are more cost-effective and better in preserving the unique aroma and taste of CW.

Forward osmosis (FO) is a low-energy, low-pressure process for dewatering of aqueous solutions. The osmotic potential maybe supplied by synthetically prepared draw solutions of inorganic salts, sugars, or suitable approved food additives. FO allows water removal without heat preserving all nutritional and aromatic compounds, while reaching higher Brix than RO processes which are limited by membrane fouling, and at lower operational cost compared to conventional freeze-drying or vacuum/thermal evaporators.

FO dewatering for CW is conducted in semi-batch on pilot scale over 1 month to study the optimal pairing of hollow fiber (HFFO) and tubular (TFO) FO membrane with inner diameter of 0.2mm and 5mm respectively. TFO is applied to further dewater CW concentrate with medium viscosity after HFFO processing. $MgCl_2$ is chosen as draw solute because of its high osmotic pressure, low reverse salt flux, and food grade availability. Draw solution regeneration is done by high-pressure RO where fouling is limited due to the clean synthetic draw solution. Preliminary results show that FO process with HFFO can reach >x10 concentration factor, 65oBrix concentrate with 2.5M $MgCl_2$, and initial batch flux 18 LMH.

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Mechanism of ***Bacillus subtilis*** spores inactivation induced by moderate electric fields

Langhong Wang[1], Xin-An Zeng[1], Sudhir K. Sastry[2]

[1]*School of Food Science and Engineering, South China University of Technology, Guangzhou 510641, China*
[2]*Department of Food, Agricultural, and Biological Engineering, The Ohio State University, 590 Woody Hayes Dr, Columbus, OH 43210, USA*

Abstract
Bacterial endospores are sometimes implicated with problems of food safety. In this work, the inactivation of Bacillus subtilis spores (107 CFU/mL) using moderate electric fields (MEF, 300 v/cm) under different temperature (<30, 55, 65 and 75 °C) was investigated. Studies at temperatures below 30 °C showed that MEF treatment resulted in slightly inactivation of spores. However, the inactivation effect of B. subtilis spores by MEF was improved significantly when the treatment temperature was 55, 65 and 75 °C. Result from the germination of spores revealed that MEF, mild heat (55, 65 and 75 °C) or MEF-mild heat-treated spores scarcely lost heat resistance, suggesting that spores did not germinate during MEF or heat treatment. Recovery analysis showed the viability of MEF-treated spores did not increase by addition of lysozyme (3 mg/L) in recovery plates, preincubation for 1 h in a 1:1 mixture of 60 mM Ca2+ and DPA, or lysozyme treatment in hypertonic medium. Confocal laser scanning microscopy photomicrographs showed that exposure to MEF induced a marked increase in the permeability of inner membrane and cortex of B. subtilis spores. These findings suggested that damage of the cortex and inner membrane, rather than spore nutrient germinant receptors or cortex lytic enzymes, are the possible reasons for inactivation of B. subtilis spores by MEF. This study indicated that combination of MEF with mild heat have the potential for inactivation of spores by itself or as a complement of the traditional heat-dependent techniques.

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The formation and characterization of antioxidant pickering emulsions：effect of the interactions between gliadin and chitosan

Yang YUAN[1], Mengfan LI[1], Qingzhu ZENG[1], Shan HE[1], Dongxiao SU[1]

[1] *School of Chemistry and Chemical Engineering, Guangzhou University, Guangzhou 510006, PR China*

Abstract
This paper investigated the formation of Pickering emulsion stabilized by three types of structure of gliadin–chitosan nanoparticles (GCNPs). The stability, rheological and antioxidant properties of the Pickering emulsion were mainly studied. Three types of GCNPs structure, including primary complexation, soluble complexes, and coacervates were obtained by a facile pH alteration approach to represent three kinds of gliadin–chitosan interaction levels. The obtained GCNPs with diverse size (125.13 ~ 5000.67 nm) and various wettability (θ = 37.88 ~ 96.32°) were then selected to fabricate Pickering emulsion. The droplet size of Pickering emulsions stabilized by soluble complexes and coacervates showed unimodal distribution with high symmetry. The surface loading and microstructure of emulsion confirmed that the coacervates could stabilize more oil (90.24%) via bridging droplets together and producing the percolating network structure against coalescence. The coacervate-stabilized Pickering emulsions were especially stable during the storage period, showing high viscoelasticity and solid-like behavior. Furthermore, the retarding effect of Pickering emulsion by embedding curcumin was confirmed and the coacervates were resistant to lipid oxidation, evidenced by low lipid hydroperoxides (15.22 mmol/kg of oil) and hexanal levels (Peak area 73.9) in the emulsions after thermally-accelerated storage. The findings showed that the stability, rheological and antioxidant properties of GCNPs stabilized Pickering emulsion could be regulated by gliadin–chitosan interactions through only changing pH. This study could be an available reference for the practical applications of Pickering emulsions stabilized using the gliadin–chitosan systems.

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Pulsed electric fields (PEF) as a pre-treatment for sous vide processing to improve the quality of tough meat cuts

Amali U. ALAHAKOON[1], **Indrawati OEY[1,2]**, Phil BREMER[1], Patrick SILCOCK[1]

[1]*University of Otago, Dunedin, New Zealand*
[2]*Riddet Institute, Palmerston North, New Zealand*

Abstract
Tough meat cuts can be tenderised using sous vide processing (SVP) however they require a long processing time. Pulsed electric field processing (PEF) of meat disrupts the myofibrillar network and the structure of the connective tissue, decreasing its thermal stability. This research investigated the use of PEF prior to SVP to decrease process time and improve the quality of brisket.

Briskets were treated at different electric field strengths of either 0.7, 1.0, or 1.5kV/cm with specific energy of 90-100kJ/kg followed by sous vide at 60°C for either 12, 18, or 24h. The effect of PEF followed by SVP on meat quality (tenderness, cooking loss, colour, lipid stability, microbial numbers) was modeled using multiple regression.

PEF treatment at 0.7 kV/cm reduced the meat shear force and hardness after SVP (12 or 18h). Increasing the electric field strength and/or prolonging sous vide time significantly increased collagen solubilisation. Scanning electron microscopy examination of either PEF treated meat (1.5kV/cm) or untreated meat revealed evidence of pore formation in the connective tissue after PEF treatment. The effect of post-PEF ageing (0, 3, 7, or 14d) was also studied. Longer ageing times significantly ($p<0.05$) increased the lipid and colour oxidation of the meat after SVP regardless of the pre-treatment. SVP reduced the total microbial numbers and lactic acid bacteria numbers (<1 log CFU/g) regardless of the pre-treatment used.

These finding demonstrate industrial benefits of using PEF pre-treatment to improve the tenderness and decrease the SVP time, while not having any deleterious effects on other meat qualities.

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The potential use of pulsed electric field (PEF) processing in combination with heat to produce extended shelf life (ESL) milk products

Muhammad Syahidi SAFIAN[1], Mohammed FARID[1]
[1]*The University of Auckland, Auckland, New Zealand*

Abstract:
Pulsed electric field (PEF) processing is gaining increasing interests as a method of food preservation since it could retain nutritional and organoleptic properties of food. The approach of using PEF in combination with heat has been shown to be more effective than either of the preservation method separately. Nonetheless, the information on the use of combining mild heat and PEF as a milk preservation strategy is still scarce. Therefore, this research aims to study the potential use of hurdle approach of high temperature short time (HTST) pasteurisation and PEF treatment at elevated processing temperature to extend shelf life of raw bovine whole milk.
In this study, raw milk treated with HTST pasteurisation at 72°C for 15 seconds prior to PEF treatment at optimized parameters with a maximum outlet temperature of 90°C would have longer shelf life with minimal effect on quality. These attributes are investigated through microbiological studies along with changes in α-lactalbumin, β-lactoglobulin, furosine and lactulose during treatment.
The rationale of this idea is that the synergistic effect resulted by pasteurisation to induce physical and chemical damage to microbial membranes followed by PEF processing at elevated temperature to facilitate the pulse shock through the inner cell membranes. The outcome of this research could represent a valid complement to the current technology towards meeting the increasing demand of global trades in fresh milk exports.

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Novel Approaches to Dairy Processing

George CHEN, Sahar TALEBI, Kezia KEZIA, Qiuyue WANG, Armineh HASSANVAND, Sally GRAS, **Sandra KENTISH**

ARC Dairy Innovation Hub, Department of Chemical Engineering, The University of Melbourne, Australia.

Abstract

The ARC Dairy Innovation Hub is a five year research program co-funded by industry stakeholders, dairy manufacturers and the Australian Research Council. This presentation will give an overview of some of the new technologies that have been explored within the Hub for the processing of dairy ingredients; and for the concentration and disposal of the resulting saline wastewater. These processes include forward osmosis, electrodialysis, electrodialysis with bipolar membranes, electrodialysis with ultrafiltration, capacitive de-ionisation, eutectic freeze crystallisation and membrane distillation. Each technology has its ‘sweet spot’ where it is best applied. Ion exchange membranes are used in many of these emerging approaches, but much work is still required to fully understand how these membranes behave and how fouling of the membranes occurs.

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Stability enhancement of natural antioxidants in black rice flour by heat and enzyme treatment

Yun-Kyoung JUNG, Shin-Joung RHO, and Yong-Ro KIM

Department of Biosystems and Biomaterials Science and Engineering, and Center for Food and Bioconvergence, Seoul National University, Seoul 08826, South Korea

Abstract

Black rice has high antioxidant activity because it contains a large amount of anthocyanin compared with white rice. Anthocyanins are water soluble flavonoid and have high antioxidant activity, which has potential health benefits against cancer, aging, and inflammation. However, extracted anthocyanins are labile when exposing to light and at high pH and temperature during processing and storage. In this study, functional modified black rice flour (CGT-BRF) was produced by heat and enzyme treatment to improve antioxidant activity of natural antioxidants in black rice. CGT-BRF was produced by directly treating BRF with 100 Unit/g of flour (d.b) cyclodextrin glucanotransferase applicable to food at various temperatures and treatment times, and optimum production conditions for the maximum antioxidant activity and CD production yield was determined. The antioxidant activity and total phenolic content of the CGT-BRF were increased about 2-fold compared to those of BRF. This enhancement was attributed to an increase in soluble phenolic content and the production of protocatechuic acid from thermal degradation of C3G by heating. Also, the use of CGTase produced cyclodextrin that interacted with natural antioxidants to improve their stability in aqueous condition. The modified BRF with enhanced stability and functionality could attract industrial interest as a food additive with a source of bioactive compounds.

Study on Degradation Conditions of Four Aflatoxins（AFB_1、AFB_2、AFG_1、AFG_2） by Laccase

Yingli LIU, Huijia MAO, Jing WANG

Beijing Advanced Innovation Center for Food Nutrition and Human Health， Beijing Technology and Business University (BTBU), 11 Fucheng Road, Beijing, China

Abstract

Aflatoxin is a secondary metabolite produced by fungi. It is extremely toxic. Biodegradation of aflatoxins has the advantages of mild reaction conditions, strong specificity of the substrate, and unbreakable nutrients. Laccases are copper-containing compounds and belong to oxidoreductase with a wide range of substrates. In this study, laccase was selected as the research object, and the effects of reaction time, reaction temperature and laccase addition on the degradation efficiency of four aflatoxins were discussed. The experimental results showed that laccase had the highest degradation efficiency and the shortest action time when AFB_1 was used. Degradation conditions were as follows: AFB_1, AFB_2, AFG_1, and AFG_2 were treated for 1 h, 8 h, 4 h, and 24 h at 30℃, respectively. The degradation efficiency of four aflatoxins ranged from high to low: AFB_1>AFG_1>AFB_2> AFG_2, respectively 95.24%, 88.98%, 93.07%, 38.08%, and the first three degradation rate reached more than 85%, while the lowest degradation rate was the treatment of AFG_2. By optimizing the degradation conditions of AFB_1, AFG_1, when the reaction time was 1h, 6h, the reaction temperature was 35℃, the total activity of laccase was 4U, and the final degradation rate could achieve to 97.24% and 98.44% respectively. Enzymatic degradation of aflatoxins is becoming an efficient strategy to ensure food and feed safety.

Key words: Laccase, Degradation, Aflatoxin

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Physico-chemical, structural and emulsifying characteristics of sonicated milk protein systems with varying casein to whey protein ratios

Mayumi SILVA[1],Bogdan ZISU[1], Jayani CHANDRAPALA[1]

[1] *Biosciences and Food Technology Discipline, School of Science, RMIT University, Melbourne, Australia*

Abstract

Most of the sonication-induced functionality improvements of dairy products relate with the physico-chemical and structural alterations of the dairy proteins present. The present study examined the effect of low-frequency ultrasound (20 kHz) on the physico-chemical and structural changes of milk protein systems with varying casein to whey (C:W) protein ratios (80:20, 60:40, 50:50, 40:60, pure MPI and pure WPI) at 0 – 75.6 J/mL energy densities. These changes were further linked with the interfacial properties at the oil-water interface in determining the emulsifying abilities of these systems as a result of sonication. The physico-chemical, structural and interfacial properties mainly governed by the C:W ratio of the milk system. A decrease in particle size was observed in C:W ratio of 80:20, 60:40, MPI and WPI while production of aggregates were observed with C:W ratio of 50:50 and 40:60 systems. Sonication dissociates, denatures and unfolds the dimeric form of β-lactoglobulin in to random coils and creates aggregates through β-sheet intermolecular crosslinking. An increase in the whey protein fraction produced large amounts of disulphide linked aggregates while the casein-rich systems produced more hydrophobically mediated aggregates. Primarily, β-lactoglobulin was involved with the hydrophobic aggregation process and β-lactoglobulin, bovine serum albumin and κ-casein participated in the disulphide mediated aggregation process under all ratios. The C:W ratio of 80:20 milk system showed the highest interfacial tension whereas WPI showed the lowest interfacial tension. Therefore, predicting the composition-dependent functional properties of sonicated milk systems could be beneficial to the food industry.

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ICEF13 – Abstract proposal

The international regulatory environment of novel food processing technologies

Dominique TAEYMANS[1], Tatiana KOUTCHMA[2], Simon BROOKE-TAYLOR[3]

[1]*FoodREG Consult Ltd, Brent (Montreux), Switzerland*
[2]*Agriculture and Agri-Food Canada, Guelph (ON)Canada*
[3]*Brooke-Taylor & Co pty Ltd, Milawa (VIC), Australia*

Abstract

Novel food processing technologies, particularly non-thermal technologies, are very attractive for food manufacturers for many good reasons: they ensure the safety of foods; offer new product development opportunities; and present highly sustainable alternative to heat (no chemicals, less waste, lower energy). Currently, the most relevant non-thermal food processing technologies are irradiation, ultra-violet (UV) light treatment and high hydrostatic pressure (HPP). However, before any novel process can be used and food products can be sold, regulatory authorities must be assured of their safety. Potential microbiological, toxicological, or nutritional concerns that can result from new processing techniques have to be assessed and addressed.

The paper will describe the international regulatory environment (North America, Australia & New Zealand, European Union) of those three technologies. It will also explain how to proceed to get official authorization to use these technologies in food processing. The differences in safety evaluation of novel foods by government agencies around the globe such as food additive in USA and novel foods regulations in Canada, Australia & New Zealand and EU will be presented.

Based on these inventories and the expertise of the authors, the paper will recommend further harmonization at international level and identify which next steps should be taken to help food innovators to promote their novel technologies. Understanding the regulations for each continent and country and science-based approaches for compliance will assist food companies and equipment manufacturers in marketing their products or technologies.

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Utilization of hydrocolloid-based organogel with a foam-structure as an alternative to solid fat

Im Kyung OH, **Suyong LEE**

Department of Food Science & Biotechnology and Carbohydrate Bioproduct Research Center, Sejong University, Seoul, Korea

Abstract

Food manufacturers have been making a concerted effort to reduce the levels of saturated fat since its excessive intake is well-known for increasing the risk of chronic disorder development such as coronary heart disease and obesity. However, there is still a need to develop new alternatives to solid fat without affecting the qualities of food products. The foam-structured hydroxypropyl methylcellulose (HPMC) was thus utilized to structure canola oil into solid-like oleogels, and the HPMC oleogels were then evaluated as an animal fat replacer for saturated fat-reduced meat patties. The textural properties (firmness and work of shear) of HPMC oleogels were higher than those of beef tallow. The HPMC oleogels showed frequency-independent viscoelastic properties and also exhibited temperature-independent solid fat contents. They had greater resistance against oxidation than the canola oil. When animal fat in the formulation of meat patties was replaced with HPMC oleogels, the cooking loss was lowered, and the patty texture became softer. Furthermore, the application of HPMC oleogels produced meat patties with nutritional superiority by significantly reducing the level of saturated fat. This study demonstrated that hydrocolloid-based oleogels could be successfully utilized as a potential solid fat replacer in meat products by improving their cooking qualities as well as nutritional values.

Food process models for training purpose through knowledge engineering methods (MESTRAL).

Ioana SUCIU[1], Amadou NDIAYE[2], Cedric BAUDRIT[2], Christophe FERNANDEZ[2], Alain KONDJOYAN[3], Pierre-Sylvain MIRADE[3], Jason SICARD[3], Pascal TOURNAYRE[3], Philippe BOHUON[4], Patrice BUCHE[5], Francis COURTOIS[4], Valérie GUILLARD[5], Violaine ATHES[6], Denis FLICK[7], Artemio PLANA-FATTORI[7], Christian TRELEA[6], Gilles TRYSTRAM[7], Guillaume DELAPLACE[8], Sébastien CURET-PLOQUIN[9], Dominique DELLA VALLE[10], Laurence POTTIER[9], Hubert CHIRON[1], Sofiane GUESSASMA[1], Kamal KANSOU[1], Magdalena KRISTIAWAN[1], **Guy DELLA VALLE**[1]

1 INRA UR-1268, Biopolymers, Interactions & Assemblies (BIA), Nantes, France
2 INRA USC-1368, Institut de Mécanique et d'Ingénierie (I2M), CNRS, Université, Bordeaux, France
3 INRA UR-370, Qualité Produits Animaux (QuaPA), Saint-Genès-Champanelle, France
4 UMR-Qualisud, SupAgro, Université, CIRAD, Montpellier, France
5 INRA, UMR-1208, Ingenierie Agropolymères & Technologies Emergentes (IATE), Université, Montpellier, France
6 AgroParisTech, UMR-782 Génie & Microbiologie Procédés Alimentaires (GMPA), INRA, Thiverval-Grignon, France
7 AgroParisTech, UMR-1145, Ingénierie Procédés Aliments (GENIAL), INRA, Université Paris-Saclay, France
8 INRA, UMR-638 Processus Interfaces & Hygiène Matériaux (UMET), Université, Lille, France
9 Oniris, UMR-6144 Génie Procédés Environnement Agroalimentaire (GEPEA), CNRS, Université, Nantes, France
10 Oniris, Nantes, France

Abstract
The use of models and simulators in food industry remains limited, despite its interest to predict complex situations, as shown by an abundant scientific literature[5]. Although carried out in many establishments and universities, teaching about food modelling faces theoretical hurdles (mathematical formalism ...) who tend to discourage students, who are the future engineers and managers of food industries, but may have uncertain basis in physics, for instance. A generic response through a "learning by doing" approach is possible to teach these modelling approaches. Actually, digital resources offer an opportunity to address these issues[6]. In the MESTRAL (Modelling and simulation for food processes) project, we have built such resources for teaching through knowledge representation and transfer tools, in particular electronic knowledge books (eK-Book). The eK-Book is a Web based tool, where knowledge is represented with concept maps, process and influence graphs, knowledge sheets, and their relationships stated as hypertext links. The effectiveness of knowledge transfer via these tools has already been validated[7]. MESTRAL now encompasses 15 modules covering about 150h, each one presenting a couple (food, process) – from "heat exchanger for starch suspensions" to "cheese ripening" – in an eK-Book. Each module contains model-based simulators, used for virtual practice, and also includes exercises and tests for applying and assessing the knowledge acquired. MESTRAL has already been successfully tested for various classes, either for self-training or hybrid learning. Current prospects include its integration as a MOOC (Massive Open Online Courses).
This work was supported by AgreenCamp project (ANR-15-IDFN-0001-01).

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Role of the protein composition and rheological properties on the structuring of soy-based meat analogues in extrusion processing

Patrick WITTEK, Heike P. KARBSTEIN, M. Azad EMIN

Karlsruhe Institute of Technology, Karlsruhe, Germany

Abstract
There is an increasing demand by consumers for meat analogues offering a unique texture and mouthfeel resembling meat products. Extrusion processing of plant proteins allows achieving fibrous, meat-like structures by mixing proteins with water, plasticizing/melting them, and structuring of this mixture by pushing it through a die mounted at the end of the extruder. Structure formation in the die is a function of the rheological properties of proteins, which again depend on protein structure and morphology. Control of structure formation can only be achieved if these complex relationships between the rheological properties, protein structure, and morphology are known.

This study will focus on presenting and discussing these property-structure functions required for controlling extrusion processing of meat analogues. To deal with the complexity of the process, we used a novel *closed cavity rheometer* allowing us to perform a thorough analysis of the rheological properties of extruded samples at extrusion-like conditions. This way, not only the dynamic rheological properties, but also the non-linear viscoelastic behavior of proteins as a function of the composition could be determined. In this contribution, the influence of these properties on the resulting product structure and texture and its implications for the design of meat analogues by extrusion processing will be discussed in detail.

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A new gelation technology and its application in improving the edible quality and health value of dried noodles

Ying YANG, Wenjing ZHAO, Yuanyuan WANG, Huanbo LI, Qinlu LIN

National Engineering Laboratory for Rice and By-Product Deep Processing and College of Food Science and Engineering, Central South University of Forestry and Technology, Changsha, China

The concentration-induced sodium alginate gel based on water evaporation prepared by the authors for the first time has the effects of inhibiting starch retrogradation and improving starch digestion properties. Free water in a system can be reduced by the dough formation of flour through absorbing water, resulting in a concentration effect on the solute in the system that is similar to the evaporation of water. Thus, this work hypothesizes that the concentration-induced sodium alginate gel having an improving effect on the quality and health value of flour products can be prepared in the formation of dough.

In order to confirm the hypothesis, the dough formation process of flour containing sodium alginate and Ca^{2+} was investigated using rheological method, and the edible quality and digestion properties of dried noodles made of the dough were determined by sensory evaluation and in vitro digestion methods, respectively.

The results showed that the concentration-induced sodium alginate gel was formed during the formation of the dough when the mass fraction of low-gluten and medium-gluten flour is 50% or more and high-gluten flour is 25% or more. Furthermore, the gel not only significantly improved the palatability, toughness and smoothness of the dried noodles, but also increased the resistant starch content in the dried noodles by 49.5% and decreased the rapidly digestible starch by 49.6%. Therefore, the flour competition water-based concentration-inducing gelation technique was developed, and it provides a new method for improving the edible quality and health value of flour products.

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New potential of using Pulsed electric fields to modify the thermal properties of flour fractions of oat

Sheba Mae M. DUQUE[1,2,4], Sze Ying LEONG[1,4], Dominic AGYEI[1], Jaspreet SINGH[4], Nigel LARSEN[3,4], Indrawati OEY[1,4]

[1]*University of Otago, Dunedin, New Zealand*
[2]*University of the Philippines Los Baños, College, Laguna, Philippines*
[3]*The New Zealand Institute for Plant & Food Research Limited, Lincoln, New Zealand*
[4]*Riddet Institute, Palmerston North, New Zealand*

Abstract
Pulsed electric fields (PEF) has been shown to offer novel technological applications on solid foods, including cereal grains. Most PEF studies on cereals tend to focus solely on starch. Moreover, despite the increasing industrial significance of oats, the effects of PEF treatment on it have not been investigated. Our preliminary study found additional and altered fractions (layers) within oat flour suspension after PEF processing. This study aimed to investigate the thermal properties of solid fractions of oat after PEF treatment.

Oat four suspensions (8% in distilled water) were PEF-treated at various electric field strengths (EFS, 2 to 4kV/cm) and specific energies (SE, 50 to 400kJ/kg) using 100Hz pulse frequency and 20µs pulse width. Samples were then centrifuged to collect the different fractions, freeze-dried, and analyzed for their thermal (gelatinization enthalpy (ΔH_{gel}), transition temperature) and microscopic properties.

Results showed differences in the overall thermal properties within fractions in a sample and between PEF treatments. More particularly, top fraction samples from high SE (400kJ/kg) treated flour have the lowest ΔH_{gel} observed, showing a decrease of up to 91% compared to Non-PEF treated sample. This was also supported by scanning electron microscope-generated images showing partially gelatinized starches. Transition temperatures did not vary too much within fractions in the sample but were observed to increase with increasing EFS and SE.

Based on the observed results, this study shows the potential of single PEF treatment producing variants of products with different thermal properties.

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Investigation of reduced heat transfer due to fouling in multiple effect evaporators of sugar manufacturing process using combined experimental and mathematical approach

A.B.G.C.J. DE SILVA[1], M.A.S.PERERA[2], P.G. RATHNASIRI[3]
[1]*Industrial Technology Institute, Malabe, Sri Lanka*
[2]*Safelink AS, Posgrunn,Norway*
[3]*Department of Chemical and Process Engineering, University of Moratuwa, Sri Lanka*

Cane sugar manufacturing is performed by extraction of juice, clarification of juice, concentration of clear juice, crystallization and drying. Juice concentration is accomplished by multiple effect evaporators. Fouling on the heat transfer areas (calandria) of the evaporators leads to weekly shut down of the processing plants. The objectives of this study are to analyze and quantify the rate of fouling, model the reduced heat transfer in calandria with fouling and thereby emphasize the increased energy efficiency with reduced fouling. The study focuses on two sugar factories operating quadruple effect evaporators and quintuple effect evaporators. Scale (fouling) samples were collected from each evaporator and chemically analyzed for major constituents. The rate of fouling was determined by chemically analyzing clear juice and syrups for 40 hrs before and after shut down. Mathematical model was developed in MATLAB 7.0 using balance equations for energy, material and species assuming that fouling occurs predominantly by particulate and precipitation fouling. The major constituent for fouling was detected as Calcium and the rate of fouling in terms of Calcium was 0.27 kg and 0.093 kg per tonne of juice boiled, respectively in quadruple and quintuple effects. The model predicts the growth rate of fouling and temperature variation with time. The model compares the heat transfer in using electromagnetic ionization apparatus; a fouling reduction technique in quintuple effects. The model can further be improved by changing brix% of juice, inserting effect of convective heat transfer coefficient of cane juice and including effect of vacuum to final effect evaporator.

Keywords: sugar, evaporators, fouling, modeling

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A Finite Element Modelling (FEM) and ultra-fast X-Ray tomography study of soft cereal foods damage during chewing

Melissa ASSAD-BUSTILLOS[1,2,3], Sofiane GUESSASMA[1], Anne-Laure RÉGUERRE[1], **Guy DELLA VALLE[1]**

[1]*INRA UR-1268, Biopolymers, Interactions & Assemblies, Nantes, France*
[2]*INRA UMR-1324, Centre des Sciences du Goût et de l'Aliments, Dijon, France,*
[3]*Cérélab®, Aiseray, France*

Abstract
Cereal foods may be considered as soft solid foams and the study of their damage mechanisms under mechanical load is essential to better capture their texture and to enlighten the process of human mastication[1]. This work focuses on two cereal foods, sponge-cake (SC) and brioche (B), with a porosity of about 75%. Their mechanical properties have been characterized under large compression levels (>90% in height reduction). The evolution of their cellular structure under compression was captured using high resolution fast x-ray microtomography at the European Synchrotron Radiation Facility (ESRF-Grenoble), for two geometries: plane/plane and grooved surface / plane, the latter allowing large shear deformation, while recording their compression response. Resulting 3D images allow implementing numerical models using COMSOL®. Finite element computation was used to derive the mechanical model that accurately represented the compressive response up to densification as compared to experimental data. The Young Modulus of the dense material constitutive of the cereal foam was estimated to 0.5 and 4 MPa for SC and B, respectively. Additionally, meshes from the 3D images were generated including 10^8 degrees of freedom to complete these findings and identify accurately the damaged parts.
By predicting the microstructural changes of two soft cereal food foams under conditions that mimic oral processing[2], our results provide an accurate description of the mechanisms of food fragmentation during chewing and opens prospect to design food products with adapted texture.

This work was supported by AlimaSSenS project (ANR-14-CE20-0003).

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Effect of glyceryl monostearate on fat crystallization behavior and stability of whipped-frozen emulsions

Jinju CHENG[1], Xiaodong LI[1], Tingsheng YAN[1], Ying MA[2]

[1]*Northeast Agricultural University, Harbin, China*
[2]*Harbin Institute of Technology, Harbin, China*

Abstract
Emulsifier concentration and fat type are very important in controlling the stability of fat droplets. This study focuses on the effect of glyceryl monostearate (GMS) on the crystallization behavior of two fats (anhydrous milk fat and coconut oil) and stability of whipped-frozen emulsions (10% w/w fat). Parameters such as particle size, surface protein adsorption, crystallization behavior, rheological properties, morphology and physical properties of whipped-frozen emulsions were determined. GMS retarded the nucleation of emulsified anhydrous milk fat, but accelerated the crystal growth. An opposite result was found in coconut oil emulsions. Crystal growth property was related to crystallization-induced destabilization of fat droplets in the two fat emulsion systems. Amplitude oscillatory rheology showed that increasing GMS concentration increased and decreased the deformability of fat droplets in anhydrous milk fat emulsions and coconut oil emulsions, respectively. Aeration activity (overrun) depended on both flocculation degree and partial coalescence degree of fat droplets, and maximum overrun was found at 0.2% (w/w) GMS for both two fat emulsion systems. Anhydrous milk fat whipped-frozen emulsions were characterized by an increased partial coalescence degree and a decreased melting rate with increase of GMS concentration. However, insignificant effect of GMS was found in coconut oil systems. Anhydrous milk fat was superior to coconut oil in producing well-textured frozen aerated emulsions with GMS as an emulsifier.

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Post-processing feasibility of dual-nozzle-extruded 3D printed beef products

Arianna DICK, Bhesh BHANDARI, Sangeeta PRAKASH

The University of Queensland, Brisbane, Australia

Abstract

3D food printing by dual-nozzle extrusion can meet the requirement of innovative ready-to-eat and post-processing-requiring meals. The study of the post-processing feasibility of 3D printed food products involves the study on the integrity of the designed internal and external structures, which may be altered by the physical and chemical changes resulting from cooking, affecting the textural attributes of the printed meat.

This study adopted the dual-nozzle extrusion methodology to 3D print meat products with composite-layers of lean beef paste and lard. After sous-vide cooking, the changes in the physical parameters (cooking loss, shrinkage, moisture retention, fat retention) and textural properties by Texture Profile Analysis (hardness, chewiness, and cohesiveness) and Puncture test (Hardness) were evaluated, as affected by the infill densities (50%, 75%, 100%) and fat contents (0, 1, 2, 3 fat layers within a structure).

After post-processing cooking, the 3D printed meat products well-preserved the internal and external structural arrangements. Overall, the higher the infill density, the higher the moisture retention (76.7-78.2%), hardness (50.2-76.6N), and chewiness (84.1-120.1N), and the lower the shrinkage (9.5-8.4%) and cohesiveness (1.7-1.6). Whereas, as the fat content increased, so did the cooking loss (14.90-28.57%), shrinkage (6.9-10.85%), and cohesiveness (1.46-1.88), while the fat retention (85.9-21.0%), moisture retention (80.6-74.9%), hardness (81.8-40.0N), and chewiness decreased (121.0-74.3N). In addition, the interaction of infill density and fat content showed significant effect ($P<0.05$) on all the dependent variables, excepting fat retention. The outcomes of this research provide information about the physical and textural modifications arising during cooking of 3D printed meat products.

ICEF13 ABSTRACT TEMPLATE

Integrating text mining and network analysis for ethnomedicinal profile of Bambara groundnut in Mpumalanga Province, South Africa

Victoria A. JIDEANI[1], Muthoni KIMANI[2], Afam I. O. JIDEANI[3]

[1]Department of Food Science and Technology, Cape Peninsula University of Technology, Symphony Way, Bellville 7535.
[2]University of Cape Town, Rondebosch, Cape Town 7700, South Africa
[3]Department of Food Science and Technology, University of Venda, University Road, Thohoyandou 0950, South Africa

Abstract
A questionnaire was used to capture the information on the medicinal uses of Bambara groundnut (BGN) from 163 farmers in Mpumalanga Province of South Africa. Ethnomedicine section collected information on the medicinal benefits associated with BGN if any and the parts of BGN used for such, diseases that BGN can prevent/treat/cure and how it is applied as well as taboos associated with BGN. The unstructured texts were tagged with the OSCAR (Open Source Chemistry Analysis Routines) chemical named entity and pre-processed by filtering and stemming, thereafter the topic of discussion was detected with the Latent Dirichlet Allocation and term co-occurrence determined using KNIME data mining software. The co-occurrence terms were converted to node adjacency matrix and imported into Gephi Graph Visualisation and Manipulation software version 0.02. The estimated Network statistics were modularity class, degree, eigenvector and betweenness centrality. The directed network consists of 67 nodes and 1978 edges. There are three modularity class; the base class consisting of 44.8%, class 1, 28.4% and class 2, 26.9% of the nodes. The terms with high betweenness centrality were eat (446), strengthen (282), bean (196), immune (169), kidney (135), burn (126), water (104) and boil (104). The central ethnomedical use of BGN is to strengthen the immune system and kidney wellness by eating the boiled bean which promotes the desire to drink more water. Alternatively, the seed was burnt and warm water poured into it and drank. Four topics each consisting of four terms were extracted from the ethnomedicinal response. Topic 0 contributing 52.3% correlates to eating boiled BGN seeds for kidney wellness. Topic 1 (36.5%) correlates to other diseases that BGN can resolve such as stomach pain, hiccup and strengthening immune system. Topics 2 (1.9%) and 3 (9.4%) relate to the use of dry seeds of BGN to stop a child from bed wetting and late puberty. There is a correlation between the ethnomedicinal uses of BGN and its nutraceutical content.

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Engineering Products of the Future

Christoph HARTMANN[1]

[1] *Nestlé Research Lausanne, Nestec Ltd., Lausanne, Switzerland*

Abstract

The food system faces global socio-economic challenges. Governments, NGOs, and consumers request the food industry to deliver beyond safety, sensory appeal, and affordability nutritious, natural and sustainable solutions. This requires new thinking in the design and engineering of packaged food, since conventional design criteria (e. g. taste, price, convenience) often compete with new ones (sustainability, nutrition, naturalness).

We illustrate on the example of challenges related to reduction of public-health sensitive nutrients and to plant-based nutrition how novel engineering approaches can deliver novel product design.

It will be shown that optimizing sensory availability of drivers of product choice such as sweetness and mouthfeel can lead to substantial reduction of public-health sensitive nutrients and, thus, offer a more responsible while still enjoyable product offering.

Further to this, we outline approaches to overcome the sensory unpleasantness of high-protein plant-based nutrition solutions. Here, starting from the root cause of sensory unpleasantness we illustrate a back-engineering approach considering the entire food chain.

Yet, it remains questionable in how far consumers will accept products and how durable a consumer tend is, especially when a pay-off is required in sensory properties, price, or convenience. We present some considerations related to trend prediction, consumer decision-making and the importance of clearly set product design-criteria.

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Concentration-induced sodium alginate gel inhibits retrogradation of rice starch by in situ immobilization of starch molecular state

Qinlu LIN, Ying YANG, Lu HE, Ying CHEN, Zhongqi XIANG

National Engineering Laboratory for Rice and By-Product Deep Processing and College of Food Science and Engineering, Central South University of Forestry and Technology, Changsha, China

Phenomenon of hardened and difficult to digest usually occurs in rice staple food during storage, and it is mainly attributed to rice starch retrogradation. Concentration-induced sodium alginate gelation method initiated by the authors is a new gelation technique that converts the Ca^{2+}-containing aqueous system of sodium alginate from a solution state to a gel state by water evaporation, enabling the gelling process of alginate is perfectly integrated with the gelatinization process of starch, which provides a new way to control starch retrogradation. The effects of concentration-induced sodium alginate gel (AC) on rice starch retrogradation were investigated in this work.

Rice starch in water (S) and its sample containing alginate and Ca^{2+} (SAC) were stored in 4 °C for retrogradation after heating for 30 minutes, and their retrogradation degrees were determined by iodine method, low-field NMR spectrometer, X-ray diffractometer, and scanning electron microscopy (SEM). The affecting mechanism of AC on rice starch retrogradation was investigated by rheological method and SEM.

Compared with S, the initial free amylose content decline rate of SAC was greater than 53%; the peak point relaxation time of colloidal bound water of SAC was 74 ms slower after 14-day retrogradation treatment, and correspondingly, the free water reduced by at least 71% and appeared 14-day later, no amylopectin retrogradation crystallization peak appeared, and showed a sheet-like ordered compact structure. Obviously, AC can inhibit rice starch retrogradation. Furthermore, mechanism study results showed that the inhibition was achieved by immobilizing the molecular state of rice starch after gelatinization.

State Transitions in Food Engineering - Encapsulation and Protection

Yrjö H. ROOS[1], Mackenzie HANSEN[1], Valentyn MAIDANNYK[2], Aaron LIM[2], Potes, N[1]

[1]*University College Cork, Cork, Ireland.*
[2]*Teagasc Food Research Centre, Fermoy, Co. Cork., Ireland*.

Abstract
Non-equilibrium states are important properties in characterization of food materials and glass transition has become a well-known concept in characterization of food materials. Glass transition occurs in non-equilibrium food solids with a significant role in structure formation and materials properties during water loss in food preparation and processing, particularly in dehydration, extrusion and freezing. Glass transition also contributes to sensory properties and nutrient release. Food materials engineering often uses emulsification of liquid components and gelling of liquid structures to achieve protection of nutrients and flavors. Such structures may also be stabilized by water removal and combined with use of components enhancing digestion and health. Spray-drying and extrusion represent continuous processes in which carbohydrates form glassy membranes around dispersed particles. We have also developed simple carbohydrate-protein solutions to produce solid beads to entrap sensitive components in protein gels followed by dehydration to vitrify carbohydrate structures for protection of water and oil soluble food components. We have also shown stability improvements of encapsulated carotenoids in spray dried emulsions with layer-by-layer interfaces. Solidification of non-crystalline structures has been described by using temperature dependence of structural relaxation times around glass transition. The resultant structures from spray-drying and other processes have been characterized by the use of microscopies and analysis of distribution of structural components. A critical analysis of the benefits of glass transition during food processing while taking into account the complexity of food formulation and roles of other food components in protecting and encapsulating sensitive components is often needed. Materials stability, however, is strongly water content dependent and final shelf life assumes the use of protective packaging.

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Modulation of protein aggregation by extrusion mechanical energy

Bo Zhang[1], Yanqiang Fang[1], Danyang Ying[2]

[1] *Institute of Food Science and Technology, Chinese Academy of Agricultural Sciences, Beijing, People's Republic of China*
[2] *CSIRO Agriculture&Food, 671 Sneydes Rd, Werribee, VIC 3030, Australia*

Abstract
Specific mechanical energy (SME) provided by the extruder refers to the amount of mechanical energy received per unit mass of material in the barrel. The average molar mass of extruded soybean protein isolate (SPI) decreased from 1.1 to 0.9×10^7 g/mol when SME increased from 820 to 1259 kJ/kg (Fang et al., 2013, J. of Food Engineering). Meanwhile, the color of the extruded SPI tends to darken (L* from 34.7 to 33.4), and the hardness (1.8 to 2.1 kg) and tensile strength (1.7 to 2.4 kg) significantly increased (Fang et al., 2014, J. of Food Engineering). SME, varying from 24 to 110 kJ/kg, was positively correlated with protein extraction ratio in extruded canola meals ($p < 0.01$), however, *in vitro* protein digestibility of extruded canola meals was highest when SME varied from 40 to 77 kJ/kg with 30% barrel moisture (Zhang et al., 2017, Food research International). It indicated that SME has influence not only on the degradation of protein, but also on viscous dissipation which could lead to the protein aggregation.

Artificial oral processing of extruded pea flour snacks

Magdalena KRISTIAWAN[1], Guy DELLA VALLE[1], Anne-Laure REGUERRE[1], Valérie MICARD[2], Azad EMIN[3], Christian SALLES[4]

[1]INRA, UR 1268 Biopolymères Interactions Assemblages (BIA), 44316 Nantes, France
[2]Montpellier SupAgro-INRA-UM-CIRAD, JRU IATE 1208, 34060 Montpellier, France
[3]Karlsruhe Institute of Technology, Institute of Process Engineering in Life Sciences, 76131 Karlsruhe, Germany
[4]CSGA (Centre des Sciences du Goût et de l'Alimentation), AgroSup Dijon, CNRS, INRA, Université de Bourgogne Franche-Comté, F-21000 Dijon, France

Abstract
Starch and protein changes during extrusion of pulse legumes (i.e. pea flour) lead to expanded snacks with various density (texture) and cell wall morphologies, which may affect chewing performance. Our objective was to relate the bolus properties (fragmentation, moisture content, and viscosity) of chewed extruded pea snacks with their structure and functional properties. To control oral physiological parameters, we opted for an *in vitro* approach using a chewing simulator, which variables were the flow rate of artificial salivary fluid and chewing time. Extruded snacks were characterized by their density and protein solubility in dithioerythritol, which reflected the amount of protein aggregates cross-linked by S-S bonds. Size distribution and median width (*D50*) of bolus fragments were determined by imaging. Bolus viscosity and saliva uptake ΔWC were determined by capillary rheometry and gravimetric method, respectively. Extruded snacks were reduced to small particles (~2 mm) during chewing following a unique curve *D50*=f(chewing time) fitted by a power function. ΔWC evolution during chewing was expressed as a function of structure index, defined as the product of the snacks relative density by their protein solubility. Boluses viscosity exhibited a shear thinning behaviour with the consistency index negatively correlated to the saliva uptake (ΔWC) through plasticization coefficient (α). α values (< 2) were much smaller than those reported for cereal products (15-30) and depended on protein solubility. Reverse engineering based on the model of oral processing mechanism will allow us to design extruded legumes with targeted structure, adapted to chewing behaviour and oral physiology of consumers.

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Water crystallisation in model sugar solutions by *in situ* CO_2 nano-bubbles generation

Bhaskar Mani ADHIKARI[1]**,** Ven Ping TUNG[1], Tuyen TRUONG[1,2], Nidhi BANSAL[1] and Bhesh BHANDARI[1]

[1]*School of Agriculture and Food Sciences, The University of Queensland, Brisbane, Australia*
[2]*School of Science, RMIT University, Melbourne, Australia*

Abstract
This study was directed to observe the impact of nano-bubbles from dissolved CO_2 (up to 2000-ppm) on the water crystallisation during freezing of sugar (lactose, sucrose, glucose and fructose) solutions (2-5% w/v) in the tubes immersed in an ethylene glycol bath at -15 ^{o}C for 90 min. When the temperature of the model sugar solutions in the tubes reached 0 ^{o}C, ultrasound (US; 20 kHz) was emitted in the coolant bath for 20 s duration through a transducer to generate the nano-bubbles in the tubes with dissolved gas. A weak ultrasound mechanical effect transmitted to the tubes through the coolant bath generated nano-bubbles of about 100-500 nm range from dissolved CO_2. The nano-bubbles acted as nucleation sites for the ice crystallization. Obtained freezing curves for sugar solutions were analysed for freezing parameters. In general, the gas nano-bubbles promoted earlier freezing of water. For instance, nucleation time with *in situ* nano-bubbles generation in 2000-ppm carbonated water (7.8 min) was shorter than that of pure water (19.1 min). The former initiated ice nucleation just below sub-zero temperature (-0.2 ^{o}C) whereas the onset of nucleation of control pure water was -11.3 ^{o}C. A similar effect was observed for all model sugar solutions. The current findings suggest that nano-bubbles can be applied to refine the food freezing process.

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Key Components and Corresponding Bioactivities of Different Teas Processed from the Same Fresh Leaves

Heyuan JIANG[1,2,3], Ulrich H. ENGELHARDT[2], Jianyong ZHANG[1,3], Weiwei WANG[1,3], Lin CHEN[1,3], Wei SU[1,3]
[1]Key Laboratory of Tea Biology and Resource Utilization of Ministry of Agriculture, Tea Research Institute, Chinese Academy of Agricultural Sciences, Hangzhou, China
[2]Institute of Food Chemistry, Technische Universität Braunschweig, Braunschweig, Germany
[3]Key Laboratory of Tea Processing Engineering of Zhejiang Province, Hangzhou, China

Abstract

Tea (Camellia sinensis L.O. Kuntze) is the most popular healthy beverage in the world. China has a lot of teas based on different processing, with the largest tea production amount. Usually, catechins are the most important compounds accounting for 12% to 25% in fresh tea leaves, and have strong physiological activities, and also do affect tea brew color and taste. In different kinds of teas, catechins might encounter different reactions, to be kept, or to be oxidized into dimers, trimers, and polymers. These reactions might change their flavors and bioactivities.

We picked the fresh tea leaves, and produced some teas with different processing methods, like green tea, black tea and oolong tea, respectively as non-, full- or partial- fermentated teas. Then, we evaluated their sensory qualities, and detected their contents and composition of catechins and their major dimers including theaflavins, theasinensins, and theacitrin, for those tea samples through all the processing procedures, based on UHPLC and HPLC assisted with electrospray tandem MS. Theasinesins, accompanied with theaflavins, increased double or threefold in oolong tea and black tea, compared with green tea, whilst catechins decreased by 12% and 68%.

The antioxidative bioactivities of those tea samples were also analyzed based on in-vitro and in-vivo studies. Catechin dimers had also strong antioxidative abilities and antiaging effects similar with catechin isomers. Their compositions might lead to different biological activities for those tea samples due to different fermentation degrees.

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Mechanical wheat flour modification and its effect on flour properties and bread quality

Yi CHEN[1], Sophia CACIAGLI[1], Ciatta WOBILL[1], Peter FISCHER[1], Erich WINDHAB[1]

[1]*ETH Zurich, Zurich, Switzerland*

Abstract

Wheat flour contains mostly starch and proteins. By applying mechanical flour treatment, starch and proteins will undergo structural and functional changes. Due to the mechanical force occurred during flour treatment, some starch granules can be damaged and broken into smaller particles, which is referred to as starch damage. In addition, such mechanical treatment will also influence the physicochemical characteristics of proteins. Starch damage and protein alteration will in turn affect flour properties, dough rheological properties and eventually the quality of baked products.

In this study, wheat flour was mechanically modified by grinding with different milling processes, which induced different levels of starch damage and protein alteration. The aim of the study was to investigate effects of mechanical flour modification by various milling processes on flour properties and bread quality especially on bread staling. In the study, the level of starch damage from different milling processes was identified. Fahrinograph and Viscograph were used to characterize the flour properties. The obtained results showed that mechanically modified wheat flour had a higher water absorption and different pasting behaviors compared to untreated flour. Furthermore, baking trials were conducted by using such mechanical modified flour and bread crumb firmness and amylopectin retrogradation were studied over a storage period of 14 days. The bread baked with desired mechanically modified flour resulted in lower crumb firmness during storage. Therefore, mechanical flour modification can be used as a potential tool to reduce bread staling and increase bread shelf life.

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Engineering plan protein-based yoghurt products for nutrition and health

Stephan DRUSCH[1], Martina KLOST, Monika BRÜCKNER-GÜHMANN

[1]*Department of Food Technology and Food Chemistry, Technische Universität Berlin, Berlin, Germany*

In developed countries, nutritional behaviour and diets have contributed to an increasing prevalence of obesity and associated diseases. Consequently, diets high in plant-based proteins are increasingly recommended, as plant-based foods provide more unsaturated fatty acids, antioxidant vitamins, minerals, phytochemicals and fibre. Moreover, the substitution of animal derived proteins with those from plants increases the sustainability of raw materials by lowering the carbon footprint and even utilises side-streams that would otherwise go to waste. A suitable product-category for incorporation of nutritionally relevant amounts of protein are yoghurt-type gels. Yoghurt is associated with protein-rich food and generally has a high consumer acceptance.

In studies on pea and oat protein we have shown that plant proteins are able to gel via microbiological fermentation. However, in plant-based yoghurt alternatives, the formation of a stable texture and a superior sensory quality are the main challenges. In addition, one major disadvantage of plant-derived proteins is their pronounced flavour that does not meet consumers' expectations regarding yoghurt-style products. Therefore, the aim of our research was to develop strategies to meet consumers' expectations concerning plant protein based foods. Analyses include rheological and physical methods to elucidate structuring mechanisms and to identify the most important factors affecting gelation. Furthermore data on modification of sensory perception by selection of microorganisms modifying the aroma profile are presented. In summary, our research has identified promising approaches to improve the textural and organoleptic properties of plant protein based yoghurt-alternatives based on pea and oat create a range of nutritionally valuable products.

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Effect of pre-heat treatment of skim milk on reverse osmosis membrane filtration performance and storage stability of concentrated milks

Morten Vormsborg CHRISTIANSEN[1], Lilia AHRNÉ[1], Leif Horsfelt SKIBSTED[1]

[1]*University of Copenhagen, Department of Food Science, Copenhagen, Denmark*

Abstract

Concentrated dairy products are of increased interest within the dairy industry. Skim milk concentrates (SMC) can be produced by reverse osmosis (RO) membrane filtration, which can be considered a non-thermal concentration process, and therefore the properties of the concentrates differ from the ones traditionally produced by evaporation. In this study, the effect of heat treatment of milk before and after RO concentration on the performance of the concentration process and the following effect on age thickening mechanisms of SMC were investigated.

Pasteurization of skim milk (73 °C, 15 s) prior to RO filtration increased the processing time significantly by up to 20% compared to raw skim milk. The milk pasteurization also resulted in larger casein micelles and whey protein denaturation.

The viscosity of SMC was hardly affected by the pre-pasteurization treatment. The enlarged micelle particles appeared stable, but during storage (5 °C, up to 30 days) protein-protein interactions increased, which resulted in structure build-up, age gelation, and shifts from Newtonian to shear-thinning flow behavior. This tendency was enhanced when SMC were heat treated after RO concentration.

Production of storage stable milk concentrates is a balance between sufficient heat load to avoid spoilage organisms but at the same time minimize protein denaturation and the following protein interactions and age gelation. Thermal treatment prior to concentration increased the physical-chemical stability of milk concentrates, but decreased the efficiency of the concentration process.

Further results will be presented to understand and map this balance.

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Digestibility of Milk Proteins in Elderly

(Kataneh AALAEI, Lilia AHRNÉ)

(Department of Food Science, University of Copenhagen, Denmark)

Abstract

The rapid growth of the world's aging population will definitely be a challenge for the health-care systems worldwide in the foreseeable future. One approach to promote healthy aging is through designing foods tailored to the needs and physiological capabilities of the elderly. Protein digestion is not only determined by the physiological conditions of the host, but also affected by other parameters such as food structure which is in turn influenced by food processing and formulation. Therefore, the objective of this study was to improve our understanding of digestibility of milk proteins in the elderly in comparison with protein digestion in adults.

Pasteurized and UHT milks as two widely consumed products were characterized and exposed to two simulated gastric digestion for adults and elderly. The method was based on an international consensus (INFOGEST) recently achieved to be used as a standardized static method. Samples taken at intervals during the digestion were analyzed using LC-MS to investigate the proteins degradation rate and peptides release.

Our results so far have shown that there are noticeable differences regarding fate of milk proteins in digestion tract of adults and elderlies. The findings of this study indicate that the extent of the proteins digestion in adults and elderly is varied depending on factors such as type of the protein, whether it belongs to caseins or whey proteins. This knowledge will assist the industry to develop foods with modulated protein digestion rate to address nutritional needs of this group of population.

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Enzymatic hydrolysis and fermentation of soybean dregs and extraction of polyglutamic acid

Wang Jianming[1], Xia Yidan[1], Shi Lei[2], Yang Chen[1], Hu Yunfeng[1], Wang Yangping[1],
[1]*Tianjin University of Science and Technology, Tianjin, China*
[2]*Tianjin limin seasoning co. LTD, Tianjin, China*

Soybean residue is a cheap by-product of bean processing, but it has a rough taste as food directly. The physicochemical properties and sensory quality of soybean residue can be improved by fermentation technology, and the value of its reprocessing and utilization can be enhanced. In this study, different fungi, lactic acid bacteria and Bacillus subtilis were used to ferment soybean dregs. It was found that the fermentation of composite bacteria could cause degradation of macromolecules in soybean dregs, and expose some characteristic groups and improve their functions. The protein, fat and IDF in soybean dregs were degraded by fermentation. In addition, soybean residue fermentation can also be a good source of polyglutamic acid. Particle size analysis and microscopic observation showed that fermentation could reduce the particle size of dietary fiber and make its internal structure fluffy and fragile from the original dense network structure; improve the hydration properties of dietary fiber from soybean dregs, especially the high value of water solubility index was 4.01 times of the control; enhance the ability of cholesterol adsorption by 2.01 times of the control; fermentation also enhanced the ability of dietary fiber from soybean dregs to absorb nitrite and nitrite. The total reducing power and the yield of polyglutamic acid reached 3.1g/L. Fermentation of soybean residue can not only improve the rough sensory quality of soybean residue, but also improve the functional characteristics of soybean residue. Using low-cost soybean residue to produce functional food with higher nutritional value than natto.

Symbiotic effect of β-glucan and phytosterols on the textural properties and viability of probiotic L. rhamnosus in functional reduced-fat cream cheese

Dian W. NINGTYAS[1], Bhesh BHANDARI[1], Nidhi BANSAL[1] and Sangeeta PRAKASH[1]

[1]*The University of Queensland, Queensland, Australia*

Abstract

The symbiotic effect of functional ingredients (β-glucan and phytosterols) and probiotic *L. rhamnosus* on the microstructural, textural, rheological and lubrication properties of reduced-fat cream cheese was investigated. The viability of probiotic over a period of 35 days at 4°C were also observed. *L. rhamnosus* (encapsulated and non-encapsulated) were incorporated in two formulations of cream cheese with added β-glucan and phytosterols (in emulsified and esterified form) and compared with cream cheese without functional ingredients. The results from scanning electron microscopy (SEM) showed an open cream cheese structure with probiotic cells distributed in the casein matrix. A relatively compact and denser structure due to the addition of encapsulated probiotic were also observed showing a firmer and thicker cream cheese compared to non-encapsulated form. In addition, cream cheese with encapsulated *L. rhamnosus* was more elastic as observed by higher G′ values, in agreement with firmness (3.10N) and viscosity (9.36 Pa.s) results. The functionality of both β-glucan and phytosterols as fat replacer also contributed in lowering the friction coefficient (< 0.25) of probiotic cream cheese. After 35 days of storage at 4°C, the probiotic *L. rhamnosus* (encapsulated and non-encapsulated) remained viable at minimum of 10^6 CFU/g in all cream cheese samples. The combined effect of β-glucan and phytosterols emulsion in probiotic cream cheese resulted in a higher number of viable cells (9.95×10^7 CFU/g) than with phytosterols ester (8.78 x 107 CFU/g). This finding suggests the potential of reduced-fat cream cheese as a food matrix to deliver probiotic (*L. rhamnosus*) and prebiotic (β-glucan).

Understanding the potential synergistic effect of milkfat with omega- 3 fatty acids

Mitra NOSRATPOUR[1], Cordelia SELOMULYA[1], Meng Wai WOO[2]
[1]Department of Chemical Engineering, Monash University, Clayton, VIC 3800, Australia
[2]Department of Chemical and Materials Engineering, University of Auckland, New Zealand

Abstract
Long chain omega-3 polyunsaturated fatty acids, especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in marine sources like fish oil, have lots of health benefits for human body [1]. However, they are extremely susceptible to oxidation because of high number of double bonds in their structures. Milkfat is one of the most stable edible oil with a pleasant flavor. This fat contains high amount of saturated fatty acids that could stabilize oxidation when blended with other oils [2-4]. This is because of the kinetic resistance of more saturated hydroperoxides of milkfat to decomposition in oxidation process [5]. Therefore, milkfat can potentially be used to improve the stability of the fish oil. Fish oil and milkfat were mixed at different proportions (fish oil: milkfat ratio of 60:40, 50:50, 40:60). The samples were heat treated at 80 °C at different durations to mimic a typical oxidation processing of oils. The amounts of primary and secondary oxidation products were measured by hydroperoxide value and thiobarbitoric acid value, respectively. The results showed that by increasing the rate of milkfat in the mixtures, the production of primary and secondary oxidation products, decreased significantly to almost 85 %. Therefore, blending fish oil with milkfat could be a viable practice for improving fish oil oxidative stability and altering its physicochemical properties such as sensory attributes. The outcome of this work can be used to provide an initial assessment on the potential synergistic effect of milkfat with fish oil (liquid form), and the challenges associated with handling and processing of edible oils.

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Effect of glass transition on soymilk powder stability during storage

Juliana MARTINS[1], Bruna OLMOS[1], **Louise KUROZAWA[1]**

[1]*University of Campinas, Campinas, Brazil*

Abstract

The objective of this work was to evaluate the effect of glass transition on soymilk powder stability during storage. Sample was stored for 18 weeks under 5 relative humidities (RH) and temperatures (T) in order to verify chemical changes in the amorphous powder at glassy and rubbery states. Glass transition temperatures (Tg) of soymilk powders equilibrated over several RHs were obtained by differential scanning calorimetry. The Gordon-Taylor model was adjusted to the experimental Tg values to determine the storage conditions evaluated in this work. At 25°C, glassy state occurred at RH above 76%; thus, based on this value, the following storage relative humidities were defined: 32.8 and 52.9%; 75.3%; and 84.3 and 90.2%, corresponding to the rubbery state, glass transition, and glassy state. Since water activity of soymilk powder was 0.542, the Tg was 43°C. Thus the storage temperatures were: 10, 25, and 35°C; 43°C; and 55°C, corresponding to the rubbery state, glass transition, and glassy state. Every 3 weeks of storage, the powders were withdrawn and analyzed with respect to antioxidant capacity by the DPPH and FRAP assays and total phenolic compounds content. Overall, at higher RH or T, in which soymilk powder was at the rubbery state, there was a higher degradation rate of antioxidant capacity and total phenolic compounds content during storage. These results can be explained by glass transition phenomenon, since the rubbery state is characterized by great molecular mobility inside the food matrix, which facilitates the degradation during storage

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Electromagnetic Fields Assisted Blanching - Effect on the Dielectric and Physicochemical Properties of Cabbage

Jingjing Xu[1], **Yuchuan Wang[1]**, Min Zhang[1], Bo Wang[2]

1 Jiangnan University, Wuxi, China
2Jiangsu University, Zhenjiang, China

Abstract
Four electromagnetic fields, including radio frequency (27.12 MHz), low frequency microwave (915 MHz), high frequency microwave (2450 MHz) and infrared radiation (wavelength of 2.40 μm) assisted blanching of cabbage were studied and their effect on the dielectric and physicochemical properties of blanched cabbage were analyzed. Results showed that compared to hot water blanching, all four electromagnetic fields improved the dielectric capacities and physicochemical qualities of blanched cabbage. The pretreated cabbage using radio frequency blanching possessed the highest dielectric constant value and dielectric loss factor value followed by microwave and infrared radiation treatments. Better flavor, high chlorophyll (348.99 mg/100g dw) and ascorbic acid contents (206.38 mg/g dw) were observed in the radio frequency blanching pretreated cabbages as compared to the conventional hot water blanched samples. Therefore, radio frequency blanching appeared to be the most promising blanching method to improve the dielectric properties and preserve the physicochemical characteristics of cabbage.

Combined microwave/rotating-pulsed fluidized bed drying of okara: evaluation of nutritive properties of dried product

Renan LAZARIN[1], Mariah SILVA[2], Elza IDA[2], Michele BERTELI[3], **Louise KUROZAWA[1]**

[1]*University of Campinas, Campinas, Brazil*
[2]*State University of Londrina, Londrina, Brazil*
[3]*Institute of Food Technology, Campinas, Brazil*

Abstract

The objective of this work was to study the effect of microwave-assisted rotating-pulsed fluidized bed drying (MW-FBD) of okara on the inactivation of trypsin inhibitors and retention of the isoflavones. Experiments were carried out at air drying temperature of 70°C and air flow rate of 0.8 m^3/min. The pulsation effect was caused by rotating of a flat-holed disc (16 Hz) installed at the bottom of the dryer chamber. Four microwave power levels (100, 200, 300, and 400 W) were applied during at the initial 10 minutes or throughout the drying process. Freeze dried sample was used as a control. Drying was accomplished till the moisture content of okara decreased from 2.5 to 0.05 kg water/kg solids. Total time of drying ranged from 18 to 26 min. MW-FBD inactivated 19 to 26% of trypsin inhibitors activity present in the control sample (9.9 TIU/mg solids). The highest total isoflavone content was obtained for MW-FBD carried out at 200 W/10 min (1.8 µmol/g solids), indicating a retention of 86% of isoflavone present in the control (2.1 µmol/g solids). Overall, after MW-FBD, there was an increase in the percentage of aglycones and a decrease in the percentage of malonylglycosides in relation to the total isoflavones. As a conclusion, MW-FBD showed a good preservation of isoflavones and favored the hydrolysis of malonylglycosides to aglycones, which is beneficial to human health. However there was a low inactivation of the antinutritional factor trypsin inhibitors.

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Translational nutrition and food science in human biomedical research: focus on complex carbohydrates from food in human nutrition

Yuguang DU[1], Zhuo A. WANG[1], **Bing WANG[1,2]**

[1,2] Graham Centre for Agricultural Innovation, Charles Sturt University, Wagga Wagga, Australia; [1]State Key Laboratory of Biochemical Engineerin, Institute of Processing Engineering, Chinese Academy of Sciences, Beijing, China,

The complex carbohydrates have an essential role as a food source for animals and humans. Glycosylation plays an essential role in health and disease. Over the past decade, we have demonstrated dietary sialic acid glycans (Sia-glycans), a family of 9-carbon sugar acids, presents in high concentration of human milk and conventional food products, e.g. milk, animal and dairy products. Dietary Sia- glycans can influence neuronal Sia-glycan accretion in the brain and improve cognition and memory in the animal models of neonatal piglet, pregnant pig and rats. Our recent MRI and mechanism studies quantifying both translational and post-translational levels of neural biomarkers mediating brain plasticity, neurogenesis and cognitive behaviour characterization have provided new information to aid in the development of new nutritional food products that are backed by robust health claims. We also developed a novel "green production" strategy for chitooligosaccharides (COS) preparation based on microwave assistant dissolution/degradation followed site-specific enzymatic degradation. COS are degradation products of chitin, non-toxic and environmentally friendly with multiple biological functions. By this method, a series of complex COS with different structural characters have been prepared through a highly controlled, repeatable process. Together with MS and NMR analysis, we found that the sequence signature of D-glucosamine and N-acetylglucosamine arrangement was another determination factor on COS functions besides degree of polymerization and degree of deacetylation. We also demonstrated material COS intervention can improve milk production, animal reproduction and immunity in pig and its piglets. These findings imply the development of a new generation of COS products.

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Microstructure dependence mechanical properties of extruded pea starch-proteins blends

Imen JEBALIA, Jean-Eudes MAIGRET, Anne-Laure REGUERRE, Sofiane GUESSASMA, Denis LOURDIN, Guy DELLA VALLE, **Magdalena KRISTIAWAN**

INRA, UR 1268 Biopolymères Interactions Assemblages (BIA), 44316 Nantes, France

Abstract
The texture of legumes based extruded snacks depends on the intrinsic properties of cell wall materials built of starch-protein composite. In this work, the composite materials were obtained by extrusion of pea flour and blends of pea starch-protein isolate SP (2/1, 1/1, 1/2 dry basis) at various moisture content (25-35% wet basis), specific mechanical energies (100-2000 kJ/kg) and die temperature of 95°C to avoid expansion. As shown by confocal scanning laser micrographs, the composite microstructure varied from protein aggregates dispersed in amorphous starch to bi-continuous starch-protein matrix, depending on composition and extrusion variables. A protein/starch interface index was derived from the total perimeter and surface of protein aggregates, determined by image analysis. Mechanical properties of composites, such as breaking stress (σ_b) and strain (ε_b), were determined using a three-point bending test. Pea flour composites with σ_b 10-30 MPa and ε_b 1-1.5% exhibited brittle behaviour with rupture in the elastic domain. The SP blend composites had higher breaking stress (σ_b 30-50 MPa) and strain (ε_b 1.5-3%) with rupture in the plasticity stage. Increasing the interface index (0.3-3) between the phases decreased rupture stress (50-10 MPa) and strain (3.5-1%) whatever the formulation, which may be attributed to poor compatibility between starch and proteins. These results show that it is possible to modulate the mechanical properties by tuning the composite morphology through extrusion variables. These results will contribute to the determination of constitutive laws of starch-protein composites in order to predict the mechanical properties of legumes based extruded snacks by numerical modelling.

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Engineering common beans for the generation of microstructures with specific *in vitro* nutritional functionality: a kinetic approach

Andrea PALLARES PALLARES[1], Shannon GWALA[1], Clare KYOMUGASHO[1], Marc HENDRICKX[1], Tara GRAUWET[1].

[1] *KU Leuven, Leuven, Belgium*

Abstract

Common beans constitute a potential solution to the diet-environment-health trilemma[1], given their attractive nutritional profile and environmentally-friendly growing conditions. In this work, processing was used as a tool to generate common bean (micro)structures with tailored *in vitro* nutritional functionality. Initially, the effect of different processing variables (high temperature, processing time, and/or mastication behavior) on the structural properties of common beans was evaluated. In a following stage, distinct (micro)structures were analyzed in terms of *in vitro* starch digestion kinetics.

Upon conventional thermal treatment (*i.e.* cooking) and standardized mechanical disintegration, (micro)structures with different starch bio-encapsulation degrees were obtained. Specifically, an evolution from cell clusters and open cells to individual intact cells was observed as processing time increased[2]. When thermally treated common beans were subjected to *in vivo* human mastication, it was determined that irrespective of processing time or mastication behavior, the major constituent fractions of oral boluses were seed coat particles and individual intact cotyledon cells (starch-rich fraction). Further analyses of the starch-rich fraction demonstrated that increasing the processing time had an enhancing effect on cell wall permeability[3].

During *in vitro* simulated digestion of process-induced intact cells, longer lag phases and lower reaction rate constants were found in cells with lower permeability degree and/or higher amount of remaining protein[3]. In fact, starch-encapsulating protein was proven to be an additional barrier for *in vitro* starch digestion. A multiresponse kinetic evaluation of digestion, aiming to increase mechanistic understanding of the process, was made by quantification and mathematical modelling of both the released sugars and the remaining starch.

Overall, our investigation evidences the potential of targeted processing to modulate *in situ* the nutritional functionality of common beans (a sustainable source) through modification of structural properties.

1 Tilman & Clark (2014). Global diets link environmental sustainability and human health. Nature, Vol. 515, pp. 518–522.

2 Pallares Pallares, *et al.* (2018). Temperature-pressure-time combinations for the generation of common bean microstructures with different starch susceptibilities to hydrolysis. Food Research International, Vol. 106, pp. 105–115.

3 Pallares Pallares, *et al.* (2018). Process-induced cell wall permeability modulates the *in vitro* starch digestion kinetics of common bean cotyledon cells. Food & Function, Vol. 9, pp. 6544–6554.

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Supplementation with *Lactobacillus kefiranofaciens* ZW3 from Tibetan Kefir improves depression-like behavior in stressed mice by modulating the gut microbiota

Yanping Wang, Ye Sun, Yufen Hu, Jianming Wang, Jinju Wang

Faculty of Food Engineering and Biotechnology, Tianjin University of Science and Technology, Tianjin, 300457, China

Abstract
Increasing evidence indicates that probiotics can effectively improve depression-like behavior. However, the underlying mechanism is still unclear. In this study, the antidepressant effect of *Lactobacillus kefiranofaciens* ZW3 isolated from Tibetan Kefir grains was investigated using a mouse model of chronic unpredictable mild stress (CUMS). ZW3 improved depression-like behavior and independent exploration ability in the CUMS group. Moreover, ZW3 regulated biochemical disorders in the hypothalamic–pituitary–adrenal axis, immune system and tryptophan metabolism caused by stress. Furthermore, ZW3 could modulate the composition of the gut microbiota, and alleviate constipation by improving the fecal water content in stressed mice. We found that the probiotic strain was present in the whole intestine, even 7 days after administration was stopped. These results suggest that *L. kefiranofaciens* ZW3 might improve depression by regulating gut microbiota as a probiotic food.

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Kinetic modelling on colour development during frying of Pulsed Electric Fields (PEF) pre-treated potatoes

Setya Budi Muhammad ABDUH[1,2,3], Sze Ying LEONG[1,3], Samantha BALDWIN[4], David BURRITT[5], Dominic AGYEI[1], Indrawati OEY[1,3]

[1]*Department of Food Science, University of Otago, Dunedin, New Zealand*
[2]*Department of Food Technology, Diponegoro University, Semarang, Indonesia*
[3]*Riddet Institute, Palmerston North, New Zealand*
[4]*Plant and Food Research, Christchurch, New Zealand*
[5]*Department of Botany, University of Otago, Dunedin, New Zealand*

Abstract

Pulsed electric fields (PEF) has been used in the potato industry as pre-treatment to soften the texture and facilitate sugar and protein release which could affect the frying kinetics and quality of potato chips. So far, detailed studies on the changes in frying kinetics of potato are limited. This study aims to describe the kinetics of colour development during frying of potato after being pre-treated by PEF.

Potatoes (*Solanum tuberosum* cv. Moonlight) were peeled prior to batch PEF-treatment (electric fields strength of 0.9 kV/cm and specific energy of 50 kJ/kg). Four independent replicates of both non-PEF and PEF-treated samples were carried out on different experimental days. Subsequently, potatoes were sliced (1.0±0.5 mm thickness), blanched (boiling water, 3 min), air-dried (10 min at room temperature), and fried (170, 180 and 190°C for 18 different time intervals, 0–18 min). The L^* values of chips were measured in triplicate using colorimeter. Fractional conversion model based on first order reaction was used to estimate the rate constant (k value). Activation energy values (Ea) were estimated using Arrhenius model.

The results showed that PEF did not change the reaction order of colour development (which was first order) during frying. For the PEF conditions tested, k values increased with elevating temperature. PEF increased the Ea value i.e. 27.96 kJ/mol compared to 16.20 kJ/mol for non-PEF potatoes.

This study showed evidence that PEF pre-treatment of Moonlight potato affects the estimated kinetic parameters during frying, and this knowledge can be exploited by the potato chips industry.

Synthesis and solubility measurement of 2,3-dichloro-1,4-naphthoquinone (dichlone) derivatives in supercritical carbon dioxide

Adolfo L. CABRERA[1], Flavia C. ZACCONI[2], J. Alejandro LOZADA[2], José M. DEL VALLE[3] and **Juan C. DE LA FUENTE**[1],*

[1]Laboratorio de Termodinámica de Procesos, Departamento de Ingeniería Química y Ambiental, Universidad Técnica Federico Santa María, Valparaíso, Chile
[2]Facultad de Química, Departamento de Química Orgánica, Pontificia Universidad Católica de Chile, Santiago, Chile
[3]Departamento de Ingeniería Química y Bioprocesos, Pontificia Universidad Católica de Chile, Santiago, Chile

Abstract
In the context of the recovery and purification of solvent-free bioactive phytochemical compounds from natural substrates or reaction mixtures, to be used in the food and pharmaceutical industries, this work proposes the use of supercritical (SC) carbon dioxide (CO_2), an inert atmospheric gas, as an alternative solvent to those commonly used in industrial processes, which are frequently harmful for the consumers. The physicochemical properties of SC-CO_2 make it attractive for the extraction of phytochemicals; particularly, its relatively low critical temperature (31.1 °C) avoids deterioration of thermolabile compounds; its ability to selectively solvate different compounds in a mixture with slight changes in pressure and temperature; and the easiness of its removal from the extract by depressurization [1]. 2,3-dichloro-1,4-naphthoquinone (dichlone) is a yellow crystalline solid at room temperature that has been used as fungicide for agriculture, as a foliage spray for the control of plant diseases, and to control algae growth for preserving water quality [2]. Consequently, dichlone and its synthetic derivatives can potentially be used as food additives. In this work, we have performed the organic synthesis, isolation and chemical characterization of two aromatic dichlone derivatives: 2-chloro-3-((4-fluorobenzyl)amino)-naphthalene-1,4-dione and 2-chloro-((4-fluorophenethyl)amino)naphthalene-1,4-dione. Additionally, we measured the thermodynamic solubility of each derivative in SC-CO_2 in the binary (solute + CO_2) two phase (solid + fluid) systems (verified visually), at temperatures of (313, 323 and 333) K and pressures in the range of (8 to 32) MPa. Results indicate a monotonous increase in solubility with temperature at constant density and with density at constant temperature.

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Energy requirements of equivalent HPP, PEF, ultrasound and thermal pasteurization processes

Filipa SILVA[1,2], Elham MILANI[3], Sanelle VAN WYK[1], EVELYN[4], Alifdalino SULAIMAN[5]

[1]*University of Auckland, Auckland, New Zealand*
[2]*Universidade de Lisboa, Lisbon, Portugal*
[3]*Chemistry and Chemical Engineering Research Center of Iran, Tehran, Iran*
[4]*University of Riau, Pekanbaru, Indonesia*
[5]*Universiti Putra Malaysia, Serdang, Malaysia*

Abstract

In this study equivalent pasteurization processes for different foods and beverages were compared in terms of energy requirements. The pasteurization intensity of the processes was assessed in terms of microbial/enzyme inactivation (log reduction, enzyme residual activity-RA) from kinetic data of several experiments carried out at laboratory scale in the University of Auckland. A methodology for estimating energy of high pressure processing (HPP), pulsed electric fields (PEF) and power ultrasound treatments alone or combined with heat was developed.

The following beverage/food pasteurizations using key specific microbes were considered for the energy comparison study: 15 PU (pasteurization units) process based on *Saccharomyces cerevisiae* yeast ascospores inactivation in 4% alc/vol beer; 6D (decimal reductions) on *Brettanomyces bruxellensis* yeast in red wine; 6D in *Byssochlamys nivea* mould ascospores in strawberry puree; 6D for *Bacillus cereus* bacterium in milk and beef slurry; 3D (decimal reductions) in *Alicyclobacillus acidoterrestris* bacterium spores in orange juice. Spoilage and resistant enzymes were also targeted in pasteurization studies, namely the endogenous polyphenoloxidase (PPO) browning enzymes in strawberry, apple and pear products.

Some of the processes were not effective to pasteurize certain foods, for example HPP at 600 MPa-70°C was not good for *B. cereus* and *B. nivea* spore and pear PPO inactivation. Beer pasteurization by HPP at room temperature required much less energy than heat assisted PEF, thermosonication (TS) and thermal treatments. A reduction to <18% RA in the PPO of apple juice required 200-300 kJ/L for PEF-thermal and thermal, while TS required much more energy (930 kJ/L).

Development of a marking methodology for X-Ray µCT to describe the microstructure of cereal products.

Sylvie CHEVALLIER[1], Vanessa JURY[1]

[1] *GEPEA, ONIRIS, Rue de la Géraudière, CS 82225, 44322 NANTES CEDEX 3, France*

Abstract

The organoleptic properties (texture, flavor, color) play a very important role in the acceptance of food products by the consumer. These properties depend on the ingredients but also on the structure of the food at the different scales (molecular, micro- and macroscopic scales). The manufacturing process and the formulation of the products control the structuration of cereal products. Optimizing structuring phenomena involves mastering and developing methodologies for analyzing the internal structure of products.

X-ray micro-tomography has become a popular tool in the study of materials structure since it is non destructive and provides understanding of the physical structure of the product from an engineering perspective.

The objectives of the study are to describe the internal microstructure of cereal products by X-ray micro-tomography, and to develop a complete marking methodology applied to cereal products.

Several markers were integrated to mark proteins, lipids and starch. Final structures were characterized by X-ray micro-tomography using the Skyscan 1174 (Skyscan, Kontich, Belgium).

In a first step, each component was studied separately to analyze performance of each marker. Once the optimal marking method was found, binary mixing was performed, each component was retrieved and quantified on the reconstructed images based on the grey-levels histograms of the scans.

This methodology seems promising to evaluate component distributions in 3D in food products.

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MicroRNA-497-5p regulates acrylamide-induced neurotoxicity in the rat primary astrocytes through apoptosis and autophagy pathways

Liuqing YANG[1,2,3]**,** Li DONG[1,2,3], Lujia ZHANG[1,2,3], Fang CHEN[1,2,3]*

1. College of Food Science and Nutritional Engineering, China Agricultural University, Beijing, China.
2. National Engineering Research Center for Fruit and Vegetable Processing, Beijing, China.
3. Key Laboratory of Fruits and Vegetables Processing, Ministry of Agriculture Beijing, China.

Abstract
Acrylamide (AA) is a well-known neurotoxin derived from food processing at high temperature. MicroRNAs (miRNAs) are short non-coding RNAs that regulate the expression of target mRNAs involved in a wide range of biological processes including inflammation, apoptosis and autophagy. The aim of this study is to investigate the role of miRNAs in acrylamide neurotoxicity. We discovered that AA exposure at 35 mg/kg/bw/d for 18 days down-regulated eight miRNAs (miR-1298, -497-5p, -497-3p, -206-3p, -1912, -488, -34b, -195-5p) in the brains of Sprague-Dawley rats. Further studies showed that miR-497-5p could directly target the 3'-untranslated region of TP53INP2 mRNA, the majority of which is involved in p53 signaling pathways. We then chose the rat primary astrocytes to further evaluate the role of miR-497-5p in AA-induced neurotoxicity. In treated cells with 2 mM AA for 48 h, miR-497-5p expression decreased and TP53INP2 mRNA increased. Moreover, our data indicated that miR-497-5p mediated AA neurotoxicity through inducing apoptosis and autophagy pathways which were upregulated after the treatment of AA, which could been suppressed by over-expressed miR-497-5p. Our study provided a possible novel indicator of AA neurotoxicity and further insights into functions of miRNAs in demonstrating the toxicity mechanisms of food-borne hazardous compounds.

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The effect of marinade composition on the water holding capacity of meat analogues

Steven CORNET[1,2], Ruud van der SMAN[1,2], Atze Jan van der GOOT[2]

[1] Wageningen University and Research, Food and Biobased Research, Wageningen, The Netherlands

[2] Wageningen University and Research, Department of Food Process Engineering, Wageningen, The Netherlands

Abstract

Marinating is a common way of introducing flavours and water into meat products, and is frequently applied to plant-based meat analogues. Meat analogues currently lack important sensory attributes such as juiciness, which impedes their widespread adoption. Juiciness of meat is often associated with the water holding capacity (WHC). WHC of cross-linked polymer networks (such as meat analogues) can be described with Flory-Rehner theory, which relates the WHC to the swelling pressure (van der Sman, 2015) The swelling pressure depends on polymer-water interactions, charge distribution, and cross-link density. We have explored the possibility of improving the juiciness of meat analogues through marination. Our approach was based on Flory-Rehner theory.

By varying both the pH and ionic strength of the used marinade we induced changes in the distribution of charges between meat analogue and water. Via the addition of cross-linking and reducing agents we disrupted or formed cross-links. These methods have a significant effect on the WHC, affecting the maximum water uptake, as well as the pressure dependence of the WHC. We have formulated a model based on the extension of the Flory-Rehner theory by English et al. (1996) to analyse our experimental observations. A better understanding of the decisive parameters affecting juiciness are vital for the development of the next generation meat analogues.

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Influence of thermomechanical treatment on the reaction behavior and functionality of highly concentrated whey proteins

Maria QUEVEDO, Heike P. KARBSTEIN, M. Azad EMIN

Institute of Process Engineering in Life Sciences, Chair of Food Process Engineering, *Karlsruhe Institute of Technology, Karlsruhe*

Abstract

Proteins are nutritional, technological, and functional ingredients, which properties strongly depend on their native structure. Among others, thermomechanical treatment can be used to modify the structure and functionality of proteins. In recent years, extrusion processing has been applied to produce protein-based products such as meat and dairy analogues as well as protein-based emulsifiers and thickeners with specific functionalities.

During extrusion processing, highly concentrated proteins are simultaneously subjected to thermal and mechanical stresses through the heated barrel and the rotating screws, which leads to protein denaturation. By this, reactive sites become available and new protein-protein interactions are formed, leading to protein aggregation. The properties of aggregates (e.g. size, form and intermolecular interactions) play a crucial role on the performance of the resulting products. The final product characteristics can only be controlled if the reaction behavior and kinetics are known. This is well investigated for dilute protein solutions especially under thermal stress. Results for highly concentrated protein solutions under thermomechanical treatment are missing.

In this contribution, we will present the results of a kinetic study on heat- and shear-induced structural changes of highly concentrated whey proteins. The results show that the reaction kinetics in highly concentrated systems significantly differ from the kinetics of diluted systems. Furthermore, besides temperature, shear rate has a pronounced effect on the kinetics of denaturation and aggregation, and by this, on the functional properties such as emulsifying properties of treated proteins. These results will be presented in detail and their implications for the extrusion processing will be discussed.

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Modular sensor system for real-time monitoring of gas composition and respiration rate for controlled and modified atmosphere application

Nandita KESHRI[1,2], Ingo TRUPPEL[1], Werner B. HERPPICH[1], Martin GEYER[1], Cornelia WELTZIEN[1,2], Pramod MAHAJAN[1]

[1]*Leibniz Institute for Agricultural Engineering and Bioeconomy, Potsdam, Germany*
[2]*Technical University of Berlin, Germany*

Abstract

Monitoring and maintenance of optimal O_2 and CO_2 composition inside packaging and storage system of fresh produce is the key to extending their shelf life. Also, it is very important to continuously monitor the gas composition of fresh produce at all levels of supply chain. Gas composition and therefore, respiration rates are mostly measured by gas chromatography or headspace gas analysers. Both these methods are manual and work with discrete data accusation. Given the weakness, a compact and modular sensor system for real-time gas monitoring and respiration measurement called sphere or RMS88 was developed. The sphere (diameter: 76 mm, mass: 191 g) consists of O_2, two CO_2, temperature and relative humidity sensors for continuous, non-invasive and real-time monitoring of respiration rate. A 256 kByte F-RAM attached inside is used to store raw measurement data and a transceiver is provided for wireless data transfer and communication with a PC. As soon as the sphere is activated, it starts measuring, recording and transferring wirelessly O_2, CO_2, temperature and RH data. With the help of a LabVIEW based terminal program, gas concentrations as well as respiration rates and respiratory quotient is viewed in form of real-time graphs on the PC screen. With a battery inside, the sphere can measure for up to 100 d with 5 min measuring interval. Such wireless and portable system was shown to be a useful tool to measure and monitor gas composition, respiration rate and respiratory quotient of fresh produce in real-time. Due to its compact and mobile design, the sphere offers great potential to be incorporated in any storage and packaging applications across the supply chain.

Keywords: respiration rate, real-time, compact, fresh produce O_2 and CO_2 sensor.

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Sustainable performance of nitrites reduction scenarios in ham production.

Vanessa JURY[1], Gaëlle PETIT[1], Marie DE LAMBALLERIE[1]

[1] *GEPEA, ONIRIS, Rue de la Géraudière, CS 82225, 44322 NANTES CEDEX 3, France*

Abstract

Nitrosamines are toxic molecules largely encountered in meat products. Their precursors, nitrites, are used for their technological and preservation role. In addition, meat products are partly responsible of the 20 to 30% of food in the environmental impact of total household consumption in the European Union. As frequently consumed, they need to be assessed to evaluate their potential impact both on the environment and human health.

Life cycle assessment (LCA) is a holistic and systemic methodology, largely used for quantifying the contribution of each step of the product/service life cycle to impacts categories such as climate change, resource depletion, human and ecotoxicity.

The objectives of this study are to evaluate the potential environmental impact of conventional ham production and to compare with innovative processes in order to reduce the amount of nitrites embedded in ham. This study includes high pressure processing, biopreservation and a combination of both. New indicators are used as complement to conventional LCA indicators in order to take into account the product quality and to characterize the performance of new scenarios both on human health and environmental sustainability.

This research helps better taking into account food sustainability in identifying the most performant technological pathways for ham production-distribution: combination of high pressure and biopreservation seems to be promising.

Performance evaluation of mare milk concentration by single- and multi- pass forward osmosis

Lukas GOSMANN1**,** Josef ROBERT1, Görge DEERBERG1

1*Fraunhofer UMSICHT, Oberhausen, Germany*

Abstract
Healthy nutrition is worldwide gaining more and more interest. Due to the potential of mare milk as milk substitute for infants, it can be considered as high-end liquid food. Special milk production like mare milk production is typically a small-scale, decentralized process.
The current study investigates the concentration process of mare milk by single-pass and by multi-pass forward osmosis (FO). The aim of the study is to develop a process for the concentration of special milk products requiring gentle concentration technologies in small-scale processes to save transportation, cooling and sublimation costs. Especially for small amounts of feed substances, FO processes represent an economic alternative to high pressure or thermal concentration, due to their low investment costs. In contrast to pressure or temperature driven operations, in FO processes short process duration, low pressures, low temperatures and low velocities assure high quality products.
In this study, a FO evaluation of permeate flux and reverse salt flux under varied process conditions was performed. During the experimental work, mare milk was concentrated in a single-pass and multi-pass FO process. NaCl, NaHCO3 and MgCl2 were used as drawsolutes. A three times concentration of mare milk has been achieved, using NaCl as drawsolute. Temperature had a massive effect on the process performance. Rising temperatures lead to low viscosities, even at high dry matter contents. Thus, higher permeate fluxes and short process times were reached.

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Effect of coarse and superfine-ground wheat bran fortification on dough properties and quality of dried Chinese noodle (DCN)

Xiaoxuan JIN[1,3], Suyun LIN[1,3], Jing GAO[1,3], Yong WANG[2], Zhizhong DONG[2], Jian YING[2], Weibiao ZHOU [1,3]

[1] *Food Science and Technology Programme, National University of Singapore, Singapore, Singapore.*
[2] *COFCO Nutrition & Health Research Institute, Beijing, China.*
[3] *National University of Singapore (Suzhou) Research Institute, Jiangsu, China.*

Abstract
Wheat bran is widely used in the food industry to produce fiber-rich food products. This research examined how wheat bran fortification influenced dough and DCN properties, as well as the applicability of superfine grinding technique in producing bran fortified DCN of high quality. Coarse (D_{50}=358.67 μm) and superfine-ground (D_{50}=11.43 μm and 23.33 μm) wheat brans were introduced into the DCN formula to replace up to 30% of refined wheat flour. Dough rheology tests and noodle quality (cooking and sensory) tests were performed. Results suggested that both bran addition level and particle size distribution were crucial factors. Dough water absorption capacity increased while dough strength decreased with an increasing fortification level. The superfine grinding technique effectively reduced bran particle size, and the dough fortified with the finest bran (D_{50}=11.43μm) showed a relatively higher stability and extensibility. Meanwhile, the resultant DCN possessed a darker color and a higher cooking loss. Consumer study results showed that DCN fortified with 10% finest bran had comparable sensory quality and overall acceptability as the control noodle (which contained no bran). However, when DCN was fortified with coarse bran, especially at higher addition levels, its appearance and texture were remarkably affected negatively. The present study suggested that the superfine grinding technique does not necessarily improve all aspects in noodle processing and its cooking quality, but can exert an overall improvement on the sensory quality of bran-fortified noodle. In addition, it is possible to produce bran fortified DCN of acceptable quality at relatively higher (10-20%) bran addition levels.

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Impact of whole-wheat flour particle size on bread structure and *in vitro* digestion

Suyun LIN[1,2], Xiaoxuan JIN[1,2], Jing GAO[1,2], Yong WANG[3,4], Zhizhong DONG[3], Jian YING[3], Weibiao ZHOU[1,2,]*

[1]*National University of Singapore, Singapore*
[2]*National University of Singapore (Suzhou) Research Institute, Jiangsu, China*
[3]*COFCO Nutrition & Health Research Institute, Beijing, China*
[4]*Beijing Advanced Innovation Center for Food Nutrition and Human Health, Beijing, China.*

Abstract
Consumption of bakery products made from whole-wheat flour (WWF), often referred as whole-wheat products, is commonly encouraged due to their important nutritional attributes that significantly benefit human health. However, the consumption is severely limited because of their poor end-product quality. Varying flour particle size could be one of the effective ways to structure whole-wheat bread with desired texture. This study investigated the effect of WWFs' particle size on dough development, bread structure, quality attributes and in vitro digestibility. Coarse, medium and fine WWFs with mean particle sizes of 1315, 450 and 199 μm, respectively, were used to produce baked bread by the same bread-making procedure. Results showed that dough and bread made from WWFs of larger particle size had lower dough extensibility, more compact structure and harder texture. These together significantly affected bread digestibility. Bread made from the coarse and medium WWFs showed a higher glucose release rate (k) and a lower predicted final concentration of released glucose (C_∞) as compared to those made from the fine WWF and control white flour. Results of this study demonstrated that the particle size of WWF is an important factor in determining bread structure and consequently its texture and digestibility.

Key words: particle size; whole-wheat; dough property; bread structure; *in vitro* digestion;

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Characterisation of Hazelnut-Cocoa Spreads for Rheological and Tribological properties

Laura PRINCIPATO[1], Guillermo DUSERM GARRIDO[1], Roberta DORDONI[1], Giorgia SPIGNO[1]*****

[1]*DiSTAS – Department for Sustainable Food Process, Università Cattolica del Sacro Cuore, Piacenza (Italy)*

Abstract text (Arial, 10pt font, single spaced, left aligned)

Abstract
The principal aim of this work was to investigate the rheological properties of semi-solid systems as hazelnut-cocoa based spreads. Five commercial cocoa spreads with different hazelnut/fat compositions were selected and rheological and tribological tests were assessed. Bulk and lubrication properties were estimated to investigate the occurring of microstructural changes from handling and storage step to oral consumption, respectively.
Both rheological and tribological tests were carried out with a laboratory rheometer (Anton Paar MCR 302). Flow curves parameters (flow and consistency indices) were obtained at different temperatures using various geometries. Oscillatory mode tests were carried out to determine linear viscoelastic region (LVR) , storage and loss modulus (G' and G'') complex viscosity (η),and tan(δ). Three-run flow cycle was conducted to estimate the variation of thixotropic properties with temperature. Finally, friction factor was evaluated by tribological Stribeck curve.
Rheological analysis highlighted a pseudo-plastic behaviour in all spreads with the elastic component prevalent on the viscous one (G'>G''). Rotational analysis showed the strictly dependency of flow curve on temperature in all cases. Moreover, geometry changing determined only flow index (n) value modification. A stronger dependency of consistency index (K) on temperature may be related to higher thermal sensitivity of microstructural change. Spread with grater K variation demonstrated a higher tendency of G' and G'' curves to cross-over at higher temperature. In addition, a greater decrease of friction factor and more significant Stribeck curve shape modification highlight thermal structural changes.

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Computational fluid dynamics in thermal processing

Stylianos CHATZIDAKIS[1], **Nikolaos G. STOFOROS[1]**

[1]*Department of Food Science and Human Nutrition, Agricultural University of Athens, Greece*

Abstract
Computer simulation is proven to be an alternative to experimentation for gaining a quantitative and qualitative understanding of food process operations. Computational Fluid Dynamics (CFD) is a tool that can be used for modeling and optimization of food engineering operations. Applications of CFD in food processing include baking, drying, thermal processing, refrigeration etc[1].
The objective of this work is to present a number of CFD applications used for thermal process design. Product temperature histories, integrated process *F* values, and quality retention calculations, as a function of different process parameters, during hot fill processes of tomato products are presented**.** The determination of quality equivalent points for volume average quality evaluation in conduction heating canned foods through CFD is compared to traditional numerical approaches[2]. Comparisons of CFD data with empirical equations for plate heat exchanger analysis are also included. Finally, the residence time distribution in a holing tube during aseptic processing of liquid/particulate food products is investigated through CFD simulations.

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A novel mechanistic understanding for the stabilization of emulsions and foams by native or aggregated whey proteins

Franziska KURZ[1], Ulrich KULOZIK[1]

[1]*Technical University of Munich, Freising, Germany*

Abstract

It is widely accepted that biogenic particles as emulsion and foam stabilizers behave differently from inorganic Pickering particles [1]. Nonetheless, inorganic and biogenic particles share the commonality of a high desorption energy, which in turn, is responsible of the high stability of particle-stabilized systems. Apart from that, however, there is still a multitude of open questions regarding the stabilization of interfaces by biogenic particles.

Therefore, the objective of this work was to establish a comprehensive knowledge platform on the interfacial behavior of structurally well characterized biogenic particles in comparison to synthetic particles. Using whey proteins as model, thermal treatment (80 °C/90 min) under variation of milieu conditions (i.e., pH, ionic strength) allowed for the production of a wide spectrum of particles in terms of size, structure and surface properties. Performed analyses comprised solution properties (e.g., degree of denaturation, particle size, stabilizing bonds, surface charge), interfacial characteristics as well as emulsifying and foaming behavior (e.g. bubble/ oil droplet size distribution).

Summing up the results, ability to promptly adsorb at the interface seems to be the key factor. Favorable particle characteristics with regard to the stabilization of both, emulsions and foams, are a rather small size, low surface charge and a high number of covalent bonds. Adverse impacts can be compensated by factors like a decrease of degree of denaturation.

[1] Schmidt et al. (2011), Langmuir, 27, 9801-9806.

Gas transfer modelling in foods with a heterogeneous porous microstructure

Siem JANSSEN[1], Agnese PIOVESAN[1], Bayu NUGRAHA[1], Pieter VERBOVEN[1], Bart NICOLAI[1,2]

[1] *KU Leuven - University of Leuven, 3001 Leuven, Belgium*
[2] *Flanders Centre of Postharvest Technology, 3001 Leuven, Belgium*

Abstract
Gas exchange between a fruit and its environment is of a crucial importance for metabolic processes such as respiration, where sugars and other reducing metabolites are oxidized by molecular oxygen to water and carbon dioxide. As a result, gas concentration gradients develop in bulky organs such as fruit, in which the internal structure imposes a limitation on gas transport. It has been shown that gas transport is directly related to the microstructure of the fruit, more specifically to the network of cells and pores.
Modelling gas exchange in fruit such as apple gives a better understanding regarding the relation between diffusion in the tissue and the microstructure of the fruit. The latter has been shown to be a highly heterogeneous concept considering the different tissue structures inside apples. To cope with the heterogeneity in a computationally efficient way, a network modelling approach can be used. This approach simplifies the microstructure to a 3-D network of nodes where each node represents an individual cell or pore. Nodes are connected to each other by tubes that represent the transport channels for gasses.
Here, X-ray micro-CT was used to reconstruct the microstructural networks of pores and cells in apple tissue for performing pore-cell network simulations. Simulated results were verified with measurements in a dedicated gas diffusion setup which allowed the measurement of the relevant gas concentrations across the sample. Also, the diffusivity calculated from the network was compared to measured diffusivity values for tissue samples.

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A framework for multi-objective optimization of small-scale food processes

Martial MADOUMIER[1], Arnaud CHAPUIS[1,2], Antoine COLLIGNAN[1], Gilles TRYSTRAM[3], Michel RIVIER[1,2]

[1]*Qualisud, Univ. de Montpellier, Montpellier SupAgro, CIRAD, Univ. d'Avignon, Univ. de la Réunion, Montpellier, France*
[2]*CIRAD, UMR Qualisud, F-34398 Montpellier, France*
[3]*Université Paris-Saclay, Agroparistech, Inra, UMR 1145, Paris, France*

Abstract

Food process design is a challenging task, as several potentially conflicting objectives are targeted (product quality, cost reduction, environmental impact reduction...) under a number of constraints (e.g safety). Multi-objective optimization (MOO) is a powerful tool to solve this kind of problem but is still only partially used within design methods for food processes. By contrast, in other sectors such as mechanical engineering, Multi-criteria Decision Making (MCDM) methods are at the core of design optimization procedures.

To help design food processes in a more holistic way, we propose a framework to develop MOO methods, consisting of five "building blocks":

i. a predictive process model;
ii. performance indicators;
iii. decision-maker and/or expert preferences;
iv. a selection method to select one or several "best" trade-offs;
v. an optimization algorithm to find the best design solutions among the feasible ones.

This framework was used to solve a number of design problems at the QualiSud Joint Research Unit, including a fish hot-smoking process, a cassava starch dryer, and a supply of bioenergy for a cereal based dryer. The authors used these examples to illustrate the design framework and highlight the interest and the potential of coupling design theory principles to MOO and MCDM methods.

The results first demonstrate the ability to find satisfying solutions despite multiple constraints and conflicting objectives. They also show the opportunity to provide guidelines for equipment design among numerous possible solutions. They finally show that decision-maker preferences and expert knowledge can be integrated in the design procedure thanks to MCDM methods.

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Development of encapsulated air microparticles: Particle formation during sessile single droplet drying of mixed maltodextrin and gum Arabic solutions

Tengku Farizan Izzi CHE KU JUSOH[1], David FAIRHURST[2], Serafim BAKALIS[3], Joanne GOULD[1], Bettina WOLF[4]

[1]*University of Nottingham, Loughborough, United Kingdom*
[2]*Nottingham Trent University, Nottingham, United Kingdom*
[3]*University of Nottingham, Nottingham, United Kingdom*
[4]*University of Birmingham, Birmingham, United Kingdom*

Abstract
This research is concerned with the development of encapsulated air microparticles to be applied as the dispersed gas phase in foam-based processed foods, removing conventional whipping processes and offering new avenues for product innovation. To be successful, a thorough understanding of the microstructure development during the particle formation process is required. Spray-drying as a well-established encapsulation technology was selected to process these particles from maltodextrin (MD) and gum Arabic (GA), often combined for spray drying. MD is a hydrophilic biopolymer. GA is amphiphilic and therefore frequently added to control surface tension as a parameter affecting droplet formation. In the final particle, it is found preferentially at the surface of the dried particle. For application as dispersible food ingredient, partial surface hydrophobicity is desired to control the particle wetting so the air does not escape and the particles collapse before they have been kinetically trapped in the food matrix.

Having validated the process and materials to produce encapsulated air particles, the drying of sessile single droplets containing different ratios of MD:GA (30% w/v total solids) in an environmental chamber between 80-120°C was video recorded and nano-CT imaged to understand microstructure development. Initially, droplets just shrank, not influenced by composition. An earlier locking point (onset of skin formation) was observed at higher temperature or amount of GA. During the subsequent falling rate period, particles experienced inflation/deflation cycles due to bubble nucleation. The time between locking point and bubble formation critically affected the formation of particles with a smooth surface and one vacuole.

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Defatting of Assaí waste using supercritical CO_2: determination of kinetic behavior and mathematical modeling

Adina L. Santana[1], Renato Souza[2], Nelio T. Machado[2], Marilena E. Araujo[2], **M. Angela A. MEIRELES[1]**

[1]LASEFI/DEA/FEA (School of Food Engineering), UNICAMP (University of Campinas), Campinas, Brazil
[2]Faculty of Chemical Engineering, UFPA (Federal University of Pará), Belém, Brazil

Abstract
Literature information about processing of defatted assaí waste (DAW) obtained from previous cold-pressing for industry applications is scarce. In this work, supercritical fluid extraction (SFE) was applied to DAW to process this material into natural added-value products.
The kinetic parameters were obtained by fitting the overall extraction curves (OECs) using three mass transfer models and an algorithm implemented in MS Excel. The temperatures of 40 ^{o}C and 50 ^{o}C and pressures of 200, 250 and 300 bar were used. Solvent flow was13.33 gmin^{-1} and extraction length was 200 minutes.
The adjustable parameters used to analyze the extraction behavior were desorption constant, K_d, expressed in min^{-1} (Tan and Liou model), the dimensionless global coefficient of mass transfer, φ, and desorption constant, K (Goto *et al.* model). the time span periods for the constant and falling extraction rates, i.e., t_{CER} (min) and t_{FER} (min) and the extraction rate for the constant extraction period, b_1, expressed in g.min^{-1} (three straight-line spline).
The SFE process applied to DAW resulted on extract yields varying between 5.5–7.6 wt.%. In the studied kinetics, the CER and FER steps evidenced by their respective time-span periods, varied approximately between 25–50 min and 50–100 min, the K_d=0.01-0.03 min^{-1}, φ=0.09-0.36 and K=0.18-0.5. The best fitting was attributed to the spline model. The SFE was able to process DAW for the obtaining of extracts composed of antioxidant substances.

Development of honey powder produced by spray drying

Taíse TONIAZZO1, Carmen C. TADINI1. *1Department of Chemical Engineering, Escola Politécnica, Main Campus, FoRC/NAPAN- Food Research Center, University of São Paulo, 05508-010, São Paulo, SP, Brazil*

Honey is a special product widely appreciated due to its peculiarity as flavor, aroma as well as its beneficial effects on health. However, the use of honey in its natural form can present several disadvantages due to its high viscosity and density. Also, honey can crystallize in a long period of storage, which can lead to the fermentation and spoilage. Spray drying is highly used in the food industry and can be a very interesting method to dry honey. Additionally, it can provide powder with good quality and low water content, facilitating its transportation and storage. The objective of this study was to develop honey powder by spray drying and evaluate the effects in the physical properties. Preliminary tests were performed by spray dryer with a 0.7 mm diameter nozzle. Drying air flow rate at 35 m3/h, nitrogen air pressure at 0.6 MPa, inlet temperature at 180 °C and feed flow rate at 10 mL/min were used. Also, starch modified was utilized as carrier agent at 1:2 (honey:carrier agent) ratio. Natural honey showed water content of 17 ± 0.1% g/100 g, and total solid mass concentration of 82 ± 0.1% d.b. Preliminary tests showed it was possible to dry honey mixed with carrier agent. Powder showed water content at 2 ± 0.5%, and a capacity to be wetted at 2 ± 0.1 s. Thus, honey powder can be an interesting food product produced by spray drying, enhancing the utilization of honey as a food ingredient.

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Influence of spatial dependency on filtration performance of spiral-wound membranes

Martin HARTINGER[1], Ulrich KULOZIK[1]

[1]*Technical University of Munich, Freising, Germany*

Abstract

The fractionation of complex media such as skim milk is an emerging field in food technology. To date, ceramic membranes are often used for this purpose. In pressure driven crossflow filtration, the axial pressure drop along the flow path induces wall shear stress to limit the intensity of deposit formation of retained proteins. Contemporaneously, a spatial dependency of flux and protein transmission result from that pressure drop. Membranes with a gradient in membrane resistance can help to reduce spatial effects and to significantly increase filtration performance.

As an alternative to ceramic membranes, spiral-wound membranes (SWM) with a more complicated architecture and spacer nets are also used for protein fractionation. However, an understanding of spatial effects does not exist for SWM yet.

Therefore, a SWM prototype was developed allowing to assess flux and protein transmission as a function of the axial position in the module.

The axial pressure drop in SWM is linear and induces a length dependent decrease in transmembrane pressure (TMP). Therefore, flux decreases, whereas protein transmission increases along the flow path. Furthermore, the axial distribution of the deposit layer formed by retained proteins could be detected by using a special staining technique and image analysis: It could be shown that the intensity of deposit layer formation decreases along the flow path. The results also prove that filtration performance in SWM depends on the TMP´s spatial distribution. These findings help to develop new SWM concepts with a filtration performance independent of the axial position analogous to ceramic gradient membranes.

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Thermal Characteristics of Date-Pits as Affected by Heating Rate of Differential Scanning Calorimetry

Mohammad Shafiur RAHMAN[1], Nasser AL-HABSI[1], Kutiala AL-FARSI[1]

[1] *Sultan Qaboos University, Muscat, Oman*

Abstract

In many instances, complex foods and biomaterials showed multiple exothermic and endothermic peaks as well as multiple shifts in the Differential Scanning Calorimetry (DSC) thermogram. Date-pits is considered very complex biomaterial and it is used a model system to explore the effects of heating rate on the multiple shifts and multiple endothermic peaks. DSC thermogram of date-pits showed two to four shifts (depending on the heating rate) and two endothermic peaks. The first endothermic peak was due to the melting of oil, and second endothermic peak was due to the solids-melting. A shift in the thermogram is usually considered glass transition, which is plasticized by water. The effect of heating rate was used to determine the characteristic types of the melting process and the characteristics of the shifts were explored to determine whether all these shifts were glass-rubber transition and whether these were plasticized by water. In addition, characteristic temperatures (i.e. onset glass transitions and melting peaks), enthalpies at melting and specific heat changes at the shifts were modeled based on thermodynamic equations. This study showed that the structural characteristics of complex biomaterials could be further explored when thermograms are developed as a function of heating rate.

Supercritical fluid extraction of volatile oil from Sucupira (*Pterodon emarginatus*) seeds

Larry Oscar CHAÑI PAUCAR[2], Júlio Cezar JOHNER Flores[1], Maria Angela A. Meireles
[1]*LASEFI/DEA/FEA (School of Food Engineering), UNICAMP (University of Campinas), Campinas, Brazil*
[2]Amazon National University *of* Madre de Dios*, Madre de Dios, Perú*

Abstract
The present work consists of an extraction process to produce Sucupira (*Pterodon emarginatus*) volatile oil. The volatile oil derived from Sucupira seed is a potent anti-inflammatory with various bioactive compounds including humulene and caryophyllene structures. The bioactive properties of native Brazilian seed extracts are the great interest to the food and pharmaceutical industries to be used as functional foods and cosmetics. The milled raw material was tested under different extraction conditions with supercritical carbon dioxide (Pressure 200-400 bar, Temperature 313 and 333 K). The extracts from the process conditions with higher and lower yield were analyzed by Gas Chromatography Mass Spectrometry (GCMS). The obtained product presented a pleasant aroma, the process obtained yield of 15% in the extraction condition of 300 bar and 313 K; at 200 bar and 313 K the yield was 11.4%; in both conditions the solvent to feed ratios, S/F, was 12. The GCMS analyze indicated the presence of 11 different compounds in the extract obtained at 300 bar and 313 K, including humulene and caryophyllene. The yield obtained and the results of the analysis indicate that the extraction with supercritical fluid can be applied to obtain Sucupira extracts of high quality.

Development of controlled delivery functional systems by microencapsulation of plants extracts with health benefits and food technological interest

Berta ESTEVINHO[1], Fernando ROCHA[1]

[1]*LEPABE, Departamento de Engenharia Química, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal*

Abstract
Different plants (*Sambucus nigra L.*, *Laurus nobilis L.*, *Syzygium aromaticum*, Turmeric (*Curcuma longa*), *Salvia officinalis L.*, and *Hypericum perforatum*) mainly with Euro-Asian representation and some of them worldwide widespread were selected considering their health potential. These plants were used in the traditional medicine for different civilizations and during centuries. Compounds extracted from these plants, mainly polyphenols, can provide extra health benefits, preventing chronic diseases, delaying the aging process, increasing life expectancy, or supporting the structure or function of the human body.

However, in general, these compounds are very sensitive and with low bioavailability in human body. Microencapsulation is a promising alternative to improve their stability and bioavailability, to protect and to improve sensitive compounds with a controlled release, enabling their incorporation in active food products, nutraceuticals and in therapeutic formulations.

The microparticles were prepared by a spray drying process using different biopolymers. They were fully characterized (e.g. size, morphology and stability) and evaluated in terms of controlled release. Proper mathematical models were applied to the release profiles obtained in simulated conditions.

Microparticles (average size around 5 µm) with rough or smooth surface and with fast or slow release were obtained depending of the encapsulating agent used. Korsmeyer-Peppas and Weibull models are the models that best adjust to the experimental release profiles.

This study proves that is possible to produce microparticles with good quality and stability. These microparticles can be easily incorporated in commercial instantaneous powder food products like gelatin or even cookies that can be fortified with bioactive compounds.

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Technology Advantages and Challenges of Plasma Activated Liquids in a Circular Bio-Economy

Kevin M. KEENER[1]

[1]*Iowa State University, Ames, IA, USA*

Abstract
In a circular bio-economy, outputs or products from one manufacturing operation become inputs in sequential operations at the end of their useful life. Atmospheric cold plasma and plasma activated liquids (PALs) can play an integral part of a circular bio-economy because the plasma generation processes are derived from natural processes and produce products that have a prescribed lifetime after which the products breakdown into natural products (air and water) allowing reuse. Atmospheric cold plasma can provide a rich source of reactive gas (RG) - radicals, excited neutrals, ions, free electrons, and UV light - that can be efficiently used for sterilization and decontamination. A limitation of cold plasma RG is the limited half-life of many species and their minimal contact with microorganisms on food contact surfaces. As an alternative, capturing the plasma benefits through the generation of PALs is an emerging area of study. A number of recent publications on PAL's have reported on many potential applications focusing on antimicrobial and agronomic properties in areas such as food, medicinal, and agricultural production. PALs chemistry can be tailored by adjusting the plasma generation characteristics of electricity, water and gas composition. The wide range of reactive gas chemistries used to generate PALs leads to questions on their safety, their active life, and their environmental impact. Additionally, the associated regulatory approval process requires significant data demonstrating the efficacy under the range of normal operating conditions for the specific applications along with PAL generation system reliability, process control monitoring, scalability, and worker safety protections.

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Commercialization of Continuous Flow Microwave Processing of Foods

K.P. SANDEEP[1], Josip SIMUNOVIC[1]

[1]*North Carolina State University, Raleigh, NC, USA*

Abstract

Consumer demand for better quality foods has led to the exploration of new technologies to process foods that results in minimal over-processing. Volumetric heating technologies such as the use of microwaves, radio frequency waves, and ohmic heating fall under that category. For the past 20 years, our research group has focused on developing a systematic approach of developing the protocols for continuous flow microwave processing of hard-to-heat foods (viscous and particulate foods).The first step involves determination of the physical, rheological, thermal, and dielectric properties of the liquid and solid portions of the food product. Next, mathematical modeling is conducted to determine the design of a small scale system to conduct preliminary studies. Based on the results from the small-scale studies, scale-up of the system is performed to design a large-scale system to process the food product. During this process, several important aspects were learnt. These include the appropriate design of the product tube (material design to withstand both high temperature and pressure, and yet be transparent to microwaves) and the development of a sterilization solution to sterilize the system prior to processing (instead of using the conventional setup of water, we had to develop a sterilization solution to match the dielectric properties of the food being processed to ensure a smooth transition from sterilization solution to product, in terms of temperature). This technology has successfully been tested for various categories of foods and has been commercialized for processing both viscous and particulate foods.

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Towards 3D printing of artificial plant tissue for innovative food manufacturing

Valérie VANCAUWENBERGHE[1], Pieter VERBOVEN[1], Bart NICOLAI[1]

[1]*BIOSYST-MeBioS, KU Leuven – University of Leuven, Leuven, Belgium*

Abstract
3D food printing (3DFP) is an emerging technology that offers the potential to create new food products. The diversity of texture properties of food objects that can be produced by 3DFP remains limited so far, and 3DFP is almost exclusively used today for producing ordinary foods with fun shapes. An exciting idea is 3D printing of tissues consisting of plant cells, or artificial cells with similar properties, to yield foods similar to edible plant tissues that have unique texture properties that are a consequence of their particular microstructure.

A 3D printing method based on the extrusion of cellular food materials is developed in this attempt. The food-ink consists of a porous pectin gel matrix in which, alive plant cells are embedded. The plant cells isolated from the maceration of edible plant tissues and encapsulated into the pectin matrix can be successfully 3D printed with a viability up to 60 %. More innovative food products can be conceived that are composed of core-shell microcapsules mimicking cells and, thus, providing the typical texture of plant based foods but containing unexpected flavour components and personalised health promoting substances.

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Effects of electric fields on enzymes: molecular dynamics simulations and experimental approaches

Authors Chaminda SAMARANAYAKE[1] and **Sudhir SASTRY**[1]

Affiliations [1]*The Ohio State University, Columbus, Ohio, USA*.

Abstract

Studies on the effects of electric fields a number of enzymes, including pectin methylesterase, alpha amylase, peroxidase and cellulase, have shown activation of the enzyme at sub-optimal activity temperatures, and accelerated inactivation at above-optimal activity temperatures. Further, studies on the effect of frequency have shown enhanced activity below specific frequencies. Experimental approaches to elucidate such effects require the simultaneous maintenance of constant temperatures and electric field strengths, a challenging requirement that may be met in specific cases. Further insights into such behavior may be achieved using molecular dynamics. We modeled the motion of pectin methylesterase (PME) under electric fields, using the GROMACS 5.1.2 code, with PME data obtained from the Protein Data Bank. various molecules. Due to the extremely computation-intensiveness of the calculations (13 h on a 88 teraflop supercomputer for a 5 ns simulation), we conducted MD simulations to validate assumptions regarding the moment of inertia of the molecule over extended periods. This permitted the use of rigid-body dynamics as an approximation. Results show that the electrophoretic motion experienced by enzymes within an electric field results in an effective temperature increase for the molecule, which alters enzyme behavior in a manner consistent with experimental findings. Further, we found that the increase in activity of the molecule below specific frequencies corresponded to the transition of enzyme motion from oscillatory to rotational. These studies suggest that the evaluation of effects of electric fields on enzymes can be benefited by use of molecular dynamics.

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Mathematical modeling of thawing in a staggered through-field electrode radio frequency system: a case study for frozen tuna for process efficiency

Ozan Altin, **Ferruh ERDOGDU1**
Ankara University, Ankara, Turkey

Radio frequency (RF) and microwave applications are dielectric heating methods available for industrial thawing processes. RF has a better penetration with its longer wave length and more controllable heat generation with its lower frequency (13.56 or 27.12 MHz). Despite advantages and resulting shorter process times, non-uniform temperature distribution still remains a significant challange for an efficient thawing process.
While through-field electrode RF systems have been used in the literature for industrial thawing applications, use of staggered through-field electrode systems have not been common. These systems used circular - rod shaped electrodes where bottom electrode was charged while top electrode served as ground opposite to the through-field systems.
Considering that the electric field distribution due to the electrode design within a system has a significant effect on temperature change besides the effects of cavity and product geometry, the objective of this study was to develop a mathematical model for a staggered through-field electrode system for thawing of frozen tuna and demonstrate the process performance for industrial design purposes.
For this purpose, first a mathematical model was developed to determine the temperature and electric field distribution within a 10 kW – 27.12 MHz RF system. Experimental validation studies were carried out with ≈6 kg frozen tuna samples, and valdiated model was used to demonstrate the efficiency of the RF system, and the results were also compared to the through-field RF systems.

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Degradation of aflatoxin in corn using high voltage cold plasma: efficacy and reaction mechanisms

Hu Shi[1], Kevin M Keener[1], Richard L Stroshine[2], and Klein Ileleji[2]
[1]*Iowa State University, Ames, USA*
[2]*Purdue University, West Lafayette, USA*

Abstract

This study investigated the efficacy and reaction mechanisms of high voltage atmospheric cold plasma (HVACP) treatment on degradation of aflatoxin in corn. The effect of different gas types (Air, MA65), relative humidities (5, 40, 80% RH), exposure time (1, 2, 5, 10, 20, and 30 min), reaction modes (direct, indirect), stirring and post-treatment storage were investigated to optimize the degradation efficacy of HVACP treatment. Generated reactive gas species was characterized with optical emission spectroscopy and absorbance spectroscopy. Higher concentration of ozone and NOx were generated during HVACP treatment in MA65 than in air at lower relative humidity. Aflatoxin in corn was rapidly degraded by HVACP treatment following a logistic model. Aflatoxin in corn was degraded by 82% by 10 min HVACP treatment with RH 40% air. Higher degradation could be achieved in gas MA65 at higher relative humidities (40%, 80%), with stirring the corn sample and post-treatment storage. The degradation products of aflatoxin B_1 were separated. Their formulas and structures were elucidated using liquid chromatography time of flight mass spectrometry (HPLC-TOF-MS) and orbitrap mass spectrometry. Six main degradants were elucidated and two degradation pathways of aflatoxin B_1 were proposed. Degradation of aflatoxin by HVACP treatment involves addition of H•, OH•, CHO• radicals, epoxidation by HO_2• radicals, and oxidation by species OH•, H_2O_2 and O_3. The toxicity of aflatoxin degradants were significantly reduced according to structure-bioactivity relationship of aflatoxin.

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Increase sustainability in freeze-drying by processing less water

Nur MALIK[1], **Ourania GOUSETI**[2], Estefania LOPEZ-QUIROGA[1], Peter J. FRYER[1], Serafim BAKALIS[2]

[1]*University of Birmingham, Birmingham, UK*
[2]*University of Nottingham, Nottingham, UK*

Abstract
Freeze-drying is associated with good quality dried foods. However, it is expensive and high energy demanding. One way to increase sustainability and decrease costs involved in freeze-drying is by processing less water. This requires in-depth knowledge of the link between processing parameters and properties of the final product, which is currently not well understood.

We have studied the effect of freezing conditions (-40°C or oscillating between -20 and -40°C) and primary drying temperature (-20, -30, -40°C) on the structure (SEM, X-Ray CT) and reconstitution (evaluated visually or by measuring changes in conductivity) of freeze-dried gum arabic systems at a range of concentrations (20-60% w/w).

We found that increasing initial concentration resulted in denser dried structures, except for the cases where the material puffed and large (200-1800μm), circular-type bubbles appeared, compared to the smaller (<250μm), needle-like voids observed in the non-puffed regions. This “pop-corn” effect was stronger for the highest investigated concentration (60% w/w), in particular when frozen at -40°C and dried at -20 and -30°C. Puffing was attributed to heat and mass transfer resistance due to the formation of a dense, dried top crust, and the lower melting temperature (e.g. -5 and -15°C for the 50 and 60% systems, respectively, measured with DSC). Temperature oscillations effectively increased crystal sizes, resulting in larger pores. The presence of large pores, increased porosity, and thinner cell walls in the structure appeared to accelerate reconstitution kinetics.

Overall this work demonstrates the potential of process design to control microstructure and functionality of sustainable, freeze-dried products.

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Technologies for dynamic controlled atmosphere of fruit and vegetables

Bart NICOLAI[1,2], Niels BESSEMANS[1], Bert VERLINDEN[2], Pieter VERBOVEN[1],
[1] KU Leuven – University of Leuven, Leuven, Belgium,
[2] VCBT – Flanders Centre of Postharvest Technology, Leuven, Belgium

Abstract
Dynamic controlled atmosphere (DCA) technology is an energy-efficient and sustainable solution for optimal quality preservation of fruit and vegetables after harvest, while minimizing the development of gas-dependent storage disorders. In DCA the optimal oxygen and carbon dioxide gas concentrations are dynamically identified and controlled in response to measured low oxygen stress signal of the product, which can be detected by different sensing principles. Novel DCA methods have been proposed using different product signals, including the respiratory quotient (RQ) and volatile release. In this contribution we present the progress made on DCA technology development, effects on product quality and future perspectives. Particular emphasis goes to Improve understanding of respiratory gas exchange dynamics in storage rooms. Thereto, a computational fluid dynamics (CFD) model of the airflow, heat and gas exchange was developed and validated and combined with models for fruit respiration and quality change kinetics at very low oxygen conditions. The model is used to explore system and product dependent parameters affecting gas exchange and product responses in very low oxygen conditions. A robust, accurate and sensitive RQ-based control algorithm was developed to correct influences of leakage of the storage facility on the O_2 and CO_2 changes and eliminating measurement noise via signal processing of the measured O2 and CO2 signals.

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Factors influencing calcium infusion using high pressure processing

Noopur GOSAVI[1], Mukund KARWE[1]

[1]*Rutgers, The State University of New Jersey, New Brunswick, U.S.A.*

Abstract

We evaluated the role of food microstructure on calcium infusion using high pressure processing (HPP) to gain quantitative insights into the mass transfer process under HPP.

Baby carrots, celery, and mango were used as substrates for HPP assisted calcium infusion. Substrate tissues (5µm) stained with hematoxylin and eosin were observed under a confocal laser microscope and their microstructure was quantified in terms of their characteristic cell-lengths (µm). Samples vacuum packed with 6% calcium lactate gluconate solution were subjected to HPP (100, 200, 300, and 400 MPa) for 15 minutes. Cell damage due to HPP was measured using electrical impedance spectroscopy and quantified as cell permeabilization index (Z_P). Processed samples were tagged with Fluo-8 to visualize the loci of infused calcium, and the total amount of calcium infused was measured using spectrophotometry.

Baby carrots, celery, and mango were observed to have significantly different microstructures (50.6, 113.2, and 89.1 µm, respectively) and amounts of infused calcium (58.1±1.6, 48.7±1.6, and 88.7±9.0 mg/100g at 300 MPa, respectively). Pressure level and microstructure had significant effects on Z_P, which in turn significantly influenced the amount of calcium infused. Calcium loci were observed around the transport tubes of the tissues, indicating that radial infusion was not the primary infusion mechanism. Based on these insights, a mathematical model is being developed to establish quantitative relationships between the processing parameters, food microstructure, and mass transfer under HPP.

This study can help the industry understand the role of HPP in enhancing nutritive value of common foods that have inadequate micronutrients.

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Study of continuous cake pre-baking in a rectangular channel using ohmic heating

Olivier ROUAUD[1,3], Monique KHODEIR[1,3], Vanessa JURY[1,3], Anthony OGE[1,3], Patricia LE BAIL[2,3], Alain LE BAIL[1,3]
[1]*ONIRIS, GEPEA, UMR CNRS 6144, Nantes, France*
[2]*BIA, INRA, Nantes, France*
[3] *SFR IBSM 4202, INRA-BIA, CNRS-GEPEA, Nantes, France*

Abstract
The aim of this study is to develop an original concept to pre-bake a cake batter in a rectangular channel dedicated to additive manufacturing (3D printers head). To perfectly control the heating process, ohmic heating was selected and implemented in the channel. Ohmic heating consists of using electrical current to heat foods which are used as electrical resistances.
The thermophysical properties of the cake batter were first measured according to several recipes. Among the properties, the viscosity and the electrical conductivity were particularly of interest because they contribute to the flow behavior and the heating rate respectively. Measurements have shown the influence of water content and the starch gelatinization on the properties.
A standard formulation (22.6% wheat flour T55, 19.2% sugar, 15.4% fat, 19.2% liquid egg,0.4% salt, 23.2% water) was then chosen to perform numerical simulations and experiments. A numerical model including heat transfer, laminar flow, electrical field establishment and Joule heating was developed, the temperature dependency of all thermophysical properties giving rise to strongly non-linear equations. An experimental set-up was also designed to perform the experiments. The geometry is constituted by a rectangular channel 100 mm long. The gap between both electrodes can vary between 5 and 10 mm and the width between 20 and 40 mm. Several experiments were conducted with different flow rates and voltages and compared with numerical simulations. All results show that there can be strong detrimental temperatures heterogeneities at the exit of the nozzle but numerical simulations help us to find useful solutions.

Influence of osmotic dehydration pre-treatment on the drying with Refractance Window™ of apple (cv Granny Smith) slices.

Simpson [1,2], R., Almonacid[1,2], S., Nuñez[1], H., Jaques, A[1]. Hernandez[1], Y., and Ramírez[1,2] C
[1] Departamento de Ingeniería Química y Ambiental; Universidad Técnica Federico Santa María; Valparaíso, Chile.
[2] Centro Regional de Estudios en Alimentos Saludables (CREAS), CONICYT-REGIONAL R12C1001, Blanco 1623, Valparaíso, Chile

Refractance window™ (RW™) is a technology patented by Magoon (1986) and developed by MCD Technologies Inc. (Tacoma, Washington, USA). Dehydration through the RW™ technique usually uses hot water at a temperature of around 90°C as an energy source and an infrared transparent plastic film (MylarTM), as a contact-surface. The objective of this research was to explore the advantages of apple slices dehydration using RW™ with and without osmotic dehydration pretreatment as compared with conventional hot-air drying. Apple slices (40 mm in diameter x 4.0 mm in thickness) were osmotically dehydrated coupled to a moderate electric field (9.3 V/cm) using a sucrose solution (45 °Brix) at 40°C up to until a_w=0.95. Then, apple slices (with and without pretreatment) were dehydrated by RW™ at 55, 75 and 95°C. As a control, hot-air drying was performed at 55°C. The mathematical models of hot-air drying and RW™ were based on both, the analytical solution of Fick's second law and anomalous diffusion based on fractional calculus. The results showed that RW™ allowed apple slice dehydration using higher temperatures (95°C) in a short process time (50 min) maintaining the final quality as compared with the conventional process (55°C, 270 min). The anomalous model, significantly improved data fitting. Finally, RW™ did not present differences in terms quality between untreated and pre-treated hot-air dehydrated samples, which suggest that osmotic dehydration pretreatment was not necessary when RW™ is applied, which is great advantage in term of processing time reduction.

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An overview of thermal inactivation kinetic parameters determination

Maria C. GIANNAKOUROU[1], **Nikolaos G. STOFOROS[2]**

[1]*Department of Food Science and Technology, University of West Attica, Athens, Greece*
[2]*Department of Food Science and Human Nutrition, Agricultural University of Athens, Greece*

Abstract
Experiments at either constant or dynamic temperature conditions have been used to model food safety and quality during processing and storage; the former appear more often in the literature while the latter, if properly designed, can extract kinetic parameter values with less experimental effort. During constant temperature experiments, one- or two-step regression procedures are associated with kinetic parameter estimation through appropriate primary and secondary models. When implementing the traditional two-step approach, the variability of secondary model parameters is often ignored [1]. In principle, both primary and secondary model kinetic parameters can be evaluated through remaining concentration data versus time from a single experiment at dynamic conditions [2]. However, the selection of the particular temperature profile can affect the feasibility of such a procedure and the accuracy of predictions. The objective of this work is to present a comparative evaluation of different approaches applied to design thermal inactivation experiments and subsequently analyze the recorded kinetic data.

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Foresight study: Influence of the new information and communications technology on the food value creation network

Katrin MATHMANN[1], Christiane RAU[1]
[1]*University of Applied Sciences Upper Austria, Wels, Austria*

Abstract
ICT is expected to accelerate the development of a complex value creation network in the food industry. Using the Austrian market as an example, a foresight study identified the dominant drivers and developments for small and medium-sized enterprises.
From literature, we have identified factors that influence the digital revolution in the food industry. The factors can be assigned to the subject areas "Data Collection & Analysis", "Production & Logistics" and "Customers & Markets". In 6 focus groups, a total of 49 stakeholders from the entire value creation network (e.g. producers, suppliers, retailers, food bloggers and authorities) discussed the complex topic with regard to potentials and risks. Finally, each participant assessed the relevance of the factors on a 5-point Likert scale.
The qualitative data analysis revealed several crucial aspects, such as regulatory uncertainty about data ownership, availability and privacy, the benefits of Big Data Analytics, the challenges of implementation due to the lack of standardization of interfaces, the potential of advances in sensor technology and concerns about a possible reduction in product diversity. Based on the individual quantitative evaluation, we have compiled a ranking. The participants considered (1) the traceability of the supply chain with regard to product conditions, (2) the potential for cost reduction and (3) training in digitization skills to be the most essential developments in the coming years.
In conclusion, the focus group event shows that cooperative and interdisciplinary work can help SMEs in the food sector to develop a more differentiated understanding of the digitized future.

Modelling the airflow distribution in a pallet arrangement in forced-air cooling operations

Nicolas TAPIA1, Richard LOVE2, Emilia NOWAK3, Andrew EAST1, Justin O'SULLIVAN1

1 *Massey AgriTech Partnership, Massey University, Palmerston North, New Zealand*
2 *School of Food and Advanced Technology, Massey University, Palmerston North, New Zealand*
3 *School of Food and Advanced Technology, Massey University, Auckland, New Zealand*

Abstract:
A number of research groups are currently working on understanding the cooling performance of packed horticultural produce in a pallet arrangement as influenced by packaging design. Most commonly, numerical approaches such as Computer Fluids Dynamics (CFD) are used to solve the complex energy and momentum balances. These numerical modelling approaches often requires high computational capacity resulting in long solution times (hours to days). In order to optimize packaging systems, it is preferred that numerous packaging designs can be tested and hence speed of system definition and solution become important. In this work an alternative approach to modelling the complex airflow pathways through a pallet that enable rapid solution is developed. A preliminary simplified airflow resistance network modelling approach for a forced-air cooling operation is presented and validated for packages of kiwifruit that include an internal polyliner bag. This model is capable to predict airflow distribution within a pallet by building a network of airflow pathways linked by nodes with a known resistance based on the geometry arrangement of the system (i.e. vents and headspace). A laboratory pallet scale experiment using a set of differential pressure barometer to monitor pressure drop within the pallet was designed and used to validate the model predictions using a pallet pressure drop as a model input. Results were also validated using a previously developed and validated CFD model.

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Physical property of fruits and vegetables and its implication on health benefits: a review

Olaniyi FAWOLE[1], Umezuruike OPARA[1, 2]

[1]*Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Horticultural Science, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa.*

[2]*Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Food Science, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa.*

ABSTRACT

Several epidemiological and intervention studies have reported a direct relationship between the consumption of fresh fruits and vegetables, and prevention of most degenerative diseases as well as the slowing of the aging process. Fruits and vegetables are rich in polyphenols, which do not only play physiological roles in plants but also act as antioxidants by donating a hydrogen atom or an electron to other compounds, scavenging free radicals, quenching singlet oxygen, and maintaining a balance between oxidants and antioxidants to improve human health. However, fruit and vegetables are both physically and nutritionally complex, which will affect digestion and absorption. Furthermore, the health benefits of fruit and vegetables are associated with their structure and the way that they deliver nutrients to the human gastrointestinal system. In the past decades, research efforts to better understand the role of the food structure in health outcomes has been on the rise. In this review, we describe recent knowledge on the role of food structure in fruits and vegetables on health benefits. Furthermore, a comprehensive overview of the effects that the properties of the underlying structures of food is also discussed.

Keywords: *Punica granatum*, hot-air drying, modeling, effective moisture diffusivity

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Enhancement of The Nutritional Value and Functionality of Grain Sorghum *via* Solid State Fermentation with Co-culture of *Aspergillus oryzae* and *Bacillus subtilis*

Delmy DIAZ[1], **Rubén MORAWICKI[1]**

[1] *Department of Food Science, University of Arkansas, Fayetteville, AR, USA.*

Abstract

Grain sorghum is a drought-tolerant crop with many pest-resistant cultivars. However, from a nutritional point of view, grain sorghum has important limitations due to its low protein content and the presence of anti-nutritional factors such as phytic acid. Thus, the development of processing techniques to reduce anti-nutritional compounds and enhance protein content would expand the use of grain sorghum for both humans and animals nutrition and contribute to the sustainability of the food supply chain. This study aimed to improve the nutritional value and functionality of grain sorghum by solid-state fermentation with a co-culture of *Aspergillus oryzae* and *Bacillus subtilis* and to evaluate the effect of the fermentation on the reduction of phytic acid and the potential augmentation of protein content. Coarsely-ground white grain sorghum was mixed with water (2:1 ratio) in Erlenmeyer flasks and sterilized at 121^{o}C. Sterilized samples were inoculated with *Aspergillus oryzae* and incubated at 30^{o}C for seven days. Then samples were inoculated with *Bacillus subtilis* and incubated at 37^{o}C for two days. Subsequently, samples were oven dried at 60˚C, re-ground, and stored at 4^{o}C until analyzed. Results showed an increment in crude protein content from the naturally contained 10 percent to 18 percent, without any media supplementation or optimization of the fermentation, likely due to biomass production. These results were also confirmed by the Lowry colorimetric assay. At the same time, the phytic acid content in the grain was reduced by 95 percent.

Application of a novel drying technology (low-temperature vacuum drying) to improve the quality parameters of Chilean papaya

Antonio VEGA-GALVEZ[1], Jacqueline POBLETE[1], Macarena VEGA[1], Elsa URIBE[1,2], Cristina BILBAO-SAINZ[3], Alexis PASTEN[1]

[1]*Universidad de La Serena, La Serena, Chile.*
[2]*Instituto de Investigación Multidisciplinar en Ciencia y Tecnología, La Serena, Chile.*
[3]*U.S. Department of Agriculture, Albany, CA, USA.*

Abstract

Chilean papaya (*Vasconcellea pubescens*) has been identified as a valuable source of nutrients and antioxidants, which are beneficial for human health. However, papaya is a fruit that has a very fast ripening cycle and high perishability. The most common preservation method for papayas is convective drying, but can cause degradation of desirable qualities. Thus, the development of novel drying processes that can improve dried product quality has been increasing in recent years. Low-temperature vacuum drying (LTVD) is a novel drying technique developed for the drying of sensitive food ingredients, but its application for fruit drying has been little investigated to date. This study aimed to assess the feasibility of low-temperature vacuum drying to improve the quality parameters of Chilean papaya (*Vasconcellea pubescens*). LTVD was conducted at four temperatures (10, 20, 30 and 40 °C) and one vacuum pressure (10 mbar). Fresh and dried samples were evaluated in terms of proximate composition, sugars, color and non-enzymatic browning. The results showed that low temperatures (10 and 20 °C) presented the highest of total fiber dietary values, while higher temperatures (30 and 40 °C) presented the lowest values. Fructose and glucose increased significantly after drying, especially in samples dried at 30 °C. All the dried samples had a high luminosity and a yellow color, and low values of non-enzymatic browning. Based on these results, the study concludes that the use of LTVD provides a useful tool to improve quality with respect to preserving physicochemical properties of Chilean papaya

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ITEX/GC-MS : An analytical method to a better detection of sulfur compounds in food products.

Emilie DESCOURS[1], Bernard COUTURIER[1], Nadine VALLET[1]

[1]*ISIPCA (International Institute of Perfume, Cosmetics and Aroma), 34-36 Rue du Parc de Clagny, 78000 Versailles, France*

Abstract

Volatile sulfur compounds (CSVs) are formed during the degradation of a food product or a drink. It results the presence of a unpleasant odor or taste.

So, the presence of these compounds in a food product is a major issue for the food industry.

Thus, it is necessary to detect the presence of CSVs to prevent or eliminate them. Solid-Phase Micro-Extraction (SPME) method to preconcentrate volatils compounds before analysis by GC-MS is the most used analytical method for the detection of aromas compounds. This method is simple to implement but is not efficient to detect the sulfur compounds (lack of sensibility and repeatability).

This is why a new technique, a dynamic head space method called In Tube Extraction (ITEX)(1), has been developed to overcome these problems. The aim of this project is to develop an ITEX method and to compare it with the SPME on a food product model medium for the detection of CSVs. The results are: a better extraction of volatile molecules with better repeatability is obtained with the ITEX technique. Especially, the method shows better detection limit for analyses of CSVs and with better precisions and repeatabilities.

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Effect of the differences in protein structure on digestibility

Meltem BAYRAK[1,3], Charlotte CONN[2], Juliane FLOURY[3] Amy LOGAN[1]

[1]*CSIRO Agriculture and Food, Werribee, Australia*
[2]*School of Science, RMIT University, Melbourne, Australia*
[3]*UMR-STLO INRA-Agrocampus Ouest, Rennes, France*

Abstract
Food is a complex combination of chemically diverse structures, influenced by composition and processing. The nutritional quality of food cannot be solely based on individual contents in nutrients as food structure will strongly modulate the bioaccessibility of nutrients upon digestion. In previous studies, the most common approach for measuring the extent of proteolysis and nutrient uptake was to compare the initial macroscopic features of ingested food to final concentrations in the bloodstream. However, there is limited literature to the support underlying mechanisms of the digestion of food in the stomach and enzyme diffusion in solid food substrates. In the present work, the influence of casein protein gel microstructure on enzymatic digestion was investigated for the future development of personalised foods. Casein gels with an identical composition, but differing by the coagulation mode, were characterized and submitted to simulated gastric digestion. The changes in gel structure over time were studied using confocal microscopy and small angle x-ray scattering (SAXS). The molecular interactions that occur as a gel network is formed, and subsequently broken down under digestive conditions will be discussed.

Fouling of ion-exchange membranes during the processing of fresh whey solutions

Sahar Talebi1, George Chen1, Karren Bathurst 2, Sandra Kentish1

1 ARC Dairy Innovation Hub, University of Melbourne, Melbourne, Australia
2 Bega Cheese Pty. Ltd., Melbourne, Australia

Abstract
Whey is the industrial term used to describe the excess liquid generated during cheese and yogurt manufacturing. Depending on the manufactured product, a dairy plant can produce acid whey or sweet whey. The acidic nature of the former results in a high mineral and lactic acid content; and low levels of protein. The lactic acid and mineral concentrations must be reduced if the protein is to be recovered as a saleable product. One technology that shows promise for this purpose is electrodialysis. However, the separation can prove costly if the process is not optimized to avoid fouling of the ion-exchange membranes. Such fouling adds extra resistance to current flow thus reducing process efficiency and increasing operating costs. In this work we studied the extent of membrane fouling using fresh acid and sweet whey obtained from a dairy plant in Victoria, Australia. In addition to the use of these two feed solutions, we manipulated other process parameters such as the pH and conductivity of the concentrate solution. While membrane fouling occurred in all experiments, the reductions in current fell by less than 20% of the original value in all cases. Although, no obvious difference was noticed in the feed
demineralization rate, the percentage removal of different ions changed when the concentrate pH was varied. It was found that greater amounts of lactic acid were removed when an acidic concentrate was used, while a greater removal of divalent ions were noted at neutral pH values.

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Development of Separating and Cleaning Set for Infrared Rotary Dryer

Juckamas LAOHAVANICH[1], Suphan YANGYUEN[1], Worachet SRIPRAMAI[1], Areerat BOONBUNDA[1]

[1] *Mahasarakham University Maha sarakham, Thailand*

Abstract

This research presents the development of paddy separating and cleaning system for infrared rotary dryer. The system device was designed to use a 1.8 x 20 mm sieve with oval hole shape. The sieve was rolled as a cylinder which having the same size of the rotary drum and was mounted at the end of the dryer. Paddles were installed to convey paddy through the sieve drum and separated husk from whole paddy grain. Experiments were carried out at the rotary drum speed of 4, 6 and 8 rpm. The feed rates were 350±50 and 550±50 kg/hr. The angles of conveyed paddles were set at 15 degrees and 30 degrees in the sieve testing. The results showed that the sieve could work well at low level of feed rate, low rotary drum speed and small angle of conveyed paddles. With those conditions, the percentage of cleanliness was increased. The optimum setup of separation and cleaning set was at the paddles speed of 4 rpm and the angles of conveyed paddles of 15 degree. It resulted in the cleanliness percentage of 99.76 % at the feed rate of 350±50 kg/hr.

Key words: Infrared rotary dryer, Separating, Cleaning

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Airflow resistance characteristics of sliced sweet potato for CFD modeling of a novel solar-driven dryer in Ethiopia

Petros Demissie Tegenaw[1], Wim DEWULF[1], Pieter VERBOVEN[2], Maarten VANIERSCHOT[1]

[1]*KU Leuven Faculty of Engineering Technology, Leuven, Belgium*
[2]*KU Leuven Division of Mechatronics, Biostatistics and Sensors (MeBioS), Leuven, Belgium*

Abstract

Modeling and simulation of transport phenomena in food and moving air is used as a design and optimization tool for food storing, processing, and transporting facilities. The most customary modeling approach is to treat a stack of food as a porous medium through which air passes, ensuring simultaneous heat and mass transfer. This approach is particularly necessary to model and simulate sliced food drying kinetics with reasonable computational resources. As a layer of sliced sweet potatoes cannot be approximated with existing porous media correlations, an appropriate model needs to be identified by experiment. For this purpose, in this study a test channel, with slices of sweet potatoes placed in a wire mesh is designed and manufactured. The pressure drop versus air flow velocity relationship was established for different layer porosities and thicknesses, for different slice mean diameters, and for varying moisture content of the slices (at different drying stages). The insights from the measurements were used to develop model equations that can be used in computational fluid dynamics (CFD) simulations to optimize a novel design of solar powered food dryer to be implemented near fields in Ethiopia. Although, we used sliced sweet potatoes, the correlations can also be utilized in CFD modeling and simulation of other sliced foods and vegetables.

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Biomimetic plant foods: Nature inspired food structures to control starch digestion

Jaspreet SINGH[1,2]

[1]*School of Food and Advanced Technology, Massey University, Palmerston North, New Zealand*
[2]*Riddet Institute, Palmerston North, New Zealand*

Abstract
The term *Biomimetics* represents imitation of nature's methods, mechanisms and processes and it provides enormous opportunity to create new or man-made *"Biomimetic Plant Foods (BPFs)"* with similar structure and functionality like naturally occurring foods. Our research underpins fundamental understanding about how the cell components are assembled and form the native microstructural organisation in plant-based starchy foods; dis-or re-assembled during processing (milling, thermal), post-processing storage (refrigerated) and digested in the gastro-intestinal tract (*GIT*). The manufacture of *BPFs* involve the creation of an interpenetration network with re-inforced starch, cell wall and various plant-based food components (e.g. proteins, lipids and or bioactive/functional compounds) through high shear-temperature based technologies. These BPFs and ingredients are expected to provide benefits similar to health promoting whole natural foods during in-body gastro-intestinal digestion, thus presents a completely new range of processed low glycaemic foods for our food industry.
The major aims of our research are: (a) to advance our understanding of how the natural food structures are influenced by conditions during processing and gastro-small intestinal digestion; b) to study how the interactions among starch, cell wall components and proteins are influenced during processing and storage and affects the functional and digestion behaviour; and (c) Using knowledge gained from (a) and (b) to create slowly digestible biomimetic ingredients.

Polydiacetylene film-based sensors as an indicator for food spoilage at low temperatures

Long H. NGUYEN,[1] Sina NAFICY,[1] Robyn MCCONCHIE,[2] Rona CHANDRAWATI[3], Fariba DEHGHANI[1]

[1]*School of Chemical and Biomolecular Engineering, Centre for Excellence in Advanced Food Engjnomics (CAFE), The University of Sydney, Sydney, NSW 2006, Australia.*
[2]*School of Life and Environmental Sciences, The University of Sydney, Sydney, NSW 2006, Australia*
[3]*School of Chemical Engineering, The University of New South Wales (UNSW Sydney), Sydney, NSW 2052, Australia.*

Abstract
Polydiacetylenes have been widely used for various sensing applications owing to their unique optical properties. There are some successful examples of polydiacetylene-based composites for ammonia detection, which is a prime indicator for food spoilage. However, to our knowledge, free-standing flexible polydiacetylene films with the ability to detect ammonia at low temperatures in food packaging do not exist. We report a low cost, sensitive polydiacetylene film-based ammonia sensor that can be incorporated into food packaging to monitor food spoilage at temperatures between -20 °C and room temperature. We fabricate polydiacetylene films using cellulose nanocrystal/chitosan composites, and we show that the films provide direct qualitative and quantitative detection of ammonia with a detection limit of 300 ppm. The sensors developed in this study showed faster response, better colour transition visibility, and lower detection limit than previously reported PDA sensors. The flexible polydiacetylene film sensors exhibit a distinguished blue-to-red colourimetric response after being exposed to spoiled meat, even at sub-zero temperatures.

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Food preservation properties and antibacterial mechanism of in-situ modification nano-CaCO3/TiO2-chitosan composite coatings

Lili Yang[1,2#], **Keli Zhong**[1,2#], Tong Sun[1,2*], Wenting Hao[3], Qiu-ying Li[1,2], Ying Han[1,2], Yingchang Li[1,2], Tingting Li[4], Jing Xie[5], Jianrong Li[1,2*]
[1]College of Food Science and Engineering, Bohai University, Food Safety Key Lab of Liaoning Provincey, Jinzhou, Liaoning, 121013, China
[2]National & Local Joint Engineering Research Center
of Storage, Processing and Safety Control Technology for Fresh Agricultural and Aquatic Products, Jinzhou, Liaoning, 121013, China
[3]Publicity Department, Wuyi County Party committee, Shijiazhuang, Hebei, 053400, China
[4]College of Life Science, Dalian Nationalities University, Dalian, Liaoning, 116600, China
[5]College of Food Science and Technology, Shanghai Ocean University, Shanghai, 201306, China

Abstract: The nano-$CaCO_3$/TiO_2-chitosan composite coatings were prepared, and modified by *in-situ* modification nano-$CaCO_3$ and modified nano-TiO_2. The microstructures of the coatings were characterized by SEM, TEM, XRD and FT-IR, and its physicochemical properties were measured. The preservation performances of the composite coatings were shown using the *Sciaenops ocellatus* as the object. The antibacterial mechanism of the composite coatings against dominant spoilage bacteria in aquatic products was revealed through *Shewanella putrefaciens* and *Pseudomonas aeruginosa*. The results show that the tensile strength (*Ts*) and elongation at break (*EB*) of the chitosan composite coatings are improved, which are modified by *in-situ* nano-$CaCO_3$ and modified TiO_2, and the water-vapor permeability (*WVP*), carbon dioxide permeability (*CDP*), oxygen permeability (*OP*) and transparency (*T*) are also improved. The freshness change of *Sciaenops ocellatus* is effectively delayed by chitosan composite coatings. In particular, for *Shewanella putrefaciens* and *Pseudomonas aeruginosa*, the nano-$CaCO_3$/TiO_2-chitosan composite coatings can effectively disrupt the integrity of the cell membrane, improve the permeability of the inner and outer membrane, reduce the enzyme activity, change the synthesis and expression of the protein, and then inhibit the growth and reproduction of the dominant spoilage bacteria in aquatic products. The microstructure, physicochemical properties and preservation properties of the chitosan coatings are improved by the *in-situ* modification nano-$CaCO_3$ and modified nano-TiO_2, and further to inhibit the growth and reproduction of the bacteria.

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Preparation of zinc oxide films by hydrothermal synthesis and their antibiofilm properties to *Shewanella putrefaciens*

Xuqing Wei[1,2#], **Xuepeng Li**[1,2#], Tong Sun[1,2*], Qiu-ying Li[1,2], Keli-Zhong[1,2], Yingchang Li[1,2], Jing Xie[3], Jianrong Li[1,2*]

[1]College of Food Science and Engineering, Bohai University, Food Safety Key Lab of Liaoning Provincey, Jinzhou, Liaoning, 121013, China
[2]National & Local Joint Engineering Research Center
of Storage, Processing and Safety Control Technology for Fresh Agricultural and Aquatic Products, Jinzhou, Liaoning, 121013, China
[3]College of Food Science and Technology, Shanghai Ocean University, Shanghai, 201306, China

Abstract: ZnO films on titanium sheet were prepared by hydrothermal synthesis method at different raw material concentration, and were characterized by X-ray diffraction (XRD), fourier transform infrared spectroscopy (FT-IR), scanning electron microscope (SEM), transmission electron microscope (TEM), X-ray photoelectron spectroscopy (XPS) and contact angle (CA). The obtained ZnO was hexagonal wurtzite type. On the titanium sheet surface, nano-rod ZnO are deposited, and the microstructure and surface hydrophobicity of the ZnO film were affected by raw material concentration. At $Zn(NO_3)_2$ concentration of 0.020 mol/L, the ZnO film is hydrophobic. To explore the influence of ZnO film on superior spoilage bacteria of aquatic product, crystal violet staining, ultrasonic plate method, SEM and confocal laser scanning microscopy (CLSM) were used to observe the growing situation of *Shewanella* biofilm on the ZnO films. The change of polysaccharide adhesin, extracellular polysaccharide, metabolism, ATP and AKP enzyme activity, membrane protein content and protein electrophoresis were used to study the antibiofilm properties and mechanisms of the ZnO films on *Shewanella* biofilm. The results show that the antibiofilm property of the ZnO film is the optimal, which is prepared from $Zn(NO_3)_2$ concentration of 0.020 mol/L. Because it has the optimal hydrophobicity and antibacterial property, the produce and adhesive of the polysaccharide and extracellular polysaccharide of the *Shewanella* biofilm are increased slowly, and the metabolism of *Shewanella* are effectively mitigated. Meanwhile, ATP and AKP enzyme activities of *Shewanella* are destroyed, and the membrane protein of capsule bacteria are damaged. The *Shewanella* biofilm can be effectively controlled by the ZnO film, so it can be applied to food storage and processing equipment.

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Design of fermentation processes for the production of functional apple based products guided by untargeted metabolomics approach

Shalveen S. RAJ[1,2], Netsanet SHIFERAW TEREFE[2] Mary Ann AUGUSTIN[2], Milton T. W. HEARN[1], Philip J. MARRIOT[1]

[1]Australian Centre for Research on Separation Science, School of Chemistry, Monash University, Clayton, Victoria 3800, Australia
[2]CSIRO Agriculture and Food, 671 Sneydes Rd, Werribee, Victoria 3030, Australia

Abstract
Fermentation by lactic acid bacteria (LAB) fermentation, is a well-established traditional technology used globally to alter biochemical constituents of raw bio-sourced feedstocks, and represents a simple and valuable biotechnology that can be used to enhance shelf life, nutritional and organoleptic qualities of fruits and vegetables. However, a challenge faced by food manufacturers designing products with the desired balance between nutritional and sensorial quality, is lack of insight into the impact of processing on metabolite profile. Metabolomics, the systematic determination of small molecule metabolites present in complex biological samples, can be used to generate insights into the effect of processing, on metabolite profiles that will guide design of processing conditions for targeted metabolite and hence nutritional and sensorial profiles. In this study, LC-HRMS based untargeted metabolomics approach was used to get a broad insight into the changes in the metabolic profiles of Red Delicious apple puree during pasteurisation and fermentation with *L. plantarum ATCC 8014*. The resultant data was subjected to multivariate statistical analyses to determine changes in metabolite profile during the different processing stages, followed by putative identification of characteristic bioactive compounds formed during fermentation. Metabolites of significant interest included polyphenols (e.g. (Z)-resveratrol 3,4'-diglucoside), fatty acids (e.g. (±)-2-hydroxy-4-(methylthio)butanoic acid) and amino acids (e.g. L-glutamic acid).The systematic metabolomics approach adopted in the present study may provide an informed basis for the design of fermentation processes for functional apple beverages with desirable sensory profile enriched with several LAB induced bio-transformed health promoting compounds, while at the same time adding value to second-grade apples.

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Protein Concentration and Protein-Hydrocolloid Interactions on the Tribo-Rheometry Behaviour of Resulting Protein Solutions

Yang ZHU, Bhesh BHANDARI & **Sangeeta PRAKASH**
School of Agriculture & Food Sciences, The University of Queensland, Brisbane, Australia

Abstract
The consumption of high protein beverages (mainly constituted of dairy proteins) has increased in recent years due to the mindfulness of consumers about their body weight. Hydrocolloids are often used to enhance the mouthfeel properties of these beverages. Understanding the flow and lubrication properties of dairy proteins (whey protein and casein) added with hydrocolloids (gelatin, κ-carrageenan, low methoxy pectin and curdlan) can provide valuable information to manufacturers to improve the sensory quality of the beverages. The zeta-potential, particle size, rheological and tribological properties of pure proteins solutions with variable protein concentrations with/without the addition of hydrocolloids were investigated at 15 and 37 °C. The addition of WPI increased the absolute zeta-potential (from 22.37 ±1.10 mV to 24.30 ± 0.65 mV) and decreased the particle size (from 184.1± 2.46 nm to 134.3 ±1.31 nm) of the protein solution, suggesting improved stability of the protein solution against agglomeration. Furthermore, whey protein addition improved the viscosity and lubrication property (measured as friction coefficient) of the resulting protein solution. The protein solutions became less stable (indicated by increased particle size) with the addition of the hydrocolloids under investigation, however, the flow and lubrication behaviour of the protein solutions improved as the amount of hydrocolloids increased. The protein solution containing 0.25% curdlan showed the best lubrication property at both 15 and 37 °C and could be an ideal choice among the hydrocolloids investigated in this work for high-protein dairy drinks since it can increase both the viscosity and lubrication property of protein solutions.

Modeling buffering capacity of protein model food systems in the context of gastric digestion

Yamile MENNAH-GOVELA[1], Gail BORNHORST[1,2]

[1]*University of California, Davis, United States*
[2]*Riddet Institute, Palmerston North, New Zealand*

Abstract
Buffering capacity is a characteristic of foods to resist changes in pH, which is important to consider in gastric digestion as this will impact the physico-chemical breakdown of food. Linking food properties with buffering capacity and how they correlate with gastric secretions and breakdown is needed for digestion studies.
The objective of this study was to characterize the buffering capacity of protein model foods and to develop an empirical model to predict buffering capacity based on protein concentration and surface area. Heat-induced egg and whey protein gels were used as model foods, at three protein concentrations each (11%, 15.5%, and 20% w/v). Five particle sizes (i.e. surface area) were analyzed: dispersion, pureed gel, and gel cubes of three different sizes (12x12, 8x8, 4x4 mm). Buffering capacity was measured by adding aliquots of 0.16M HCl to 20 g of sample until pH 1.5, and expressed as the total µmol HCl/(g sample*ΔpH).
Buffering capacity was significantly influenced by protein source, protein concentration and surface area ($p<0.0001$). Buffering capacity ranged from 16.1±1.2 to 54.9±1.6 µmol HCl added/(g sample*ΔpH) for 15.5% large whey protein cubes and 20% pureed egg protein gels, respectively. Overall, samples with higher protein concentration and larger surface area had higher buffering capacity. An empirical model was developed to calculate buffering capacity based on protein concentration and surface area, and fit well to experimental data (R^2: 0.64 to 0.91).
Understanding buffering capacity is important, as it will influence gastric secretions, pH profile, and consequently protein hydrolysis, which has critical nutritional impact.

Flexible starch-polyurethane films for packaging application: including their formulation, characterisation and compostability

N. L. TAI[1,2], Raju ADHIKARI[2], Robert SHANKS[1], Benu ADHIKARI[1,2]

[1]*School of Science, RMIT University, Melbourne, VIC 3083, Australia*
[2]*CSIRO Materials Science and Engineering, Clayton South, VIC 3169, Australia*

Abstract

Consumers and manufacturers are increasingly favouring biodegradable packaging materials produced from renewable source. Due to ready availability, reasonably low cost and biodegradable nature of starch, research aimed at developing starch-based packaging is attracting increasing interest. While starch meets the criteria of being renewable and biodegradable, the application of starch as a major component in primary or stand-alone packaging has some major limitations. Starch film is limited by its inherent brittleness and weak moisture resistance. Development of starch-polyurethane (PU) materials is currently drawing considerable research interest due to their excellent mechanical properties, relatively good biodegradability. Starch-PU composites and hybrid materials are approved by FDA for biomedical, pharmaceutical and food application. This presentation reports structural compatibility between starch and PU and characteristics and compostability of starch-PU films.

An anionic poly(ether-ester) polyurethane (AEEPU) was synthesised using isocyanate (NCO)-terminated prepolymer which itself was synthesised using Isophorone diisocyanate (IPDI), 2,2-bis(hydroxymethyl)propionic acid (BMPA), poly (ethylene glycol) (PEG) and polycaprolactone (PCL). Starch-AEEPU hybrid films were produced. Molecular profiling and compatibility and miscibility of Starch-AEEPU films studied using X-ray photoelectron spectroscopy depth profiling, Synchrotron Infrared Microspectroscopy, and Low field nuclear magnetic resonance. The biodegradation behaviour (evolution of CO2, structure breakdown) of these films was also investigated under composting condition. The starch-EEPU films had improved mechanical properties, transparency and hydrophobicity. They were also biodegradable to a high degree. This fundamental understanding of structure-morphology-property relationship of starch-AEEPU and the biodegradation (compostability) gained from this study enabled successful preparation of films with predictable morphological features and mechanical properties. These starch-PU films are expected to find increased application as biodegradable packaging materials.

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Production and Inventory Optimization Problems in Food Industry

Regina BERRETTA, Parishehr PAAM, Shuo CHEN

The University of Newcastle, Callaghan, Australia

The food production in Australia is responsible for $117 billion per year and it is increasing by a yearly rate of 2.1% [1]. The problem of determining optimal production plans within an industry that handles perishable products presents several challenges. Food waste and loss is one of them. In Australia, around 13 per cent of the food production is wasted [1]. Another challenge is inventory management, since perishable products have variable lifetime depending on the conditions in which they are stored. In addition, the minimisation of all the costs involved, including production, inventory, setup; subject to inventory and production capacity constraints is a highly complex computational problem.
In order to achieve an optimal plan, sophisticated mathematical models are essential [2,3]. This talk will describe optimisation mathematical models for two problems. The first involves inventory management of fresh food in an environment with different types of warehouses, with the aim to reduce cost, including those costs associated with waste [2]. The second comprises of the complete production scheduling, including decision on production lots, inventory and setup considering perishable food products [3].

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Droplet Digital PCR Combined with Propidium Monoazide for Detecting Viable *Escherichia coli* O157:H7 in Food Samples

Hanxu Pan[1, 2], Kai Dong[1,2], Xiaojun Liao[1,2,*]

[1]*Beijing Advanced Innovation Center for Food Nutrition and Human Health, Beijing, PR China*
[2]*College of Food Science and Nutritional Engineering, China Agricultural University, Beijing, PR China*

Abstract

In real food samples, the underestimate of viable (including viable but nonculturable state cells which are unable to form colonies on conventional medium but are actually alive) bacteria may pose a great risk to public health. Therefore, sensitive and precise quantification of viable pathogenic bacteria is extremely important. In this study, a new method for detecting viable *E. coli* O157:H7 was established by combining a droplet digital PCR (ddPCR) with propidium monoazide (PMA). The analytical performances including specificity, accuracy and sensitivity of ddPCR were evaluated. *E. coli* O157:H7 was specifically detected by ddPCR from 5 different strains, its limit of detection (LOD) was 5 copies/μL. The measured copies of *E. coli* O157:H7 by ddPCR was linearly plotted against the concentrations by pour-plating with R^2=0.9950. Moreover, the PMA-ddPCR was able to discriminate 10^2~10^6 CFU/mL viable cells from 10^7 CFU/mL dead cells in their mixed samples. The proposed method was finally applied to detect viable *E.coli* in real life samples without the impact of dead cells. By comparison, the PMA-ddPCR method was better than the most widely used PMA-qPCR. This study enables specific, sensitive, and absolute quantification of viable *Escherichia coli* O157:H7 in food samples.

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Direct observation and analysis of disintegration of hydrogel particleswith different mechanical properties using a gastric digestion simulator

Isao KOBAYASHI[1,2], Zaitian WANG[1,2], Hiroyuki KOZU[2], Kunihiko UEMUEA[1,2], Sosaku ICHIKAWA[2]

[1]*Food Research Institute, NARO, Tsukuba, Japan*
[2]*University of Tsukuba, Tsukuba, Japan*

Abstract

There has been growing interest in gaining insights into the design of novel foods whose digestibility is controllable based on life stages and health conditions. Physical digestion is especially important in the case of solid foods, since their size reduction caused by breaking down can promote enzymatic reactions. Our human gastric digestion simulator (GDS) equipped with peristalsis enables the simulation and direct observation of the disintegration of food particles induced by simulated antrum contraction waves. The objective of this study was to investigate the effect of mechanical properties of food-grade hydrogels on their disintegration characteristics using the GDS. We prepared hydrogel samples with fracture stresses (20–60 kPa) and fracture strains (30–60%) as solid food models. Cubic hydrogel particles (5×5×5 mm), initially mixed with a simulated saliva fluid (pH 7, 37 °C), were introduced into the GDS vessel containing a simulated gastric fluid (pH 1.3, 37 °C). *In vitro* gastric digestion experiments using the GDS were performed at 37 °C for 180 min. Hydrogel particles were disintegrated by fragmentation and abrasion during the *in vitro* gastric digestion in the presence of simulated antrum contraction waves. The disintegration kinetics was affected by their fracture strain rather than their fracture stress. Disintegration of the hydrogel particles was suppressed when their fracture strain was higher than a critical value. Our findings may provide useful insights into better understanding of the gastric digestion behaviors of food hydrogels with different mechanical properties.

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Monitoring mixing during gastric digestion using the Human Gastric Simulator (HGS)

Gail M. BORNHORST[1,2], Yamile A. MENNAH GOVELA[1], Berta LASCUEVAS LAGUNA[1], Natalia CUBA[1,3], Gemma MORAGA BALLESTEROS[3], Jose Vicente GARCIA PEREZ[3]

[1]*University of California Davis, Davis, California, USA*
[2]*Riddet Institute, Palmerston North, New Zealand*
[3]*Polytechnic University of Valencia, Valencia, Spain*

Abstract
Quantitative descriptions of flow and mixing in the gastrointestinal tract are critical to predict food breakdown and nutrient release during digestion. Dynamic in vitro digestion models can be utilized to develop experimental descriptions of flow and mixing after different meals. In the human gastric simulator (HGS), a dynamic gastric model, the pH profile was measured at 13 intragastric locations and the particle size distribution was quantified by image analysis after 60 and 180 min of gastric digestion. Test meals were sweet potatoes that were fried (5.5 min at 171°C in soybean oil) or blanched-fried (1 min at 85°C in hot water followed by 5.5 min at 171°C in soybean oil). The pH distribution was not homogeneous at either digestion time, and varied between the two sweet potato meals, due to their different rates of breakdown. After 60 min of gastric digestion in fried sweet potatoes, the pH ranged from 3.4 (bottom of antral region) to 5.62 (middle of upper proximal region). After 180 min of gastric digestion the pH distribution remained nonhomogeneous throughout the gastric cavity. Mixing of gastric secretions was greater in blanched-fried sweet potatoes (pH range: 2.40 – 2.76) compared to fried sweet potatoes (pH range: 1.27 – 2.64). In addition to a more homogeneous gastric pH distribution, indicating increased mixing, blanched-fried sweet potatoes had greater particle breakdown compared to fried sweet potatoes (645 vs. 403 particles/g, respectively). The link between breakdown, gastric pH, and mixing is important, as these factors will impact the rate of nutrient hydrolysis.

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Immunomodulatory Activity of *Lepidium meyenii* Walp. Polysaccharide against Cyclophosphamide-induced Immunosuppression in Mice

Wei WANG, Weijie ZHANG，Ting ZHAO，Min ZHANG，**Liuqing YANG***
Jiangsu University, Zhenjiang 212013, Jiangsu, China
*Corresponding author

Abstract
Lepidium meyenii Walp. (maca) belonging to the Brassicaceae is a perennial herbaceous plant native to South America. Recently, maca has been attracting increasing attentions due to its multiple biological activities, such as such as immunomodulatory, antifatigue, antioxidant, anti-inflammation, enhancing fertility, and antiosteoporosis. The aim of this study was to investigate the immunomodulatory effect of *Lepidium meyenii* Walp. polysaccharide MP1 on cyclophosphamide-induced immunosuppression mice *in vivo*. Results showed that MP1 was able to ameliorate the cyclophosphamide-induced immunosuppression, significantly increased the weight growth rate and organ index, stimulated the phagocyte phagocytosis, hemolysin formation and delayed-type hypersensitivity reactions, up-regulated serum levels of IL-2, INF-γ, IgA, IgG and IgM, and activated the proliferation of leukocytes, erythrocytes and platelets from peripheral blood compared with model control group. These results suggested that MP1 could improve specific immunity and non-specific immunity (cellular and humoral immune response) in immunosuppression mice. MP1 could act as an efficacious adjuvant in immunotherapy or an alternative means in lessening chemotherapy-induced immunosuppression.
Key words：*Lepidium meyenii* Walp.; Polysaccharide; Cyclophosphamide; Immunomodulatory
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Moderate pressure and moderate to high temperature are required for meat tenderization using high pressure processing

Robyn WARNER[1], Anita SIKES[2], Long HUYNH[3], Michael LEE[3], Minh HA[1]

[1]University of Melbourne, Parkville, Australia
[2]CSIRO, Coopers Plains, Australia
[3]Meat and Livestock Australia, Sydney/Brisbane, Australia

Abstract
Meat tenderness is an important sensory trait for consumers and some willingly pay more for assured, premium eating quality. High pressure processing (HPP), also called high hydrostatic pressure, involves the static application of pressure, at or above 100 MPa by means of a liquid transmitter and has been applied to meat to induce tenderization. Objective tenderness data, peak shear force (PSF, N), was collated from 23 studies and 216 experimental treatments where HPP was applied either pre- or post-rigor, at various pressures and temperatures to beef sheep and pork muscles. The change in PSF in response to the application of HPP was expressed relative to control, variation was standardised to standard error and data was subjected to meta-analysis. The application of HPP to the meat resulted in an average decrease in PSF of 82.30 N in pre-rigor meat and 36.82 N in post-rigor meat (SED= 10.76, 4.31 respectively; $P<0.001$ for both). For the application of HPP to beef and sheepmeat, there was an interaction between pressure and temperature (average SED = 2.051; $P<0.001$). At moderate temperatures (10-30^{o}C) and low to high pressure (100-150, 200-400, 520-600 MPa), HPP increased the PSF by 5.61, 3.53 and 27.93 N respectively. Whereas at moderate to high temperature (35-45, 50-60, 68-80^{o}C) and low pressure (100-150 MPa) the PSF was reduced by 53.1, 57.8 and 110.3 N respectively. In conclusion, HPP shows great potential for meat tenderization, potentially adding value to the meat and food industry, but only when the appropriate temperature and pressure are applied.

ICEF13 ABSTRACT

Cooking is not the same as gelatinisation in extrusion

Gordon YOUNG[1], Dennis FORTE[2]

[1]*Food Industry Engineering, Brisbane, Australia*
[2]*Dennis Forte & Associates, Wodonga, Australia*

Abstract
Starch in extruded foods are often referred to as being “gelatinised”. We argue that this is false – and if we don’t understand the different ways that starches can be cooked, then we misunderstand fundamental aspects of extruded food and its quality attributes. Gelatinisation fundamentally consists of a process of hydration, swelling, and pasting of the starch. In the extruder, the starch granules are ruptured through a combination of moisture, heat, pressure and, most importantly, Mechanical Shear. These differences are discernable in the quality attributes of the food product, as well as by laboratory measurement. Wang et al (1989) and (1994) used a Differential Scanning Calorimeter (DSC) to study the cooking of waxy maize starch at a range of moisture contents. They concluded that the conversion of starch at low moisture was due to a portion of the starch undergoing a melting process. At > 60% moisture the conversion was solely due to gelatinisation.

Shear promotes dextrinization. Dextrinization can have either a positive or negative effect on the quality characteristics of the product. For example, in a direct-expanded snack dextrinization promotes a “melt-in-the-mouth” texture and rapid release of flavour – but in breakfast cereals dextrinization results in poor “bowl life”. Excessive dextrinization affects product digestibility.

Describing the transformation of starch simply as “gelatinisation” over-simplifies what is happening to foods during extrusion – unless we realise that extrusion delivers a different type of “cook”, we will not understand changes to critical quality parameters like texture, bowl life, digestibility, and water stability.

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Strengthening food engineering education with courses on novel and emerging topics

R. Paul SINGH, Gail BORNHORST

University of California, Davis, USA

Abstract
Educating the next generation of food engineers requires that the educational curricula is appropriately updated to include courses that reflect emerging areas in the food industry. Recent advances in our understanding of food digestion in the human body and the role of food in health and nutrition are providing new opportunities in designing novel foods with unique functions. Most undergraduate curricula in food science and engineering seriously lack exposure of students to topics related to design of foods for health. The functional role of the human gastrointestinal tract in breaking down food matrices to extract nutritional compounds from the food macro- and microstructure is seldom taught in detail. However, this information is critical in the design and formulation of food products with specific health benefits. Currently, no teaching resources are available in this area. To remedy this critical deficiency, a new course is designed, aimed at senior-level undergraduate students, and focused at the interface between food science and human nutrition. In addition to the novel topics that are included for instruction, teaching and learning resources using the “flipped classroom” method are used. The instructional contents include video tutorials, virtual experiments, “what-if” simulations, questions for quizzes, and discussion topics for in-class engagement. These contents are intended to be made freely available on the Internet for any instructor interested in teaching such a course. Similar approaches may be helpful in developing future contents for other emerging fields in food engineering.

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Ultra high temperature (UHT) stability of milk protein-soy protein hydrolysate mixtures at high protein content

Jaspal SINGH[1], Sangeeta PRAKASH[1], Bhesh BHANDARI[1], Nidhi BANSAL[1]

[1] *School of Agriculture and Food Sciences, the University of Queensland, Brisbane, Australia*

Abstract
The objective of this study was to investigate the effect of addition of soy proteins on UHT stability of high milk protein beverages. There is also a lack of reported data on UHT stability of soy proteins. UHT stability of 8% protein reconstituted milk protein concentrate (8-RMPC), 8% protein soy protein hydrolysate (8-RSPH) and 8-RMPC with added 1, 2 and 3% protein RSPH (e.g. 8-RMPC+1-RSPH) was studied. Both 8-RMPC and 8-RSPH showed very high UHT stability (UHT plant run-time > 120 min). Inclusion of 1-RSPH to 8-RMPC did not affect UHT run-time (> 120 min) and overall heat transfer coefficient (OHTC). Significant drop in OHTC was observed in 8-RMPC+2-RSPH without reducing the UHT run-time below 120 min mark and required UHT processing temperatures could be maintained (143-146 ºC) throughout the UHT run. 8-RMPC+3-RSPH showed markedly reduced UHT stability, as both shorter UHT run-time (61 min) and very low OHTC values were observed, which can be attributed to formation of larger protein aggregates (D(4,3) was 7.03 and 0.46 µm for 8-RSMP+3-RSPH and 8-RSMP+2-RSPH, respectively). An increase in apparent viscosity (42.03 and 11.83 mPa.s for 8-RSMP+3-RSPH and 8-RSMP+2-RSPH, respectively) of UHT processed samples would have also induced severe fouling inside the UHT plant processing line. It can be concluded that RMPC with small, but dietary significant, amounts of RSPH can be successfully UHT processed. This knowledge can be helpful in the formulation of UHT stable dairy based high protein dispersions with added soy proteins for various food product applications.

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A Superstructure Optimization Approach for a Multiple-Stage Evaporation Process

Linh T. T. VU, Parisa A. BAHRI

Discipline of Engineering, College of Science, Health, Engineering and Education
Murdoch University, Murdoch WA 6150, Australia

Abstract
A general superstructure provides a flexible way of analyzing various process configurations or layout in a single flowsheet. Thus it can be used to assess the cost and select the best design to operate a multiple stage separator with the minimum operating cost. In this paper a super structure optimization approach is developed and implemented to a flowsheet, which consists of single-effect, double-effect and triple-effect evaporators. This super structure uses a case study of a double-effect evaporator from Aspen Modeller Customer (ACM). The evaporation method is similar to that used in the industry to recover glycol from a diluted glycol solution. Different sets of model equations have been developed for single- and triple-effect evaporators in ACM. Additionally the mathematical model of each type of these evaporators have been programmed in MATLAB for the current optimization work and control system design in the future work [2]. This paper compares the optimal result of each evaporator in each individual flowsheet then presents the formulation of the superstructure including all three types of evaporators in a single flowsheet. A splitter is added to the process to optimally distribute the glycol solution feed to each of the three evaporators. The superstructure model is formulated as a Nonlinear Programming (NLP) with the cost-related function, thus can be used to find the minimum cost of glycol recovery. The significance of the work is to facilitate the applications of the superstructure model to similar separation processes without reactions in the food industry.

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Application of GC–MS combined with chemometrics methods for assessing volatile compounds of different microbe submerged fermentation instant dark tea

Mingyue ZHANG[1], Pengpeng SONG[1], Shaozhen WANG[1], Peng XIA[1], Zhengzhu ZHANG[1], Pengxiang YUE[1], *, Xueling GAO[1], *
[1]*College of Tea & Food Science, Anhui Agricultural University, Hefei, 230036, Anhui, China*

*** Co-corresponding authors:**
E-mail address: zhonghuajwh11@163.com (Pengxiang Yue)
E-mail address: sharling@ahau.edu.cn (Xueling Gao)

Abstract
The *E. cristatum* fermentation tea (EFT), *A. niger* fermentation tea (AFT) and *E. cristatum* and *A. niger* sequential inoculation fermentation tea (EAFT) were prepared using submerged fermentation mode, the effects of three different microbe fermentation mode on volatile compounds of teas product were investigated and were compared with a green tea (GT) as an unfermented raw material. Volatile compounds of four different tea samples (EFT, AFT, EAFT and GT) were extracted by headspace-solid phase microextraction (HS-SPME), and identified using gas-chromatography–mass spectrometry (GC–MS) combined with chemometric methods. Ninety-seven volatile compounds were identified in four kinds tea samples; among them, linalool oxide, linalool oxide I and linalool oxide II were significantly high ($P < 0.05$) in AFT, whereas linalool content was significantly high ($P < 0.05$) in EFT and EAFT. Venn diagram, principal component analysis (PCA), heatmap analysis and hierarchical cluster analysis (HCA) showed that volatile compounds exhibited significant difference in 4 different tea samples. This study provides valuable suggestions and information to use microbe fermentation to modify tea volatile compounds.

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Application on olive oil by an edible packaging film based on gelatin and anthocyanins nanocomplexes

Shuo WANG[1], Guangsheng WU[1], Pengxiang YUE[1], Xueling GAO[1]
[1]*College of Tea & Food Science, Anhui Agricultural University, Hefei, 230036, Anhui, China*

Abstract
In the present work, anthocyanins (ACNs) nanocomplexes were incorporated into gelatin film forming formulations to prepare function edible packaging film. ACNs nanocomplexes were fabricated with chitosan hydrochloride (CHC) and carboxymethyl chitosan (CMC) to improve sustained-release property, stability and antioxidant activity of ACNs in vitro. The effects of ACNs nanocomplexes on the antioxidant, physical and mechanical properties of the films were studied. The results suggested that the addition of ACNs nanocomplexes increased the compactness and mechanical properties of films, whereas decreased the light transmission. Furthermore, the film based on gelatin and ACNs-loaded CHC/CMC nanocomplexes (Gel-CHC/CMC-ACNs film) significantly delayed olive oil oxidation (21.2 meq O_2/kg of peroxide value at the 56th day), when compared with the films only based on Gel film (27.8 meq O_2/kg of peroxide value at the 56th day) and the films based on ACNs (unencapsulated form) and gelatin (Gel-ACNs film, 24.3 meq O_2/kg of peroxide value at the 56th day). Thus, the addition of ACNs nanocomplexes into gelatin film could be used as an active food packaging for fatty food.

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Physicochemical changes during ageing of spray dried infant milk formula powders

A K M MASUM[1], Jayani CHANDRAPALA[1], Benu ADHIKARI[1], Thom HUPPERTZ[2] and Bogdan ZISU[1]

[1]*RMIT University, Melbourne, Australia.*
[2]*FrieslandCampina, Amersfoort, The Netherlands.*

Abstract
Infant milk formula (IMF) powders should have good physical stability and reconstitution properties in addition to meeting regulatory nutritional requirements. However, problems in powders stability may result including lactose crystallization, free fat, Maillard reactions and slow dispersion. To avoid these issues, without creating others, is a matter of balancing composition, manufacturing conditions and product-process interactions. In addition to lactose, up to 30% of total carbohydrate in IMF can be maltodextrin. This study was conducted to explore the effect of different lactose to maltodextrin ratios (L:M) on the physicochemical changes of spray dried IMF powders during ageing. Spray dried IMF powders were prepared containing 15.0% (w/w) protein, 26.0% (w/w) fat and 59.0% (w/w) carbohydrate with variation in L:M ratios (100:0, 85:15 and 70:30). Powders were analyzed for moisture content, glass transition temperature (T_g), crystallinity, surface composition, surface morphology and solubility during storage at two temperatures (25^{o}C and 40^{o}C) and three relative humidities (11%, 23% and 54% RH) for six months. Addition of maltodextrin increased the T_g and decreased the crystallinity of powders. Fat was over-represented on surface of fresh powders, followed by protein and carbohydrate, which changed during storage with further increase in surface fat and decrease in surface protein and carbohydrate. Increasing temperature and RH during storage decreased the T_g (>70^{o}C to 0^{o}C) and solubility (>90% to 20%), and increased the crystallinity, aggregation and caking. The study found that, in the presence of maltodextrin, powder's physicochemical properties and functionality are better controlled during ageing.

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The impact of submerged fermentation mode by Aspergillus niger on the physicochemical, color and antioxidant activity parameters of tea infusion

Pengpeng SONG[1], Mingyue ZHANG[1], Zhengzhu ZHANG[1], Xueling GAO[1,*], Pengxiang YUE[1,*]

1*College of Tea & Food Science, Anhui Agricultural University, Hefei, 230036, Anhui, China*

* *Co-corresponding authors:*

E-mail address: sharling@ahau.edu.cn (Xueling Gao)

E-mail address: zhonghuajwh11@163.com (Pengxiang Yue)

Abstract

In the present work, Aspergillus niger from Fu-zhuan brick tea was applied for the fermentation of green tea extract. The impact of physicochemical parameters, color attributes and the antioxidant activity (DPPH·, ABTS·$^{+}$, OH^{-} scavenging ability) of tea infusion was studied by submerged fermentation at 37 °C for 168 hours. Results showed that the ester-catechins levels gradually degraded into simple catechins and gallic acid; the caffeine contents kept stable the first 84 hours and then it gradually decreased; the color of tea infusion changed from yellow-green to orange-red, and finally to brownish red; the turbidity of tea infusion decreased to a minimum at the 24th hours and then increased gradually. A series of antioxidant capacity assays revealed that high antioxidant capacity of tea infusion was associated with the high content of gallic acid and theabrownins. The strongest ABTS·$^{+}$ scavenging activity of tea infusion was observed in fermentation of 24th hours with a highest gallic acid contents; the highest OH^{-} scavenging activity of tea infusion was appeared in fermentation of 144th hours because of a high theabrownins contents. Furthermore, we demonstrated the instant dark tea product with desirable physicochemical composition and the antioxidant capacity could be collected from different fermentation time.

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Differences of Characteristic Biogenic Amines between Grass Carp and Silver Carp Fillets during Cold Storage

Jianhui WANG, Yongsheng Zhang, Xiu WANG, Yiqun HUANG, Faxiang WANG, Xianghong LI, Jian YU, Yongle LIU

Changsha University of Science and Technology, Changsha, China

Abstract In order to investigate the change dynamics of biogenic amines, and the correlation between quality indices and characteristic biogenic amines, the changes of biogenic amine contents, pH, TVB-N, TVC and sensory evaluation of grass carp and silver carp fillets during cold storage at 4℃ were detected. The results showed that TVB-N and TVC increased with the cold storage time; the fillet contents of phenethylamine, putrescent, tyramine and the total biogenic amines in the both carps changed obviously. Contents of all the detected biogenic amines changed significantly at the 10th and 8th day in grass and silver carp fillets respectively. Significant differences ($P<0.05$) existed in putrescine and tyramine between these two kinds of carp fillets after corruption. The contents of putrescine and tyramine in grass and silver carp fillets respectively were 23.39±0.40 mg/kg and 44.46±1.88 mg/kg, 25.01±1.85 mg/kg and 50.84±1.50mg/kg at 12th day. Correlation analysis showed that quality indices were significantly correlated to phenylethylamine, putrescine, tyramine in grass carp fillets ($P<0.05$), while to phenylethylamine, putrescine, cadaverine, tyramine in silver carp fillets. Therefore, their characteristic biogenic amines could be used as quality evaluation indices accordingly. In Addition, the critical values of tyramine and the total biogenic amines were very close in these two kinds of fillets correspondingly during cold storage, which could also be used as their common quality evaluation indicators.

Keywords Grass carp fillets; Silver carp fillets; Cold storage; Characteristics of biogenic amines; Correlation analysis

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Effect of blanching process on anthocyanin profile, color and antioxidant activity of blueberry (*Vaccinium ashei*) juice

Lingli ZHANG[1, &], Guangsheng WU[1, &], Wenbo WANG[1], Junyang YUE[1], Pengxiang YUE[1], Xueling GAO[1, *]

[1]*School of Tea & Food Science, Anhui Agricultural University, Hefei, Anhui, China*

**Corresponding authors:*

Fax: 86-551-65786765, E-mail address: sharling@ahau.edu.cn (Xueling Gao)

& These authors contributed equally to this work

Abstract

The effects of hot water bath blanching and steam blanching pretreatments process were here investigated, considering on color, anthocyanin profile and antioxidant activity of blueberry (*Vaccinium ashei*) juice. The juice maximum reservation of total phenolic content, anthocyanin and antioxidant activity were observed in the steam blanching pretreatment process. Eleven anthocyanins was isolated from the blueberry juice of steam blanching process, while only 10 from hot water bath blanching and 8 from the control sample. After storage at 40°C for 10 days, the anthocyanin retention rate of the juice from steam blanching process was higher than in that from hot water bath and control sample (30.71, 23.77 and 19.91%, respectively). The antioxidant capacity was also significantly higher and the hue angle (H°) was lower in the juice from steam blanching pretreatment process. Steaming pretreatment process could well prevent color deterioration, increase variety and content of anthocyanins, and improve antioxidant activity in the blueberry juice.

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Structuring Meat through 3D Printing

Sangeeta PRAKASH
School of Agriculture & Food Sciences, The University of Queensland, Brisbane, Australia

Abstract

Three Dimensional (3D) Food Printing is potentially a “print and eat” technology for the future generation. This technology uses a computer-aided design (CAD) software to generate three-dimensional food objects. It is a breakthrough technology that is based on the additive manufacturing (AM) process capable of creating complex freeform structures through a layer-by-layer deposition of the food ingredients in paste/powder form to a predetermined layer thickness. For 3D printing, the viscosity of the paste has to be low enough to flow easily through the nozzle and high enough to maintain the deposited shape, and further support the subsequent layers on top. Meat and its by-products are fibrous materials, non-printable by nature and require the modification of their rheological and mechanical properties through the addition of flow enhancers to obtain an extrudable paste-like material that can be used for 3D printing. The layered structures during 3D food printing provides opportunities for creation of novel texture (varying infill pattern and infill percentages that controls the density of the raw materials) by manipulating the internal structures of meat to micro- and nano-scale. This study presents the use of potential viscosity enhancers (hydrocolloids and fat) that can improve the flow while extrusion, cold-set binders [Transglutaminase enzyme, calcium/alginate system, and plasma protein system (fibrinogen/thrombin)] and heat set binders (blood plasma proteins and hydrocolloids) that improve the mechanical stability during deposition. This will also highlight a range of 3D printed meat objects in relation to their microstructure that’s the key to personalized nutrition based on an individual’s diet and health status.

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Analysis of physical and chemical digestion of starch-containing hydrogels using an *in vitro* gastrointestinal method

Zaitian WANG[1,2], Hiroyuki KOZU[1], Kunihiko UEMURA[1,2], Isao KOBAYASHI[1,2],
Sosaku ICHIKAWA[1]

[1] *University of Tsukuba, Tsukuba, Japan*
[2] *Food Research Institute, NARO, Tsukuba, Japan*

Abstract
The disintegration of solid foods containing nutrients in the presence of peristalsis plays important role in their physical and chemical digestion in the human gastrointestinal tract. The objective of this study was to investigate the effect of mechanical properties of starch-containing hydrogels on their gastrointestinal digestion behavior using an *in vitro* gastrointestinal method consisting of a continuous-type Gastric Digestion Simulator (c-GDS) and a small intestinal digestion model. We prepared potato starch-containing hydrogel samples using agar (AG) and/or native-type gellan gum (NGG) as gelling agent(s). The *in vitro* gastric digestion of cubic hydrogel particles (5×5×5 mm), initially mixed with a simulated saliva fluid (pH 7) was performed (180 min, 37 ^{o}C) using the c-GDS equipped with the continuous secretion of a simulated gastric fluid (pH 1.3) and the controlled emptying of the gastric digesta. The *in vitro* small intestinal digestion of the gastric digesta was subsequently performed (120 min, 37 ^{o}C) using a test-tube shaking method. At a facture stress of about 30 kPa, the starch-containing AG hydrogel with a lower fracture strain (29.8%) was disintegrated and emptied more largely than the starch-containing AG-NGG hydrogel with a higher fracture strain (48.2%). The digested starch in the digesta emptied from the c-GDS ranged between 11% and 17%. More than 90% of the starch in the gastric digesta was hydrolyzed after the *in vitro* small intestinal digestion. Our results suggested the possibility of controlling the gastrointestinal digestibility of nutrients embedded in solid foods by adequately designing their mechanical properties.

<u>(248 words)</u>

Abstract for ICEF13

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Tribo-rheometry behaviour of κ-carrageenan and gelatin solutions under dairy conditions

Yang ZHU, Bhesh BHANDARI & Sangeeta PRAKASH
School of Agriculture & Food Sciences, The University of Queensland, Brisbane, Australia

Abstract
Hydrocolloids perform many functional roles in dairy products; therefore understanding the flow and lubrication properties of hydrocolloids that are commonly used to enhance the mouthfeel properties of various dairy products can provide valuable information to manufacturers. The current study examined the lubrication (tribology) and rheological properties of gelatin (0.2~3.0%, w/w) and κ-carrageenan (0.01~0.7%, w/w) in the concentrations ideally added in dairy products in the presence of KCl (0~0.3%, w/w) within the pH range of 4.0~8.0. Both the flow and tribological behaviours are influenced by the pH (4.0-8.0), addition of salts (0–0.3% KCl; 0–3.0% $CaCl_2$, w/w) and dosage of hydrocolloids (0.2–3.0% gelatin; 0.01–0.7% κ-carrageenan, w/w). Near its isoelectric point (pI≈5.3), gelatin solution has the lowest viscosity and lubrication property. However, κ-carrageenan solution has the highest viscosity and best lubrication behaviour at neutral pH. Adding salts improved the viscosity and tribology property of gelatin solution, while decreased the tribology property of κ-carrageenan solution to some extent. κ-carrageenan solution showed higher viscosity (> 18 mPa·s) than gelatin around the same concentration (0.2-1.0%). However, the gelatin solution exhibited better lubrication property during low and medium sliding speed.

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Ultrasound assisted low temperature drying of food materials

Henry SABAREZ[1], Piotr SWIERGON[1], Kai KNOERZER[1]

[1]*CSIRO Agriculture and Food, Melbourne, Australia*

Abstract

Many drying techniques evolved due to the need to produce high quality products that are highly heat-sensitive. Such drying systems include the utilisation of low temperatures, but these often require very long drying times, are high in energy consumption and can be detrimental to the product quality. These limitations can be overcome by the combined application of ultrasound, which has been demonstrated in previous studies to intensify the convective drying processes. However, the development of ultrasonic drying technology at an industrial scale has progressed at a slow pace due to the difficulties in achieving an efficient transmission of ultrasonic energy from the transducers to the product while ensuring easy adaptability to conventional drying processes.

In this work, an ultrasonic design based on the indirect transmission of ultrasonic energy from the emitter through to the material to be dried was investigated to assist in low temperature drying of food materials. A computer-based ultrasonic drying setup was built to allow continuous recording of the process variables in real time, which also enabled simulation of drying to be accomplished under controlled conditions over a range of drying parameters. The application of the new ultrasound design tested in this work was found to enhance the low temperature drying process by shortening the overall drying time by up to 45% (i.e., lower energy consumption and better retention of product quality). This offers a promising approach towards a better applicability of ultrasound at industrial scale, since no direct contact between the sample and the ultrasonic emitter is needed.

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Engineering cell-based microstructures to study the effect of structural complexity on *in vitro* bioaccessibility of lipophilic bioactive compounds

Yixing LU[1], Rewa RAI[1], Nitin NITIN[1]

[1]*University of California - Davis, Davis, California, USA*

Abstract
Fundamental understanding of the role of microstructural properties of food in bioaccessibility of bioactives significantly influences the design of food processes and food products. The goal of this study was to investigate the effect of structural complexity on the controlled-release of encapsulated lipophilic bioactive compound (curcumin) using a bottom-up approach. The initial "building blocks" were curcumin encapsulated in single yeast cells through a vacuum infusion process. An increasing structural complexity was achieved by forming cell clusters, followed by addition of an extracellular alginate film. To form cell clusters, yeast cells were coated using oppositely-charged polyelectrolytes through layer-by-layer deposition, and aggregated through electrostatic interaction. The cell clusters were then encapsulated in
a thin layer of calcium-crosslinked alginate film. Curcumin release was measured using sequential *in vitro*
gastric and intestinal digestion.

Cell clusters with a size range between 40~50 μm in diameter were obtained using electrostatic aided clustering of individual cells. These clusters maintained their structural stability during *in vitro* simulated digestion, but did not change the release profile of encapsulated curcumin compared to isolated cells. The addition of extracellular alginate matrix significantly ($p<0.05$) increased the retention of curcumin for both single and clustered cells. Moreover, a significant difference in released curcumin after digestion with high bile salt content (25mg/ml) was observed between clustered cells in alginate film and single cells in alginate film, indicating an interacting effect between cell clustering and addition of extracellular alginate film. These results provide a foundation for designing food products and processes with controlled release of bioactives.

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Synergistic Antimicrobial Effects of Ultrasound and Natural Compounds Against Foodborne Pathogens

Hongchao ZHANG and **Rohan V. TIKEKAR**

Department of Nutrition and Food Science, University of Maryland, College Park, Maryland 20740, United States

Abstract

Fresh produce washed with chlorine-based sanitizers are sometime ineffectively disinfected causing serious foodborne disease outbreaks. Chlorine is not stable in wash water and it can form carcinogenic by-products reacting with organic matters. Low-frequency ultrasound (20-100 kHz) and high-frequency ultrasound (1-3 MHz) are sustainable and safe processes that can inactive pathogens in water and food matrixes. Ultrasound can catalyze zinc oxide inducing a stronger synergistic antimicrobial effect. The objective of this study is to investigate the potential of using ultrasound and food grade natural antimicrobials to improve fresh produce sanitation processes.

We evaluated the inactivation capacities of 20kHz ultrasound (US20) or 1MHz ultrasound (US1) pairing with 9 selected food grade natural compounds against stationary phase *Listeria innocua* and *E. coli* K12 (10^6-10^7 CFU/mL) at the power density of 200 W/L and in 22 ± 2 □C water (containing 2-5% ethanol). Results showed that both ultrasound treatments alone did not reduce *Listeria* population ($p>0.05$). However, US20 with Carvacrol (2mM), Citral (10mM) or Geranoil (5mM) induced additional 2.5-3.0 log reductions, and US1 with Carvacrol (2mM) also induced additional 1.0 log reduction of *Listeria innocua* in 15 min comparing to sum of reductions from each single treatment. But no synergistic effects were observed when treated *E. coli.* The antimicrobial mechanism was evidenced by increased intracellular oxidative stress (CellRox), decreased intracellular pH, and changes in bacterial morphology (TEM). Findings showed that ultrasound in combination with natural antimicrobial compounds can be used as a sustainable and safe process to disinfect wash water and fresh produce.

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Effects of the Degree Maturity and the Drying Process on the Composition of the Aroma Components in Japanese Pepper (*Zanthoxylum piperitum* DC.)

Moegi HORIBE[1], Takahisa NISHIZU[1], Nakako KATSUNO[1]

[1]*Gifu University, Gifu, Japan*

Abstract
Japanese pepper (*Zanthoxylum piperitum* DC) is a common spice in Japan. Japanese peppers are dried and powdered for use, and have recently started to be used in various confectioneries. Japanese peppers from different cultivars and areas have different aromas, but the aroma components have been studied little. The aroma characteristics are expected to be different when different harvesting times and processing procedures are used, but the differences have not been clarified. The aim of this study was to clarify the effects of harvest time and processing on Japanese pepper aroma characteristics. We analyzed 36 samples of different Japanese peppers cultivated in Gifu Prefecture. The aroma components were extracted using solid-phase microextraction fibers placed in the headspace of a vial containing 2.0 g of sample for 50 min at 40 °C. The aroma components were identified by gas chromatography with flame ionization detection and gas chromatography mass spectrometry. The gas chromatography with flame ionization detection peak areas of the aroma components were assessed by principal component analysis. Citronellal, which has a distinctive aroma, was one of the Japanese pepper aroma components. There were no differences between the aroma components of Japanese peppers harvested at different times and grown at different altitudes or in different areas. However, principal component analyses indicated that peppers at different stages of maturity had different aroma components. In particular, the citronellal contribution to the aroma increased with maturity.
The citronellal content of all kinds of peppers increased when the pepper was dried.

Protein digestibility of *Arthrospira maxima* evaluated in a dynamic simulated human digestion model

Nicolás TRONCOSO-LEON[1], Gipsy TABILO-MUNIZAGA[1], Cristian AGURTO-MUÑOZ[2]

[1]*Universidad del Bío-Bío, Chillán, Chile*
[2]*Universidad de Concepción, Concepción, Chile*

Abstract

Arthrospira maxima, a blue-green microalga (Cyanobacteria), has been marketed as a food supplement due to its high protein content. The enzymatic process for protein digestion depends on dynamic pH changes at different stages in the human digestive system to reduce protein size. The objective of the present study was to evaluate the digestibility of *A. maxima* under simulated human conditions.

The protein content, amino acid profile, and lipid profile were determined. Protein digestibility was evaluated by a dynamic model that simulates human gastric and duodenal conditions. Protein degradation was measured by SDS-PAGE and particle size reduction by dynamic light scattering (DLS).

Arthrospira maxima was 52.6% proteins with 4.5% leucine content (DW). Omega-6 γ-linolenic and linoleic were identified by HPLC. The SDS-PAGE analysis showed bands at 75 and 50 kDa and one band between 20-15 kDa. The latter corresponds to the alpha and beta subunits of C-phycocyanin, a water-soluble protein. Unlike trypsin, which worked optimally at pH 6.1, pepsin reached optimum pH (2.2-1.8 range) after 1 h of digestion. Therefore, no gradual decrease was observed in band intensity during the gastric stage. However, all bands disappear after 2 h of digestion. The DLS analysis showed a 97% exponential decrease at the initial particle size in the gastric stage (R^2=0.92) and 80% in the duodenal stage (R^2=0.96).

Arthrospira maxima exhibited more than 95% digestibility. These are the first recorded results of simulated microalga protein digestibility, and are relevant given an increasing interest to use *A. maxima* as a food ingredient.

Investigation of the frozen strawberry quality prepared by freezing accompanied supercooling

Rika Kobayashi[1], Toru Suzuki[2]

[1] *College of Bioresource Science, Nihon University, Kanagawa, Japan*
[2]*. Tokyo University of Marine Science and Technology, Tokyo, Japan*

Abstract

The characteristics of ice crystals have be paid much attention during food freezing. Present studies investigated that freezing a homogeneous food such as soy bean curd using deeper supercooling conditions ("supercooled freezing method ") results in the formation of fine and homogenous ice structure.[a)] Besides, the ice crystal structure in tuna meat frozen by supercooled freezing method inhomogeneous ice structures, since ice crystal have grown parallel with the myofibers affected by the cellular structure of it.[b)] Namely effect of supercooled freezing method on frozen food quality may be depends on a cell structure of foods. In this study, ice crystals, texture, drip loss, and microstructural changes were measured in frozen-thawed strawberries prepared by supercooled freezing. The results showed, although supercooled freezing has the potential to form finer ice crystals in strawberry tissues, the quality of frozen strawberries was not improved compared with conventional slow freezing. It assumed that a higher and momently ice nucleation caused by supercooling was promoted a drastic water migration and huge degradation on strawberry cells by osmotic pressure in the frozen strawberries.[c)]

a) R. Kobayashi, et al 2014. Proc.3rd IIR ICCC, London, UK. 174 of Reference number.
b) R. Kobayashi, et al 2015. Int. J. Refrig. 60, 270–277.
c) R. Kobayashi, et al 2018. Int. J. Refrig. In press.

High hydrodynamic pressure generated with electricity and detonation tenderises various beef, chicken and pork, but not turkey muscles

Robyn WARNER[1], Jim CLAUS[2], Long HUYNH[3], Michael LEE[4], Minh HA[1]

[1]University of Melbourne, Parkville, Vic., Australia
[2]University of Wisconsin, Madison, WI, USA
[3]Meat and Livestock Australia, Sydney, NSW, Australia
[4]Meat and Livestock Australia, Brisbane, Qld, Australia

Abstract
Quality assurance systems in the meat industry focus on controlling, and reducing, the toughness of muscles. Application of high hydrodynamic pressure (HHP, also called shockwave) to meat for tenderisation has potential to add value. HHP involves the application of high pressure waves, generated either through detonation (explosives) or more recently, through electrical discharge. Peak shear force (PSF, N), a measure of meat tenderness, was collated from 21 HHP studies and 67 experimental treatments. HHP was applied to muscles from various species and muscles. The change in PSF in response to the application of HHP was expressed relative to control, variation was standardised to standard error and data was subjected to meta-analysis. There was an interaction between muscles, species and type of HHP in the effect on the change in PSF in response to the application of HHP ($P<0.001$, average SED = 3.079). For beef, explosive-generated HHP resulted in greater tenderization in the *semimembranosus* (31.14 N) compared to electrical-generated HHP (10.35 N). Whereas for pork *longissimus*, tenderization was equivalent between explosive- and electrical- (5.33, 11.77 N respectively). For turkey *pectoralis major,* there was no tenderisation with either form of HHP (2.90, 3.90 N respectively) although chicken *pectoralis major* showed substantial tenderization in response to electrical HHP (18.23 N). For explosive HHP, the ‘toughest’ muscle *semimembranosus* showed higher tenderization than the naturally more tender *longissimus* (31.13, 11.322 N respectively) and there was significant variation between muscles. In conclusion, HHP shows some potential for application in the meat industry for meat tenderization.

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Effect of fat globule size on whippability of dairy creams

Pramesh DHUNGANA[1], Tuyen TRUONG[1 2], Nidhi BANSAL[1], Bhesh BHANDARI[1]

[1]*ARC Dairy Innovation Hub, School of Agriculture and Food Sciences, The University of Queensland, Brisbane, Australia*
[2]*School of Science, RMIT University, Melbourne, Australia*

Abstract
The present study reveals the effect of fat globule size on whipping and rheological properties of native and homogenised creams each of 36% (w/w) fat content. Average fat globule size (D [4,3]) used for the experiments were 2.5, 4.3 and 4.8 µm for freshly prepared native creams and ~1.5,~2.5,~3.5 and~4.2 µm for homogenized creams. Effect of fat globule size was examined at two levels of serum protein contents of 2.2 and 2.5% (w/w) for homogenized cream and results were compared with market native cream at the same protein levels.

A significant effect of average fat globule size on whipping and rheological properties of freshly prepared native creams with no added-protein (2.0%, w/w) was observed. Increase in fat globule size decreased whipping time, overrun and increased storage modulus. Whipping time, overrun and storage modulus at 5 min for 2.6, 4.3 and 4.8 µm size freshly prepared native creams were 265, 202 and 153 seconds; 119.3, 108.8 and 102.7%; and 16409, 24273 and 26816 Pa respectively. In contrast, at a given serum-protein level, increase in average fat globule size increased the whipping time and storage modulus, and decreased overrun of the whipped cream prepared from homogenized creams. Increase in protein content also increased whipping time and overrun of homogenized creams.

Addition of protein on market native cream resulted in increased whipping time, overrun, and serum drainage and decreased storage modulus. Similarly, addition of Tween-80 on homogenized creams decreased whipping time, overrun and increased storage modulus.

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Opportunities in nut shells and woods: cost-effective, durable, and smart lignin-based materials for food packaging

Farshad OVEISSI[1,2], Sina NAFICY[1,2], Fariba DEHGHANI[1,2]

[1]*Centre for Excellence in Advanced Food Enginomics, The University of Sydney, Sydney, Australia*
[2]*School of Chemical and Biomolecular Engineering, The University of Sydney, Sydney, Australia*

Abstract

With the increase in health and economy concerns, there is a great demand for using cost-effective and natural additives in edible packaging materials. Additionally, smart food packaging with integrated gas-sensors for identifying food spoilage is emerging. Despite all the progresses made in this filed, most suggested materials for food packaging are often associated with tedious multi-step processes and high-cost ingredients. Lignin is a natural macromolecule that is generously distributed in woods, nut shells, and sugar canes. Merging lignin with other polymers has been proven to be challenging because of its poor dispersibility and fragile properties. In this study, we introduced purified lignin ($0.5/kg) to hydrophilic polyurethane (HPU) through a facile one-pot fabrication. The fabricated lignin|HPU was highly durable and had toughness of 2050 J m^{-2} and Young's modulus of 2.62 MPa. Lignin|HPU composites were also sensitive to CO_2 - a gas that is often produced during fruits and vegetable spoilage. The fabricated films had antimicrobial properties and were biocompatible to human dermal cells. Our lignin|HPU composites were easily processible by various techniques, such as fiber spinning, casting, and 3D printing. Making these cost-effective materials for food packaging through our sustainable approach provides ample opportunities for the next generation of food packaging.

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Development of sorghum grain tea: investigating the effect of processing on sorghum grain tea during the tea production

Yun XIONG[1], Pangzhen ZHANG[1], Jiaqian LUO[1], Stuart JOHNSON[2], Zhongxiang FANG[1]

[1]*School of Agriculture and Food, Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Melbourne, Australia*
[2]*School of Molecular and Life Sciences, Curtin Health Innovation Research Institute, Curtin University, Perth, Australia*

Abstract
Sorghum grain is rich in phenolic compounds such as phenolic acids, flavonoids and condensed tannins and it is associated with many health benefits. It has huge potential to be developed into functional food such as sorghum grain tea beverage. In this work, we made sorghum grain tea through three consecutive processes: soaking, steaming and roasting, and investigated the effect of processing techniques on the phenolic contents, antioxidant activity, and volatile compounds of three colour sorghum varieties (white, red and black). Processing had a significant effect on phenolic content and antioxidant activity in sorghum, but the effect varied among sorghum varieties. The phenolic contents and antioxidant activity in these three color sorghum varieties were in the order of black > red > white. The detected volatile compounds include alcohols, alkanes, aldehydes, carboxylic acids, esters, ketones, pyrazines and phenylenediamine. Processing had a significant influence on the volatile compounds in sorghum especially the ester, pyrazine, phenylenediamine contents. The abundance and diversity of the volatile compounds in these three sorghum varieties were, however, in the order of: white > red > black. This work provides insights into this novel sorghum grain tea product and is first of its kind to report the volatile profile. The findings of this research have potential to expand human consumption of sorghum grain in the new form of grain tea.

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Printed, flexible pH sensors for wet environments in food application

Sina NAFICY, Farshad OVEISSI, Bianca Patrick, Fariba DEHGHANI
School of Chemical and Biomolecular Engineering, The University of Sydney, Sydney, Australia

Abstract

Current sensors for monitoring environmental signals, such as pH, are often made from rigid materials that are incompatible with flexible food packaging. Moreover, the incompatibility of such materials with water sets practical limitations on the in situ utilisation of sensors under wet conditions or at 100% RH. Here, we demonstrate an elegant approach for rapid manufacturing of highly flexible pH-sensitive films based on poly(3,4-ethylenedioxy thiophene) (PEDOT) doped with negatively charged poly(styrenesulfonate) (PSS) and robust hydrophilic polyurethanes (HPU). PEDOT that is p-doped with PSS is a hole conductor material. Given the complex nature of PEDOT:PSS, its electronic characteristics are sensitive to pH. By optimising the composition of the PEDOT:PSS-HPU inks, we were able to utilise printing for the fabrication of pH sensitive PEDOT:PSS-HPU sensors on plastic films in one step. A linear and reversible correlation between the conductivity of PEDOT:PSS-HPU film sensors in water and the pH was observed, which is attributed to the pH-sensitivity of the PEDOT:PSS element. The electrical resistance of film sensors was not affected by extreme bending and twisting, and consecutive tensile cycling – up to 400 cycles of 50% extension. Moreover, the film pH sensors remained functional after two months of storage in Milli-Q water.

This facile technique can be exploited to develop a wide range of highly flexible sensors and electronics that can be embedded in food packaging for direct monitoring of food spoilage.

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Influence of meat texture on the oral processing and bolus formation

Nelum PEMATILLEKE[1], Benu ADHIKARI[1], Mandeep KAUR[1], Peter TORLEY[1]

[1] *Biosciences and Food Technology Discipline, School of Science, RMIT University, Melbourne, Australia*

Abstract

When aging is associated with impaired mastication and difficulties in swallowing, meat is usually found among the most rejected food. Therefore, the meat, most importantly its texture should be looked into to make it suitable for the consumption of elderly population. Texture perception changes during oral processing, where initial phase changes are dominated by the bulk phase-rheological deformations and later stages by the surface tribological properties of the food bolus (Chen & Stokes, 2012). Mastication and saliva incorporation are two major aspects of oral processing which can be used to evaluate the texture perception of food. This study aimed to investigate oral responses of healthy individuals during meat chewing cooked to different textures using tribological measurements. Mastication variables (number of chews and duration) were recorded during the chewing process and boluses were collected and analysed for saliva impregnation and particle size distribution. Increasing hardness of meat with cooking did not change the number or duration of chewing cycles, but significantly increased the particle breakdown ($P<0.05$). Resulting in more saliva being required to agglomerate harder particles in order to make a safe swallow cohesive bolus. Two different groups were identified in relation to meat texture responses. where one group could swallow less fragmented muscle fibers with less saliva incorporated and the other group highly fragmented fibers with more saliva incorporated indicating inter-individual variability in bolus formation. The findings of this study will help in improving the quality of texture modified meat products.

Chen, J., & Stokes, J. R. (2012). Rheology and tribology: Two distinctive regimes of food texture sensation. Trends in Food Science and Technology, 25(1), 4-12. doi: 10.1016/j.tifs.2011.11.006

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Challenges in development of extruded functional foods for improved food and nutritional security

Danyang Ying, Luz Sanguansri, Mary Ann Augustin

CSIRO Agriculture and Food, 671 Sneydes Road, Werribee, VIC 3030, Australia,

Abstract

Extrusion is a versatile and economic process that has potential to be exploited in the development of functional food ingredients and products from conventional raw ingredients as well as edible agricultural waste streams. By pre-processing (e.g. heat treatment, drying) of waste streams from fruit and vegetable processing to stabilise nutrients using heat treatment and drying prior to extrusion, consumer acceptable shelf-stable extruded nutritious snack products containing high content of fruit and vegetables (≥20%) have been produced. It is a challenge to retain some sensitive bioactive components whilst achieving desirable organoleptic and physical properties of the extruded products. However, by judicious formulation, including the use of appropriate delivery systems to stabilise sensitive bioactive components (e.g. polyunsaturated oils, carotenes, polyphenols) during the high pressure and temperature experienced during extrusion, it is possible to improve retention of bioactives in the extruded products. Extrusion has also been used to improve potential bioavailability of nutrients, as demonstrated in *in vitro* experiments. Examples include use of appropriate formulation and processing variables for producing (i) canola meal-based ingredients with higher *in vitro* protein digestibility, and (ii) high-fibre low sugar apple pomace ingredients with improved *in vitro* antioxidant capacity. The ability to utilise edible food waste for production and stabilise sensitive bioactive components enables production of nutritious shelf-stable products and is a step towards improving the food and nutritional security.

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Comparative study of supercooling freezing with conventional freezing on the pork meat with various storage periods

Rajib Lochan POUDYAL[1], Manabu WATANABE[1], Toru SUZUKI[1]

[1]*Tokyo University of Marine Science and Technology, Tokyo, Japan*

Abstract
Supercooling freezing is the food preservation technique which has the potential to reduce the ice crystals sizes compared to a commercial freezing method and have the ability to improve the quality of foods after thawing. In the supercooling freezing process, the samples were cooled in the static air at atmospheric pressure to reach the subzero temperature with maintaining supercooling state. After spontaneously breaking of supercooling, the sample was transferred to different storage conditions for frozen storage. Similarly, in the conventional freezing process, static air freezing was applied for both slow and rapid freezing. After freezing, samples were stored in three different storage conditions; -15 °C, -25 °C, -60 °C, for the three month storage as long. The pH, color, texture, drip, and microstructure were analyzed after the several different storage periods. The non-frozen fresh sample stored at 4 °C was used as a control. The result indicated that supercooling freezing had a good influence to reduce the sizes of ice-crystals as well as better preserve color, texture and lower the drip loss than conventional freezing.

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Sweet Potato Starch as a Structural Enhancer for 3D Printing of Surimi

Xiuping DONG[1, 2,] Ying HUANG[1, 2], Sangeeta PRAKASH[3], Yuxi PAN[1, 2], Beiwei ZHU[1, 2]

[1] *School of Food Science and Technology, Dalian Polytechnic University, Dalian, PR China.*
[2] *National Engineering Research Center of Seafood, Dalian, PR China*
[3] *School of Agriculture and Food Sciences, The University of Queensland, Brisbane, Australia*

Abstract

The development and manufacturing of food with Three Dimensional Printing (3DP) technology has potential to create and produce food in a more advanced format that will be a new paradigm shift in the food industry. Through 3D printing, personalized food can be created in terms of texture and nutritional composition. Surimi is a very popular product in Asian countries with a potential to be converted into personalized food through 3DP. 3DP of surimi requires a structural modifier to achieve a stable construct. Hence this study investigated the effect of addition of the structural modifier viz. sweet potato starch (0-10 % w/w) on the physical properties [flow and gel strength behaviour, water holding capacity (WHC) and microstructure] of surimi gel and the 3D printability of these gels. The flow results indicated a pseudoplastic behaviour of the surimi-starch mixture. As the starch content increased, the viscosity of the starch-surimi mixture decreased facilitating the flow of the surimi out of the printer nozzle. The 3D printed construct of surimi gel containing 8 % (w/w) sweet potato starch showed a good gel strength (1399g), WHC (72.7), microstructure and less cooking loss (6.76 %). The comparison of traditional method of surimi preparation with 3D printing showed that surimi gel prepared by 3D printed construct was softer in gel strength and lower in hardness showing slightly higher cooking loss and lower water holding capacity than the conventional product. The results suggested that sweet potato starch can be effectively used as a rheology modifier for 3D printing and a structural enhancer for 3D printed surimi.

Adverse effects of fluorescent carbon dots from canned yellow croaker on cellular respiration and glycolysis

Mingqian TAN,[1,2] Dongmei LI[1,2]

[1.] School of Food Science and Technology Polytechnic University, Qinggongyuan1, Ganjingzi District, Dalian 116034, Liaoning, People's Republic of China.
[2].National Engineering Research Center of Seafood, Dalian 116034, Liaoning, People's Republic of China.

Abstract
The effect of endogenous carbon nanoparticles from food sources is one of the hot topics in current food research fields. The relationship between the foodborne nanoparticle properties and the cytotoxic mechanism have been insufficiently studied. In this work, carbon dots (CDs) with strong fluorescence were found and purified from canned yellow croaker, and their cytotoxicity was investigated for the first time. The canned yellow croaker CDs are nearly spherical with a particle size distribution in the range of 1.8−5.8 nm. The fluorescence quantum yield of the isolated CDs is 9.7% the maximum excitation wavelength is 340 nm, and with a significant redshift phenomenon in fluorescence spectra. The surface element analysis showed that the composition of the canned yellow croaker CDs was C (76.42%), N (6.49%), O (16.7%), and various functional groups are on the surface. The CDs have good stability in sodium chloride solution and the fluorescence intensity was stable within the pH value of 4 to 10. Strong fluorescence quenching effect was found upon the addition of Cu2 + and Fe3 + to the CD aqueous solution. The CDs can easily enter the interior of the live cells. Moreover, a concentration-dependent behavior of HepG2 cell viability was found when the cells were incubated with the canned yellow croaker CDs. Glycolysis and mitochondrial function analysis of HepG2 cells revealed that both of the extracellular acidification rate and oxygen consumption rate were significantly decreased in contrast to the normal level prior to the addition of CDs. In addition, the CDs significantly inhibited the glycolytic pathway by reducing the activity of key enzyme of hexokinase and pyruvate kinase in glycolytic pathway.

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Modelling as a tool to link food structure breakdown to sensory experience and digestion.

John E BRONLUND[1,2], Muhammad HOW[1,2], Eli GRAY-STUART[1], Jim JONES[1], Marco P. MORGENSTERN[2,3]

[1]*Massey University, Palmerston North, New Zealand*
[2]*Riddet Institute, Palmerston North, New Zealand*
[3]*NZ Institute for Plant and Food Research, Lincoln, New Zealand*

Food properties, portion size and oral physiology, all influence oral processing and the rate of food breakdown in the mouth. The changing structure of the food bolus and addition of saliva during chewing controls the rates and extent of taste and aroma compound release from the food, influencing the sensory experience of eating. The resulting structure at swallow point has implications on gastric digestion and nutrient release. Development of mechanistic models for oral processing provides tools to explore these interactions and can lead to the development of foods for sensorial and digestive outcomes.

We present a hierarchical framework for model development to link food to oral processing behaviour. Of key importance is the mixing and selection of food for occlusion. Once selected, mechanical damage to the structure will result in work softening, particle size reduction and/or pasting. Saliva uptake affects bolus adhesion and intra-bolus cohesion, may lead to particle softening and salivary amylase derived starch hydrolysis may change interstitial fluid viscosity. The changing interfacial areas and volume ratios between food, saliva and air influence aroma release and perception.

Example models are used to demonstrate implementation of the proposed framework to real food systems to predict particle size change, bolus saturation, taste and flavor release during chewing.

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The use of oral processing models for food design.

John E BRONLUND[1,2], Muhammad HOW, Eli GRAY-STUART[1], Jim JONES[1], Marco P. MORGENSTERN[2,3]

[1]*Massey University, Palmerston North, New Zealand*
[2]*Riddet Institute, Palmerston North, New Zealand*
[3]*NZ Institute for Plant and Food Research, Lincoln, New Zealand*

It has been shown through experimental trials that the way a food is eaten can directly influence the rate of digestion. Even something as simple as the portion size per mouthful, or how much water is present, can influence digesting outcomes such as glycemic response. Because of the number of sub-processes occurring during chewing and their interactions, it can be difficult to explain these observations. Mathematical modelling can be used as a tool to resolve interactions and can lead to the design of food to achieve desired digestion outcomes.

As an example of the utility of this approach, we present a model for the structural and compositional changes occurring during chewing of rice. The model is used to predict particle size, pasted starch and saliva content of the bolus as a function of chew number. The influence of portion size per mouthful and initial water content (e.g. from relatively dry steamed rice through to eating rice in a curry) and oral physiology (e.g. salivary flowrate) will be explored. Using these models we test hypotheses on how oral processing is adapted to achieve a bolus suitable to swallow and the likely impact on the resulting interfacial area available for gastric digestion.

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Improving the thermal stability of *Lactobacillus rhamnosus* GG and *Bifidobacterium animalis* subsp. *lactis* using microencapsulation in dairy processing.

Naomi VINDEN[1], Lai TRAN[1], Yong WANG[2] and Bhesh BHANDARI[1]
[1]*The University of Queensland, St Lucia, Australia*
[2]*COFCO NHRI, PR China.*

Abstract
Probiotic foods are growing in demand due to the reported health benefits that probiotic bacteria provide once they reach the large intestine. Therefore development of food products with the required numbers of viable bacteria is becoming increasingly important. Thermal treatment of food such as pasteurization is one of the most common methods to ensure a safe and stable food product. However, it has the unfortunate side effect of killing the beneficial probiotic bacteria. It has already been determined that microencapsulation is a tool which can protect probiotics during transit in the gastro-intestinal system, so it has been hypothesized that microencapsulation of probiotics prior to a thermal treatment will provide protection against thermal death, leading to an increase in viable probiotic bacteria available to the consumer. Two probiotic strains, *Lactobacillus rhamnosus* GG (LGG) and *Bifidobacterium animalis* subsp. *lactis* (BB12) have been microencapsulated using an emulsion based system and then subjected to various high temperature/short time thermal treatments. Microencapsulation of the probiotic bacteria led to a significant increase in viable probiotic numbers after a 30 second treatment at 75°C, with an increase of 1.2×10^7 CFU/g and 3.0×10^5 CFU/g for LGG and BB12 respectively, compared to zero viable free cell colonies. This could lead to the potential of new and improved food products. These products will have higher viable probiotic numbers, providing the consumer with the health benefits associated with the consumption of probiotics.

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Hardness and Syneresis of Alginate-protein Composite Gels

Tezar RAMDHAN[1], Su Hung CHING[2], Sangeeta PRAKASH[1], Bhesh BHANDARI[1]

[1]School of Agriculture and Food Sciences, The University of Queensland, Brisbane, Queensland 4072, Australia.
[2]Progel Pty. Ltd., Level 7, GP South, Staff House Road, The University of Queensland, Brisbane, Queensland 4071, Australia.

Abstract

This study investigated the effects of milk protein concentrate 85% (MPC85) (untreated, rennet treated, and high heat treated (80 ^{0}C, 30 minutes)) addition (66.6 % w/w of total solids) on the hardness and syneresis of sodium alginate (2 % w/w) composite gels. The results showed that the addition of both untreated and treated milk proteins reduced the hardness and stiffness of the alginate gels. Untreated milk protein and high heat treated milk proteins caused no effect on syneresis of alginate gels. Only the addition of rennet treated milk protein reduced (by 21.9 %) significantly ($P<0.05$) the syneresis of composite gels.

Similarly, only the addition of rennet treated protein could reduce (by 18.7 %) the degree of syneresis of the alginate composite gels after the incubation in simulated gastric fluid (SGF). After incubation in simulated intestinal fluid, the gel containing alginate only swelled while the gels containing rennet treated MPC swelled and at the same time eroded. Meanwhile, the presence of untreated milk and high heat treated milk caused the composite gels to be easily eroded in SIF, resulting in a severe weight loss.

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Development and characterization of a seaweed based snack using *Ulva fasciata* in Sri Lanka.

Mayushi Malshika JAYAKODY[1], Mihiri Priyanwadha Gunathilake VANNIARACHCHY[1], Isuru. WIJESEKARA[1]
[1]*Department of Food Science & Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka*

Sri Lanka is rich with an abundant growth of seaweeds. Due to the unawareness of health benefits of seaweed consumption, it is an underutilized marine resource in Sri Lanka. Thus the research aims to develop a seaweed based snack using *Ulva fasciata* to popularize seaweed consumption in the country. *Ulva fasciata* samples for the study were collected from Matara, Sri Lanka (Latitude: 5°56'53.74" (5.948262) north and Longitude: 80°28'17.71" (80.471588) east). The snack was developed by enhancing the flavor of *Ulva fasciata* sheet which was developed by traditional nori making technique with ginger oleoresin which is appealing to the Sri Lankan taste. The study resulted a processed snack with L* a* b*values 29.28 ± 1.14, -6.16 ± 0.25, 12.52 ± 0.81 respectively and a hardness of (g) 17.50 ± 6.45. The moisture content (%), total fat content (%), protein content (%) and ash content (%) of the snack was determined according to the AOAC procedures and resulted 12.52 ± 0.48, 0.26 ± 0.042, 19.18 ± 0.53 and 13.91 ± 0.46 respectively. Total carbohydrate content (%) was analyzed according to the Dubois method and recorded as 9.48 ± 0.14. The arithmetic difference was taken to determine the total fibre content (%) which was recorded as 44.64 ± 0.23. The elemental composition of the processed snack was determined by X- ray fluorescence elemental analysis. The results recorded a significantly high content (ppm) of Calcium 13700 ± 707 in the processed snack. As the final outcome a nutritious seaweed snack was developed.

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High pressure thermal processing – Modelling case studies

Kai KNOERZER

CSIRO Agriculture and Food, Werribee, Victoria, Australia

Abstract

Innovative food processing technologies, such as high pressure processing (at low and high temperatures), can be applied to manufacture safe foods with improved sensory and nutritional properties. High pressure processing (HPP) can play an important role towards satisfying consumer demand for safe and innovative food products.

The design, application and optimisation of suitable equipment, and the selection of process conditions for this technology require further knowledge development. Computational Fluid Dynamics (CFD) has been established as a tool for characterising, improving and optimising traditional food processing technologies; innovative technologies, however, provide additional complexity and challenges because of the interacting Multiphysics phenomena.

The presentation will briefly discuss the basics of the technology, followed by case studies highlighting the development and implementation of models developed in COMSOL Multiphysics, and the results obtained from the models, including the validation of predicted process variables. Further case studies include the prediction of microbial spore inactivation as well as utilization of the models for equipment optimization.

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Characterising the textural properties of beef boluses using instrumental techniques through oral processing

Esther ONGUTA[1,2,4], Eli GRAY-STUART[2], Joanne HORT[1,2,4], Lovedeep KAUR[1,2], Marco P. MORGENSTERN[1,3] and John BRONLUND[1,2]

[1]*Riddet Institute, Palmerston North, New Zealand*
[2]*Massey University, Palmerston North, New Zealand*
[3]*NZ Institute for Plant and Food Research, Lincoln, New Zealand*
[4]*Food Experience and Sensory Testing Lab (FEAST), Palmerston North, New Zealand*

Structure breakdown from chewing, lubrication of food particles from saliva and bolus formation are key steps in oral processing, eventually leading to swallowing and subsequent digestion processes. Factors such as shape and size, rate of breakdown, texture and flavour combine to influence the sensorial experience and digestibility of food. Changes to particle size distribution is commonly used to characterise structural breakdown of foods during chewing. For non-fracturable foods such as meat however, this is not relevant and alternative approaches, such as textural measurement must be used.

A range of instrumental methods exist that can be potentially applied to measure the texture of boluses. Key to the selection of an appropriate method is the ability to normalize samples as bolus mass, volume and shape all vary significantly over the duration of oral processing. This work compares the use of a compression test and a slip extrusion test to characterise the textural changes of beef bolus samples during chewing. The presented work will; 1) outline the methodology used to normalize bolus samples to account for variation, and 2) explore and compare the instrumental textural changes occurring through oral processing using each method. This research is part of a larger project that aims to link the structure of protein rich foods to digestibility and temporal sensory experience through oral processing.

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Measuring freezer burn of foods by X-ray computed tomography

Gabsoo DO[1], Sadanori SASE[1], Rika KOBAYASHI[1], Masugu SATO[2]

[1]*College of Bioresource Sciences Nihon University, Kanagawa, Japan*
[2]*Japan Synchrotron Radiation Research Institute, Hyogo, Japan*

Drying of frozen foods occurs on the surface through water-vapor pressure differences between the surrounding air and the frozen food surface caused by temperature fluctuations in the freezer. This drying of frozen food leads to freezer burn. This drying of frozen food leads to freezer burn. As ice crystals are sublimating, the dry solid content of the porous dried layer will increase with drying of the frozen layer composed of ice crystals and concentration layer. The objective of this work was to examine the dried and frozen layers of heat-shocked frozen foods using X-ray computed tomography (CT) with synchrotron radiation to estimate the freezer burn of frozen food. Samples were obtained from commercially available udon noodles, and were heat-shocked within the range of −20 to −10°C/h for 1, 3, 7, and 21 days. Water content of the heat-shocked samples was measured using an atmospheric heat-drying method. The X-ray energy was adjusted to 12.4 keV. Temperature of sample was maintained at about −30 °C by blowing liquid nitrogen. The dried layer and frozen layer in heat shocked samples were identified by the distribution of linear X-ray attenuation coefficients in CT images. Results showed that the thickness of the dried layer was 0.04 mm, 0.08 mm, 0.44 mm, and 1.47 mm after heat-shock of 1, 3, 7, and 21 days, respectively.

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Sensory evaluation and consumer perception of 3D printed dark chocolate

Sylvester MANTIHAL[1], Sangeeta PRAKASH[1], Bhesh BHANDARI[1]

[1]*School of Agriculture and Food Sciences, The University of Queensland, Brisbane, Australia*

Abstract
3D printing can be utilized to manipulate food texture by modifying infill structure. The aim of this study was to assess the consumers' preferences for 3D printed chocolate. Two sets of samples were prepared for sensory evaluation by ranking and paired preference. In the first test, the panelists ranked their overall preference from among the three samples of chocolate printed with honeycomb pattern of infill with 25%, 50% and 100% percentages, respectively. The panelists also ranked the samples for their preference for appearance and hardness. In the second test, the panelists voted their preference between 3D printed samples (100% infill percentage) and cast commercial chocolate. Friedman test indicated that there was no significant difference in overall preferences and preference for hardness although the panelists significantly preferred the appearance of samples with 25% and 50% over 100% infill percentage. Further, there was no significant difference in preference between the cast and 100% infill samples. Texture data of the chocolate samples showed a higher force was required to break the chocolate samples as the infill percentage increased from 25% (24.7 ± 8.6 N) to 100% (54.5 ± 3.7 N). A total of 244 consumers assessed the samples for their intricate design and novel technology concept through a questionnaire. There was awareness of the technology among the consumers who were impressed with the 3D printed constructs. The results obtained from this study provide useful insight into consumer's perception of 3D food printing that will be beneficial to promote their use in food industry.

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Abstract title: **New technology driving energy efficiency in snack processing**

Authors: Mick WALSH

Abstract text

The frying of snack food is a high consumer of energy due to the process of dehydrating products by evaporating moisture. This is done in ovens and fryers typically powered by the combustion of natural gas, ranging in size from 1MW to 10MW, making a significant target for fuel cost and emission reduction. To achieve the lowest possible energy use, you can make the heat source as efficient as possible and reusing energy through cascading re-use or other co-located energy consumers.

Up to 90 per cent of the energy input as heat is available for recapture in the form of steam from the process exhaust. Some of the issues which can occur as part of this process include entrained air, oil vapour and other contaminants from the product. Constant innovation in energy efficiency has created integrated solutions to solve these issues.

CFD analysis of product and steam flows can reduce heat losses and energy use. Tailored solutions are developed using devices such as air-locks to manage air entrainment.
Our KleenHeat technology provides pollution control with the lowest fuel consumption due to energy cascading – Incineration, Oil Heating, CAPS, SHRS (blanching).

Bespoke heat recovery systems have been engineered to power up-stream processes, such as drying and blanching, as well as co-users such as absorption chillers for office air conditioning.
Higher efficiency cooking oil heaters using analytical design optimisation can save 10-20 per cent fuel compared to industry standard processes.

Horticultural produce simulator design: a case study applied to precooling

Huijian HUANG1,2, Mark C TUNNICLIFFE3, Young-Min Shim2, John E BRONLUND1

1 Department of Chemical and Bioprocess Engineering, Massey University, Palmerston North, New Zealand
2 Massey AgriTech Partnership, Massey University, Palmerston North, New Zealand
3 Department of Operations and Engineering Management, Massey University, Palmerston North, New Zealand

Abstract

A horticultural produce simulator is a replacement for real produce in an experiment. Produce cooling studies are carried out to optimise process operation, evaluate new packaging designs or to quantify variability. Many of these studies have reported limitations and difficulties in using real produce in experiments. Although mathematical modeling approach can be used as an alternative option to experimental work, computational limitations, modeling uncertainties and the need for validation mean that experiment work is still required.

A range of simulators have been developed by different research groups, but no generalized systematic process has been proposed for their design. In these studies, the developed simulator tends to be unique only for the study context, and therefore different produce simulators might be needed for other experimental conditions or applications.

This study is to determine the important factors for a produce simulator development via the case study of bulk kiwifruit forced-air cooling. The key functional properties, and their values needed to mimic real fruit response in the application were identified. From this fruit simulators were designed through consideration of geometry, materials selection, manufacturing methodologies and cost. Validation experiments were carried out for relevant real world scenarios to compare simulated and real fruit cooling performance. A design framework for produce simulator development is proposed based on this study.

Process Damping on S-Domain Stability Analysis of a Turning Tool

Chukwuneke J. L.[1,a)], Izuka C. O.[1,b)] and Omenyi S. N.[1,c)]
[1] Department of Mechanical Engineering, Nnamdi Azikiwe University, PMB 5025 Awka, Nigeria.

[a)]Corresponding author: jl.chukwuneke@unizik.edu.ng
[b)]izukaibe@yahoo.com
[c)]sam.omenyi@unizik.edu.ng

Abstract. This work involved S-domain stability analysis of a turning tool with process damping. Process damping is a phenomenon of dry friction between the tool flank face and workpiece which induces high stability and smoothness at low turning speed. A pair of valid equations for stability analysis of turning with process damping was derived in this work using Laplace transformation method. This work for the first time introduced non-linear feed term in the existing process damping model leading to process damping force of form where is process damping force model in a related literature. It is seen that in light of experiments of the related literature, the new proposal can only be valid for low values of in the neighbourhood of 0.01. MATLAB delay differential equation solver called dde23 was used to simulate vibration response of turning processes at selected points on the stability diagram of turning with and without process damping. This helped in confirming that stable points in stability diagram of turning with process damping became unstable points in stability diagram of turning without process damping. The stability was much higher at low speed of 200rpm than at speed of 4000rpm.

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Modelling ultrasound processing based on acoustic cavitation

Francisco TRUJILLO[1]

[1]*University of New South Wales, Sydney, Australia*

Abstract

Ultrasound is an extensively researched technology that has found multiple applications for food processing. However, most of those applications have been performed in lab scale equipment and have not been able to be scaled up due to the lack of understanding and the development of reliable mathematical models that can predict the complex interactions, happening at different time and special scales, between the sound fields, the fluid flow, and the particles, droplets and bubbles within the food system. For instance, pressure waves expand and compress microsized acoustic bubbles which, depending on the pressure amplitude, may violently collapse and subsequently rebound in a single period. On the other hand, oscillating acoustic bubbles strongly attenuate the acoustic field inducing acoustic streaming that governs the hydrodynamic behavior within the time and spatial scales of the acoustic vessel. Furthermore, the formation of standing waves produce regions of maximal or minimal pressure amplitude on which bubbles, particles or droplets move towards them due to Bjerknes forces.

One of the objectives of modeling sonochemical reactors is predicting the pressure and acoustic intensity distribution to optimize and scale up the food processing operation. However, until recently, this was achieved due to simplifications imposed on current models. This presentation will explain recent advances on the nonlinear theory of sound transmission thought cavitating bubbly liquids, which allows for modeling more accurately the sound field, acoustic streaming and the formation of Bjerknes forces.

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High pressure processing improves quality and storage stability of sodium-reduced chicken sausages

Ying ZHOU[1,2], Sofia Kihlman OISETH [2], Anita SIKES[3], Conggui CHEN[1], Roman BUCKOW [2*]

[1] *Hefei University of Technology, Hefei 230009, China*

[2] *CSIRO Agriculture and Food, 671 Sneydes Road, Werribee, VIC 3030, Australia*

[3] *CSIRO Agriculture and Food, 39 Kessels Road, Coopers Plains, Queensland 4108, Australia*

Abstract：

High sodium intake has been linked to increased risk of chronic diseases. Sodium reduction has been recognized by the meat industry as an important driver for its customers. Replacing sodium by potassium salts in manufactured meat products is a challenge because this often leads to undesirable quality defects such as differences in flavor, texture, and shelf life. Thus, the objective of this study was to investigate the effects of high pressure processing (HPP) and three anion types of potassium salts (potassium chloride, potassium lactate and potassium citrate) on the storage stability of sodium-reduced chicken sausages, in which 25% Na^+ were replaced by an equal molar mass of K^+.

HPP before cooking was successfully used to counteract increased cook loss of meat patties where sodium chloride was partially substituted by potassium salts. Added potassium lactate or citrate also resulted in better microbial quality of sodium-reduced chicken sausages during the chilled storage at 4°C. This study has improved our understanding of the effect of HPP on the storage stability of sodium-reduced chicken sausages with different salts and will enable a more efficient selection of sodium salt substitutes in formulated meat products.

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Abstract submission for Engineering Innovations for Food Supply chains 2019

Processing techniques for donated human milk optimized for minimal damage to milk proteins.

Katherine BLACKSHAW[1], Aoshuang XIAN[1], Peter VALTCHEV[1], Richard BANATI[2] and Fariba DEHGHANI[1].

[1]*The University of Sydney, Sydney Australia*
[2]*Australia's Nuclear Science and Technology Organisation, Sydney Australia*

Abstract
Human milk is essential for the survival and development of infants [1]. Technologies for long-term, reliable storage and pasteurization of human milk that preserve the important biological activity are lacking. Currently, milk banks store human milk frozen with limited shelf-life and use Holder pasteurization (62.5°C for 30 min) for inactivation of pathogens, which is known to reduce some of the bioactivity naturally present in the milk [2]. Better preservation of the bioactive proteins would contribute to decreased infant morbidity [2] and reduced expenditure on disease treatment [3]. This study aimed to optimize the thermal treatment of human milk with respect to inactivation of the model pathogen *Staphylococcus aureus*. In addition, the effect of various treatment protocols on major proteins in human milk was comprehensively investigated with respect to protein misfolding and aggregation. Our hypothesis was that there is an optimal thermal exposure that is sufficient to inactivate the model pathogen and induce minimal thermal damage to the milk proteins. Experiments were conducted with temperatures ranging from 55-80^{o}C and duration of exposure from 10 sec - 45 min. It was found that *S. aureus* could be reliably inactivated at lower temperatures and shorter durations provided adequate heat transfer is assured. Durations of 35 mins, 3 mins, 1 min, and 30s were sufficient for treatment temperatures of 55°C, 62.5°C, 72°C and 80°C respectively. On protein level, it was demonstrated that α-Lactalbumin was the most heat sensitive protein. Optimal treatment protocol that induces minimal protein aggregation was 55^{o}C for 35 min.

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Crystallization of glucose in model honey

Peter Miedema, **Ken MORISON**

University of Canterbury, Christchurch, New Zealand

Abstract
Honey is a complex supersaturated aqueous solution containing fructose, glucose, other sugars and minor components. The supersaturation can cause some of the glucose to slowly crystallize. Model solutions representing honey were made using fructose and glucose in various ratios and with solids concentrations from 80% to 84%. Solutions were placed in 1.5 mm deep, 10 mm diameter wells sandwiched between two glass slides, and held at a constant temperature of 23 °C. Crystals were tracked using polarised light microscopy enabling the growth rates to be measured.

Three distinct crystal types were observed under the same conditions. They were described as needles, plates and feathers, each having their own growth rates ranging from 0.5 ± 0.4 μm day^{-1} to 18 ± 1 μm day^{-1}. The needles appeared only after about 18 days when they were at least 3 μm wide and could be seen, but extrapolation of their width and length indicated growth started as soon as samples were prepared. They were found to have a narrow size distribution. It was determined that glucose crystallization rate is a strong function of the glucose supersaturation and not controlled by the viscosity of the solution. An exponential decay relationship was also found between crystal growth rate and fructose:glucose ratio.

The crystals formed were quite different from those formed during controlled crystallization of honey, but instead reflect the type of crystals that could form in containers of uncrystallized honey when stored for extended periods.

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Study the anti-inflammatory effect of natural products for wound healing using dermal wound-on-chip model

Sahar BIGLARI[1], Sina Naficy[1], Junlae CHO[1], Fariba DEHGHANI[1]

[1] *The University of Sydney, School of Chemical and Biomolecular Engineering, Sydney, Australia*

Abstract
The management of wounds can be complicated and challenging for conditions such as microbial infection, diabetes, and poor blood circulation. It has been speculated that a range of natural and plant-derived compounds with antioxidant, anti-inflammatory and antimicrobial properties could be of great benefit for wound healing. Natural products may be extracted from the cells, tissues, and secretions of microorganisms, plants and animals. Thus natural products are often used as starting points for drug discovery.
We have developed a wound-on-a-chip model for rapid testing the effect of naturally derived products and active compounds on wound healing as an alternative to 2D cell studies and animal studies [1]. Our results demonstrated that *Centella erecta* and Propolis inhibited macrophage-simulated inflammation. The results indicated that these compound exhibited anti-inflammatory effect as we observed lower accumulation level of pro-inflammatory cytokines. Also, Incorporation of each extract to the system enhanced the vascular structure formation with linear endothelial cell-cell junctions, similar to the sample with no treatment, as seen by VE-Cadherin immunofluorescence.

[1] Biglari S, et al. doi:10.1002/adhm.201801307.

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Calculation of thermodynamic activities in concentrated milk and honey

Balaji SUBBIAH, Pariya NOEPARVAR, **Ken MORISON**

University of Canterbury, Christchurch, New Zealand

Abstract
The thermodynamic activities of components of foods determine a range of properties including shelf life, solubility and crystallization. There is a considerable amount of theory in physical chemistry which can be applied to food systems. This work considered water and solute activity in concentrated sugar systems like honey and concentrated milk. Available data for water activity of sugar solutions were reviewed to obtain accurate relationships for binary systems. The concept of hydration water was extended to multicomponent sugar systems similar to honey. It was proposed that the hydration number of each sugar depends on the mole fraction of water in the mixture. This was found to be very accurate. The effect of salts on the water activity of honey was found to be minimal apart from their effect on the mole fraction of water.

In contrast, the activities of concentrated milk systems are dominated by the ions in milk such as Ca^{2+}, PO_4^{3-}, but the non-electrolyte lactose also affects the ion activities. To determine activities and solubilities, the mean spherical approximation theory for activity coefficients was used with dissociation relationships for the ion-pairs in milk. Further, the interaction of calcium phosphate with the casein micelles was introduced as an equilibrium. The resulting model for skim milk with over 180 equations was solved using Newton's method. Dynamic predictions of precipitation were also made. While many results were validated, the accuracy of predictions of mineral precipitation in concentrated milk was limited by our understanding of metastability of supersaturated ions in milk.

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Photocatalysis and photolysis for ethylene removal in postharvest supply chain

Namrata PATHAK[1], Cornelia RAUH[2], Pramod V. MAHAJAN[1]

[1] Department of Horticultural Engineering, Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), Potsdam, Germany
[2] Department of Food Biotechnology and Food Process Engineering, Technical University Berlin, Germany

Abstract

Ethylene, a gaseous phytohormone, is known to cause rapid ripening, senescence and eventual decay of fruits and vegetables when applied externally. In fresh produce supply chains, inadvertent ethylene exposure may occur due to the ethylene, biosynthesised by climacteric fruits or released from the exhaust of forklifts and trucks used in the vicinity. Consequently, ethylene exposure of fresh produce may lead to huge economic losses, thus, making ethylene removal one of the important strategies for quality maintenance in supply chains. This study focused on using two unconventional methods -photocatalysis and photolysis- for ethylene removal. Principally, both techniques are based on generation of reactive oxygen species, using ultraviolet radiation with or without catalyst, eventually oxidizing ethylene to carbon dioxide and water. Two reactors, based on the abovementioned techniques, were designed as ethylene filtration device. Process parameters, flowrate and lamp power, were optimized for maximum percentage ethylene removal by the reactors at 0.5 L/min air flowrate and 9 W. Performance evaluation of the two reactors under different storage conditions (temperature, humidity, oxygen concentration) as well as in actual fruit storage was also conducted. On connecting the reactors to fruit storage chambers (190 L each) containing apples, ethylene reduction of 96.28 % and 66.58 % with respect to ethylene accumulated in control was achieved by using photocatalysis and photolysis, respectively. No adverse effect of the two techniques on fruit quality parameters was observed. This study presented a good potential for the application of these techniques for ethylene removal in fresh produce supply chain.

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Engineering protein digestibility: Insights form *in vitro* digestion models and digestomics analyses

David TATYANA[1], Carmit SHANI LEVI[1], Reto PORTMANN[2] and Uri LESMES1

[1]*Technion, Haifa, Israel*
[2]*Agroscope, Bern, Switzerland*

Abstract
Adeqaute provision of high quality proteins to different consumers requires smart processing that relies on understanding protein digestibility. This lecture overviews studies and unpublished data of experiments coupling in vitro digestion models and proteomic analyses of digesta (termed digestomics) aimed at elucidating digestive proteolysis in different consumers. First, this talk will discuss the differential breakdown of whey proteins in infants, adults and seniors [1,2]. Such studies show that gastric proteolysis involves two competing mechanisms: one of protein pepsinolysis and another of pH-induced protein/peptide aggregation. Mining peptide profiles of the digestome against databases of known bioactive peptides demonstartes that beta-lactoglobulin and alpha-lactalbumin generate more bioactive peptides under adult conditions contrary to lactoferrin, which is a better source for bioactive peptides for infants and seniors. Second, cooking and baking in the presence and absence of fructose will be shown to affect the colloidal properties and digestibility of insect proteins [3]. Digestomic analyses of protein-rich silk moth flour show processing helps digestion unleash antimicrobial and acyl-coA binding peptides in adults but to a lesser extent in seniors. Further, we report the identification of 14 unique peptide sequences with predicted bioactivity levels surpassing 80% that are liberated in the gut of seniors. Altogether, these findings emphasize that rational processing of edible proteins may be used to engineer their digestibility towards generation of bioactive peptides in the gut of specific target populations.

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Characterization of the Jeju horse (Jejuma) oil treated by low-temperature crystallization

Dongwan HONG, Jieun HYUN, Hajeong BOO, Jiyeon CHUN,
Jeju National University, Jeju-si, Korea

Abstract
The fatty acid composition of horse oil is quite different with other animal fats derived from pork, beef, chicken so that horse oil will show a different change of properties under same environment condition. Therefore, this study was conducted to investigate the properties of horse oil extracted by hot water extraction and then saturated and unsaturated fatty acid of extracted horse oil was separated by low-temperature crystallization. The saturated and unsaturated fatty acid of extracted horse oil was separated by low-temperature crystallization, and then the cooling curve, cloud point, iodine value, thermal property by DSC was evaluated. Solid phase and liquid phase were separated during low-temperature crystallization processing. Before separation, the cloud point of horse oil was near 25.6°C (54.3 min) and after separation, could point of the liquid phase and solid phase was observed at around 7.6°C (289.7 min) and 29.4°C (36.5 min), respectively. Iodine value was highest at liquid phase horse oil as expected ($p<0.05$). In cooling thermogram, crystallization temperature was observed at -2.11°C in liquid phase horse oil, -0.11°C and 14.59°C in whole horse oil), 2.55°C and 21.95°C in solid phase horse oil. In heating thermogram, melting temperature was measured at 2.74°C in liquid phase horse oil, -1.62°C and 21.8°C in whole horse oil, 1.01°C and 39.54°C in solid phase horse oil. After separation of saturated fatty acid from horse oil, lipid crystallization generated at a lower temperature, and the melting point increased.

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Interfacial and emulsifying properties of hydroxytyrosol- plant protein covalent complexes

Loc PHAM[1]*, Bogdan ZISU[1], Bo Wang [2] and Benu ADHIKARI[1]

[1]*RMIT University, Melbourne, Australia.*

[2] *Nu-Mega Ingredients Pty Ltd, Brisbane, Australia.*

*Presenting author

Abstract

Hydroxytyrosol (HT) is high value and phytochemical possessing very high antioxidative and anti-cancer properties. The HT-protein complexes are expected to function as highly effective emulsifiers and encapsulants. It is expected that the HT-protein complexes combine the emulsifying property of protein and antioxidative property of HT. Here, we report the interfacial and emulsifying properties of complexes formed between HT and a representative plant protein (flaxseed protein isolate, FPI). The HT-FPI covalent complex was produced under alkaline condition (pH=9.0) with the presence of oxygen. These resulting complexes were characterized in term of the interfacial properties such as dynamic interfacial tension (DIT) and dilatational behaviour and the emulsifying properties such as emulsion stability index. The results showed that the DIT of the FPI-HT complex at the oil-water interface was lower than that of the FPI at low protein concentration (0.1 mg/ml) and its corresponding diffusion rate (K_{diff}) was appreciably higher compared to that of the native FPI. This result suggests to an improved surface activity of this complex at low protein concentration. With increase of FPI concentrations (from 1 to 10 mg/ml), the DIT and the rate of penetration (K_p) of the complex system to the interface showed insignificant difference. The storage modulus of the FPI-HT complex layer was higher than that of FPI indicating a more elastic film was formed by FPI-HT complex. The loss modulus of the complex layer was lower than that of the FPI. However, emulsion produced using FPI-HT complexes were less stable than those produced by FPI.

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Application of constrained optimization techniques in optimal shape design of a freezer to dosing lines splitter for ice-cream production.

Fabrizio SARGHINI[1] , Angela DE VIVO[1]

[1]*University of Naples Federico II –Dept. of Agricultural Sciences Portici (NA) - Italy.*

Abstract

Mass flow rate splitter design in complex rheological flows like ice-cream near melting point temperature can be a challenging task. Pulsations in flow rate due to pumping process and small fluctuations in temperature, affecting flow rheology, can determine a consistent difference in a mechanical splitter, resulting in a significant difference in the distribution of the dosage. Due to the non-linearities involved, an heuristic approach can result challenging if not impossible if small errors (less than 3%) are required. On the other hand, omputational science and engineering techniques have allowed a major change in the way that products and equipment can be engineered, as a computational model that simulates the physical processes can be built rather than building real world prototypes and performing experiments Among such techniques, Optimal Shape Design (OSD) (Mohammadi,et al, 2004) represent an interesting approach. In OSD, the essential element respect to classical numerical simulations in fixed geometrical configurations, is to introduce a certain amount of geometrical degrees of freedom as a part of the unknowns, which means that the geometry is not completely defined, but part of it is allowed to move dynamically in order to minimize or maximize the objective function. The applications of optimal shape design (OSD) are uncountable. For systems governed by partial differential equations, they range from structure mechanics to electromagnetism and fluid mechanics or to a combination of the three. In food industry, optimum design is not a once and for all solution tool because engineering design is made of compromises owing to the multidisciplinary aspects of the problems, and the necessity of doing multipoint constrained design. (Mohammadi,et al, 2004) .OSD is a branch of differentiable optimization and more precisely of optimal control for distributed systems (Lions 1968), where gradient and Newton based methods are natural numerical tools. The problem is that OSD is still numerically difficult, because it is computer intensive and moreover because the “optimal” is a compromise between shapes that are good with respect several criteria. In this work the applications of a multivariate constrained optimization algorithm is proposed in the case of a mechanical ice-cream splitter required to distribute in an evenly way from one freezer into five dosing valves.

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Mathematical modeling of momentum transfer for effect of mixing in screw-drive systems

Fabrizio Sarghini[1], Ferruh ERDOGDU[2]
[1]*University of Naples Federico II, Naples, Italy*
[2]*Ankara University, Ankara, Turkey*

In food processing mixing has the objective of increasing homogeneity, and often it is also used to achieve an effective heat – mass transfer. Food processing often involves mixing high viscous liquids (viscosity larger than 1 Pa-s), and evolving flow patterns have a significant effect of increasing the homogeneity and heat – mass transfer rates.
In this study, mixing effects in a screw drive system was analyzed using a heat - momentum transfer based mathematical model. Screw drive systems consist of a central shaft and a rotating screw mounted to it. This process is enabled with rotation in a fitting cylindrical body. Fluid dynamics play an important role during the process with the effect of liquid – gas (air) interface. The external inertial forces lead to a significant effect of mixing with the increased rate of heat and mas transfer.
Continuous mixing of liquids (Newtonian case – water and non-Newtonian case – 2% CMC solution) with simultaneous heat transfer were demonstrated to design and optimize the mixing process using a mathematical model. This model utilized two – phase volume of fluid (VOF) method to monitor liquid – gas interaction and solve fluid – thermal energy interactions. A compressive interface capturing scheme for arbitrary meshes was applied to track the interface with moving mesh approach. The results were then analyzed for pressure changes with velocity field and vorticity evolutions, and a design for mixing process was suggested as a function of rotation rate and number – pitch of the blades of the screw.

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Unlocking the functionality of sugar and its replacers for structuring of bakery products

Ruud van der **SMAN**[1], Stefano RENZETTI[1], Lisa MAUER[2]
[1]*Wageningen University & Research, the Netherlands*
[2]*Purdue University, West-Lafayette, USA*
Abstract

The structure of sweet bakery products is largely controlled by phase transitions of biopolymers present in the formulation, i.e. gelatinization of starch, denaturation of egg white and/or gluten. The sugars present in classical formulations carefully control these phase transitions. In biscuits the level of sucrose prevents starch to gelatinize, but allows gluten to thermoset – while in cakes all starch, gluten and egg white undergo their phase transition. Via this control over phase transitions the proper structure is obtained, which can be conveniently illustrated by the path of the state of the baked food through in supplemented state diagram [1].

Nowadays there is a strong drive to replace sugars in bakery products with other plasticizers like polyols or fructo-oligosaccharides. We hold the hypothesis that similar structure in reformulated products is obtained if the same control over the phase transition is obtained [1]. In this contribution we show that these phase transition is controlled by the volumetric density of hydroxyl groups ($n_{OH,eff}$) [2], which is obtained from both glass transition or viscosity data [3]. We show that a master curve is obtained for the phase transition temperatures versus $n_{OH,eff}$ for both starch, gluten [1] and egg white. The framework is also extended to amino-acids as plasticizer. This approach of matching $n_{OH,eff}$, provided by the original baked good, enables rational sugar reformulation strategies.

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Effect of physical hardening and internal shrinkage of cookies during cooling on its checking

Kohei HASEGAWA[1], Yoshihiro IWASA[2], Tomoharu KAWAGUCHI[2], Nakako KATSUNO[1], Takahisa NISHIZU[1]
[1]*University of Gifu, Gifu, Japan*
[2] *MORINAGA&CO., LTD., Tokyo, Japan*

Some cookie types are prone to cracking after cooling and packaging. Although it is known empirically that checking is affected by temperature and humidity during cooling, these relationships have not yet been studied. This study was performed to clarify the mechanism by which checking occurs for cookies in terms of physical hardening and internal shrinkage during cooling.

Cookie dough in which steel powder was dispersed was baked and the movement of each steel particle from shrinkage during cooling was monitored by X-ray micro-computed tomography (XRT). The extent of starch gelatinization was determined by polarizing microscopy in volume percent and also by differential scanning calorimetry. The internal cookie structure defatted and absorbed water to remove sugar as observed by scanning-electron microscopy and XRT. The hardening temperature during cooling was measured by dynamic mechanical analysis.

According to the dynamic mechanical analysis and XRT measurements, the outer cookie layer with a lower moisture content and higher hardening temperature than the core hardened and shrunk initially. Surface residual stresses may cause checking after cooling. Most starch granules remained ungelatinized after baking. Even if the cookie was defatted, its structure and strength was maintained. The dissolution of sugar components in water caused structural collapse. These results show that the components that are included with sugar bind non-gelatinized starch particles, but fat does not. The glass-transition temperature of the sugar component may affect cookie checking strongly.

ICEF13 ABSTRACT TEMPLATE

The importance of processing of microalgae in the design of healthy food products with desired rheological properties

Tom BERNAERTS[1], Lore GHEYSEN[2], Imogen FOUBERT[2], Marc HENDRICKX[1], Ann VAN LOEY[1]

[1]*KU Leuven, Laboratory of Food Technology, Leuven, Belgium*
[2]*KU Leuven KULAK, Laboratory Food and Lipids, Kortrijk, Belgium*

Introduction:
Microalgae are promising sustainable food ingredients being rich in several health-beneficial components. The use of the total biomass might be an innovative strategy to also incorporate structural biopolymers, possibly reducing the need for other thickening agents. Processing of the microalgae might however play a key role in exploiting their structural benefits. Therefore, the aim of this work was to study the impact of different processing techniques on the rheological properties of microalgae as multifunctional food ingredients.

Methods:
Chlorella, *Porphyridium* and *Nannochloropsis* were studied in aqueous model systems (8% w/w). Food processing operations, including high pressure homogenization (HPH) and thermal processes, were applied at different intensities (homogenization pressures, temperatures,...). Thickening properties were evaluated by different rheological analyses, while changes in microstructure were studied by particle size measurements and various microscopic techniques.

Results:
Porphyridium and *Chlorella* showed potential as sustainable thickening agents. The high viscosity and gel strength of *Porphyridium* were related to the network of exopolysaccharides, which was reinforced by mild thermal processing. For *Chlorella*, cell disruption by HPH was required to release intracellular proteins, which formed strong aggregates under subsequent intense thermal processing. In contrast, no viscosity increase was observed for *Nannochloropsis*, due to the rigidity of the cell wall and the absence of exopolysaccharides.

Relevance:
This study highlights the importance of mechanical and thermal processing when using microalgae as novel food ingredients. While *Porphyridium* and *Chlorella* can be processed as multifunctional ingredients (combining nutritional and structural benefits), *Nannochloropsis* can be used without disturbing the structure of the food matrix.

ICEF13 ABSTRACT TEMPLATE

Cell disruption improves *in vitro* bioaccessibility of ω3-LC-PUFA and carotenoids in the microalga *Nannochloropsis*

Tom BERNAERTS[1], Lore GHEYSEN[2], Imogen FOUBERT[2], Tara GRAUWET[1], Ann VAN LOEY[1]

[1]*KU Leuven, Laboratory of Food Technology, Leuven, Belgium*
[2]*KU Leuven KULAK, Laboratory Food and Lipids, Kortrijk, Belgium*

Introduction:
Microalgae are promising food ingredients due to their unique composition of health-beneficial compounds, including omega-3 long-chain polyunsaturated fatty acids (ω3-LC-PUFA) and carotenoids. Since these components are located inside the cell, it is hypothesized that the surrounding cell wall acts as a physical barrier, limiting the release of intracellular components during digestion in the human body. Cell disruption might therefore be desired to increase the *in vitro* bioaccessibility of these health-beneficial compounds.

Methods:
Nannochloropsis cells were disrupted using high pressure homogenization (HPH) for 4 passes at 100 MPa. Intact cells (not HPH-treated) and disrupted cells (HPH-treated) were subjected to a standardized *in vitro* digestion protocol, simulating gastric phase and small intestinal phase. Mixed micelles were collected by ultracentrifugation, representing the bioaccessible fraction of the digested microalgae. The degree of lipid digestion was estimated by quantifying the released free fatty acids (FFA) by GC-FID. Bioaccessibility of ω3-LC-PUFA and carotenoids was determined by GC-FID and HPLC-DAD, respectively.

Results:
The digestibility of the intact cells was shown to be limited, with only ~35% of the fatty acids being hydrolyzed to FFA and low bioaccessibility values for carotenoids (below 6%). HPH was shown effective in disrupting the majority of the *Nannochloropsis* cells. This was beneficial in terms of lipid digestion (~63% FFA) and bioaccessibility of ω3-LC-PUFA and carotenoids (up to three times higher than for intact cells).

Relevance:
This study shows the importance of processing of microalgae as functional food ingredients, to maximally benefit from their health-beneficial compounds in terms of *in vitro* bioaccessibility.

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Feasibility of using pulsed electric fields as a pretreatment technique during edible films development

Stephen GITERU[1,2,3], Indrawati OEY[1,3], Azam ALI[1,2]
[1]*Department of Food Science, University of Otago, Dunedin, New Zealand*
[2]*Center for Bioengineering and Nanomedicine, University of Otago, Dunedin, New Zealand*
[3]*Riddet Institute, Palmerston North, New Zealand*

Abstract
Pulsed electric fields (PEF) have the potential to modify the microstructure and functional properties of biomacromolecules. The purpose of this research was to investigate the effects of PEF on zein (ZN), chitosan (CS), and poly(vinyl alcohol) (PVOH) as single biomacromolecules, composite dispersions and a pretreatment technique for edible films development. PEF was investigated at specific energy (Q_P) 50-620 kJ/kg, electric field strength (E) 0.8-3.4 kV/cm or pulse frequency (f) 10-220 Hz. Regarding the effect on single biomacromolecules, increasing Q_P from 50-315 kJ/kg resulted in lower intrinsic viscosity [η] of ZN but increased that of CS and PVOH. These effects were evidenced by higher particle sizes of ZN but reducing sizes of CS and PVOH molecules. Differential scanning calorimetry (DSC) revealed weaker interactions among the ZN and PVOH molecules due to PEF. Regarding the composite system, Fourier Transform Infrared spectroscopy and rheology revealed enhanced crosslinking effect between biomacromolecules at Q_P 150-400kJ/kg or E 2.4-3.4 kV/cm. These findings were attributed to the PEF-induced electrochemical reactions and free radical-mediated attacks on the peptide, glycosidic or carbon-carbon linkages in ZN, CS and PVOH respectively. Such processes resulted in higher electrostatic and covalent interactions between the amino moieties of CS and the carbonyl groups of ZN and PVOH. Edible films developed using optimized PEF parameters (385-400 kJ/kg, 50 Hz and 1.6 kV/cm) showed improved tensile strength, thermal stability and morphology. Varying the PEF parameters had significant differences in the crosslinking of the dispersions, which can be employed in the development of the desired edible films.

Alternative testing method for water vapor permeability of packaging materials based on polar polymers: Thermoplastic polyurethane

Deniz TURAN[1]

[1]*TU Delft Adhesion Institute, Delft, Netherlands*

Abstract
The barrier property of a polymer is one of the most important selection criteria to be used as food packaging. Many polymers, especially polar polymers, show a ‘non-ideal’ behavior for the permeation of water vapor. Their water vapor sorption deviates from Henry’s law and their diffusion coefficient changes by the absorption of water vapor. Therefore, studying of water vapor permeability (WVP) of such polymers with an alternative method is a great interest to show their potential use in food packaging applications. The aim of this study was to compare the results of ‘alternative’ method with standard gravimetric method and to discuss the influence of chemical composition and relative humidity (RH) on water vapor barrier properties of synthesized films. In this study, polyurethane (PU) films were synthesized from poly(ethylene glycol), hexamethylene diisocyanate, and different weight ratios of castor oil and 1,4-butanediol. The following properties have been measured: Structure (FT-IR, SEM), water vapor transmission rate (WVTR), effective water vapor diffusion (D), sorption (S) and permeation coefficients (P). The water vapor absorption of the films were measured as a function of time at 50, 85, and 97% RH at 23^{o}C. Alternative method used for determining D is described by Crank (1979). In conclusion, Castor oil effected the structure and sorption. WVTRs were enhanced above 60–70% RH. It was possible to use sorption experiments to approximate the WVTR which is a considerable simplification for polar polymers, e.g. developed PU film.

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Optimization of Di-Enzyme Extractions for Total Folate and Folate Species in Kumquat (*C. japonica*) using Response Surface Methodology (RSM)

Ziyi MENG, Jing CHENG, Hanying DUAN, **Chao WANG**

Jinan University, Guangzhou, China

Abstract

Folate is an essential B group water soluble vitamin. Folate deficiency is a prevalent problem in underdeveloped countries, and even in the developed countries, folate deficiency is still a public health problem. Kumquats were good sources of several phytochemicals. However, native folate level in kumquats has been barely reported. The trienzyme digestion including protease, α-amylase, and conjugase sources (such as chicken pancrease, rat plasma or others) for the extraction of total folate from food has been used in AOAC Official Method.

In this study, enzymatic extractions for total folate in kumquat were optimized by RSM. Total folate and folate speices were determined by a validated UHPLC-MS/MS method. From the results, pronase and amylase digestion have no significant effect ($p > 0.1$) on the response (total folate). However, pectinase ($p < 0.01$) and human recombinant γ-glutamyl hydrolase (GGH, purified conjugase) ($p < 0.01$) digestion showed significant effects. The optimized extractions for the kumquat suggest the generalized di-enzyme extraction of 2 h and 0.5 h for pectinase and recombinant GGH at pH=7.89. Under the optimized extraction conditions, the extraction efficiency was improved by 52% in comparison with AOAC tri-enzyme method. This study was the first study to show that pectinase digestion should be included for total folate extraction from high pectin samples. This study was also the first study to show that recombinant GGH (0.5 h) could replace traditional conjuase (4 h to 12 h) for shortening incubation time to decrease the degradation of folate loss under long incubation time.

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Effect of glass transition on the compressibility of soup powder

Kiyoshi KAWAI[1], Takumi MOCHIZUKI[1], Tomochika SOGABE[1], Yoshio HAGURA[1]

[1]*Hiroshima University, Hiroshima, Japan*

Hardness of compressed food products depends on the types of powder and compressive force. Since a high compressive force is required for the production, it is practically important to improve the compressibility of the powders. Dry food powders are at least partially glassy state, and thus glass to rubber transition occurs at the glass transition temperature (Tg). When mixed glassy powders are heated above the Tg before compression, it is expected that the powders are solidified even at a lower compressive force than conventional one. The purpose of this study was to understand effect of Tg on the hardness of soup solid.

A commercial chicken stock cube was employed. The cube was grinded, and the powder was equilibrated at various water activity (aw) conditions. Tg was evaluated using a thermal rheological analysis (TRA). The powder samples were thermally compressed at various temperature and compressed density, and fractural stress was investigated using a texture meter.

From the TRA curve, a clear force-drop was observed, and mechanical Tg was determined from the onset point of the force-drop. Tg decreases with an increase in aw (water content) because of water plasticizing. The fractural stress of the thermally compressed sample increased with aw, compressed density, and temperature. To understand the effect of Tg on the compressibility of soup powder, fractural stress was plotted against the difference between compression temperature (T) and Tg. It was confirmed that the fractural stress of the samples could be described as a function of T - Tg.

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Migration kinetics of carvacrol from active cellulose acetate films to food simulant fluids

Denise A. LAROQUE[1], Gláucia M.F. ARAGÃO[1], Pedro H.H. ARAÚJO[1], **Bruno A.M. CARCIOFI**[1]

[1]*Department of Chemical and Food Engineering, Federal University of Santa Catarina, Florianópolis, Brazil*

Abstract

Active antimicrobial packaging has the advantage of releasing the additives to the food surface through the contact time. This study aimed to obtain migration kinetics and diffusion coefficient (D_{FS}) of carvacrol incorporated in cellulose acetate films to distilled water and ethanol 95% at 25 °C. The migration process into the active film was described by the Fick's law of diffusion in dilute solution combining the continuity equation. The migration kinetics were determined from carvacrol quantification in UV-vis spectrophotometer at 272 nm. Aliquots were collected at predetermined times from the Erlenmeyer containing 350 mL of the simulated fluid under agitation until reaching the equilibrium. In ethanol, all of the carvacrol was migrated after 1 h of the assay. For water, the system was equilibrated after 50 h of the test, after migrating about 75% of the initial carvacrol amount. The carvacrol migration did not result in visible changes in the film. The mathematical model presented an excellent fit to the experimental data, obtaining D_{FS} of 3.6×10^{-13} m^2/s for ethanol and 4.8×10^{-15} m^2/s for water. The D_{FS} coefficient 100 times higher for ethanol results from the greater solubility of carvacrol in this simulation fluid added to ethanol penetration in polymer matrix. It causes relaxation and swelling of the chains and dissolve the carvacrol, increasing migration. The results for migration carvacrol are promising for application of the cellulose acetate film with carvacrol in contact with food as active packaging, once the sustained release of carvacrol can increase food shelf life.

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Development of Optimum Drying Processing for Improvement of Dried Carrot Chips Quality

Jieun HYUN, Hajeong BOO, Jiyeon CHUN,
Jeju National University, Jeju-si, Korea

Abstract
To optimize carrot chip processing, first sliced carrot (thickness 0.3 cm) was water blanched (85, 90, 95°C / 1, 2, 3 min) and then dehydrated by 80% maltodextrin (3 h or 6 h) for pretreatment. And conventional hot air drying (60±2.5°C, 7 h) or combined drying (infrared light and hot air, 70±2.5°C, 3 h) treated on pre-treated carrots. Finally, to observe storage stability, carrot chips were kept at various storage condition (RH60%, RH90% / package, non-package). From the results of quality analysis results, the optimum pre-treatment was 90°C and 1 min water-blanching and three h molecular press dehydration. And effective drying method was combined drying (infrared light and hot air drying) to make high-quality carrot chips. During the storage period at the different conditions, pre-treatment was more effective to maintain pH (6.1±0.05), carotenoid contents (approx. 15,000 ppm) and to inhibit surface browning of carrot. In this study, optimum carrot chip processing was the combination of water blanching and molecular press dehydration and the combined drying (infrared light and hot air drying). It was observed that pre-treatment was necessary to produce qualified carrot chip and to storage carrot for a certain time.

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The relationship between shelf life of fresh cut red meat and different packaging during refrigerated storage.

Nidhi JINDAL , Peter TORLEY, Benu ADHIKARI

[1]*School of Science, RMIT University, Bundoora West Campus, VIC, 3083, Australia*
**Presenting author*

Keywords: Meat, packaging, color, oxidation, antioxidant

Abstract

Meat is an excellent source of high- quality protein, essential amino acids, B-group vitamins and, minerals. However, meat is highly perishable and needs to be processed and packed properly to prevent the deterioration of meat quality. A broad range of packaging is applied in meat products, each with different characteristics and applications. Air-permeable packaging is mostly used for raw chilled red meat while modified atmosphere packaging (MAP), vacuum skin packaging are used for long-term chilled storage(Kerry, O'Grady, & Hogan, 2006; McMillin, 2017). Due to high moisture and fat content meat is often susceptible to spoilage by bacteria; which further leads to discoloration of meat products, lipid oxidation and, protein degradation. Meat color is a vital factor and may influence meat buying decision of consumer as it affects the visual appearance of meat more than any other quality factor(Zhang, Li, Meng, He, & Ren, 2016). High oxygen MAP has been used to maintain the red color for retailing raw meat. However, there are certain drawbacks with high O_2 in the package, as it causes fat oxidation, off-flavor development, nutritional loss, and augments the growth of spoilage microorganisms(Sandhya, 2010). Vacuum skin packaging is relatively new retail meat packaging. Consumers do not accept purple color of vacuum packed meat as they relate red color of meat to its freshness. Also, residual oxygen in vacuum packs might cause browning of the meat. We report the application of plant extracts with high antioxidant and antimicrobial activity (e.g. olive leaf extract) in different packaging systems to inhibit the oxidation processes, discoloration in meat, while retaining the label preservative-free.

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Confined compression as an analytical tool to quantify juice release kinetics from meat and meat analogues

Steven CORNET[1,2], Ruud van der SMAN[1,2], Atze Jan van der GOOT[2]
[1] Wageningen University and Research, Food and Biobased Research, Wageningen, The Netherlands
[2] Wageningen University and Research, Department of Food Process Engineering, Wageningen, The Netherlands

Abstract
Although the meat analogue market is growing, product quality should be improved to ensure their widespread adoption. Juiciness is a key sensory attribute of meat and often lacks in meat analogues. Sensory attributes are subjective by nature which impedes objective quantification. Juiciness of meat is associated with the water holding capacity (WHC), and its perception is thought to have two stages. During the first bite, sudden juice release provides the initial sensation of juiciness. During prolonged mastication, remaining juice is continuously released. This provides the sensation of sustained juiciness, and should prevent a dry mouthfeel. The sensation of juiciness seems to partially depend on the rate of juice release.
We have developed a confined compression cell as an analytical tool to measure juice release kinetics of meat(-like) materials during compression. Confined compression, as well as T_2 NMR measurements, indicate the presence of two water populations in meat analogues, similar to what was found for meat (Bertram,2005). In the meat analogue, one water population is rapidly expelled, while the other is expelled gradually during sustained compression. We hypothesise that these populations relate to initial and sustained juiciness respectively. A model was developed based on Flory-Rehner theory and Darcy flow to quantitatively describe our experimental data (Bertrand,2016). The model provides novel insights into the mechanisms governing juice release kinetics. We apply insights from experiments and modelling to develop juicier meat analogues.

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Effect of water content and droplet size on fat phase transition and water mobility in water-in-oil emulsions monitored using NMR technique

Bhavesh PANCHAL[1], Tuyen TRUONG[2], Sangeeta PRAKASH[1], Nidhi BANSAL[1], Bhesh BHANDARI[1]*

[1]*ARC Dairy Innovation Hub, School of Agriculture and Food Sciences, University of Queensland, QLD 4072, Australia*
[2]*RMIT University, Melbourne VIC 3000, Australia*
** Corresponding author; email address: b.bhandari@uq.edu.au*

Abstract
Status of water and fat components in water-in-oil emulsion based products such as butter, margarine, and low fat spreads are of utmost significance to product stability, textural and sensory properties. The present work highlights the effect of water content and droplet size on the kinetics of water and fat phase in water-in-anhydrous milk fat emulsion. Emulsions containing 15, 30, and 40 wt% of water and polyglycerol polyricinoleate (1:30 of water) emulsifier were prepared using ultraturrax homogenizer to 10 and 1.5 µm water droplet sizes. Samples were analyzed for transverse relaxation (T_2) using variable temperature low-field ^{1}H nuclear magnetic resonance (VT-NMR) technique during in-situ cooling from 40-30°C at 2°C/min and 30-5°C at 5°C/min. A notable difference in the T_2 characteristics of the milk fat population (T_{22} 10-100 ms) was observed during cooling. Initial shifts in T_{22} were noticed between 36-34°C, likely to be at the onset of crystallization. The mobility of water (T_{23} 300-10000 ms) was markedly decreased with droplet size observed as a significant drop in the T_{23} regardless of the water content. A similar trend with a non-significant difference was observed in the T_{22} which could be indicative of the enhanced rate of fat crystallization. These suggested that the water droplet size can be employed as a functional tool to improve the stability and modify the fat-crystallization characteristics in the design of final product consistency. The current outcome also demonstrated the potential use of the VT-NMR technique to monitor real-time phase transition of food components without any structural deformation.

Presence of Sodium Chloride and High Hydrostatic Pressure Improve the Stability of Chlorophyll

Yan ZHANG[1234], Liang ZHOU[1234]
[1] *1 College of Food Science and Nutritional Engineering, China Agricultural University, Beijing, 100083, China*
[2] *National engineering research center for fruit and vegetable processing, Beijing, 100083, China*
[3] *Key laboratory of fruit and vegetable processing, Ministry of Agriculture, Beijing, 100083, China*
[4] *Beijing key laboratory of food non-thermal processing, Beijing, 100083, China*

Colour is a major quality attribute of food products. Green in fruits and vegetables is derived from chlorophyll, which is unstable and cause color deterioration of green vegetables during processing. For a long time, many researches were conducted to reward the degree. The main strategies of chlorophyll protection are through controlling environmental factors, such as temperature, moisture, light, pH, etc., but its effect is not ideal. In the study, the efforts were performed to improve the stability of chlorophyll by chemicals (sodium chloride) and novel processing technology (HHP). The results indicated that that sodium chloride can improve the thermal stability of chlorophyll, however, which was no effects on the spectra properties. With the increase of sodium chloride concentration, absorbance and fluorescence intensity of chlorophyll are higher, especially in the 20% and 26% sodium chloride solutions. Moreover, the degradation of chlorophyll followed the first-order kinetic equation at 80 ℃、90 ℃、and 100 ℃ in the sodium chloride solutions. The result was consistent with previous studies in peas, broccoli and grape puree (Nuray Koca, et al., 2007; Matthias H. Roiser, et al., 2015; Zheng, et al., 2014). Sodium chloride significantly reduced the rate of degradation of chlorophyll and increased the activation energy of the reaction. And after HHP (0-600MPa/10min) treatment, the absorbance and fluorescence intensity was increased with the increase of sodium chloride concentration. It is obvious that HHP improves the protective effect of sodium chloride on chlorophyll, and they have synergistic effects. The results implied that chemicals assistant HHP would be a novel technology to retard the degradation of chlorophyll.

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From food to medicine: Use of functionalized polyclonal antibodies from cow's milk for the treatment of bacterial infections

Hans-Jürgen HEIDEBRECHT[1], Michael PFAFFL[1], Christoph von Eichel-Streiber[2] Ulrich KULOZIK[1]

[1]*Technical University of Munich, Freising, Germany*
[2]*tgcBIOMICS, Bingern, Germany*

Abstract

Clostridium difficile infection is an intestinal infection characterized by severe diarrhea and high and strongly increasing morbidity rates. Current standard therapy is the administration of antibiotics, which initially help but also destroy the intestinal microflora and leave the patient susceptible to reinfection (up to 30%).
To counteract this urgent medical need, cows were immunized with inactivated toxins and *C. difficile* to induce specific polyclonal antibodies in cow's milk. The specific antibodies (ELISA, in vitro cell assays) from the milk were enriched by means of a filtration cascade and the effect of three different concentrations of the obtained anti-*C. difficile* whey protein isolates (anti-CD-WPI) and the antibiotic therapy were investigated in an hamster model of CDI (6x10). WPI, which was obtained from the milk of exactly the same cows before immunization, and a vehicle group served as negative controls. The survival of hamsters receiving anti-CD-WPI was 50%, 80% and 100% compared to 10% and 0%for the control groups. The specific antibodies not only inactivated the toxins for the initial suppression of CDI, but also provoked the inhibition of the growth of *C. difficile*, while at the same time leading to a significantly faster regeneration of the microbiome diversity compared to the antibiotic (16-RNA sequencing) and thus prevented recurrence.
The significance of our research was in further developing and understanding this alternative approach to treat and prevent CDI leading to broader biomedical impacts, as this proceeding serves as platform technology and could open up a new field for the food sector.

Grinding of sucrose particles influences the viscosity of the chocolate mass due to locally different amorphization of surface areas

Dana MIDDENDORF[1], Knut FRANKE[1], Ute BINDRICH[1],

[1]*German Institute of Food Technologies, Quakenbrueck, Germany*

Abstract
The two different grinding principles are mainly applied in chocolate manufacturing, roller grinding and ball mill grinding. Both result in different processing behaviors of the molten chocolate despite similar particle size distributions. After grinding using a ball mill, yield value and viscosity of the chocolate mass are higher compared to those after roller grinding.

Reasons for such differences in flow behavior might be attributed to differences in the interaction between the solid particles, mainly sucrose, and with the surrounding liquid cocoa butter phase in the chocolate mass. Because of differences in the physical state of the sucrose particle surface, e.g. crystalline or amorphous, different interactions occur. Although a partial modification of the initially crystalline surface due to mechanical impact during grinding is well-known, the distribution of different kinds of surface states on the particle surface was unclear.

We used the atomic force microscopy (AFM) to measure topography and the local surface state in microscopic scale. The latter one was determined using the local thermal analysis (LTA). This technique enables a direct measurement of local softening temperatures which clearly indicates the surface state, e.g. crystalline or amorphous. The presented results of our study show that different distributions of the local surface states are generated after application of different grinding methods and that these distributions can be correlated to differences in interaction of particles and cocoa butter as well as the resulting flow behavior of the chocolate mass.

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Radio Frequency Heating of pouch packaging foods in Water

Kunihiko UEMURA[1], Chieko TAKAHASHI[1], Isao KOBAYASHI[1]

[1]*Food Research Institute, NARO, Tsukuba, Japan*

Abstract
There was an outbreak of food poisoning linked to *Escherichia coli* O157 contamination of potato salad in 2017 in Japan. We developed equipment that quickly and uniformly heats pouch packaging foods in circulating tap water using radio frequency (RF) heating. The RF heating achieved 5 log reduction of *E. coli* in potato salad at 80 ℃ for 90 s, which is time of 1/10 conventional heating. However sliced cucumber in potato salad maintained a breaking strength and color nearly to that of raw cucumber. Our results showed that RF heating process improved the safety of packed potato salad with vegetables. And we developed equipment that heats packed whole fish in circulating tap water using radio frequency (RF) heating at pressurized condition. The temperature at the center of the sauries was increased up to 130 °C for 19 min using 9 kW RF heating, and up to 119 °C for 45 min using conventional heating (CH) at 120 °C. Added *Bacillus subtilis* spores were decreased by 5 log orders using RF heating. The RF-treated meat was brighter than the CH-treated meat, and the RF-treated backbone was softer than CH-treated one. RF heating maintained larger amounts of collagen in backbone than conventional heating.

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Impact of thermal processing on the microbial diversity of cricket flour

Antje FRÖHLING[1], Sara BUßLER[1], Julia DUREK[1], Oliver SCHLÜTER[1]

[1]*Leibniz Institute for Agricultural Engineering & Bioeconomy (ATB), Potsdam, Germany*

Abstract

The role of insects for human consumption has lately increased in interest and in order to deliver safe and high-quality raw materials and ingredients for food and feed applications, processing of insects is a major pre-requisite. For edible insects a thermal treatment and appropriate storage conditions are recommended to minimize the microbiological risk and the impact of processing methods on the microbial contamination needs to be considered and determined.

The assessment of microbial diversity changes during production of flour from crickets (*A. domesticus*) was aim of this study. Crickets were washed and subsequently thermally treated by steaming for 10 min at 100 °C. Afterwards, the heat treated crickets were dried for 3 h at 110 °C and milled to cricket flour. After each process step the samples were microbiologically analyzed. Additionally, the impact of processing on product quality was evaluated.

The total viable count was reduced from 9.24 log CFU/g_{DM} to 1.98 log CFU/g_{DM} along the entire processing chain. While Bacillaceae, Enterobacteriaceae, Enterococcaceae and yeast and molds were no longer detectable in the cricket flour, Staphylococcaceae and mesophilic spore forming bacteria were still found in the flour. The results indicate that the steaming process is essential for effectively increasing microbial safety since this processed showed the highest inactivation. It is recommended to not only evaluate the total viable count but also to monitor changes in microbial diversity during processing to ensure microbial safety of the final product.

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How barrier discharge plasma affects ochratoxin A production of *Aspergillus niger* or *Penicillium verrucosum* on barley

Julia DUREK[1], Oliver SCHLÜTER[1], Pawel DUREK[2], Antje FRÖHLING[1]

[1]*Leibniz Institute for Agricultural Engineering & Bioeconomy (ATB), Potsdam, Germany*
[2]*German Rheumatism Research Centre Berlin, Berlin, Germany*

Abstract
As mycotoxins like ochratoxin A (OTA) are highly toxic and carcinogenic, but also highly stable against detoxification, the treatment with cold atmospheric plasma could be an effective alternative for their reduction in food products. Hence, *Aspergillus niger* and *Penicillium verrucosum* were incubated on barley and treated with diffuse coplanar surface barrier discharge plasma generated by dry air, CO_2 or $CO_2 + O_2$ for 1 or 3 min. After storage for up to two weeks at 9, 25 or 37 °C, reduction of the mould fungi and amount of OTA was analysed and fluorescence spectroscopy was performed.
Both moulds were significantly reduced by 2.5 to 3 log CFU/g after 3 min of air plasma treatment. The production of OTA from *A. niger* was very low, therefore the plasma effect could not be determined. Concerning *P. verrucosum*, a reduction of the OTA content from 49.0 to 23.8 ng/g could be noticed after treatment of inoculated barley with an incubation period of five days bevor treatment using $CO_2 + O_2$ plasma. There was a contrary increase in OTA from 49.0 to 72.9 ng/g when using CO_2 plasma. Treating with air plasma finally decreased OTA from 56.9 to 20.2 ng/g. However, a reduced incubation period prior to treatment with air plasma increased OTA from 3.1 to 20.7 ng/g. Fluorescence curves changed after treatments concerning peak intensity, area and position.
In conclusion, plasma gas and incubation facts are important issues for an effective reduction of mould fungi and most notably their mycotoxins.

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Impact of high-pressure homogenization on Carrageenan and subsequent ramifications to digestive proteolysis in toddlers

Shlomit DAVID[1], Shany BRAUNSHTEIN[1], Maya MAGRAM[1], Reto PORTMANN[2], Avi SHPIGELMAN[1] and Uri LESMES[1]

[1]*Technion, Haifa, Israel*
[2]*Agroscope, Bern, Switzerland*

Abstract
A recent EFSA report recommended[1] a temporary acceptable daily intake (ADI) of 75 mg/kg body weight per day for the food addtive Carrageenan (CGN)[2]. Due to indications that toddelrs surpass these exposure levels, this study sought to elucidate two working hypotheses: [i] CGN macromolecular characteristics are affected by high pressure homogenization and [ii] CGN affects digestive proteolysis in toddlers and children.
First, SEC-RI-MALS shows commercial CGN samples contain un-negligible levels of low MW CGN that has been implicated in adverse effects to human health. High and ultra-high pressure (UHP) homogenizations (at 55, 172 and 255 MPa) were found to yield suspensions with significantly ($p<0.05$) decreased particle diameters and apparent viscosity without any difference in zeta-potentials. A model system of CGN-whey protein isolate mixture digested in a semi-dynamic in vitro digestion (IVD) model of a toddler reveals CGN alters the patterns of WPI digestive breakdown. Proteomic analysis of digesta indicate that there are distinct protein "hot spots" that are sensitive to the addition of CGN that are linked to a reduction in the number of bioactive peptide homologues found in the digesta. Further, CGN addition significantly ($p<0.05$) affected levels of essential amino acids found in the digestome. Finally, UHP was used to fabricate a chocolate milk drink with 0.005% (w/w) kappa, iota or lambda CGN. Chocolate drinks were characterized (colloid size, viscosity and physical stability by analytical centrifugation) and digested in an IVD model. Again, CGN modulation of digestive proteolysis was affirmed. Overall, this study shows CGN properties are important determinants of its possible adverse side effects on digestive proteolysis in childern.

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Phase behaviour of Bambara groundnut starch-soluble dietary fibre nanocomposite

Yvonne MAPHOSA[1], Victoria JIDEANI[1]

[1]*Cape Peninsula University of Technology, Bellville, South Africa*

Abstract

Bambara groundnut [*Vigna subterranea*] (BGN) native starch (BGNS) is not robust to processing and is insoluble in water hence the need for modification. BGN soluble dietary fibre (BGN-SDF) is a thickener high in bioactive compounds- polyphenols and uronic acid. However, high concentrations (30%) of BGN-SDF effectively stabilised oil-in-water emulsion. As such, grafting BGN-SDF onto BGNS mitigates the undesirable characteristics of starch while combining the desirable characteristics of both polysaccharides. The objective of this study was to conjugate BGN-SDF and BGNS from the black-eye variety. BGN seeds were manually sorted from mixed seeds, milled, then BGNS and SDF were extracted from the flour using the wet milling method. An augmented 2^2 factorial design was used to obtain the effective ratio of BGNS (5, 15%) and BGN-SDF (0.65,1.95%) for a stable nanocomposite. Every design points was duplicated giving a total of 10 runs. The nanocomposites were obtained by chemical grafting using an ascorbic acid/hydrogen peroxide redox pair initiator system. Modified BGNS without BGN-SDF was used as a control. The. The nanocomposite was examined for crystallinity (XRD), microstructure (SEM), phase behaviour and stability (Turbiscan), functional groups (FTIR) and fluorescence wavelengths (fluorescence spectroscopy). Fluorescence peaks where at 260 (starch) and 350 nm for both SDF and BGN-SFN. BGNS showed a typical type C crystallinity with hydroxyl functional group. Destabilisation was associated with creaming, however, one of the ratios gave a stable nanocomposite with an average particle size of 74.01 d.nm and average zeta potential of -57.3 mV. This nanocomposite will be used as a beverage emulsion stabiliser.

Concentration of whey using cheese salt brine in direct forward osmosis using aquaporin-based hollow fiber membranes

Emilie N. NIELSEN[1], Sylvie BRAEKEVELT[2], Kristian R. POULSEN[3], Kim T. ANDERSEN[4], Jörg VOGEL[2], Lilia AHRNÉ[1]

[1]*University of Copenhagen, Copenhagen, Denmark*
[2]*Aquaporin A/S, Kgs. Lyngby, Denmark*
[3]*Arla Foods Ingredients, Nr. Vium, Denmark*
[4]*Tetra Pak Processing Systems A/S, Højbjerg, Denmark*

Abstract

Concentrating whey is an important step in whey processing and is often executed by reverse osmosis filtration (RO). The technology allows to remove a large amount of water without thermal processing, however it comes with a high energy consumption and has reached an upper limit of whey concentrate dry matter. An alternative to RO is forward osmosis filtration (FO), where an osmotic pressure gradient across the membrane is the driving force for water transport (*Wang* et al., 2017). This osmotic potential may be supplied by cheese salt brine, which is readily available at cheese dairies.

Three different aquaporin-based FO membrane modules were tested in lab scale, to find the best performing membrane module for whey concentration tests in pilot scale. Two membrane modules were based on hollow fiber membranes with inner diameters of respectively 0.2 and 0.7 mm, and the third membrane module consisted of tubular membranes. Moreover, it was investigated how the cheese salt brine dilution affected the membrane performance by using NaCl solutions to simulate cheese salt brine. The best performing membrane module showed a water flux above L/(m^2h) up to concentration factor 5 with a stable feed pressure drop, when using a draw solution containing 4M NaCl. In pilot tests it was found that the use of cheese brine results in a water flux of 13 L/(m^2h) and a concentration factor above 5.7. The cheese brine could be diluted 33 times. The results have shown that there is potential of using cheese brine as draw solution for FO concentration of whey.

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Plasma processed air as a tool to enhance food safety of dried products on pilot scale

Antje FRÖHLING[1], Julia DUREK[1], Jörg EHLBECK[2], Oliver SCHLÜTER[1]

[1]*Leibniz Institute for Agricultural Engineering & Bioeconomy (ATB), Potsdam, Germany*
[2]*Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany*

Abstract
Herbs and spices are normally storage-stable over years. Nevertheless, strongly fluctuating levels of contamination can be assumed for dry plant products, so that only batch-specific process control can ensure process success. Therefore, the aim of this study was to achieve microbial reduction in dry plant products while maintaining product quality by means of tailor-made treatment with plasma processed air (PPA).
A Triple Bottle Reactor (TriBO) with a two-stage microwave excited plasma torch as plasma source and air as process gas was used for the decontamination of dried tea leaves (peppermint, stinging nettle, lemon grass) The tea leaves were subjected to six different treatments both pulsed and continuous plasma treatments. Microbial diversity and its dynamics were determined by MALDI-ToF MS.
For the peppermint leaves, the increasing plasma treatment intensity led to an increasing reduction of the aerobic mesophilic total bacterial count, and with 1.6 log steps, the highest inactivation was achieved with the continuous plasma treatment of 7.5 min. Almost no reduction of the total bacterial count was observed for nettle leaves and lemon grass, nevertheless sublethal damage seems to occur due to treatment with PPA. Changes of the microbial diversity were dependent on the plasma treatment parameter as well as product-dependent.
The results clearly indicate the necessity to carry out a product-specific adjustment of the treatment parameters as well as the necessity to monitor the composition of the microbial community to avoid an enhanced growth of potentially pathogenic bacteria as a result of the application of decontamination techniques.

New paths for targeted food ingredient modification: Cold atmospheric pressure plasma for protein and fiber functionalization

Sara BUSSLER[1], **Julia DUREK[1]**, Sarah Susann NEUMANN[2], Oliver SCHLÜTER[1]

[1] *Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), Potsdam, Germany*
[2] *University of Applied Sciences, Berlin, Germany*

Abstract
Cold atmospheric pressure plasma (CAPP) was suggested as an innovative nonthermal technology for inactivating undesirable microorganisms on the surface of heat-sensitive foods. With its surface modifying effects, CAPP may further offer a promising approach for the tailored modification of product properties. Since interest has grown in the utilization of legume flour, fiber, and protein concentrate or isolate in recent years, a considerable amount of work has been accomplished to modify legume-based raw materials, intermediates and products while preserving their nutritional value.
Aim of this study was to investigate effects of CAPP on swelling ability (SA), water (WBC) and fat binding capacity (FBC) of different flour fractions (testa flour (TF), protein flour (PF), and protein isolate (PI)) from grain pea (*Pisum sativum*). The flour fractions were exposed to semi-direct and direct cold air plasma at atmospheric pressure for 1 to 15 minutes using a diffuse coplanar surface barrier discharge device.
The initial WBC of TF (2.97±0.03 g/g), PF (0.88±0.04 g/g), and PI (2.00±0.01 g/g) were only slightly affected, except for PF, in which case an increase to 1.23±0.02 g/g (15 min) occurred. Regarding the FBC, initial values of 1.02±0.02 g/g (TF), 1.11±0.03 g/g (PF), and 2.00±0.02 g/g (PI) did not change upon CAPP treatment. The strongest effects emerged with regard to the SA of the flour fractions, which increased in dependency of the CAPP exposure time.
The mentioned and further results of the study indicate that CAPP may significantly contribute to the bio-economic and resource efficient production of high-value legume-based products.

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How contact materials influence the gloss of the chocolate bar molded at these surfaces

Knut FRANKE[1], **Dana MIDDENDORF[1],** Ute BINDRICH[1],

[1]*German Institute of Food Technologies, Quakenbrueck, Germany*

Abstract
The gloss of a chocolate bar surface is one of the main quality parameters appreciated by the consumers, despite taste and texture. The chocolate should show a high and uniform gloss. It can be expected that the chocolate gloss is influenced both by the processing, especially appropriate pre-crystallization, and by the characteristics of the mold material surface which is in direct contact with the chocolate during solidification. So far, the correlation between surface properties of the mold material in microscopic scale and the resulting chocolate gloss is not really understood and deviations in gloss, like local matte areas, are still found on chocolate bars after de-molding.

Therefore, different materials were investigated with respect to the gloss of the chocolate molded at these surfaces. Materials and chocolate were characterized with respect to their microstructure by atomic force microscopy (AFM) and their surface energies. AFM analyses covered topography, including roughness, and adhesion forces.

With respect to chocolate gloss, a distinct influence of the surface roughness could be detected. Only very flat surfaces with a low roughness of less than few micrometers can produce high gloss chocolates. Additionally, the surface energy also influences the gloss indicating that the interactions of the liquid chocolate during molding and the mold material surface are relevant. These correlations were implemented in a model enabling the prediction of chocolate gloss from mold material properties.

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The potential of multiresponse modelling in the context of *in vitro* lipid digestion

Sarah VERKEMPINCK [1], Laura SALVIA-TRUJILLO [2], Marc HENDRICKX [1] and Tara GRAUWET [1]

[1] *Laboratory of Food Technology, KU Leuven, Leuven, Belgium*
[2] *Food Technology Department, University of Lleida, Lleida, Spain*

Abstract:
The conversion of a macronutrient to a, for the human body, absorbable metabolite is a multiple-step process, in which the different digestion products formed are interrelated as they are part of a common reaction network. In this context, empirical, single response modelling has proven to be able to quantitatively describe *in vitro* digestion kinetics. However, until now, there is no open literature available that evaluates the potential of multiresponse modelling to elucidate the mechanisms of digestion taking into account the change of a macronutrient and its digestion products as function of digestion time. Therefore, this work aimed to establish for the first time a mechanism-based multiresponse model focusing on *in vitro* lipid digestion of emulsified lipids, applying a particular multiresponse analytical procedure. Different reaction mechanisms and corresponding kinetic models were proposed, which were confronted with experimental data and adjusted until an adequate multiresponse model was obtained. The multiresponse model assumes that one mole triacylglycerol hydrolyzes to release either one mole of monoacylglycerol and two moles of free fatty acids or either releases three moles of free fatty acids and one mole glycerol (i.e. complete lipid hydrolysis). The validity of the model proposed was tested using different experimental datasets previously obtained at our research unit[1-4]. In all cases, the model converged, presented high goodness of fit and low standard errors of the parameter estimates, which clearly proves it reliability. This is the first proof of concept of the potential of multiresponse modelling in the context of food digestion.

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To what extent can oil-in-water emulsion characteristics tailor the kinetics of *in vitro* lipid digestion?

Sarah VERKEMPINCK [1], Laura SALVIA-TRUJILLO [2], Marc HENDRICKX [1] and Tara GRAUWET [1]

[1] *Laboratory of Food Technology, KU Leuven, Leuven, Belgium*
[2] *Food Technology Department, University of Lleida, Lleida, Spain*

Abstract
In our human diet, we consume lipids mainly as o/w emulsions, e.g. soups and sauces. This work aimed to explore the effect of (micro)structural characteristics of emulsions on *in vitro* lipolysis. Emulsions were prepared containing 5% oil and were stabilized with an emulsifier (0.5-1%), e.g. Tween, sucrose esters or pectin. The small intestinal phase was performed kinetically to determine the time dependency of the hydrolysis of multiple lipid species (TAG, MAG, FFA). The obtained kinetic data allowed to quantitatively describe lipolysis. Different emulsion characteristics led to different reaction rate constants and different final lipid digestion extents. For example, small initial droplets of an emulsion led to a faster and higher lipolysis compared to emulsions with larger initial oil droplets[1]. However, not only small initial droplets were of importance, but also their gastrointestinal stability. More specifically, unstable emulsions in the gastric phase, increasing particle size at the beginning of the small intestine, resulted in a slower and eventually incomplete lipolysis reaction[2]. Linseed oil rich in PUFA was digested slower and in a lower extent in comparison to olive oil rich in MUFA[3]. This can be partially attributed to the more bended PUFA structure which might be more resistant to lipase hydrolysis. The addition of pectin as emulsion stabilizer led to a slow and incomplete lipolysis[4]. This suggests that pectin does not hinder lipase adsorption, yet it may interact with other digestive components, inhibiting a complete lipolysis. This research showed that specific o/w emulsion characteristics can be selected to tailor lipolysis kinetics.

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Processing and physico-chemical characterization of Mango Seed Flour and oil from local varieties Rubi and Lima

Maida KHAN1, Inocêncio HORACIO1, Karina MOTANI1

1*University Eduardo Mondlane, Maputo, Mozambique*

Abstract

Mango is a tropical fruit of *Mangifera Indica L*. tree, available worldwide. The surplus production in the developing countries and the products of their processing in industrialized countries, such as peel and seeds, are continuously generated and usually discarded resulting in cost of transportation and treatment of waste and causing environmental problems. These residues can be processed to obtain new products in cosmetic, pharmaceutical and food industry. The aim of this study was to produce and evaluate the physico-chemical properties of flour and oil from mango seeds from two locally cultivated varieties Lima and Rubi. The kernel were separated from the seeds and processed into flour. The oil was obtained by solvent extraction method. Physico- chemical analysis were carried out, by standard methods. The results revealed that flours from Rubi variety had higher moisture content (7.14%, Rubi; 5.8, Lima), crude protein (7.53%, Rubi;
6.39%, Lima) and fat (12.23%, Rubi; 10.83%, Lima), being the most caloric product with 426 kcal/100 g of energy compared to Lima variety (411 Kcal/100g).
Results showed that although are both stable, there is a significant difference ($p>0.05$) of free fatty acids content (0.982 and 1.38%) and peroxide value (1,86 and 2,27 meqO2 / kg) between the oil of the two varieties. The hydrophilic antioxidant capacity was 4.93 and 5.34% and the lipophilic antioxidant capacity was 71,96% and 72,53%. Oil from mango kernel is of high quality with a high antioxidant capacity being good for consumption and with a potential for its use in cosmetic and pharmaceutical industry.

Quantification of osmotic pressure of whey under Forward Osmosis for whey concentration

Anna ARTEMI[1], George CHEN[2], Sandra KENTISH[2], Judy LEE[1]

[1] *Department of Chemical and Process Engineering, University of Surrey, Guildford, Surrey GU27XH, United Kingdom*
[2] *The ARC Dairy Innovation Hub, Department of Chemical Engineering, The University of Melbourne, Parkville, Victoria 3010, Australia*

Abstract
Cheese whey is a valuable resource for the production of protein powders of high nutritional value. Prior to evaporation and drying, pre-concentration of whey is required, which is traditionally achieved by ultrafiltration. Forward osmosis (FO) has the potential to achieve higher solids concentrations than ultrafiltration and with a lower energy requirement than reverse osmosis. In this study, whey was concentrated using a pilot scale FO system in a batch mode. A maximum initial water flux of 7.3 L/m^2h was obtained using a sodium chloride (NaCl) draw solution with a bulk osmotic pressure of 54 bar and an average hydraulic transmembrane pressure of 1.1 bar. To evaluate the process performance and predict water flux using theoretical models, quantification of the osmotic pressure of the whey during the process is critical. However, due to the complexity of whey, it is difficult to determine its osmotic pressure at the membrane surface. In this study, an empirical method of quantifying the osmotic pressure of whey at the end of the concentration process was developed by extrapolating the apparent pressure driving force when the water flux is equal to zero. This value was then used to estimate the osmotic pressure of whey throughout the process and the method was validated using a model NaCl solution. The method enables the quantification of the effective osmotic pressure driving force throughout the concentration process, whilst accounting for concentration polarisation. Such information can be used to predict the maximum concentration factor that can be achieved by a FO process.

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Relationship between chemical composition and bioactivity performance of commercial oregano essential oil and green tea and rosemary oil extracts when incorporated into biodegradable food packaging films

Cristiane C. P. ANDRADE[1], Zlatina A. GENISHEVA[1], Kelly J. FIGUEROA-LOPEZ[2], Jose M. LAGARON[2], Sergio TORRES-GINER[2], **António A. VICENTE[1]**

[1]*Centre of Biological Engineering (CEB), University of Minho, Braga, Portugal*
[2]*Institute of Agrochemistry and Food Technology (IATA), Spanish National Research Council (CSIC), Valencia, Spain*

Abstract

Plant extracts and essential oils have been widely investigated to replace conventional antimicrobial agents and synthetic antioxidants. Their application to packaging systems may extend food shelf life due to the presence of volatile compounds, mainly secondary metabolites of plant defence systems. The aim of this study was to quantify by gas chromatography–mass spectrometry (GC–MS) analysis the volatile compounds of commercially available oregano essential oil (OEO), rosemary extract (RE) and green tea extract (GTE) and relate their composition with their bioactivity and economic feasibility once incorporated in biodegradable food packaging films. OEO showed the highest concentration of volatile compounds (73.6 g/L) since it was obtained by hydrodistillation, whereas RE (1.03 g/L) and GTE (0.14 g/L) were extracted from leaves by maceration in sunflower oil. Carvacrol (72.9%), γ-terpinene (7.3%) and thymol (5.4%) were the major constituents of OEO, whereas 1,8-cineol (19.2%), carvacrol (18.3%), camphor (10.7%) and p-cymene (10.7%) were the major constituents of RE; and E-2-heptenol (48.6%), 2-pentenol (17.1%), benzyl alcohol (13.9%) and carvacrol (13.0%) of GTE. As expected, antimicrobial and antioxidant activities were in accordance with volatile compounds concentration. Despite being more expensive, OEO becomes cheaper than RE or GTE when used at Minimal Inhibitory Concentration (0.14; 0.33 or 3.20 €/L of media, respectively). When incorporated to poly(3-hydroxybutyrate-co-3-hydroxyvalerate) films, OEO was still the most efficient antimicrobial agent in conditions of use of the packaging material, suggesting that some volatile compounds of OEO were faster released from the films during processing and storage.

Effects of Ultrasonic Treatments on Prickly Pear Cellular Microstructure: An application for enhanced health benefits

Andrea GÓMEZ-MAQUEO[1,2], Tomás GARCÍA-CAYUELA[3], Jorge WELTI-CHANES[2], **M. Pilar CANO[1,2]**

[1]*Instituto de Investigación en Ciencias de la Alimentación, Madrid, Spain*
[2]*Tecnológico de Monterrey, Monterrey, Mexico*
[3]*Tecnológico de Monterrey, Guadalajara, Mexico*

Abstract

Prickly pear (*O. ficus-indica* L. Mill.) fruits are a relevant source of bioactive compounds with high antioxidant, anti-hyperglycemic and anti-inflammatory activities, such as flavonoid glycosides, phenolic acids and betalains. The objective of this study is to analyze the effect of ultrasound (US) on prickly pear microstructure and bioactive compounds to improve their potential antioxidant, anti-hyperglycemic and anti-inflammatory activities. In this work, Spanish purple and yellow prickly pears (var. Morada and Verdal, respectively) were submitted to US (frequency: 19.850-20.050 kHz; amplitude: 50, 70, 100 %; treatment time: 5,10, 20 min; temperature: 25°C). After sonication, sclerenchyma, collenchyma and parenchyma tissue sections were evaluated by confocal microscopy using three channels (to observe phenolic autofluorescence, cell walls with Calcofluor White staining and cellular viability with fluorescein diacetate staining) and light microscopy (to observe betacyanins and betaxanthins). The *in-vitro* antioxidant (DPPH radical assay and oxygen radical absorbance capacity; ORAC), anti-hyperglycemic (α-amylase inhibition, α-glucosidase inhibition) and anti-inflammatory (hyaluronidase inhibition and nitric oxide radical scavenging) activities of prickly pear tissues (peel, pulp, whole fruit) were assessed. The two prickly pear cultivars showed high levels of antioxidant and anti-inflammatory activities after US treatment which also depended on the tissue. These results show that ultrasounds could be used to increase the functional potential of prickly pear tissues, with promising applications in the pharmaceutical and nutraceutical industries.

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Changes in Cellular Microstructure and Viability in Sanguinos Prickly Pear Fruits Submitted to High Hydrostatic Pressure

Andrea GÓMEZ-MAQUEO[1,2], Tomás GARCÍA-CAYUELA[3], Jorge WELTI-CHANES[2], **M. Pilar CANO[1,2]**

[1]*Instituto de Investigación en Ciencias de la Alimentación, Madrid, Spain*
[2]*Tecnológico de Monterrey, Monterrey, Mexico*
[3]*Tecnológico de Monterrey, Guadalajara, Mexico*

Abstract

The integrity of prickly pear cells and its impact on bioactive stability after high pressurization was evaluated. In this study, red-skinned Spanish prickly pears (var. Sanguinos) were submitted to HHP (pressure: 100, 350 and 600 MPa; time: 5 min holding time and come-up time (CUT); temperature: 20°C). After pressurization, sclerenchyma, collenchyma and parenchyma tissue sections were evaluated by electron transmission microscopy (TEM), confocal microscopy using three channels (to observe phenolic autofluorescence, cell walls with Calcofluor White staining and cellular viability with fluorescein diacetate staining) and light microscopy (to observe betacyanins and betaxanthins). After being submitted to HHP, CO_2 respiration and ethylene production of Sanguinos prickly pears were recorded for all treatments during 24 h. The original volume occupied by sclerenchyma tissue diminished after HHP treatments due to the significant loss of intercellular spaces, especially at 600 MPa/5 min. Processing 350 MPa/5 min was found to cause significant cellular membrane rupture and cell deformation in collenchyma and parenchyma tissues, therefore enhancing the extractability of phenolic compounds found attached to cell walls while preserving the (more liable) betacyanins. After HHP treatments prickly pears presented advanced senescence observed by ethylene increments and gradual loss of CO_2 production reaching zero after the first 6 h. Prickly pears treated at 100 MPa/CUT, however, did not present significant changes in CO_2 production. High hydrostatic pressure may be used for the enhancement of health potential in vegetable foods by increasing bioactive extractability and modifying the food matrix.

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Multi-functional mixed plant cell wall fibers from natural food colors side streams

Kai REINEKE[1]

[1]*GNT Europa GmbH, Aachen, Germany*

Abstract

GNT is the leading global manufacturer of Coloring Foods made exclusively from fruits, vegetables and edible plants. Solid and liquid side streams in fruit and vegetable processing are primarily being considered as waste, and thus destined for the ‘cheapest gutter’ which is in the best-case feed. However, the deep understanding of our raw materials and the vertical integration starting from seed breading until our final products, enables GNT to valorize high value side streams.

With focus on the manufacturing process of different colored carrot cultivars, this presentation will give insights on how the carrot pomace could be processed in a brought set of dryers and how they affect the functional properties. Energy efficient process like super-heated steam negatively impacts properties like water binding capacity (WBC) and cause intense browning, whereas fast drying in flash or flash-mill dryers enables the production of a fine carrot pomace flour with WBC > 15 g/g and simultaneous preservation of the color shade of the raw material. With fibers content of more than 60 % these colored fibers, does contain a high amount of anthocyanins or carotenoids as well as all the micro- and macro-nutrient from the carrot. These minimal processed fibers deliver besides the know functions of mixed plant cell wall fibers from vegetable origin the additional function of a natural and clean label color solution, which will be presented for viscous beverages, cereals and meat products.

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Enhancement of anti-inflammatory and antioxidant activities of prickly pear fruits by high pressure applications: A phytochemical approach

Andrea GÓMEZ-MAQUEO[1,2], Tomás GARCÍA-CAYUELA[3], Jorge WELTI-CHANES[2], **M. Pilar CANO[1,2]**

[1]*Instituto de Investigación en Ciencias de la Alimentación, Madrid, Spain*
[2]*Tecnológico de Monterrey, Monterrey, Mexico*
[3]*Tecnológico de Monterrey, Guadalajara, Mexico*

Abstract

Prickly pears are relevant sources of bioactive compounds with potential antioxidant and anti-inflammatory activities. For prickly pear biaoctives to become bioaccessible, they must be first liberated from the food matrix. High hydrostatic pressure (HHP) is an innovative technology which allows us to obtain enhance bowel-related antioxidant and anti-inflammatory activities. The aim of this study was to submit Mexican and Spanish prickly pear slices (Pelota and Sanguinos varieties, respectively) to HHP (pressure: 100, 350 and 600 MPa; temperature: 20°C time: come-up time (CUT) and 5 min) to enhance their health benefits by increasing bioactive extractability. The profile of individual betalains and phenolic acids and flavonoids was characterized and quantified by high performance liquid chromatography (HPLC-DAD-ESI-QTOF) and ascorbic acid was determined spectrophotometry in peels and pulps to determine the contribution of each bioactive to *in-vitro* bowel-related antioxidant (oxygen radical absorbance capacity; ORAC) and anti-inflammatory activities (hyaluronidase inhibition and nitric oxide radical scavenging activity). Antioxidant activity in Pelota and Sanguinos prickly pear pulps increased 81.1 and 68.2% at 350 MPa/20°C/5min, respectively, and correlated with the extractability increase of phenolic acids and isorhamnetin glycosides, particularly isorhamnetin glucoxyl-rhamnosyl-rhamnoside (IG1) and isorhamnetin glucoxyl-rhamnoside (IG5). Anti-inflammatory activity (hyaluronidase inhibition) increased 85.7 and 117.5% in Pelota and Sanguinos pulps, respectively, treated at 600 MPa/20°C/CUT and correlated with extractability increase of isorhamnetin glucoxyl-rhamnosyl-pentoside (IG2), isorhamnetin glucoxyl-pentoside (IG4) and IG5. The use of non-thermal technologies for the enhancement of health potential in vegetable foods is key for the development of the novel foods of the 21st century.

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Effects of ultra-high pressure assisted acid extraction on characteristics of pomelo peel pectin

Hanying DUAN, Qun PENG, Chao WANG, Luyue YE

Jinan University, Guangzhou, China

Abstract

Ultra-high pressure (UHP) has already been applied on pectin extraction. However, none of these research studied pectin extracted from UHP treated fresh peels. Considering UHP has functions including inactivation of enzyme activity, cell membrane damage and biopolymers conformation, it’s interesting to find out whether UHP on fresh peels would change pectin properties.
The objective of this study was to investigate the effect of UHP on pomelo peel before acid extraction (AE) on the properties of pectin. Pectin were extracted from pomelo peel which was blanched before (B-UHP) or after UHP (UHP-B) and then AE. The effects of pressure (300, 450, 600MPa) and pressure-holding time (0, 5, 10 min) on the extraction yield, physicochemical and rheological characteristics of pectin from B-UHP-AE, UHP-B-AE and AE were compared. When pressure was 600MPa, Galacturonic acid (GalA) content (75.1-91.3%) were much higher for UHP-B-AE pectin. The degree of esterification (DE) (42.5-76.1%) increased with UHP holding time, but had no significant relationship with pressure. The results showed that the intrinsic viscosity of pectin extracted by UHP-AE were much higher than those by AE. The same results were also obtained in the rheological characteristics. This was the first report to study UHP effect on pectin properties by applying UHP on fresh peels, which offered a new method to extract pectin and alter pectin properties.

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Basic analysis of flavor compounds of food combined with the color changes during grilling process

Mika FUKUOKA[1], Kaori ISHIZAWA[1], Yuko Furukawa[1], Yumiko Yoshie-Stark[2], Noboru SAKAI[1]

[1]*Tokyo University of Marine Science and Technology, Minato-ku, Tokyo, Japan*
[2]*Toyo University, Oura-gun, Gunma, Japan*

Abstract
Changes in color and flavor during cooking process are important for the quality attributes of food. In addition, since excessive heating may lead to produce new harmful substances, it is quite important to aim for optimum cooking. The objective of this study is to analyze flavor behavior of fish or chicken grilling process related with surface color change to get knowledge which provides the optimum cooking process. First, we collected temperature history and color (CIE L^*, a^*, and b^* values) at surface position on food material in whole grilling process to use digital camera and infrared thermometer. The grilling process was divided into 4 stages (1) raw, (2) protein denaturation, (3) browning reaction, and (4) carbonization reaction by surface color and temperature. Then each of the 4 stages sample was analyzed flavor compounds. We found significant difference of flavor compounds by Gas Chromatography (GC) with head space solid phase micro extraction method (SPME). GC-sniffing test was used for charactering smell-like to each peak detected by GC. We identified the characteristic flavor compounds at each stage of grilling process using GC-MS analysis. We also discussed the flavor behavior of each stage from the odor similarity and contribution by using the electronic nose method.

Comprehending the effect of operational characteristics of alginate-based edible coating formulations containing thyme essential oil

Nazia TABASSUM, **Mohammad Ali KHAN**
Aligarh Muslim University, Aligarh,India,

Abstract
Edible coating provides a modified atmosphere to a food produce by acting as a barrier to gases and water vapor. Inclusion of plant-based oils further helps in increasing the shelf-life of the produce by improving the antimicrobial property of the coating. However, use of essential oils in food is limited due to their low water solubility and strong, penetrating aroma which most often negatively impacts the original aroma of the produce. Thus to improve oil-in-water solubility and reduce the aroma effect, formulation of emulsions in nano form emerged as a possible alternative. Alginate-based emulsions incorporated with TH-EO were formulated in nano and non-nano form using non-ionic surfactant Cween 80 (1% v/v) and double-distilled water by ultrasonic emulsification method. The formulated emulsions were subjected to characterization study and examined for antimicrobial activities using well diffusion method against food spoilage organism *Escherichia coli*.
This study compared the physical attributes, viz. particle size, stability, turbidity and color characteristics of the formulated emulsions. The nanoemulsions were reported to have smaller particle size and better stability as compared to the conventional emulsions. Increasing the concentration of TH-EO increased the antimicrobial activity of the emulsion which was evident by larger inhibition zones. Also improved antimicrobial activity was observed for nanoemulsions of the same concentration as the conventional emulsion. The correlation observed among the formulated emulsions and their respective antimicrobial activities could have significant implication in their utilization as effective edible coatings on several food products.
***Keywords*:** nanoemulsion, thyme oil, antimicrobial, edible coating

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Impact of amorphous sugars ratio and fiber addition in crystallization, in model food systems as affected by different water activities

Evgenia N. NIKOLAOU[1], Eirini K. NIKOLIDAKI[1]**,** Spyridon E. PAPADAKIS[2]**,** Nikolaos P. ZOGZAS[2]**, Vaios T. KARATHANOS[1]**
[1]*Harokopion University, Athens, Greece*
[2]*University of West Attica, Athens, Greece*

Corinthian currants are sun or shade dried vine products rich in simple sugars, where fructose and glucose are found in an almost equal ratio. During prolonged storage currants become susceptible to crystallization, a complex phenomenon responsible for their significant quality degradation. The fundamental understanding of the principles that control the formation or inhibition of the crystalline sugar phase in a solution is of practical importance for designing the optimal conditions and processes for the development of sugar-rich products. The main objective of this study was the investigation of the impact of currants' dominant sugars and fiber content in their standard mixtures, simulating natural dried fruit systems, in crystallization as affected by different water activities. For this purpose, various ratios of sugars were selected, from 2:1 to 1:2 for glucose:fructose concentration, followed by the addition of 5%, 7% and 10% of pectin and cellulose. The increase in glucose concentration contributed in the significant increase in the melting enthalpy values (ΔH_m) of the mixture, possibly favoring crystallization phenomena. Furthermore, a decrease in crystal growth was observed with the increase in fructose concentration. Samples with 7% of pectin addition demonstrated reduced crystal formation, reflected by their lower melting enthalpy values in comparison with cellulose samples at every level of addition. The increase in water activity resulted to the significant decrease in glass transition temperature (T_g), in all cases.

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Heat transfer modeling of black pepper seeds in star valve type cryogenic precooler

Bhupendra M GHODKI[1]
[1]*Horticultural Crop Processing Division, ICAR-Central Institute of Post-Harvest Engineering and Technology, Abohar, 152116, India*

Abstract
In the last decade, cryogenic grinding has already been emerged as a superior milling technique for spices over traditional or conventional counterparts in view of obtaining a high-quality of spices powder. However, the overall energy requirement along with a relatively higher operating cost seems to be one of the most significant challenges before commercializing this advantageous method. Thus, an understanding of heat transfer phenomena of spices inside the system is essential. A cryogenic grinding system generally consisted of two primary components: a cryogenic precooler (precooler), and a grinder. The study aimed for modeling of three-dimensional granular heat transfer in a star valve type precooler by utilizing black pepper seeds.

Hertz-Mindlin with conduction contact model of discrete element method (DEM) was utilized for modeling of granular motion and heat transfer. Maximum granular temperature and flow pattern of numerical and experimental approaches were in good agreement. Overall, the results confirm the applicability of DEM as an efficient tool to model granular heat transfer phenomena along with an insight of particle mechanics in the precooler. In the future, an advanced study on granules and fluid interaction can be performed. Granular heat transfer model for a cryogenic grinding system is obligatory in improving its mechanical design and processing aspects. Furthermore, the results of this study are essential in establishing the following: (i) an optimal cryogenic grinding temperature for black pepper; (ii) calculating theoretical minimum requirement of cryogen; (iii) scaling up the findings.

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Ultraviolet-C radiation as a non-thermal pasteurization method for progressive freeze concentrated coconut water

Erandya JAYAWARDENA[1], Mihiri VANNIARACHCHI[1], Jagath WANSAPALA
[1]*University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka*

Abstract
Emerging non-thermal pasteurization techniques are applied as substitutions to thermal processes in order to maintain the microbial safety and quality of the liquids. There is a growing demand for coconut water as a beverage due to its health benefits. Maintaining the original quality of Coconut water during concentration and preservation processes is an important factor for consumer acceptance. Ultraviolet-C (UV-C) light wavelength at 253.7 nm is proven to be appropriate for maintaining liquid quality with minimal deterioration of nutrients. The aim of the study is to preserve the microbial, nutritional and organoleptic properties of PFC coconut water by applying UV-C light as non-thermal pasteurization method. Mature coconut water (MCW) with initial Brix 3.5^0 was concentrated up to Brix 8.5^0 by progressive freeze concentration (PFC). Concentrated MCW was circulated through a tubular system which consists of liquid storage tank, circulation pump and UV-C lamp (11W/50Hz/253.7nm) covered with quartz sleeve. Ultraviolet dosage (Jcm^{-2}) 9.9, 12.38, 16.5, 24.75 and 49.35 were applied to PFC coconut water and determined the reduction of microbial load and Vitamin-C content. Total plate count (TPC) 2.49, 2.44, 2.07, 1.9 and 1.47 $\log_{10}$ CFU/mL and Fungi count (FC) 1.3, 1, 0, 0 and 0 $\log_{10}$ CFU/mL were detected respectively. Loss of Vitamin-C percentage was increased 17%, 25%, 31%, 44%, and 58% respectively with increased UV-C dosage. Organoleptic properties of UV-treated and fresh MCW will be assessed in further studies. UV-C radiation is a promising method to extend the shelf life of MCW with minimal deterioration of the quality.

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Reduced order Phase-Field models for crystallisation

Estefania LOPEZ-QUIROGA[1], Peter J. FRYER[1]

[1]*University of Birmingham, Birmingham, UK*

Abstract

A wide range of manufacturing methods and applications in food processing involve crystallisation processes. As crystal/microstructure formation determines both quality and function of frozen and freeze-dried products, a proper control of crystallisation conditions during processing is critical. In this context, mathematical models can help to design and optimise efficient crystallisation industrial processes.

Phase Field models have been increasingly used to simulate and predict the formation and evolution of material microstructure and phase change interfacial kinetics. However, these methods usually lead to computationally involved numerical schemes, revealing the need for more efficient computational solutions: i.e. industrial applications, like real-time control and optimisation, require the development and implementation of process models that are capable to operate at faster time scales than the process itself.

This work presents a reduced order Phase-field model for ice crystal formation in food model systems. The model couples heat and mass transfer phenomena, describing the evolution of the solid/liquid interface. We have considered two different model reduction techniques: (i) Proper Orthogonal Decomposition (ii) Laplacian Spectral Decomposition, and we have compared their performance using a range of undercooling and seeding conditions.

Results obtained show that reduced models can accurately describe the behaviour of the full system, including the effect of the degree of supercooling on the formed crystals morphology. Overall, this work demonstrates the potential of reduced order approaches for the modelling of phase change processes and also for the development of virtual tools that allow a “fast” (yet accurate) monitoring, design and optimisation of food manufacture operations.

SUPERCRITICAL CARBON DIOXIDE TECHNOLOGY FOR FERMENTABLE SUGARS RELEASE FROM SUGARCANE BAGASSE

Maria Augusta SILVELLO1, Julian MARTÍNEZ1, Rosana GOLDBECK1*

1University of Campinas, Campinas, Brazil
*goldbeck@unicamp.br

Abstract

Supercritical technologies offer the possibility of new products and processes development with a sustainable approach by reducing the energetic consumption. The use of carbon dioxide in supercritical conditions is a green technology and its use can enhance mass transfer rates. The hydrolysis of the cellulose present in the sugarcane bagasse (lignocellulosic byproduct from the sugar and ethanol industry) into fermentable sugars using enzymatic and supercritical technology is an alternative pathway for the valorization of this byproduct. The objective of this study was to evaluate the effect of supercritical carbon dioxide (SC-CO2) on the enzymatic hydrolysis of sugarcane bagasse aiming the fermentable sugars release. The influence of the supercritical treatment on the enzymatic hydrolysis of sugarcane bagasse (2 % m v-1) was assessed using a commercial cellulase Cellic CTec2 (Novozymes®) in a Central Composite Design (CCD) to determine the effect of the temperature (40 a 60 ºC), pressure (100 a 300 bar) and time (60 a 180 min). After the treatment, the samples were kept at 50ºC for 24 hours to complete the hydrolysis. The fermentable sugars concentrations were quantified by chromatography. The fermentable sugars release was increased in 32.49% in comparison to the control experiment (without supercritical treatment) in the condition of 200 bar, 50ºC and 120 min. The condition that provided the highest concentration of released sugars (2.340 g.L-1) achieved a cellulose hydrolysis yield of
32.4%. In this way, it was possible to increase the hydrolysis of a lignocellulosic by-product using sustainable technologies.

Study on extraction of active ingredients from capsicum by surfactant-assisted enzymatic hydrolysis

Ce WANG, Xiaoxu ZHANG, Hongqin LIU, Baocai XU
School of Food and Chemical Engineering, Beijing Key Laboratory of Flavor Chemistry, Beijing Higher Institution Engineering Research Center of Food Additives and Ingredients, Beijing Technology and Business University, Beijing, China

Abstract

Extracts of Capsicum such as capsaicin, dihydrocapsaicin and capsicum red pigment can not only be used as food additives, but also be used in medicine and military fields.

The nutritional components of capsicum were extracted by surfactant-assisted enzymatic hydrolysis, including capsaicin, dihydrocapsaicin and capsicum red pigment. The extraction process was optimized by single factor test and orthogonal test. The results showed that the optimum extraction conditions of capsaicin and dihydrocapsaicin were as follows: the cellulase addition was set of 0.4 % (w/w), surfactant (sodium stearoyl lactylate) addition was 1% (w/w), the enzyme hydrolysis time was 4 h, the enzymolysis temperature was 45^{o}C, the solid-liquid ratio was 1:8 (g/mL), capsicum granularity was less than 100 mesh. The optimum extraction conditions of capsicum red pigment were as follows: the amount of cellulase and sodium stearoyl lactylate addition was 0.8 % and 0.6 % (w/w), respectively, the enzymolysis time was 2 h, the enzymolysis temperature was 55 ^{o}C, the solid-liquid ratio was 1:5 (g/mL) and the granularity was less than 100 mesh. Under these conditions, the content of the extracted capsaicin, dihydrocapsaicin and capsicum red pigment was 7.82 mg/g, 4.94 mg/g and 31.25 mg/g, respectively. The study provided a certain scientific theoretical basis for the fine processing and comprehensive utilization of capsicum.

DIFFERENT LIGNOCELLULOSIC BIOMASSES AS A SOURCE OF XYLAN FOR THE PRODUCTION OF XYLOOLIGOSACCHARIDES BY ENZYMATIC HYDROLYSIS

Patrícia Félix ÁVILA[1], Rosana GOLDBECK[1]*

[1]University of Campinas, Campinas, Brazil

*goldbeck@unicamp.br

Abstract

Xylooligosaccharides (XOs) are sugar oligomers formed from the hydrolysis of xylan, which is the main component of hemicellulose in plants. These compounds are considered prebiotics and have several biological effects on human health. Two different agricultural residues, called sugar cane straw (SS) and coffee peel (CP) were tested for the XOs production. The production of XOs was performed by enzymatic hydrolysis of xylan, which was obtained by alkaline extraction of these agricultural wastes. Depending on the source, these two agricultural wasteswere found to contain different amounts of hemicellulose, cellulose and lignin. The highest amount of arabinose was found in SS xylan, while CPxylan had mainly xylose and small amount of glucose. The commercial xylanase (Endo-1,4-β-xylanase) Aspergillus niger from Megazyme® was evaluated for the production of XOs from these xylan sources using a 2, 4, 6 and 10U /mL enzyme concentration in a solid loading of 5% (w/v) for 12 hours at 50°C. The higher enzymatic loading (10 U / mL) provided the higher conversion of xylan to both residues, however both also presented lower concentration of XOs and higher xylose concentration. When decreased to 4U / mL, the highest total concentration of XOs (678.78 ± 1.08 mg/L) was found mainly in X3 and X4 in CP xylan, while in SS xylan (789.56 ± 1.19 mg/L), although using
6 U/mL. HPLC analyzes of the hydrolysis products indicated that the two sources of xylan showed a similar profile of xylooligosaccharides (X2> X3> X4> X5> X6), thus demonstrating that both are potential sources of xylan for the production of xylooligosaccharides.

Key-words: Enzymatic hydrolysis, Coffee Peel, Sugarcane Straw, Xylooligosaccharides

Antidiabetic effect of jujube leaf tea and optimum extraction conditions

Youngje JO[1], Sujin HWANG[1], Jahyun LEE[1], Bomi KIM[1], Sanguine BYUN[2], **Seokwon LIM[1]**

[1] *Department of Food and Biotechnology, Hoseo University, Asan, Republic of Korea*
[2] *Division of Bioengineering, Incheon National University, Incheon, Republic of Korea*

Abstract
Antidiabetic effect of jujube leaf tea was investigated, and the optimum condition of extraction was explored. Conventional α-glucosidase inhibitors used for antidiabetic therapy exhibit serious side effects for simultaneously inhibiting α-amylase. However, tea of jujube leaf did not inhibit α-amylase while significantly reduced α-glucosidase activities. When applying to α-glucosidase from almond, tea of jujube leaf exhibits stronger effect than acarbose, the most well-known antidiabetic agent. Via *in vivo* tests, jujube leaf tea showed significant effect but less than acarbose. Employing response surface methodology, optimum extraction conditions were explored considering the temperature and the time of extraction and the amount of leaf powder (/10 mL of distilled water) as control factors. Optimum extraction conditions for each inhibition were estimated as 52℃, 43 min, 0.6433 g for α-glucosidase and 42℃, 32 min, 0.3976 g for α-amylase inhibition. However, extract from long time extraction at low temperature was investigated as the most advantageous showing the highest α-glucosidase inhibition without α-amylase inhibition. Consequently, jujube leaf tea can be used as an effective antidiabetic agent without showing undesirable side effects. To obtain those benefits, the method of extraction should be carefully considered.

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Effect of particle size reduction on the antioxidant, anti-inflammatory properties and dietary fibre functional properties of herbal medicines as a novel food supplement

Yanwei MA[1], Jiadai WU[1], Peter VALTCHEV[1], Fariba DEHGHANI[1]
[1] *The University of Sydney, Centre for excellence in Advanced Food Enginomics, Sydney, Australia*

A range of beneficial traditional Chinese herbal medicines have been formulated as a novel food supplement because of their potent antioxidant, anti-inflammatory properties. Meanwhile, due to the natures of these herbals, they are also promising sources of pre-biotic fibres which can improve glucose metabolism and promote gut health.

In this study, the effect of particle size on the release of anti-oxidative and anti-inflammatory components from these herbals were first investigated. The antioxidant released from coarse (Dx90 = 500 µm), medium (Dx90 = 200 µm) and fine (Dx90 = 10 µm) particles were evaluated using three different assays including FRAP, DPPH and the ABTS free radical assay. The nitric oxide (NO) inhibitory activity of resulting extracts was measured to evaluate their anti-inflammatory properties as food supplement. The expression levels of inducible nitric oxide synthase (iNOS) and cyclooxygenase (COX-2) were estimated via immunoblotting. ELISA was adapted to quantify the expression of cytokines in macrophage cells after treatment with extracts.

The physiochemical and functional properties of soluble and insoluble dietary fibres extracted from processed herbal particles were investigated. Water retention, water swelling and oil absorption capacities of the extracted fibres were measured to quantitatively evaluate the water and oil absorption capacity during digestion. Functional properties such as glucose absorption capacity, α-amylase inhibition and bile acid retardation index were also studied to evaluate the dietary fibres’ ability to regulate glucose release and cholesterol metabolism. As the first comprehensive investigation about the impact of particle sizes on the releasing of active compounds from these herbs, the obtained results will serve as a foundation for the development of novel food supplements with promising functional properties.

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Controlled ice crystal formation in ice cream by ice structuring proteins

Dana MIDDENDORF[1], Andreas JUADJUR[1], Ute BINDRICH[1], **Volker LAMMERS[1]**

[1]*DIL German Institute of Food Technologies e.V., Quakenbrueck, Germany*

Abstract
Ice Structuring Proteins (ISP) are naturally produced by a variety of living organisms, including certain vertebrates, plants, fungi, and bacteria that permit their survival in subzero environments. ISP adsorb at the surface of ice crystals and form a barrier layer which inhibits growth and recrystallization processes.

The application of plant-based ISP is of high interest for formulations of frozen foods as natural ingredients preserving the initial ice crystal structure. We report on developed procedures for the cultivation, harvest, and extraction of plant-based ISP and their application potential in ice cream. Cultivars from winter rye were selected and cultivated in glasshouses applying a defined temperature protocol to stimulate the ISP formation. Afterwards, the leaves were harvested and subjected to an extraction process. The ice structuring potential of the extracts was investigated by monitoring changes of the ice crystal structure after heat shocks. Results were compared to a reference ISP from artic fish confirming a significantly preserving effect on ice crystal structure. Finally, the efficacy of plant-based ISP was validated in ice cream products on a pilot scale.

Summarizing, this study demonstrates that plant-based ISP from winter rye leaves have the potential to prevent product damage by stabilizing the initial ice crystal structure of frozen foods and, therefore, maintain the ice cream quality also after temperature fluctuations occurring during transport and storage.

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Enzyme hydrolysis of bakery leftovers for sugar recovery: Effect of enzyme concentration.

Nurfatimah MOHD THANI[1], Siti Mazlina MUSTAPA KAMAL[1], Farah Saleena TAIP[1], Alifdalino SULAIMAN[1], Rozita OMAR[2]

[1]*Department of Process and Food Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.*
[2]*Department of Chemical and Environmental Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.*

Abstract

Bakery leftovers such as doughnut and croissant are among the major contributors to global food wastes. About 1.2 million tones of food wastes are being discarded annually, which may affect the environment, as its will produce harmful gasses through its biological degradation. Bakery leftovers contain carbohydrates and sugars in its formulation, thus suitable as renewable resources for sugar recovery. This research focused on using enzymatic hydrolysis for sugar recovery from leftover doughnut and croissants. Hence, the objective was to study the effect of enzyme concentration (0.1-1% w/w) on total sugar recovery and analyze the sugar profile of the hydrolysate. It was found that as the enzyme concentration increased, total sugar recovery also increased. Enzyme concentration of 1% recorded the highest total sugar yield for leftover doughnuts with 135.89±0.59 g/L (pH value of 5.21±0.01), while enzyme concentration of 0.7% have the highest total sugar yield of 137.58±0.79 g/L (pH value of 5.15±0.01) for leftover croissants. Sugar profile analysis of the hydrolysate, indicate the presence of fructose and glucose. The highest fructose and glucose were obtained from leftover croissant with 12.76±0.18 g/L and 10.10±0.12 g/L, respectively.

Keywords: Bakery leftovers, croissants, doughnuts, enzyme hydrolysis.

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Fingerprinting as a tool to assess merlot wines produced from PEF treated grapes

Biniam KEBEDE, Sze Ying LEONG, Indrawati OEY
Department of Food Science
University of Otago, Dunedin, New Zealand

Background & Objectives:
Pulsed electric field (PEF) is an innovative processing technology currently used to advance the age-old art of winemaking. PEF can be used as a pre-treatment prior to the maceration step, to cause permeabilization of the gape skin cell and accelerate/increase the extraction of phenolic and aroma compounds during the maceration-fermentation step of red winemaking. This can create wines with unique quality properties. However, there is a limited understanding of these complex metabolite changes. Currently available analytical (e.g. fingerprinting) techniques offer an opportunity to overcome these limitations.

Method(s) and Results:
Integrated volatile and phenolic fingerprinting approach is used to increase insight into metabolite changes during maceration-fermentation step. This work demonstrated that PEF processing clearly increased the rate of release of phenolic compounds and modified the volatile fraction.

Conclusions:
The integrated volatile and phenolic fingerprinting obtained an increased understanding of the complex metabolite changes during the maceration-fermentation step. PEF processing is an innovative pre-treatment before the maceration step to enhance the release of metabolites, reduce the maceration time and create unique sensorial and nutritional properties.

Significance and Impact of the Study:
PEF will significantly reduce the maceration time and create wines with unique sensorial and nutritional properties.

Conflict of interest disclosure:
The authors declare no conflict of interest, in terms of scientific, financial and personal.

Keywords: Red wine, pulsed electric field, bioactive metabolites, food fingerprinting, chemometrics.

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PHYSICAL AND CHEMICAL PROPERTIES OF DRY GRAIN AND RHEOLOGICAL PROPERTIES OF COCOA LIQUOR OF THREE-VARIETY OF *Theobroma cacao* L. (ICS 95, ICS 39 and CCN 51)

Katia PANDURO-SOTO, Richer GARAY-MONTES[1], **Mari Luz MEDINA–VIVANCO[1]**
[1]*Universidad Nacional de San Martín, Tarapoto, Perú*

ABSTRACT

The physical and chemical properties of the dry grain and rheological properties of the cocoa liquor of three varieties of *Theobroma cacao* L., ICS95, ICS 39 and CCN51, were determined. The following were analyzed: weight, longitudinal and transverse diameters and the centesimal composition of the grains. A randomized complete block design (RCDB) was carried out, with the localities, Ahuihua and Montevideo, as blocks and the factor to be evaluated was the variety; the tests were performed in triplicate with a level of significance of 5%.

For the cocoa liquor rheological properties evaluation a RCDB was used. Blocks, locations, and factors, variety and temperature (60, 70 and 80ºC) were used. The rheological properties of the cocoa liquor were determined with a BROOKFIELD viscometer, RVDV-III ultra, spindle SC-18. The experimental values were adjusted to three models (Ostwald de Waele, Herschel-Bulkley and Casson).

The ANOVA indicated that the effect of variety was significant ($p \leq 0.05$) for the longitudinal and transverse diameters. In relation to centesimal composition, the effect of variety and location was significant ($p \leq 0.05$) for crude protein and fat content. The ICS 39 variety obtained the highest values in transverse and longitudinal diameters, crude protein and fat content.

The Herschel-Bulkley model was better adjusted to the experimental data, with $R^2 \approx 0.999$. The analysis of variance indicated significant influence ($p \leq 0.05$) of temperature and varieties in the índices and consistency coefficients, yield stress and viscosity.

Keywords: rheological properties, cocoa liquor, rheological models

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Effect of high-pressure homogenization on the rheological and physical properties of aqueous dispersion of okara

Fabiana de OLIVEIRA MARTINS[1,2], Bruno Ricardo de CASTRO LEITE JÚNIOR[2], Thiago SOARES LEITE[2], Marcelo CRISTIANINI[2] and **Flavia Maria NETTO[2]**
[1]Federal Institute of Education, Science and Technology of the Southeast of Minas Gerais, Juiz de Fora, Brazil
[2]School of Food Engineering, University of Campinas, Campinas, Brazil

Abstract

Okara, a byproduct from water-soluble soybean extract production, has been discarded or used in animal feed despite its rich nutritional and bioactive composition. Its use in food systems is limited mainly because of its high fiber content and unpleasant texture. In this study, high-pressure homogenization (HPH) was used to modify the physical characteristics of okara. An aqueous dispersion of okara (5% of protein) was subjected to HPH (from 0 to 175 MPa) using one, two or three passages. The use of one passage led to a decrease of 82% in D[3,2], 92% in D[4,3], 66% in shear stress ($\sigma 0$), and 85% in fluid consistency index (k), and, while the fluid behavior index (n) increased up to 53%. Multiple passages affected rheological parameters, notably two passages at lower pressures. Microscopic observations, using a confocal microscope, revealed cell disruption after homogenization that changed the appearance, from a coarse heterogeneous to smooth homogenous, and in the instrumental color (ΔE^* increased up to 5 times with one passage) of okara. The effects of HPH on the rheological parameters, especially the decrease in the consistency index, may be due to the reduction of particle size, since no changes in the fiber profiles occurred, suggesting that this technology gives okara the characteristics that make it suitable for use in food systems.

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Inspection of semi-solid food products for the presence of fungal contaminants using hyperspectral imaging.

Sholeem GRIFFIN[1], Owen FALZON[1], Kenneth CAMILLERI[1], Vasilis VALDRAMIDIS[1]

[1]University of Malta, Msida, Malta
The 'Food Inspection using Hyperspectral Imaging' (FIHI) project is financed by the Malta Council for Science and Technology, for and on behalf of the Foundation for Science and Technology, through the FUSION: R&I technology Development programme.

ABSTRACT

Feeding an ever-growing population is a global problem that we face as the human race. Ensuring food availability and security is essential to reduce world hunger, where 1 in 9 people are malnourished. However, annually 1.3 billion tonnes, a third of the total food produced is wasted, costing 990 billion globally. The utilisation of this wasted food would contribute significantly towards ending world hunger. Affordable and high nutrition food products with a long shelf-life are required to reduce food wastage. However, over time microbial contaminants can spoil foods rendering them unsafe for human consumption. Therefore, these products require remote monitoring to ensure that they are safe for consumption.

We propose the use of hyperspectral imaging to detect these microbial contaminants during production. In contrast with a typical digital camera, which compiles the light signal into three broad wavelength bands; red, green and blue, a hyperspectral camera records numerous narrow and contiguous wavelength bands reflected from an object. This produces a series of images, each corresponding to the reflected electromagnetic energy in the respective narrow band of wavelengths. This image series may, in turn, be used for early fungal detection and identification.

To test this hypothesis, a model cheese and bean dip was produced to conduct compatibility and stability studies. The model cheese and bean dip was then challenged with fungal strains and imaged using a hyperspectral camera. An algorithm is under development to differentiate contaminated samples from uncontaminated ones using image analysis and multivariate statistics, and predict their shelf life.

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Inline rheometry and die entry flow simulation of high moisture extruded meat analogues

Juliette RUDZICK[1], Tobias HERKEN[2], Max POHL[2], Volker LAMMERS[1]

[1]*DIL German Institute of Food Technologies e.V., Quakenbrueck, Germany*
[2]*IANUS Simulation GmbH, Dortmund, Germany*

High moisture extrusion (HME) is a process fostering the production of meat analogues from various protein sources. The formation of fibrous, meat-like structures is based on the thermomechanical energy input in the extruder and the subsequent alignment of proteins in a cooling die. Even if the HME-technology is available on a production scale, only little is known about the mechanisms behind the structure formation in the cooling section. This results in time-consuming product developments and laborious determination of optimal process settings.
The aim of this study was to better understand and predict protein structuring behavior by characterization of the material properties and numerical simulation of the die entry flow. Rheological data of protein-water mixtures from soy and pumpkin protein was obtained inline at the extruder end plate using capillaries with different length/diameter ratio. The total throughput was varied from 5 to 30 kg/h covering apparent shear rates in the range of 0.1 to 100 s^{-1}. Shear viscosities were calculated from measured pressure drop differences and corrected for entry effects. A rheological and thermodynamic model was developed describing the die entry flow behavior and temperature conditions during extrusion. The rheological analysis was the basis for subsequent 3D CFD flow calculations supporting R&D of meat analogues and the optimized design of HME cooling dies.

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Effect of high pressure homogenization on the bioactivity of okara

Fabiana de OLIVEIRA MARTINS[1,2], Fernanda Guimarães Drummond e SILVA[3], Bruno Ricardo DE CASTRO LEITE JÚNIOR[2], Thiago SOARES LEITE[2], Marcelo CRISTIANINI[2] and **Flavia Maria NETTO[2]**
[1]Federal Institute of Education, Science and Technology of the Southeast of Minas Gerais, Juiz de Fora, Brazil
[2]School of Food Engineering University of Campinas, Campinas, Brazil
3School of Nutrition, Ferderal University of Ouro Preto

Abstract

Okara, a byproduct from the production of water-soluble soybean extract, has been discarded or used in animal feed despite its rich nutritional and bioactive composition. In this research, we investigated the effects of high-pressure homogenization (HPH), from 0 to 175 MPa, on protein digestion and bioactive properties of an aqueous dispersion of okara (5% of protein). As a result of the increasing homogenization pressure, the reducing capacity, measured as the content of Folin-Ciocalteau reagent reducing substances, increased up to 66% and antioxidant capacity increased up to 28% when measured by Ferric reducing antioxidant power assay (FRAP), but no change was observed when measured by Oxygen radical absorbance capacity assay (ORAC). These results suggested that phenolic compounds played an essential role in the antioxidant capacity. HPH caused up to 79% increase in protein solubility in water and up to 12% in protein digestibility. The molecular mass profiles of the peptides of the digested samples varied with the pressure, indicating different susceptibility of the proteins to the digestive enzymes as a function of the pressure. The okara matrix was modified differently by increasing pressure, which resulted in various matrix microstructure, before and after the simulated gastrointestinal digestion, which may have facilitated the release of antioxidant compounds and protein, as well as protein digestion. Thus, in addition to improving rheological properties, as observed in a previous study, HPH has shown to be useful in improving the bioactive and nutritional properties of okara dispersion, making it a valuable alternative for its use in the food industry.

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Assessment of ultrasound efficacy based on population and single spore responses of *Alicyclobacillus acidoterrestris*

Myrsini KAKAGIANNI[1], Christina CHATZITZIKA[2], Konstantinos KOUTSOUMANIS[1], **Vasilis VALDRAMIDIS[2]**

[1]*Department of Food Science and Technology, School of Agriculture, Faculty of Agriculture, Forestry and Natural Environment, Aristotle University of Thessaloniki, Thessaloniki, Greece*
[2]*Department of Food Science and Nutrition, University of Malta, Msida, Malta*

Abstract
Consumer demand for healthy, safe and minimally processed foods with high-quality attributes has increased in the last decades. Increased consumption of fruit juices has direct influence on economy in positive way but in negative way also when spoilage problems occur. In recent years, *Alicyclobacillus acidoterrestris* has emerged as a new thermoacidophilic, endospore-forming spoilage bacterium for commercialized fruit juices that can survive pasteurization and spoil heat treated fruit juices by the production of taint compounds (e.g. guaiacol). Mild heat technologies, such as (thermo)sonication, are receiving good attention as an alternative treatment because of its potential for quality and safety improvement of food. Hence, the objective of this study was to investigate the separate and combined effect of ultrasound operating at 26 kHz, 90 μm, 200 W for 5 and 15 minutes, and heat treatments (80°C for 10 min) on the kinetic growth (between 35 to 45^{o}C) of *A. acidoterrestris* spores at population and individual spore level. At the population level, the ultrasound process resulted in an increase of the lag phase for the highest processing time and the lowest incubation growth temperature. Additionally, an increase in the heterogeneity and the duration of the lag times was observed when individual spores where treated by ultrasound and thermal treatment. This work would help to a better understanding of the response to the proposed combined treatments, since ultrasound and thermal treatments could work synergistically on delaying the germination and outgrowth of the tested bacterial spores.

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Evaluation of antioxidant capacity in native fruit: *strychnosmadagascariensis* (macuácua); *Strychnos spinosa* (massala) and the *Vangueria infausta* (maphilwa)

Isabel GUIAMBA[1], Maida KHAN[1], Asmina SULEMANE[1]
[1]*Faculty of Engineering, Eduardo Mondlane University, Maputo, Mozambique.*

Abstract
Native fruits such as *Strychnos madagascariensis* (macuácua); *Strychnos spinosa* (massala) and *Vangueria infausta* (maphilwa) grow in the southern region of Mozambique and are usually collected and consumed fresh being an alternative source of nutrients that contributes to malnutrition alleviation in some areas. During surplus periods are commercialized in local markets to obtain revenues to buy other foods. Although there is an attempt to develop new products to add value and promote its consumption there is still little knowledge about their potential as pro-antioxidants. The objective of this study was to evaluate the antioxidant capacity and phenolic compounds of this native fruits preserved by freezing. Antioxidants are important substances that can prevent or slow cell damage caused by free radicals. The total phenolic compounds were evaluated by measuring the absorbance at 515 nm of the fruit extracts obtained in methanol at a ratio of 1:4 weight of the sample per volume of methanol and incubation for 16-18 h at 5 ° C, followed by centrifugation. The antioxidant capacity was measured using the ABTS and DPPH methods for hydrophilic and lipophilic capacities and the total capacity were determined. Macuácua showed a high phenolic content in its matrix (520 mg EAG./100g), massala contained 280 mg EAG./100g and maphilwa, 215 mg EAG./100g. Massala resulted in the highest total antioxidant capacity (786 M Trolox equivalents) and maphilwa the lowest (584). The ABTS and DPPH methods had good correlation for the hydrophilic antioxidant capacity. The DPPH method showed lower hydrophilic antioxidant capacity values compared to ABTS.

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Dietary supplemental effect of Enzymatic Hydrolysate from Dark Muscle of Tuna (Thunnus albacares) and Cooking Waste Liquor resulting from Tuna Canning Processing on Gut Microbiota in the Bama minipigs

Xiurong SU[1], Jun ZHOU[1], Chenyang LU[1], Jiaojiao HAN[1]

[1] ***Ningbo University, Ningbo, P.R.China***

ABSTRACT

To further use the by-product and provide theoretical basis for developing new feed additives, liquid waste liquor and the dark muscle were collected from commercial tuna canning. We hydrolyzed the by-product with different enzymes and found optimum conditions. Bama pigs were randomly allocated to receive the dietary supplements of 6% concentrations of enzyme hydrolysate (EH) from dark muscle of yellow fin tuna and cooking liquor (CL) from tuna canning processing continuously for 60 days. All the data were compared with untreated pigs (CK). Pigs treated with enzyme hydrolysate demonstrated enhanced growth rates and normal biochemical indices in serum. Whereas, Pigs treated with cooking liquor showed deterioration in liver and kidney development. The gut microbiota population analysis showed that EH and CL both shifted in the microbial composition of less abundant species. Growth promotion could be mediated by the change of beneficial bacteria, such as Lactobacillus, Ruminococcus and Enterorhabus that contribute to the metabolism of the animal. This study confirmed the effect of the EH on feed efficiency, as well as on the gut microbiota structure alterations. Conversely, the CL can increase diversity of the intestinal microflora, which resulted some damages in viscera. Furthermore, the data will aid in the identification of alternative strategies to improve animal health and consequently production.

Key Words：Bama pig；yellow fin tuna；enzyme hydrolysate；Cooking Liquor；Gut microbiota；feed supplement

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Study of the microwave-assisted processing of cloudy apple juice: inactivation kinetics, process modeling and quality evaluation

Érica S. SIGUEMOTO[1], **Jorge A. W. GUT[1,2]**

[1]*University of São Paulo, Dep. Chemical Eng., Escola Politécnica, São Paulo, Brazil*
[2]*FoRC – Food Research Center, University of São Paulo, São Paulo, Brazil*

Abstract

Continuous-flow microwave processing of apple juice was studied to assess the enzymatic inactivation kinetic, process modeling and final quality changes. Fresh cloudy apple juice was pasteurized in a pilot-scale continuous-flow unit using two heating system (tubular heat exchanger and focused microwave) at three process temperatures (70, 80 and 90 °C). Heat transfer and resident time distribution were studied using tap water at several flow rates to determine the overall heat transfer coefficients, level of dispersion and mean residence time. Combination of heat transfer and residence time distribution provided the time-temperature history along the product path. The two-fraction first-order kinetic model was fitted to the experimental residual activities of polyphenol oxidase (PPO), peroxidase (POD) and pectin methylesterase (PME) for conventional and microwave heating in batch experiments considering the whole time-temperature profile. Model validation for apple juice processing was performed using final residual activity of POD, PPO and PME, as time-temperature integrators. A comparative evaluation on quality changes (phenolic and volatile compounds) was carried out in cloudy apple juice samples pasteurized under conventional and microwave heating. Predicted enzyme inactivation curves at 80 °C showed that PME has the highest thermal resistance and no significant evidence of non-thermal microwave effects on the enzymatic inactivation. Good agreement between predicted temperature histories and experimental data were obtained, as well as the final activity of POD and PPO. The come-up time of microwave heating showed to be faster than conventional processing, consequently, the microwaved samples presented the phenolic and volatile composition more similar to unpasteurized juice.

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Synthesis and characterisation of silver nanoparticles with antimicrobial properties

Marina VENTOURATOU[1,2], Sholeem GRIFFIN[2], Analisse CASSAR[3], Ourania GOUSETI[4], Miroslaw DUDEK[5], Petros TAOUKIS[1], Pierre SCHEMBRI WISMAYER[3], Ruben GATT[5], **Vasilis P. VALDRAMIDIS**[2,3]

[1]*School of Chemical Engineering, National Technical University of Athens, Athens, Greece*
[2]*Department of Food Sciences and Nutrition, University of Malta, Msida, Malta*
[3]*Centre of Molecular Medicine and Biobanking, University of Malta, Msida, Malta*
[4]*Faculty of Engineering, University of Nottingham, Nottingham, UK*
[5]*Institute of Physics, University of Zielona Gora, Zielona Gora, Poland*
[5]*Metamaterials Unit, University of Malta, Msida, Malta*

Abstract
Nanoparticles have unique physiochemical properties compared to the bulk material comprising them making them preferable in applications including bio-imaging, drug delivery and food packaging. In this study, AgNPs were synthesised using a modified Turkevich method whereby trisodium citrate and silver ions were dissolved in glycerol and heated to 70^{o}C. Two molar ratios of silver nitrate: trisodium citrate were used, namely 1:10 and 1:5. Through UV-VIS spectroscopy and TEM analysis, it was determined that using a molar ratio of 1 silver nitrate : 10 trisodium citrate, predominantly spherically shaped silver nanoparticles with sizes of 7-15 nm were obtained. On the other hand when using a molar ratio of 1 silver nitrate : 5 trisodium citrate a number of shapes were obtained, with a large proportion of them being pyramidal (size of 6-84 nm). The AgNPs were tested against Salmonella enterica for their antimicrobial efficacy (0-6 h) and on Normal Human Dermal Fibroblasts for toxicity (0-72 h) at a range of concentrations. The AgNPs synthesised using a molar ratio of 1 silver nitrate : 10 tri-sodium citrate had the greatest antimicrobial activity. All AgNPs also significantly reduced fibroblasts viability in a concentration-dependent manner, but AgNPs synthesised using a molar ratio of 1 silver nitrate : 10 tri-sodium citrate were the less cytotoxic (19.7 % total reduction of viability) allowing their application in different food related applications, e.g., coating of air filters used in warehouse ventilation, and incorporation in materials for active food packaging.

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The application of ecoefficient electrotechnologies for the production of biologically active peptides

Sergey MIKHAYLIN[1,2,3], Rock-Seth AGOUA[1,2], Jacinthe THIBODEAU[1,3], Laurent BAZINET[1,3], Eugène VOROBIEV[4], Nabil GRIMI[4]

[1]*Institute of Nutrition and Functional Foods (INAF), Dairy Research Center (STELA), Food Science Department, Université Laval, Québec , QC, Canada*
[2]*Laboratory of Sustainable Food Processing (LSFP), Food Science Department, Université Laval, Québec, QC, Canada*
[3]*Laboratory of Food Processing and Electro-Membrane Processes (LTAPEM), Food Science Department, Université Laval, Québec, QC, Canada*
[4]*University of Technology of Compiègne, Laboratory of Agro-industrial technologies, Compiègne, France*

Abstract

The world population growth and urbanization raise serious challenges for the agri-food sector since there will be a 50% increase of the global food demand by 2050. To satisfy the demands of a growing population, the food industry should significantly increase its productivity taking into account environmental impacts. One of the main issues of the modern agri-food industry is food losses and waste. Thus, the current project will tackle this issue via innovative sustainable concept comprising the synergy between enzymatic, pulsed electric field and electromembrane technologies to valorize agri-food by-products and particularly protein-based by-products. Enzymatic hydrolysis stands among the most important approaches for the valorization of protein-rich by-products. However, there are several drawbacks hampering the wide industrial application of this technology such as relatively high cost of enzymes, their stability and activity. Therefore, the project focuses on the development of the synergistic approach allowing the significant improvement of enzymatic hydrolysis and separation of generated bioactive peptides. The results demonstrate that application of sustainable Pulsed Electric Field (PEF) technology to the by-product matrix allows modification of the protein molecules' structure releasing the active sites for the enzymatic action. These structural modifications improve by 80% the overall hydrolysis degree compared to conventional process. Moreover, PEF pretreatment of protein solution can liberate peptides even prior to enzymatic hydrolysis. Finally, electromembrane technology (electrodialysis with filtration membrane) allows the efficient separation of bioactive peptides of interest (antihypertensive, anticancer, antimicrobial, etc.). The obtained biologically active peptides can be used as nutraceuticals or food supplements.

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Whey demineralization by electrodialysis with pulsed electric field: a more energy-efficient approach

Noémie LEMAY[1,3], **Sergey MIKHAYLIN[1,2,3]**, Laurent BAZINET[1,3]

[1]*Institute of Nutrition and Functional Foods (INAF), Dairy Research Center (STELA), Food Science Department, Université Laval, Québec , QC, Canada*
[2]*Laboratory of Sustainable Food Processing (LSFP), Food Science Department, Université Laval, Québec, QC, Canada*
[3]*Laboratory of Food Processing and Electro-Membrane Processes (LTAPEM), Food Science Department, Université Laval, Québec, QC, Canada*

Abstract

The high mineral content of whey has a negative impact on its quality, flavor and functionality. Electrodialysis (ED) is one of the membrane-based separation technologies that allow the demineralization of whey. However, membrane fouling and concentration polarization phenomena are still common problems in ED that alter irreversibly the membrane integrity and decrease the process efficiency. Pulsed electric field (PEF) has been demonstrated as a promising approach to reduce those phenomena, but never tested on complex food systems such as sweet whey.

In this study, seven PEF pulse-pause combinations (0.1s-0.1s, 1s-0.1s, 1s-1s, 10s-0.1s, 10s-1s, 10s-10s and 100s-1s) were tested and compared with a DC continuous current condition to assess their impact on sweet whey demineralization. Results demonstrate that high frequency PEFs such as 0.1s-0.1s improved the demineralization rate by more than 81 % for the same number of charges transported while low frequency demonstrated no significant impact. In fact, after each pause lapse, a gain in voltage was observed for a short period of less than 0.06 second, after which it rapidly vanished. Because the high frequency PEFs had this gain more often, they were more efficient for the improvement of the demineralization rate than the low frequency PEFs. Hence, the 0.1s/0.1s and 1s/1s PEF combinations reduced the energy consumption of the process for about 20 % and 9 % for the same demineralization rate. Finally, PEF with ratio pulse/pause of 1 decreased pH changes through the ED compartments and thus could prevent scaling and organic fouling formation on the membrane.

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Comparative study on the effect of Cold Atmospheric Plasma, Ozonation, Pulsed Electromagnetic Fields and High Pressure technologies on sea-bream fillets quality indices and shelf-life extension

Marianna GIANNOGLOU[1], Panagiotis DIMITRAKELLIS[2], Aspasia EFTHIMIADOU[3], Evangelos GOGOLIDES[2], George KATSAROS[1]

[1]*Institute of Technology of Agricultural Products, Hellenic Agricultural Organization-DEMETER, Lykovrissi 14123, Attica, Greece*
[2]*Institute of Nanoscience and Nanotechnology, National Center for Scientific Research "Demokritos", Aghia Paraskevi 15341, Attica,, Greece*
[3]*Institute of Soil and Water Resources, Hellenic Agricultural Organization-DEMETER, Lykovrissi 14123, Attica, Greece*

Abstract

The processing of highly perishable food products such as fresh fish fillets using Non-thermal technologies seem to lead to maintenance of their quality, efficient microbial load reduction and shelf life extension. A comparative study on the effect of Cold atmospheric plasma (CAP), Ozonation (OZ), Pulsed electromagnetic fields (PEMF) and High Pressure (HP) processing technologies on the quality of seabream fillets was conducted. The target was the selection of the optimum processing conditions for minimum effect on the fish quality and maximum effect on their initial spoilage microbial load. Air plasma was generated using a Surface Dielectric Barrier Discharge (DBD) source (3 kV, 32 kHz) and the fillets were processed for 15 min. PEMF (80 J/pulsed energy, 12.5 mT, 3 Hz) and OZ were applied for 15 min. HP 300 MPa for 5 min was studied. The processed fillets and untreated ones were stored at 4 °C for 20 days. At appropriate time intervals samples were analysed for their microbial load, pH, texture, colour and sensorial characteristics. The shelf life of the product was increased for 4 and 2.5 days after processing using HP and CAP, respectively. HP appeared more effective on the microbial load reduction but color and texture alteration was observed. CAP processing led to sufficient decrease of the microbial load without affecting the measured quality indices significantly. PEMF and OZ also did not affect the quality indices significantly nevertheless found to be less effective on the load reduction with 1 day increase of the shelf life of the fillets.

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Development of a multidisciplinary post-graduate educational activity on quantitative tools for sustainable food and energy in the food chain (Q-Safe): from problem based learning to e-learning

Vasilis P. VALDRAMIDIS[1], **Enda CUMMINS[2]**, Jan F.M. VAN IMPE[3], Jeanne-Marie MEMBRE[4], Konstantinos P. KOUTSOUMANIS[5], Serafim BAKALIS[6], Almudena HOSPIDO[7], Ismael MARTINEZ LEDE[8]

[1]*Department of Food Sciences and Nutrition, Faculty of Health Sciences, University of Malta, 2080 Msida, Malta*
[2]*School of Biosystems Engineering, Agriculture and Food Science Centre, University College Dublin, Belfield, Dublin, Ireland.*
[3]*Department of Chemical Engineering, Katholieke Universiteit Leuven, Gent, Belgium*
[4]*Department of Food Safety and Microbiology, INRA, UMR1014 Secalim, Oniris, Nantes, France*
[5]*Department of Food Science and Technology, Aristotle University of Thessaloniki, Thessaloniki, Greece*
[6]*Faculty of Engineering, University of Nottingham, Nottingham, UK*
[7] *Group of Environmental Biotechnology, School of Engineering, University of Santiago de Compostela, Santiago de Compostela, Spain*
[8]*Cooperatives Lacteas Unidas, Santiago de Compostela, Spain*

Abstract

Predictive modelling and quantitate risk assessment is playing an ever-increasing role in food quality and safety across the globe. Recent assessments have also shown that food production has significant environmental impacts, both in terms of carbon emissions and food waste. Q-Safe was an Erasmus plus project in the agro-food field. The partnership consisted of seven different institutions across Europe (UK, Ireland, Belgium, France, Spain, Greece, Malta (lead partner)). The primary aim of Q-Safe was to train early stage researchers, i.e., MSc and PhD candidates, in the area of predictive modelling, risk assessment and Life Cycle Assessment through inter-institutional cooperation. It also enhanced innovative problem based learning initiatives by the use of simulation, optimization modelling tools and relevant software (@RISK, MATLAB, etc.). The simulation tools used in this partnership can be applied to various aspects in the food and bio industries, from food technologies to food management, food engineering and quantitative microbial risk assessment. This partnership was an excellent opportunity for early stage researchers to build scientific networks, increasing collaboration, and stimulating advanced research in academia and industry. One of the main outcomes of this activity was the development of e-learning material which cover all the aforementioned areas. Major modelling principles including but not limited to experimental design, parameters estimation, regression analysis, microbial risk assessment techniques and life cycle assessment are introduced to the students. The e-learning material are also supported by a comprehensive textbook with several exercises in the form of spreedsheets, programming codes or calculation exercises.

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The competition between oil penetration and oil dripping elucidated during deep-frying of French fries

Maxime TOUFFET[1], Gilles TRYSTRAM[1], Olivier VITRAC[1]

[1]*UMR 1145 ''Food Processing and Engineering'' INRA, AgroParisTech, Université Paris-Saclay, 91300, Massy, FRANCE*

Even if it suffers few exceptions, the internal overpressure during deep-frying prevents oil from penetrating inside the product during the immersion stage [1]. We report in this study the first observations and interpretation of the competition between oil drainage and imbibition when the product is removed from the oil bath. All the governing physics occur between 10^{-2}s and few seconds when the first end of the French-fry is removed. While the other end is submerged, oil is dragged by the relative displacement of the product. The internal overpressure is maintained by the sensible heat of the oil film and oil adhesion is the sole mechanism of oil pickup. The breaking of the oil bath surface by the last extremity of the French-fry triggers the oil film thinning and the creation of the first droplet. The inversion of the temperature profile in the oil film causes a film contraction and lowers the internal overpressure below the capillary pressure in the parenchyma cells in contact oil. These phenomena were decoupled by imaging (>160 fps) the oil flow and dripping along real French-fries and similar metallic sticks (impervious). A multiscale description of oil coating, drainage, dripping, imbibition and heat transfer, from cellular scale to product scale, was developed by extending our meshless simulation strategy of oil uptake [2]. The good agreement between experimental and simulated kinetics enabled to identify the conditions maximizing oil dripping.

[1] Vitrac et al., Eur. J. Lipid Sci. Technol. 2000, 102.
[2] Vauvre et al., AIChE J. 2015, 61.

Innovative application of β-galactosidase in acid and sweet whey for the production of oligosaccharides with prebiotic properties

Athanasios LIMNAIOS, Elena TSIKA, Maria TSEVDOU, Evangelos TOPAKAS, **Petros TAOUKIS**
School of Chemical Engineering, National Technical University of Athens, Athens, Greece

Effective and environmentally sound management of sweet and acid whey from dairy industries is a major problem. Acid whey is far less studied as it has become a major issue after the exponential increase of Greek yogurt global production recently, but novel ways of sweet whey sustainable exploitation are continuously being sought. Since both wheys are rich in lactose, its conversion into high added value ingredients, like galactooligosaccharides (GOS), through novel enzymatic applications can contribute to the effective exploitation of dairy by-products.

Commercial lactase from *Kluyveromyces lactis* is currently used only to produce lactose-free products or to convert pure lactose into GOS. In this study, the ability of this lactase to produce GOS through transgalactosylation of whey lactose was investigated and optimized regarding parameters such as pH, temperature, enzyme activity, and reaction time. Additionally, the influence of several substances in the reaction system, like whey proteins and minerals, was also studied. Products were analyzed through chromatographic techniques and kinetic models describing GOS production were developed.

The activity of the tested lactase depended on the whey type, with the use of sweet whey resulting in higher GOS yields as compared to acid whey. Yet, both wheys can be used for GOS production, with maximum yields ranging from 13 to 35%. Additionally, the effect of whey proteins and minerals on lactase activity was not significant. Concluding, the optimization of enzymatic reaction parameters is very important in order to scale-up the conversion of whey lactose into high added value ingredients in industrial level.

Production of cheeses in brine applying High pressure technology: quality and safety improvement, shelf-life extension and necessary ripening time decrease

Marianna GIANNOGLOU[1], Aggeliki Nikoli[2], George Kakogiannis[2], George KATSAROS[1]

[1] *Institute of Technology of Agricultural Products, Hellenic Agricultural Organization-DEMETER, Lykovrissi 14123, Attica, Greece*
[2] *MINERVA SA Edible Oils Enterprises, PZ CUSSONS, Metamorfosi, 14452, Attica, Greece*

Abstract

Research has focused the last years on the application of HP into cheese production mainly for shelf-life extension. The aim of this work was the study of the effect of High Pressure (HP) on spoilage microflora of cheeses in brine and on the survival of inoculated foodborne bacteria (*Listeria monocytogenes*). In addition, the potentiality of ripening time decrease was also studied. HP treatment was applied directly to cheese pieces after the 1st stage of ripening (time for pH decrease to 4.6). A kinetic study of the effect of various combinations of HP-time-temperature was carried out and the optimal processing conditions were determined depending on the targets of the HP application (shelf-life increase or safety assurance or ripening time decrease) using appropriate mathematical equations.
Based on the determination of the optimum HP processing conditions for each studied case, the application of HP in real production scale was tested. The benefits of HP technology on cheeses with regards their improved quality indices, safety indices, and accelerated ripening indices in terms of shelf-life increase and reduction of ripening time and improvement of the physicochemical, organoleptic and structural characteristics of the final products were validated and confirmed. The reduced cost of cheese production due to reduced ripening time and extended shelf-life as well as the improved quality characteristics of the final products will significantly contribute to the commercial success and sustainability of the brined cheeses industry allowing consumers access to high quality products at more affordable prices.

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Vibrations as a cause of texture defects during yogurt manufacturing

Adrian KÖRZENDÖRFER[1], Jörg HINRICHS[1]

[1]*University of Hohenheim, Institute of Food Science and Biotechnology, Stuttgart, Germany*

Abstract

The quality of stirred yogurt is determined by texture attributes like appearance, flow behavior, and mouthfeel. In dairy industry, machines like pumps used for the commercial production generate vibrations that can spread to the fermentation tanks and disturb the gelation. Removal of visible particles by mechanical post-processing will lead to structure losses and lower viscosities.

In order to study the effect of vibrations on yogurt structure systematically, an experimental setup was developed consisting of a vibration exciter (shaker) to generate defined vibrational states and accelerometers for monitoring. Tactile and audible frequencies as occurring in dairies up to 5,000 Hz can be generated during the fermentation process. A novel method based on image analysis was established to quantify large particles (d > 0.9 mm) and evaluate textures objectively. Vibrations increased particle numbers from 37 ± 3 (control) up to 144 ± 12 (25 m/s^2, $p<0.001$) particles per 100 g. Yogurts exhibiting a high particle number showed an inhomogeneous texture and a reduced water-holding capacity. Furthermore, the presence of large particles resulted in reduced apparent viscosities ($p<0.001$). We concluded that vibrations increase the collision probability of aggregating milk proteins entailing a coarser network structure and stirred products with unfavorable texture properties. Manufacturers should consider vibrations as a further cause for quality defects.

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Modeling of phenolic acid diffusion in rice kernels during boiling in spearmint aqueous extracts of various concentrations

Panagiotis IGOUMENIDIS[1], Sergios IOSIFIDIS[1], Estefania LOPEZ-QUIROGA[2], Serafim BAKALIS[3], **Vaios KARATHANOS[1]**

[1]*Harokopion University, Athens, Greece*
[2]*University of Birmingham, Birmingham, UK*
[3]*University of Nottingham, Nottingham, UK*

Abstract
White milled rice is a staple food which could be considered a promising carrier of useful compounds after fortification.
In this study, an attempt was made to fortify rice grains with phenolic acids using a hydrothermal process and spearmint aqueous extracts of different % w/v concentrations, while a mathematical model was acquired to simulate the diffusion of the investigated phenolic acids in rice kernels. Results showed that the diffusion process could be described by a Fickian model. In addition, the amount of phenolic acids and the potential equilibrium concentration values of these compounds in rice seemed to be positively affected by the increase in % w/v bulk concentration of the aqueous extract. Moreover, the estimated diffusion coefficients ranged from 6.86×10^{-12} to 3.56×10^{-11} m^2/s, with the p-coumaric acid presenting the highest average diffusivity in boiling rice material among all examined compounds, while diffusivity of phenolic acids in rice kernels was generally found to be concentration dependent. The chemical affinity of each phenolic acid to rice macromolecules was believed to play the most important role concerning their diffusivity in rice during fortification process.
This study may act as preliminary for the production of enriched rice products, which possess adjusted-predicted concentrations in bioactive compounds, in industrial scale. The proposed application seems to be quite interesting for the food industry, as it may offer the opportunity to produce fortified rice of either quick-cooking or ready-to-eat type and this could probably be achieved by utilizing existing parboiling units of rice industries, after making slight modifications.

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The scale factor in food manufacture: a tool for the assessment of decentralised food production scenarios

Alberto ALMENA[1], Estefania LOPEZ -QUIROGA[1], Peter J. FRYER[1], Serafim BAKALIS[2]

[1]*University of Birmingham, Birmingham, United Kingdom*
[2]*University of Nottingham, Nottingham, United Kingdom*

Abstract

Decentralised food manufacture systems – e.g. a cloud of small local production sites and shorter distribution networks – can be a powerful tool in the development of more sustainable and safe food chains. In this context, new production scenarios based on emerging "on-demand" and "sharing" models, together with distributed manufacture methods, are potential alternatives to the current centralised paradigm. However, there are scarce studies on how these new production scenarios might unfold.

To address this need, we have developed a scenario-based modelling tool for process design, techno-economic and environmental assessment that shows how decisions between local and centralised manufacture could be made. We have studied how supply chains and structures might look for different scales of production, taking different foods - dry babyfood, bread and ice cream - as exemplars. The models considered different levels of complexity (e.g. number of unit operations or production lines) and uncertainty sources (e.g. fluctuation of raw materials and/or energy prices). Results showed at what production level different production scales become profitable: e.g. distributed manufacture of dry babyfood could compete with plant production assuming low management costs and savings on transportation/storage along the chain, while centralised production for bread is still the best option. This demonstrates that the shift on manufacture paradigm can be studied as a scale-down engineering problem.

Overall, this work presents a robust and simple tool that will help food manufacturers and stakeholders in the complex decision between centralised vs decentralised food manufacturing systems, supporting decision-making and strategic planning across the food supply chain.

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Modelling the effect of surface washing treatment on inactivation of spoilage bacteria and shelf life extension of fresh fish

Theofania TSIRONI, Ioanna SEMENOGLOU, Athina NTZIMANI, Petros TAOUKIS

Laboratory of Food Chemistry and Technology, School of Chemical Engineering, National Technical University of Athens,

Abstract

Current research evaluates the efficacy of washing and sanitizing treatments for food microbial control. The objective of the study was to investigate and mathematically model the effect of surface decontamination of fresh fish using alternative organic acids on the quality and shelf life during refrigerated storage.

Marine cultured gilthead seabream (*Sparus aurata*) and European sea bass (*Dicentrarchus labrax*) fillets were studied. The incorporation of organic acids (i.e. lactic acid, performic acid, peracetic acid) at different concentrations in the washing water was investigated for different combinations of time and temperature for its efficacy to reduce initial microbial load and prolong shelf life. Samples were stored under controlled isothermal and variable conditions (0-15°C). Quality assessment was based on microbiological analysis (total viable count, *Pseudomonas* spp., *Enterobacteriaceae* spp., lactic acid bacteria, *Shewanella putrefaciens,* etc), pH, lipid oxidation, biogenic amines, colour and texture measurement and sensory scoring.

Initial surface decontamination up to 2.0 logcfu/g by the addition of organic acids in the washing water resulted in 3-4 days shelf life extension of fish fillets at 0°C. Mathematical models were developed for the inactivation of spoilage bacteria as a function of treatment conditions and the initial concentration of acid in the washing water.

The results of the study indicated that the application of minimal treatment during washing led to improved quality stability during subsequent refrigerated storage and shelf life extension, in terms of microbial growth, physicochemical and organoleptic degradation of fish fillets.

"Glow to make your plants Grow": Connecting discovery and community engaged research to the Undergraduate curriculum

Paula BOURKE[1], Agata LOS[1], SingWei NG[1], Sonal CHAPLE[1], Dana ZUIZINA, Julie DUNNE[1]
[1]School of Food Science and Environmental Health, Technological University of Dublin, Dublin 1, Ireland

"Glow to make your plants Grow" is a project linking research teams, undergraduate students and the community in STEM discovery. There is a communications gap between school level children and high level research in STEM which served as an opportunity for this project.

The technical aspects of this project explored the use of cold plasma technology to drive sustainability in the agricultural and food sector. *One of the most promising applications of cold plasma is for plant seed germination control, plant growth promotion or seeds decontamination which are the scientific focus of this study.*

A team of undergraduates from food science and technology degree programs collaborated with a PhD Level research team to develop a resource light and simple project, feasible to roll out to local schools. The objective was to enhance knowledge of sustainable food systems and embed a relationship with school level practitioners. The undergraduates task was to understand the interaction between cold plasma effectors and seed or plant biological responses; they developed protocols where cold plasma technologies were used for seeds germination and subsequent plant growth promotion.

The foundation group developed the project, followed by the heritage project group which builds and forms the basis of a hands-on community outreach programme, where school children can understand the basics of growing seeds, how plants grow, the importance of plants in our food chain, food sustainability and security. This project exposes high level research within National and Internationally funded research Institutes to school communities.

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Approaches for Food Scientists to Model Gut Microbiota Dynamics

Viridiana TEJADA-ORTIGOZA[1], Jorge WELTI-CHANES[2], Osvaldo H. CAMPANELLA[3,4]

[1]*Tecnológico de Monterrey, Escuela de Ingeniería y Ciencias, Querétaro, Mexico*
[2]*Tecnológico de Monterrey, Escuela de Ingeniería y Ciencias, Monterrey, Mexico*
[3]*Whistler Center of Carbohydrate Research, Food Science Department, Purdue University, West Lafayette, USA*
[4]*The Ohio State University, Department of Food Science and Technology, Columbus, USA*

Abstract
There is a well-stablished symbiotic relationship of humans with up to 10^{14} microorganisms mainly located in the gastrointestinal tract that play an important role in human health. A complete understanding of relationships among the microbiota, their production of metabolites, and how this affect the host health is required. However, the gut microbiota is a complex and dynamic community with metabolic and ecological interactions that are not completely understood. Modeling has been used as an approach to investigate the microbial gut and its processes. With the main objective of evaluating the impact of the microbiota in health or disease, models to describe the dynamics in the gut microbiota are being developed. They can be grouped in mechanistic, ecological and virtual models. Because of the relation between the gut microbiota and health, and since the first is flexible and variable and can be changed by the host diet, nutrition-based and processing interventions are a viable alternative to promote human health. Therefore, the food industry is facing the challenge of designing and developing new products and processes based on impacting the gut microbiota for specific health targets. To achieve this, food engineers should reach a good understanding of the gut microbiota, in particular its dynamics and processes, using physics-based mechanistic approaches. The objective of this presentation is to give a general overview of existing modeling framework to study the gut microbiota, focusing on mechanistic models commonly used in food engineering research and industry to describe other transport phenomena. Particularly, a principal objective of this work is to describe how momentum and mass transfer phenomena can be used to describe processes in the gut microbiota.

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The effects of pulsed electric fields on the properties of the porous corn starch

Zhong HAN*, Yu HAN, Jinhua WANG, Xinan ZENG
College of Food Science and Engineering, South China University of Technology, Guangzhou 510641, China

Abstract
Porous starch (PS) is one of such materials with good absorption ability which is attracting very much attention recently. This study was conducted to develop a new type of PS using a combination of enzymatic method and pulsed electric fields (PEF) treatment compared to a single enzymatic method or PEF treatment. Microstructure, adsorptive capacity, hydration capacity, and paste clarity were determined to assess the properties of porous starches. Scanning electron microcopy showed that enzyme treatment produce some pores on the exterior of the starch granules, while PEF treatment caused some pits or grooves. The oil adsorption of the enzymatic samples was higher than that of the native and PEF-treated ones and the maximum oil adsorption (128.71%) was obtained using a combination of enzymolysis with 4.5 h and PEF treatments at 15 kV/cm. Hydration capacity of the native starch increased from 93.77% to 153.80%, 104.35% and 156.21% after enzymolysis for 4.5 h, PEF treatments at 15 kV/cm, and the addition of enzymolysis with 4.5 h and PEF treatments at 15 kV/cm, respectively. The specific surface area of corn starch after enzymolysis for 4.5 h and PEF treatments at 15 kV/cm improved 4.8 times compared with that of native starch. The highest paste clarity (86.61%) was observed for the sample treated with a combination of enzymolysis for 4.5 h and PEF treatment at 15 kV/cm. Generally, the combination of enzyme and PEF treatment really offer an attractive alternative for obtaining PS granules that would have wide potential applications in many fields.

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In vitro fecal fermentation of high pressure processed fruit peels dietary fibers

Viridiana TEJADA-ORTIGOZA[1], Luis Eduardo GARCIA-AMEZQUITA[2], Osvaldo H. CAMPANELLA[3,4], Jorge WELTI-CHANES[5]

[1]*Tecnológico de Monterrey, Escuela de Ingeniería y Ciencias, Querétaro, Mexico*
[2]*Tecnológico de Monterrey, Escuela de Ingeniería y Ciencias, Guadalajara, Mexico*
[3]*Whistler Center of Carbohydrate Research, Food Science Department, Purdue University, West Lafayette, USA*
[4]*The Ohio State University, Department of Food Science and Technology, Columbus, USA*
[5]*Tecnológico de Monterrey, Escuela de Ingeniería y Ciencias, Monterrey, Mexico*

Abstract
Orange, mango and prickly pear peels untreated (OU, MU and PPU) and high hydrostatic pressure (HHP) treated at 600 MPa (OP/55°C and 20 min, MP/22°C and 10min, PPP/55°C and 10 min) were evaluated. The processed fruit peels had properties that qualifies them as good dietary fiber sources. Neutral sugar composition and linkage analysis of untreated and treated fruit peels were performed. Also, the fruit peels were subjected to fecal *in vitro* fermentations where pH, gas production, and Short Chain Fatty Acids (SCFA) production were determined. The neutral sugar composition and linkage glycosidic positions were closely related to the production of SCFA that resulted from the fermentation of the materials. After HHP-treatments, structural changes from multibranched sugars to linear sugars were observed. After 24 h of fermentation, OP yielded the highest amount of SCFA followed by PPC and MP (389.4, 282.0 and 204.6 µmol/ 10 mg DF, respectively). HHP treatment increased the SCFA concentration of orange and mango peel for 7 and 10.3% respectively, compared with the untreated samples after 24 of fermentation. Results presented herein and determined by *in vitro* fermentations suggest that HPP treated fruit peels could be used as prebiotics because they yield large amounts of SCFA.

Effect of drying methods on the quality and antioxidant activity of bitter gourd during storage period

Insha ZAHOOR[1], Mohammad Ali KHAN[1], **Sadaf ZAIDI[1]**
[1] *Department of Post-Harvest Engineering and Technology,*
Faculty of Agricultural Sciences,
Aligarh Muslim University,
Aligarh- 202002, India

Abstract
The effect of drying methods and storage period on the retention of ascorbic acid, total phenolic content, vitamin A, DPPH radical scavenging activity, total color change and rehydration ratio was studied. Bitter gourds were dried by convective drying at 40, 50 and 60 °C and by microwave assisted convective drying at 320, 400 and 480 W coupled with hot air at 40, 50 and 60 °C. The simultaneous application of microwave power and hot air during microwave assisted convective drying increased the drying rate and limited the loss of quality attributes of the bitter gourd. The ascorbic acid and total phenolic content was higher in microwave assisted convective dried bitter gourd but decreased during storage in all the dried samples. The DPPH radical scavenging activity and total color change increased during storage. However, microwave assisted convective dried samples retained better color throughout the storage period. There was a little decrease in vitamin A content with increase in storage period in both drying methods. However, retention of vitamin A content was found higher in a microwave assisted convective dried samples. Rehydration ratio showed a continuous decline with increasing duration of storage in both the drying methods, but were consistently superior in microwave assisted convective drying method. The retention of ascorbic acid, total phenolics, vitamin A, antioxidant activity, surface color, and rehydration capacity was better retained in microwave assisted convective dried bitter gourd due to faster and shorter drying.

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PlaSmarter – Cold Plasma functionalised liquid platform for food and agriculture interventions

Daniela BOEHM[1], Peng LU[1,2], *Sonal CHAPLE*[1], *Singwei NG*[1], *Evanthia TSOUKOU*[1], *Alba ILLERA GIGANTE*[3], Ed CAREY[4], John JONES[4], **Paula BOURKE**[1]

[1]School of Food Science and Environmental Health, Technological University of Dublin, Dublin 1, Ireland
[2]ABB Group, Zurich, Switzerland
[3]Department of Biotechnology and Food Science (Chemical Engineering Section), University of Burgos, 09001 Burgos, Spain.
[4]School of Science and Computing, Technological University of Dublin, Dublin 24, Ireland

Exposing liquids to cold plasma conveys a broad range of effects of relevance for food, environmental decontamination and plant growth promotion. Liquids under significant investigation include water, processing effluents, saline or more complex liquid foods such as juice and dairy. Devising the reactive species ingredients and controlling the biological response of plasma treated liquids is of great interest. It is emerging how to purposely functionalize liquids through plasma process control based largely on readily available inputs of water or other liquids, air and electricity.

We introduced an approach based on open-air spark or glow discharge to control the principal reactive species composition. Controlling spark or glow discharge in conjunction with other process parameters can generate a plasma functionalized liquid to control a biological response such as antimicrobial efficacy and cytotoxicity; which is important for safe technology adoption. Chemical effector measurements are used to demonstrate stability and efficacy of plasma functionalized liquids in response to common environmental and storage variables. This approach is extended to complex liquids and hydrocolloids where antimicrobial and structural functionality are proven. Quality and nutritional functionality of apple juice have been promoted using this plasma process where antioxidant, color, cloud stability and particle size distribution are beneficially controlled. Further, plasma functionalized water is demonstrated to decontaminate fresh produce and grains whilst improving quality characteristic retention and process water decontamination for re-use; promoting process sustainability. This talk provides insights to how plasma treated liquids may be harnessed and controlled for food and agriculture processes.

ICEF13 ABSTRACT

Physicochemical impact of slip additives in migration through packaging material made from high-density polyethylene

Nabeen Dulal[1], Robert Shanks[1], Benu Adhikari[2], David Chalmers[3], Harsharn Gill[2], Isaac Rubens Matínez Pardo[1], Martin Orzinski[4]
[1]School of Science, RMIT University, Melbourne, Australia
[2]School of Science, RMIT University, Bundoora, Australia
[3]Coca-Cola Amatil, Eastern Creek, Australia,
[4]Coca-Cola Amatil, Melbourne, Australia

Abstract
The migratory slip additives have been used as processing aids in several semicrystalline packaing materials. The amount, morphological distribution and texture of slip additives which determine the surface properties of high-density polyethylene are highly dependent on their physical and chemical properties. Physicochemical characteristics of the migratory slip additives, their self-association and interaction with polymer influence their diffusion through high density polyethylene. Behenamide migrated to the surface in lesser amount as it had a lower diffusion coefficient than oleamide and erucamide. This is because of the linear hydrocarbon chain of behenamide which was more compatible with polyethylene than the chains of erucamide and oleamide which had kink in their chains due to double bonds. Upon a thermal treatment of erucamide and oleamide, their placoid-like structures became more larger while the peaklets like structures of behenamide grew larger due to migration across the surface. An initial drop in contact angles that was followed by higher contact angles imdicated a preliminary formation of a surface amide layer which is hydrophilic in nature. The impact of physicochemical properties on behavior of slip additives in high-density polyethylene was explained by their diffusion, surface energy and surface morphology.

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Elucidating the role of lecithin in the wettability of agglomerated cocoa beverage powders

Edgar CHAVEZ MONTES[1], John CRAVEN[2], Thierry BOURGEOIS[1]

[1]*Nestlé Research & Development Orbe, Orbe, Switzerland*
[2]*Nestlé Research, Vers-chez-les-Blanc, Switzerland*

Abstract
Cocoa beverage powders often suffer from poor wettability and the most common way to overcome this is to add a surface active ingredient, namely lecithin, to the formulation. Soybean lecithin is the most widely used lecithin, however, concerns about the supply and GMO status of this particular lecithin has motivated suppliers to put in the market lecithin from other origins, such as sunflower or rapeseed.

We propose an in-depth characterization of the interactions of various lecithins with cocoa lipids and to extrapolate our findings in the production of agglomerated cocoa beverage powders with improved wettability. We highlight in particular the importance of lecithin origin and composition, final particle size after agglomeration and storage time.

We also present in this work a novel approach to characterize quantitatively, in a consumer relevant fashion, the wettability of cocoa beverage powders, with the use of a robotic arm and advanced image analysis.

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Agglomeration of sugar reduced cocoa beverage powders: an industrial perspective

Edgar CHAVEZ MONTES[1], Colin CHIRON[1]

[1]*Nestlé Research & Development Orbe, Orbe, Switzerland*

Abstract
Cocoa-based beverage powders face today two simultaneous challenges: the need for an improved nutritional profile, while maintaining consumer preference in terms of convenience, taste and appearance. An integrated approach on how to incorporate healthier ingredients in beverage powders is then necessary and this implies the adaptation of currently used industrial processes to allow handling of new materials.

Including healthier, more natural or better-perceived ingredients inevitably bring along some difficulties in terms of processing and product performance, since their incorporation is difficult to implement with the usual unit operations and product performance (physical stability and reconstitution properties) is often negatively affected.

This work presents a concomitant formulation and processing approach in order to produce instant cocoa beverage powders with improved nutritional profile. We compare the performance of several ingredients used to replace sugar and we compare the reconstitution properties of final products obtained by different drying and agglomeration technologies. We also unveil an improved method to characterize the reconstitution kinetics of food powders by refractive index. Finally, we propose processing routes to achieve acceptable and stable reconstitution properties over shelf life.

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Understanding the mechanical performance of raw and cooked potato cells for the design of biomimetics

Ioanna ZAFEIRI [1], Peter LILLFORD [1], Ian NORTON [1]

[1]*School of Chemical Engineering, University of Birmingham, UK*

Abstract
There has recently been an interest in developing synthetic potato cells which could have implications on the expansion of the geographical boundaries for the use of potato-based food products. Understanding the properties of potato cells is of vital importance when it comes to constructing materials that can act as potato cell mimetics. The micromechanics of individual potato cells comprising of cell wall and embedded native or gelatinised starch were explored. Micromanipulation was used to compare cells of distinct strengths and study (bio)mechanical issues related to industrial processing (e.g. heat treatment). Two types of commercially available potatoes were selected to conduct microcompression experiments. Clusters of behaviours were observed, related to different turgidity as a result of ripening and/or storage conditions. Cooked cells suffered a decrease in their turgidity, with force-deformation curves showing single or multiple bursting events.
Gel beads with entrapped starch were used as the replicates of potato cells. Alginate/starch beads were formulated using different ratios of both ingredients and were produced using two different methods resulting in particles in the macro- and micro-scale size range. Compression tests revealed an effect of bead size and a dominant role of the hydrocolloid on the material properties. Beads' stiffness values were significantly lower than the respective ones for natural potato cells for low deformations but there was a closer match with a shift to micrometer sizes.
This study provides fundamental work and an insight on the behaviour of potato cells and could pave the way to understanding other starch-containing cells (e.g. pea).

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Electric heating- assisted extraction of biocompounds from seaweeds

Gabriela SANTOS SOUZA MATOS[1], Sara G. PEREIRA[1], Catarina TEIXEIRA-GUEDES[1], Ricardo N. PEREIRA[1], José António TEIXEIRA[1], **Cristina M.R. ROCHA[1]**

[1]*Centre of Biological Engineering, University of Minho, Braga, Portugal*

Abstract
The increasing ecological concerns have boosted the search for eco-friendly technologies for extraction processes. The aim of the work was to access the feasibility of using electric heating (EH) assisted extraction in the recovery of compounds from *Gracilaria vermiculophylla*. Mixtures water/ethanol ranging from 75 to 0 % ethanol were used to extract different seaweed fractions. Extractions were made using a solid: liquid ratio of 1:30, in a cylindrical glass reactor with two electrodes separated by 3.2 cm. Electric field was set to maintain constant temperature at 82 ^{0}C. Control extractions were made using the same set up with temperature control to keep the same temperature profile, but no electric field was applied. Analyzed parameters include overall extraction yield as well as protein, total polysaccharides, lipids, ashes, moisture, total phenolic compounds and pigments (carotenoids+chlorophylls) content in the extracts, polysaccharides average molecular weight, antioxidant activity and gelling ability. EH improved by up to 30 % the overall extraction yield, in comparison with conventional heating. This was particularly evident in the aqueous extraction of polysaccharides and in the ethanolic extraction of pigments. Furthermore, for the phenolic compounds, the electric effect was improved for mixtures with higher amounts of ethanol. Antioxidant properties of phenolic compounds and pigments as well as the gelling ability of the extracted polysaccharides (agar) were not impaired by the use of moderate electric fields. Therefore, EH is an interesting alternative, with reduced energy consumption and improved extraction performances, to recover functional ingredients or additives from seaweeds for the food industry.

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Effect of extraction methods on chemical composition and nutritive characteristics of sea buckthorn seed oil

Sijia PENG[1], Liang ZHAO[1], Xiaojun Liao[1]

[1]*College of Food Science and Nutritional Engineering, China Agricultural University; National Engineering Research Center of Fruit and Vegetable Processing; Key Laboratory of Fruits and Vegetables Processing, Ministry of Agriculture; Beijing, China*

Abstract

To obtain high quality sea buckthorn seed oil (SBSO), solvent extraction (SE), ultrasonic assisted extraction (UAE) and high pressure assisted extraction (PAE) were adopted and the physicochemical and nutritive characteristics of SBSOs were compared in this study. Results shows that the extraction efficiency of UAE was 69.00±3.70 g/100 g, which was 59.72% and 33.72% higher than PAE and SE, respectively. Accordingly, the SBSO extracted by UAE displayed the most desirable bright yellow color, and it was also characterized with the lowest acid value (8.23±0.06 mg/g). To assess the nutritive characteristics, HPLC was applied to evaluate the content of antioxidative compounds, which revealed that the oil extracted by UAE retained 156.25±6.58 mg/100 g of tocopherols and 938.35±13.08 μg/100 g of β-carotene, which has no significant difference with SE and PAE. Besides, gas chromatography analysis showed that the SBSO extracted by UAE could retain high level of unsaturated fatty acids (87.19%) and the proportion of linoleic acid was significantly higher than others($p<0.05$). Therefore, UAE is a more efficient method to extract higher quality SBSO. This study provided a theoretical basis for the industrialization of sea buckthorn seed oil.

Key words: Sea buckthorn seed oil; Solvent extraction; High pressure assisted extraction; Ultrasonic assisted extraction; Quality characteristic

New Processes for New Products?

Peter FRYER[1], Serafim BAKALIS[2], Estefania LOPEZ-QUIROGA[1],Yrjo ROOS[3]

[1]*Centre for Formulation Engineering, Chemical Engineering, University of Birmingham, UK,*
[2]*Faculty of Engineering,University of Nottingham UK.*
[3]*School of Food and Nutritional Sciences, University College, Cork, Ireland*

The food industry faces a series of challenges, with increasing human population, decreasing resources and land availability, and the need to deliver sustainable healthy and attractive solutions to consumers. This requires control and understanding of how food is made, transported, eaten and digested, and better energy and resource efficiency. At the same time, the internet and digital technologies enable much more rapid communication between consumer and manufacturer, and lower the barriers to market entry faced by small companies with potential disruptor technologies.

A number of routes to create new technologies and products have been proposed by food engineers, including distributed rather than centralized manufacture, changing supply chains to minimize waste and allow personalization against individual consumer health needs The creation of these new products, linking to new supply chains, challenges the historic model in which economies of scale have led to bigger and more central factories, with big R+D departments. In addition, innovation is coming from small companies with new products, such as artificial meats, potentially reducing the environmental stresses created by livestock farming. Making these approaches feasible at the scale needed is an engineering challenge.

The symposium presents a number of approaches to the above problems from a food engineering perspective. This presentation will address how food engineers should respond; what processes might be necessary to bring about the changes needed? – and what research is needed for such new products to be introduced? For example, this may create a structure similar to that in the pharmaceutical industry, in which innovation occurs through start-ups (usually academic-led) and through large companies buying out small ones.

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Effect of high hydrostatic pressure and pasteurization processing on quality properties of green compounded juice

Sijia PENG[1], Liang ZHAO[1], Xiaojun Liao[1]

[1]*College of Food Science and Nutritional Engineering, China Agricultural University; National Engineering Research Center of Fruit and Vegetable Processing; Key Laboratory of Fruits and Vegetables Processing, Ministry of Agriculture; Beijing, China*

Abstract
In this study, the optimum proportion of green compounded juice was obtained through sensory evaluation, which was 40% apple juice, 20% pineapple juice, 15% kiwi fruit juice, 10% cucumber juice, 10% spinach juiceand 5% wheat seedling juice (v/v). Microbial inactivation effect and quality of green compounded juice were assessed after high hydrostatic pressure (HHP) at 600 MPa/5min and pasteurization at 86℃/15 s, respectively. After treatment, The aerobic plate count was decreased by 4.11 and 4.07 log_{10}CFU/mL, reaching 1.07 and 1.11 log_{10}CFU/mL. The yeast and molds, *lactobacillus* and psychrophilic bacteria were not detected. Besides, The compounded juice processed by HHP maintained better suspension stability and color compared with pasteurized juice. Higher levels of total phenol (43.65±0.74 μg/mL) and antioxidant capacity analysised by ·DPPH and FRAP method were also retained. During the 15-day storage at 4℃, the plate count remained stable, only *lactobacillus* grew up but was less than 1 log_{10}CFU/mL. In the aspect of juice quality, HHP compounded juice displayed better suspension stability, color and higher total phenol content and antioxidant capacity than pasteurized juice. Finally, a better sensory evaluation was shown in HPP compounded juice during storage, which was still over the minimum acceptable standard even at the 7th day. Therefore, compared with the traditional pasteurization, HHP can effectively inactivate microorganisms and retained a better quality of green compounded juice.
Key words: Compounded juice; High hydrostatic pressure; Pasteurization; Quality characteristic

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Ecotoxicological and Life Cycle considerations of cold plasma as an advanced oxidation process for contaminated wastewaters.

Dana ZUIZINA[1], Apurva PATANGE[1], Chaitanya SARANGAPANI[1], Daniela BOEHM[1], Michelle GILTRAP[1], Brendan GILMORE[2], PJ Cullen[1], **Paula BOURKE**[1, 3]
[1]*School of Food Science and Environmental Health, Technological University of Dublin, Dublin 1, Ireland*
[2]*School of Pharmacy, Queens University Belfast, Northern Ireland, UK.*
[3]*School of Biological Sciences, Institute for Global Food Security, Queens University Belfast, Northern Ireland, UK.*

Atmospheric cold plasma (ACP) is widely researched for wastewater decontamination. ACP harnesses a multiplicity of mechanisms which contribute to chemical and physical effects that can subsequently attack pollutant active molecules and decompose them into more environmentally friendly products. Despite efficient reported treatment of dyes, pesticides, antibiotics and pathogenic bacteria, our data suggest that the life cycle ecotoxicological impact of plasma process should be considered.

Aquatic toxicity of meat and dairy process effluents was assessed using fish cell lines, a crustacean model (Daphnia magna) and a free living brown hydra as a freshwater biomarker. Whilst untreated effluents were toxic to the aquatic models, plasma treatment limited the toxic effects. However, prolonged contact with plasma-processed effluent liquids of up to 48 h was toxic to Daphnia magna. Further, using a free-living brown Hydra, toxic effects were observed for plasma treated water in correlation with contact time and concentration.

Antibiotics, ofloxacin (OFX) and ciprofloxacin (CFX) were successfully degraded by ACP. Disk diffusion assays revealed that the activity of both antibiotics was considerably reduced by plasma treatment. However, a microdilution method demonstrated that CFX exhibited higher antimicrobial activity after ACP treatment; revealing a potential platform to improve antibiotic efficiency. Importantly, short-term exposure to sub-lethal concentrations of antibiotic equally reduced bacterial susceptibility to both Plasma treated and untreated CFX. Whilst ACP remediation of antibiotic contaminated complex wastewater effluents is possible, it is recommended that plasma processes encompass degradant structure activity relationships to ensure that biological activity is eliminated against non-target organisms to achieve life cycle safety.

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Inactivation of *Listeria monocytogenes* and *Salmonella* Typhimurium planktonic cells and biofilms using plasma activated liquid (PAL)

Cindy SMET[1,2,3], Marlies GOVAERT[1,2,3], Alina KIRILENKO[3], Md. EASDANI[3], James L. WALSH[4], **Jan F.M. VAN IMPE[1,2,3]**

[1]*BioTeC+ - Chemical & Biochemical Process Technology & Control, KU Leuven, Ghent, Belgium*
[2]*OPTEC - Optimization in Engineering Center-of-Excellence, KU Leuven, Ghent, Belgium*
[3]*CPMF² - Flemish Cluster Predictive Microbiology in Foods, Ghent, Belgium*
[4]*Department of Electrical Engineering and Electronics, University of Liverpool, Liverpool, United Kingdom*

Abstract
Recent research has demonstrated the ability of cold atmospheric plasma (CAP) for food decontamination. A flexible and transportable alternative concerns plasma activated liquids (PAL), which are known to have antimicrobial properties. However, little is known on their potential to assure food safety. This work focusses on identifying the impact of the (i) foodborne microbial species and its cell mode of living (planktonic cells or biofilms), (ii) CAP settings (gas composition and generation time) and (iii) PAL related factors (treatment time and PAL age) on the inactivation efficacy.

Cell densities were monitored using the plate counting technique and the results were analyzed using predictive models. The pH and the concentrations of long-lived species were measured to characterize the PAL.

Although the pathogen impacts the PAL efficacy, mainly the cell mode has an important effect, i.e., biofilms prove to be partly resistant to PAL treatment. Oxygen in the operating gas ensures generation of PAL solutions with higher antimicrobial activities. Also, to ensure sufficient microbial inactivation, PAL generation times need to be sufficiently long. Both CAP settings result in a higher amount of long-lived species, thus enhancing inactivation. However, loss of PAL activity for stored solutions, together with the frequent appearance of a tailing phase in the inactivation kinetics, hints at the importance of short-lived species generated.

The pathogen and its cell mode, the CAP settings and PAL related factors, prove to impact the antimicrobial efficacy of the solutions, and should be considered with respect to future (industrial) applications of this novel technology.

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Milk fat globules- A universal delivery systems for bioactives

Nitin NITIN[1], Maha ALSHEHAB[1]
[1]*University of California - Davis, Davis, California, USA*

Abstract
The conventional approaches to deliver many of these hydrophobic micronutrients and phytochemicals in food systems have used engineered emulsions, liposomes and other lipid based delivery systems including solid lipid nanoparticles. These engineered systems face significant challenges due to (a) requirements to use preservatives and/or metal ion chelators and sacrificial antioxidants to stabilize encapsulated bioactives; (b) emerging evidence that relatively low concentrations of these emulsifiers, namely carboxymethylcellulose and polysorbate-80, can negatively influence gut health and (c) negative consumer perception. In our quest to address these challenges, we have discovered that naturally present milk fat globules (MFGs) composed of a lipid core surrounded by unique and complex multilayer lipoprotein membrane (MFGM) can effectively encapsulate diversity of exogenous micronutrients such as vitamins A and D and phytochemicals including curcumin and quercetin. The presentation will discuss the role of process conditions in influencing encapsulation efficiency and yield of bioactives in MFGs. Under optimal conditions, the efficiency of this process is high enough that 1 g of milk fat globules can deliver 100% of the recommended daily intake of a vitamin such as Vitamin D, thus enabling efficient use of a naturally occurring resource. The presentation will also discuss the barrier properties of MFGs and present data on the role of these properties in reducing degradation of bioactives under acidic and oxidative conditions. In summary, this discovery provides a natural alternative to conventional lipid carriers and has a potential to address many of the key limitations

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The combined effect of Cold Atmospheric Plasma (CAP) and hydrogen peroxide (H_2O_2) on the inactivation of *Listeria monocytogenes* and *Salmonella* Typhimurium biofilms on abiotic surfaces

Marlies GOVAERT[1,2,3], Cindy SMET[1,2,3], Davy VERHEYEN[1,2,3], James L. WALSH[4], **Jan F.M. VAN IMPE**[1,2,3]

[1]*BioTeC+ - Chemical & Biochemical Process Technology & Control, KU Leuven, Ghent, Belgium*
[2]*OPTEC - Optimization in Engineering Center-of-Excellence, KU Leuven, Ghent, Belgium*
[3]*CPMF² - Flemish Cluster Predictive Microbiology in Foods, Ghent, Belgium*
[4]*Department of Electrical Engineering and Electronics, University of Liverpool, Liverpool, United Kingdom*

Abstract
Biofilms are omnipresent on industrial abiotic food contact surfaces and are therefore an unquestionable source of food contamination, resulting in foodborne illnesses and economic losses. Due to their high resistance towards traditional cleaning and disinfection methods (i.e., (hot) water combined with chemicals and a mechanical action), novel biofilm inactivation methods are currently under investigation. Cold atmospheric plasma (CAP) is one of those promising methods since log-reductions up to 3.5 log(CFU/cm²) can be obtained. Nevertheless, as this is not sufficient for complete inactivation, CAP treatment of surfaces should be incorporated within a full cleaning schedule (e.g., combined with a (mild) chemical treatment), to (possibly) obtain complete biofilm inactivation.

In the present study, CAP treatment was combined with a hydrogen peroxide (H_2O_2) treatment and possible synergistic effects were identified by means of viable plate counts. Three different treatment sequences (i.e., (i) first CAP, then H_2O_2, (ii) first H_2O_2, then CAP, or (iii) CAP and H_2O_2 at the same time) were applied to determine the preferred treatment sequence for inactivation of 1 and 7 day(s) old *L. monocytogenes* and *S.* Typhimurium biofilms. To assess if the obtained log-reductions were (partially) due to biofilm removal, the crystal violet staining method was used to determine the total biofilm mass before and after each treatment.

This study indicated that the combined treatment of CAP and H_2O_2 resulted in (i) log-reductions up to 6 log(CFU/cm²), (ii) synergistic effects, and (iii) (partial) removal of the biofilms. Consequently, the investigated combined treatment is very promising towards industrial applications.

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Identification of mechanisms of multistage structure-formation in processed cheese model products

Stefanie SEDLMEIER[1], Ulrich KULOZIK[1]
[1]*Technical University Munich, Chair for Food and Bioprocess Engineering, Freising, Germany;*

In multiphased products like processed- or cream-cheese, thermally induced structure build-up reactions can be observed. Such cheese-systems typically possess high protein concentrations and high fat contents. Under thermal- and shear-stress, proteins, predominately caseins, act as the structure-building component. During structure formation, the proteins seem to undergo specific chemical reactions leading to a distinctive multistage structure build-up. Despite their importance for our understanding of food-structures, those reactions have so far only been described phenomenologically.

The aim of this study is to characterize the single stages of this multistage process and describe them as distinct partial reactions. Furthermore, the dispersity of the system is to be characterized. Previous studies lead to the hypothesis that emulsified fat with adsorbed proteins serves as a reactive surface, giving the proteins the possibility to interact faster with those in the continuous phase allowing them to form a network in the continuous phase, which, in turn, results in structure formation.

Therefore, a rheometer with custom made stirrer blades and processing cup was used, to process model-cheese products and follow the structure build-up online while processing. Using light scattering and chromatographic analysis, we found a linear correlation between structure build-up and protein concentration at the interface.

Thus, this study gives a deeper understanding of amphoteric biomolecules in a concentrated, dispersed process environment.

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Predicting Intramuscular Fat Quality in Pork Loin by Hyperspectral Imaging

Christopher KUCHA[1], Liu LI[1], **Michael NGADI[1]**, Claude GARIEPY[2]

[1]Department of Bioresource Engineering, McGill University, Macdonald Campus, 21,111 Lakeshore Road, Ste-Anne-de-Bellevue, QC, Canada H9X 3V9
[2]Agriculture and Agri-food Canada, 3600 Cassavant West, Saint-Hyacinthe, QC, Canada J2S 8E3

Abstract
The amount of intramuscular fat and its quality present in the meat is associated with the juiciness, flavor, tenderness, and nutritional value. Therefore, the prediction of fat quality is an essential to assess overall consumer acceptability of meat. The measurement of fat quality currently relies on gas chromatography (GC). This method is labour-intensive and time-consuming and thus there is need for a rapid alternative. Accordingly, the aim of this study was to investigate the prospect of using hyperspectral imaging technique to predict the quality of intramuscular fat in pork loin cuts. Pork loin cutlets from the longissimus dorsi muscles were purchased at random from different commercial brands. The samples were scanned using a hyperspectral imaging (900 – 1700 nm) followed by GC analysis of the fatty acid profile. Wide line detector feature (WLD) technique was used to extract the fat marbling. Mean centering and SNV preprocessing were used as the image preprocessing methods. Calibration models were developed using partial least square regression from the mean spectra of the extracted fat or the combination of the lean and fat. When independent samples were used to validate the models, the results show coefficient of determination (R^2) for C14:0, C16:0, C16:1, C18:0, C18:1, C18:2, polyunsaturated, monounsaturated and saturated acid ranged from 0.785 - 0.891 and root mean square error of prediction (mg/g) ranged from 0.001 – 0.231. The result indicates that NIR hyperspectral imaging technique could be a rapid tool in the pork industry for assessment of the FA composition.

Crispiness and microstructure of breaded deep-fried chicken nuggets

Jacob T. LIBERTY, **Michael O. NGADI**

Department of Bioresource Engineering, McGill University, Macdonald Campus, 21,111 Lakeshore Road, Ste-Anne-de-Bellevue, QC, Canada H9X 3V9

Abstract

Understanding the relationship between microstructure and texture is critical in optimizing process and product quality. This study was undertaken to examine the influence of microstructure on texture of breaded deep-fried chicken nuggets using acoustic-mechanical and scanning electron microscopy.

Samples were fried at 170, 180 and 190^{o}C at 2, 4, 6 and 8 mins and separated into crust and core parts. An acoustic enveloped detector (AED) was attached to a texture analyzer and the following parameters were analyzed: maximum force (F_{max}), number of force peaks (NFP), area under force-deformation plots (AF), sound pressure level (SPL), number of sound peaks (AUX) and area under amplitude-time curves (AS). AUX was used as crispiness indicator. Microstructural indices such as number of pores, average pore area, polydispersity index and average shape factor were estimated from the SEM images using a MATLAB algorithm. Gaussian filter was applied to reduce noise.

There were positive correlations between most of the microstructural attributes with texture. However, microstructure did not have significant ($P<0.05$) effect on crispiness of the fried chicken nuggets. The textural parameters that were significantly affected by microstructure include: SPL, AS, F_{max}, NFP and AF with AS being the most affected. Number of pores showed to be the microstructure that had the most influence on texture.

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Synergistic low intensity non-thermal food processing for enhanced microbial inactivation

Nitin NITIN[1], Erick Falcao de OLIVERIA[1], Cuong Nguyen HUU[1]
[1]*University of California, Davis, California, USA*

Abstract
Reduction of microbial load in food and water systems is critical for their safety and shelf-life. To complement the high intensity non-thermal technologies, there is a need to develop low-medium intensity non-thermal processing technologies for diversity of food applications. These innovations can significantly improve food quality and safety as well as reduce the cost of processing. This presentation will focus on our efforts to develop nature inspired synergistic non-thermal low intensity food processing approaches for enhanced microbial inactivation. This novel approach is based on discovery and translation of synergistic interactions between natural food grade compounds and low intensity non-thermal technologies. Two case studies will be presented. The first part of the presentation will focus on a synergistic combination of sub-lethal levels of stresses induced by UV-A light and food grade bioactives. The results will demonstrate enhanced and rapid inactivation of both *E.coli* O157:H7 and *Listeria spp.*) in the presence of organic matter as well as on the surface of fresh produce. The second part of the presentation will focus on synergistic combination of ultrasonic processing with food grade compounds to inactivate target bacteria in liquid systems. The results of mechanistic investigations for both the synergistic low intensity non-thermal processing technologies will be presented. These studies will include changes in membrane permeability, intracellular thiol content, metabolic activity and antioxidant competition assays. In summary, the presentation will illustrate novel approaches to enhance efficacy of non-thermal processing technologies for improving safety and quality of food systems.

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Control viral and bacterial pathogens in ready-to-eat meals using microwave assisted pasteurization systems

Juming TANG
Washington State University, Pullman, WA, USA

Abstract
Consumer desire for convenience, food safety risks associated with e-commerce and home delivery of prepared meals, and regulatory requirements imposed by Food Safety Modernization Act (FSMA) in the USA have generated great commercial interest in in-package pasteurization technologies.

In this presentation, we discuss application of a new in-package pasteurization technology, Microwave Assisted Pasteurization System (MAPS), for control of bacterial and viral pathogens in ready-to-eat (RTE meals). These meals have a shelf-life between 10 days to up to 14 weeks in refrigeration. A MAPS system consists of 915 MHz single-mode microwave cavities and a shallow bed of circulating water to provide predictable heating patterns in food packages without edge heating. The unique system design allows the use of metal carriers with partial metal shielding to alter electric field distribution in food packages when moving through the microwave cavities. Typical pasteurization processes consist of preheating, microwave heating, holding and cooling, all accomplished in one system. The microwave heating takes 2-4 mins (depending upon package size) to raise the cold spot temperature in a food package from preheating temperature of 40^{o}C to 90^{o}C. The pilot scale system at WSU are used to pasteurize a wide range of products in 10-20 oz packages, for our internal product evaluation or for private companies. In technology transfer, we offer 3-day bootcamps that provide theoretical training and hands-on experiences to participants from food companies. In the presentation, we will also share recent results for product quality and our vision for future commercial applications.

A generic algorithm for simulation of different distillation processes

Lilian BIASI[1], Matthias HEINKENSCHLOSS[2], Fabio BATISTA[3], **Antonio J. A. MEIRELLES[1]**

[1]*School of Food Engineering, University of Campinas, Campinas, Brazil*
[2]*Rice University, Houston, United States*
[3]*EEL, University of São Paulo, , Brazil*

Abstract
Distillation techniques involving parallel streams comprise parastillation and metastillation. In these processes, the vapor (parastillation) or the liquid (metastillation) is divided into two or more streams, improving the separation with possible reductions in energy and/or equipment costs. They can improve the distillation of natural mixtures, for instance the purification of ethanol for producing potable alcohol in the beverage industry, or the fractionation of fatty acids in the edible oil industry. However, commercial simulators are not suitable for simulating columns with parallel streams. We developed an algorithm able to simulate conventional distillation, parastillation and metastillation with any integer number of phase divisions. It uses a unique set of MESH equations to represent the three processes. This algorithm is suitable for simulation of complex distillation processes, taking into account multiple feeds and side-streams, Murphree efficiency, non-ideal vapor and liquid phases, pressure loss, and multicomponent separation. The novelty is the consideration that a given stage may receive income flows from a tray different from the neighbor ones. A stage of conventional distillation receives the inlet liquid from the stage immediately above, and the vapor flow from the tray immediately below. However, a parastillation tray receives the vapor from β stages below, where β is the number of vapor divisions. Analogously, the metastillation tray receives the liquid from θ stages above, where θ is the number of liquid divisions. The algorithm was validated using alcoholic mixtures. Results show a reduction in energy consumption up to 40%, in comparison to conventional distillation.

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Shifting food engineering to food-packaging engineering

Yan ZHU[1], Olivier VITRAC[1]

[1] *UMR 1145 Food Processing and Engineering, INRA, AgroParisTech, Université Paris-Saclay, Massy, France*

Abstract

Can we afford to keep the status quo with one hand packaging engineering and on the other side food engineering? Food contact materials on plastic are the main sources of chemical contaminants into food and of marine litter and microplastics. The challenge is tremendous, but both authorities and public provide incentives to modify industrial practices by encouraging local food systems, material recycling including for food contact, packaging reuse... If the supply chain is shorter or if the consumer practices change, the whole food and packaging system can be revised to meet an optimized shelf-life, to minimize environmental impacts and the migration of chemicals. The local adaptation of a packaging to a typical food application, food process and shelf-life requires a specific engineering, which does not exist yet. This communication takes the example of PET bottles (strongest impact and cost) used for beverages (water and alcoholic beverages) to present a new computational approach for the rational and multicriteria optimization of food packaging integrating cross-mass transfer between the food, packaging walls and the surrounding. The optimization of the 3D shape, the distribution of the mass of plastics are carried out under constraints of product capacity, overpressure/collapse and shelf-life (mass loss, alcoholic strength). Simulations integrate cycles of temperature, binary and ternary mixture properties. Optimality is internally checked via the Karush–Kuhn–Tucker first-order optimality conditions. Designs with minimized packaging weights extracted along the Pareto front are available for immediate 3D printing or augmented reality.

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Large Scale modeling of food systems: from molecules to food quality and safety

Olivier VITRAC[1], Yan ZHU[1], Phuong-Mai NGUYEN[2], Gilles TRYSTRAM[1]

[1] *UMR 1145 Food Processing and Engineering, INRA, AgroParisTech, Université Paris-Saclay, Massy, France*

[2] *LNE, French National Laboratory of Metrology and Testing, 29 Avenue Roger Hennequin, 78197 Trappes Cedex, France*

Abstract

Food production systems are facing cumulative hazards and challenges. We need to reevaluate situations, alternatives and strategies at a pace never seen before. Sustainability, equity, responsibility are not easy concepts to integrate into conventional engineering approaches, either because the indicators are subjective or because uncertainty starts to dominate when the system under scrutiny becomes too large. The problem is even considered of tremendous complexity if actions are envisioned: changing local practices, shifting production and supply chain, banning or regulating the use of some substances, products or processes. The chief difficulty is that there is no best solution only trade-offs. This presentation will illustrate how various modeling techniques (molecular modeling, continuum mechanics, chained simulations and probabilistic modeling) can be nested to tackle global problems such as the ubiquitous contamination of food by materials in contact or the restoration of the confidence in the food supply chain after a nuclear disaster. Food contact substances are the largest source of chemical contaminant in food. Generalizing the use of recycled polymers and food packaging reuse reduces environmental impacts but increases the packaging misuse and the global contamination fate. We will show how they can be both included in a bottom-up approach to promote safe-by-design and eco-design concepts. The top-down approach will be exemplified on the coupling between the dispersion of radionuclides during the 2011 Fukushima-Daichi accident and a food contamination model. In both cases, uncertainty needs to be evaluated and converted into a minimum safety margin to be fulfilled by models.

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The influence of fatty acid profile of vegetable oils on the kinetic stability of emulsions containing bio-based ionic liquids

Ariel A. C. TOLEDO HIJO[1], Aureliano A. D. MEIRELLES[1], Guilherme J. MAXIMO[1], Rosiane L. CUNHA[1], Jorge F. B. PEREIRA[2], **Antonio J. A. MEIRELLES[1]**

[1]*School of Food Engineering, University of Campinas, Campinas, São Paulo, Brazil, 13083-862*
[2]*School of Pharmaceutical Sciences, Universidade Estadual Paulista, Araraquara, São Paulo, Brazil, 14800-903*

Abstract

ILs obtained from natural sources have attracted the interest of the food industry due to their sustainable appeal and possible low or non-toxic effects. This is the case of lipidic ILs synthesized by using fatty acids (FAs), which are biocompounds that can be obtained from vegetable oils, considered as GRAS substances and as food additives. This work was aimed at the evaluation of the use of IL derived from diethanolamine and stearic acid as emulsifier, and the effect of the type of vegetable oil (olive or sunflower) on the stability of O/W emulsions at 30:70 (FO:FA). Emulsions were prepared by using an Ultra Turrax (IKA, Germany) at 5.000 rpm for 5 min followed by 10.000 rpm for 20 min. Emulsion microstructure, kinetic stability and rheological behavior were characterized, and droplet size and size distribution were measured. Emulsions presented a bimodal distribution profile and mean droplet size of 4.0925 ± 0.2861 µm and 4.0925 ± 0.1079 µm after 7 days when sunflower and olive oil were used as oily phase, respectively. Emulsions presented kinetic instability after 7 days of storage, characterized by a cream layer formation, being the destabilization mechanism more pronounced for emulsions containing olive oil, which presented a more accentuated increasing of the droplet size. This behavior could be attributed to the difference on the FA profile of vegetable oils, since olive oil is mainly composed by oleic acid. In summary, bio-based ILs showed to be an alternative to produce emulsions and possible candidate additives for the food industry.

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Influence of food microstructure on thermal inactivation dynamics of *Listeria monocytogenes* in the SHAKA reciprocal agitated retort

Davy VERHEYEN[1,2,3], Ozan ALTIN[4], Ferruh ERDOGDU[4], Dagbjørn SKIPNES[5], Torstein SKÅRA[5], Jan F.M. VAN IMPE[1,2,3]

[1]*BioTeC+ - Chemical & Biochemical Process Technology & Control, KU Leuven, Ghent, Belgium*
[2]*OPTEC - Optimization in Engineering Center-of-Excellence, KU Leuven, Ghent, Belgium*
[3]*CPMF² - Flemish Cluster Predictive Microbiology in Foods, Ghent, Belgium*
[4]*Department of Food Engineering, Ankara University, Ankara, Turkey*
[5]*Nofima, Stavanger, Norway*

Abstract
The Shaka process involves heating of liquid food products in a broad viscosity range using a horizontally reciprocating agitated retort at frequencies higher than 1 Hz. Heat transfer is promoted drastically in comparison with classical rotary agitated retorts, effectively reducing processing times and increasing food quality. However, research on the influence of food microstructural aspects on thermal inactivation in the Shaka process has been limited thus far. The objective of this study was to investigate the effect of product viscosity and fat content on heat transfer and inactivation dynamics of *L. monocytogenes* during the Shaka process.

Four fish-based food model systems (i.e., low-viscosity liquid, high-viscosity liquid, emulsion with 10% fat, emulsion with 20% fat) were inoculated with a *L. monocytogenes* strain cocktail and processed using the Shaka technology. Inactivation temperatures of 59, 64, and 69°C were used, at an agitation of 100 rpm. Temperature profiles were recorded and microbiological samples, taken at different time-intervals, were plated on selective and nonselective media to quantify survivors and sublethal cell injury.

Temperature distribution in the model systems over the course of the inactivation treatments was simulated numerically. Thermal inactivation dynamics were modelled using the model of Geeraerd et al. (2000) and differences in inactivation parameters were interpreted in terms of viscosity and fat concentration. An increase in both parameters significantly reduced heat transfer efficiency, hence also influencing microbial inactivation dynamics. This study will contribute to the introduction of the Shaka process in food industry, leading to increased food safety and energy efficiency in the sector.

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Production of functionalized low viscosity gelatin: thermo-mechanical and rheological properties

Cielo. CHAR, Marzena PEPCZYNSKA, Paulo DIAZ-CALDERON, **Javier ENRIONE**

Biopolymer Research & Engineering Laboratory (BIOPREL), Facultad de Medicina, Universidad de los Andes, CHILE

Production of functionalized gelatin from fishing byproducts is an excellent opportunity to increase its commercial value. The aim of this work was to produce and characterize salmon gelatin (SG), methacrylamide salmon gelatin (SGelMa) and SGelMa hydrogels. The extraction process was performed at pH 4, 60ºC for 3.5h. Gelatin was derivatized with methacryl anhydride (2, 5, 8% p/v) at 60 °C for 3 h. The hydrogels were cross-linked by UV (365 nm) using 0.1% Irgacure 2959 as photoinitiator. SG, SGelMa were characterized in terms of molecular weight (Mw) by capillary viscosimetry, functional chemical groups by Raman spectroscopy, gelling temperature and ΔH by differential scanning calorimetry, G' and G'' by oscillatory rheology and gel strength by compression tests. The hydrogels produced were assessed by compression and rheology. SG showed an average Mw of 94.45 kDa, while SGelMa showed Mw values between 40.7 - 24.2 KDa. Raman data showed a decrease in intensity at 420 cm^{-1} and 930 cm^{-1} as methacrylation was increased. SGelMa presented lower gelation temperature (8.6, 6.9 and 5.4 ºC for 2, 5 and 8% p/v methacrylation, respectively). These results were correlated with a decrease in G'. Gel strength and Young modulus of SGelMa hydrogels depended on methacrylation degree and UV time. The absence of thermal transitions indicated the irreversibility of gel formation, which did not melt even at 150ºC. These results showed that SGelMa is a versatile material suitable for applications that have traditionally used commercial gelatin from mammals.

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Mathematical modeling of microwave thawing: cavity geometry effect and design for scale-up of an industrial process

Ozan Altin[1], Ferruh Erdogdu[1*], Dagbjørn Skipness[2] and **Torstein SKÅRA[2]**
[1]Ankara University, Ankara, Turkey
[2] Nofima, Stavanger, Norway

Microwave (MW) heating is an innovative thermal process applied from thawing to heating, and it has been available for industrial thawing processes. Even though MW application is known to lead to a volumetric heating with shorter processing times, non-uniform electromagnetic field formation results in temperature non-uniformities within the sample. Overheating over the surface is such a challange during the process. Besides the physical (especially dielectric properties) and thermal properties of the frozen commodity, cavity geometry and mmovement of the smaple within the cavity have a significant effect on the evolution of electrmagnetic field and eventual temperature increase. Literature studies mostly focus on lab – scale cases with the available rectangular cavity systems with rotation. However, the industrial scale focus and determining the process parameters are rather significant challages.
Therefore, the objective of this study was first to demonstrate the effect of cavity geometry and rotaion on temperature uniformity in a pilot scale MW system. For this purpose, a matheamtical model was developed and validated at various process conditions(location and rotation rate effects within a cylindrical cavity) experimentally using frozen tylose samples (77% moisture content). Then, this model was used for further design and optimal scale – up studies where a number of successive cavities, sample size and amount, MW power and process time were the main variables.

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Investigating the microstructure of frozen foods using X-ray microtomography: a comparative study.

Fatou-Toutie NDOYE[1], Hayat Benkhelifa[1,2]

[1]*Refrigeration Processes Engineering Research Unit, Irstea, Antony, France*
[2]*UMR GENIAL, AgroParisTech, Inra, University of Paris-Saclay, Massy, France*

Abstract
Quality properties of frozen foods are strongly related to the product microstructural organization such as ice crystal structures. Ice crystals characteristics are defined both by the freezing process and the frozen storage conditions. For example, fluctuating storage temperatures cause ice crystals growth by recrystallization, leading to tissue damages and subsequent quality losses. Microstructure imaging techniques such as X-ray microtomography could be useful for a better understanding of the complex mechanisms that take place at the microscopic level in order to reduce macroscopic quality changes during frozen storage.

In this work, X-ray microtomography was used to characterize ice crystals growth in stored frozen carrots and potatoes at fluctuating temperatures. Two methodologies were used: (i) imaging the product directly at frozen state using a cooling stage (-20 °C) (ii) then, freeze-drying the same sample before imaging at ambient temperature. The quantitative analysis of X-ray images showed that ice crystals sizes increase with storage temperature, temperature fluctuation and storage duration, for both methodologies and for both carrots and potatoes. Results also showed that ice crystal sizes measured after freeze-drying are smaller than the sizes measured directly in the frozen products. This result suggests that freeze-drying would modify the frozen food microstructure and be a source of artifacts, probably due to shrinkage. Therefore, freeze-drying results should be taken with caution.

Enhancement of light utilization efficiency and vegetable seedling production on indoor farming racks using novel adjustable reflector

Jim Junhui HUANG[1], Craig D'SOUZA[1,2], Weibiao ZHOU[1,2,*]

[1]*NUS Environmental Research Institute, National University of Singapore, Singapore 117411, Republic of Singapore*
[2]*Food Science & Technology Programme, c/o Department of Chemistry, National University of Singapore, Singapore 117542, Republic of Singapore*

*Corresponding Author. Tel.: +65 6516 3501, Fax: +65 6775 7895
E-mail address: chmzwb@nus.edu.sg (W. ZHOU)

Abstract

Uniform-light-radiation is an essential factor to achieve desirable growth of vegetable seedlings in indoor farming prior to transplantation. However, the current light-distribution-uniformity on indoor-farming-rack is generally low due to the inevitable light-tube-arrangement-issue and the low-reception-rate of light rays towards the cultivating shelf brims. To optimize vegetable production, a novel adjustable lampshade-type reflector was designed and validated on indoor-farming-rack, which directed those rays originally emitting away from the racks back to the shelves. In this study, a custom-made 10-cm-reflective-board-width reflector was applied to an indoor-farming-rack that had a 12-cm-vertical-distance between five 22W-LED-light-tubes and the soil surface in germination trays on a shelf (120cm×55cm). The effects of various included angles of the reflector were investigated, regarding the increased amount of uniform-light-distribution-area (defined as within 10%-variation in light intensity) on the shelf and the amount of increased vegetable seedling production. Results showed that 15º of included angle was the optimal, obtaining 80.5% of uniform-light-distribution-area compared with 51.2% at the no-reflector control setting. The light intensity within the uniform-light-distribution-area was 228.56±12.39 µmol/(m^2s), under which the average dry and fresh weights of 16-day-cultivated-Choy-sum-seedling (*Brassica rapa* var. *parachinensis*) reached 198.22±20.79 and 2.48±0.26 g/seedling, respectively, compared with 176.74±23.76 and 2.16±0.29 g/seedling under control, while those of 21-day-cultivated-Kailan-seedling (*Brassica olearacea* var. *alboglabra*) achieved 384.16±27.07 and 3.40±0.13 g/seedling, respectively, compared with 327.47±30.94 and 2.85±0.15 g/seedling under control. The application of this novel adjustable reflector can thus enhance the light utilization efficiency in indoor farming, thereby improving vegetable seedling growth and consequently decreasing the energy cost of vegetable seedling production.

Keyword
adjustable reflector; lampshade; indoor farming rack; light distribution, vegetable, biomass

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In situ characterization of crystal growth process in raisin: 3D image-based using micro-CT

María Carolina MORENO[1], Ingrid CONTARDO[1], Sergio ALMOANCID[3], Lorena ALVAREZ[2], Paulina URRUTIA[2], Pedro BOUCHON[1]

[1]*Pontificia Universidad Católica de Chile, Santiago, Chile*
[2]*Centro Regional de Estudios en Alimentos Saludables (CREAS), Valparaíso, Chile*
[3]*Universidad Técnica Federico Santa María, Valparaíso, Chile*

The presence of perceptible sugar crystals (sugaring) is a main quality defect of raisins. In order to minimize the occurrence of this problem, it is necessary to understand the characteristics of these crystals and their growth rate under different storage conditions. Available literature describes sugar crystal-development in some solid foods, but very little is known about this phenomenon in rich-sugar dehydrated fruits. To do so, adequate protocols and techniques must be developed. This work uses X-ray micro-computed tomography (Micro-CT), a non-destructive tool that discriminates structures within a three-dimensional matrix based on the differences in the strength of X-ray attenuation to identify sugar crystals in raisins. The aim of this work was to characterize crystal growth over time using non-invasive techniques.
To do so, raisins without quality defects were stored under two controlled humidity conditions (57% and 66%RH) at constant temperature (25°C) and were observed every 15 days using micro-CT (without filter, 40kV of voltage, and 13 µm image pixel size). The volumetric fraction of sugar crystals was determined for each scanned raisin from reconstructed cross-section images by segmentation process (global thresholding). At the beginning, the volumetric fraction occupied by sugar crystals on entire raisin was on average 2.1 and 2.0% and increased to 2.7% and 2.3% after 42 days of storage (57% and 66% RH, respectively). These differences are not statistically significant ($p<0.05$). Based on the results, it is concluded that micro-CT is an adequate tool to characterize sugar crystal in these type of systems; sugar crystals grow inside the raisins during storage, and relative humidity is not an important factor within the studied humidity range.

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Freezing of palletized food products

Hongchang CAI[1], Dennis R. HELDMAN[1]

[1]*The Ohio State University, Columbus, USA*

Abstract
The freezing of food products after being placed on a pallet is influenced by several process parameters. The time to freeze is a function of dimensions of the containers holding the product, the vertical space between layers of product packages and the velocity of cold air within the space between layers of product containers. The unique parameters are in addition the typical parameters such as initial product temperature, cold air temperature, and the thermophysical properties of the food product. Time to freeze has been predicted based on computation of convective heat transfer coefficients and expressions for estimating time to freeze. The results indicated that for a given vertical space, the time to freeze decreased significantly as the velocity of cold air within the vertical space increased. Under the same condition, thinner layer of product containers and more package surface exposed to flowing cold air also decreased time to freeze significantly. By changing the size of products in the packages, the space that was not occupied by the products or the volume fraction of air in the packages also changed. For any given vertical space and cold air velocity, the time to freeze decreased when the volume fraction of air in the packages decreased. The dimension of vertical space between layers of product containers had minor influence on the time to freeze when the cold air velocity was set. The conclusions from this research could be helpful for warehouse to reach higher efficiency in freezing of palletized food products.

Application of CO2-laser micro-perforation technology to freeze-dry whole Strawberry in reduced processing-time

Authors Cynthia KUSCH[1], Marlene PINTO[1], Cristian RAMíREZ[1,2], Helena NUÑEZ[1], Ricardo SIMPSON[1,2], Sergio ALMONACID[1,2.]

[1]*Universidad Técnica Federico Santa María (UTFSM), Valparaíso, Chile*
[2]*Centro Regional de Estudios en Alimentos Saludables (CREAS), Valparaíso, Chile*

Nowadays, society has growing interest in the incorporation of pro-health foods, as one of the main agents for maintaining and improving health, life quality and well-being.
The main problem is to extend its shelf life and safe availability, with minimum impact on its quality characteristics.
Freeze-drying processing has been recognized to be the most expensive process for manufacturing dehydrated products. The process consists basically of freezing the food system, following sublimation of the ice and finally desorption of the remaining water content.
The use of CO2-laser technology to make micro-perforations in food systems, could improve mass transfer in a controlled manner, being an attractive alternative to reduce primary drying-time.
The general objective of this is to develop scientific and technological resources to apply a novel combination of technologies (Freeze-drying and CO2-laser micro-perforations) in order to reduce primary drying-time and energy consumption of freeze-dried.
An array of 5 micro-perforations is used, which reach the central part of the fruit.
The lyophilization process is carried out at a shelf temperature of 50 [°C] and a pressure of 0,3 [mbar].
A primary drying-time of 18 hours is obtained for strawberries without micro-perforations and it is reduced to 14 hours with micro-perforations; showing a reduction of 22% of the primary drying-time and 20 energy reduction. Energy required to perform the micro-perforation is neglectable.

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A digital library to aid curriculum internationalisation in Biosystems and Food Engineering

Enda Cummins[1], Nick Holden[1], Mary Leigh Wolfe[2], Jactone Ogejo[2]

[1]*School of Biosystems and Food Engineering, Agriculture and Food Science Centre, University College Dublin, Belfield, Dublin, Ireland.*
[2]*Biological Systems Engineering, Virginia Tech, USA*

Abstract

The internationalisation of higher education can augment the quality of teaching while also enhancing the student learning experience. The purpose of this project is to design and build a Biosystems Engineering Digital Library (BEDL) to aid curriculum internationalisation in the discipline, and moreover to widen student's knowledge or teachers' and researcher's information exchange within Biosystems Engineering discipline. This project builds upon previous work to develop an innovative internet-based tool to facilitate the sharing of teaching examples and learning objects from around the world to enable the internationalisation of courses. The BEDL acts as a repository for materials which can be used by other Biosystems/Agricultural Engineering teachers/tutors to increase global relevance and create an international dimension to their teaching. Previous versions of the tool were shown to have merit and, with wider dissemination, the BEDL has the potential to become an essential part of curriculum internationalisation in Biosystems Enginering. This project looks to further develop and implementation a secure Biosystems Engineering Digital Library with a business model / life plan for its ongoing development and use. It is anticipated the BEDL will supply educational materials in graduate/undergraduate programmes in multiple countries using innovative technologies, leading to better internationalisation of teaching resources and wider global understanding of Biosystems engineering with an international perspective.

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Bridging knowledge gaps for thermal control of bacterial pathogens in low moisture foods

Juming TANG
Department of Biological Systems Engineering, Washington State University, Pullman, WA

Abstract:
Microbial safety is an emerging issue associated with low moisture foods and ingredients. The food industry is experiencing major challenges in seeking solutions to control bacterial pathogens, such as *Salmonella* and *Listeria monocytogenes,* that can survive in low moisture conditions. Those bacteria, when desiccated, have extremely high tolerance to thermal and other treatments. There exist major knowledge gaps related to important factors contributing to the enhanced thermal resistance. Bridging those gaps should help identify important control parameters for developing and validating novel or legacy industrial operations to ensure microbial safety of low moisture products.

In this presentation, we provide a summary of recent results from our research that has elucidated the important role of water activity of food matrices at treatment temperatures on thermal inactivation of *Salmonella* and a surrogate, *E. faecium*, in low moisture foods. Our studies show that at given temperature, D value for *Salmonella* and *E. faecium* increased exponentially, by up to 100 fold, with reduction of water activity in food matrices (measured at treatment temperature). Our data show that water activity of foods rich in protein and starch increased sharply with increasing temperature, whereas that of samples with high oil contents did not increase or even decreased with temperature. Our findings explain the difficulty in thermally control of bacteria pathogens in oil-rich foods. Our studies suggest that relative humidity at treatment temperature should be considered as a control parameter in designing effective thermal treatment operations for pathogen control in low moisture foods.

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Supercooling Technology for Extended Shelf Life of Perishable Foods

Soojin JUN

Department of Human Nutrition, Food and Animal Sciences, University of Hawaii at Manoa, HI 96822, USA

Abstract

An innovative supercooling device was developed to preserve fresh quality of foods at subzero temperature by treating them with a combination of pulsed electric field and an oscillating magnetic field. The magnetic and electric fields keep water molecules vibrating to prevent the formation of ice crystals even as products drop below freezing temperatures. Therefore, under the subjected environment, supercooled foods do not need to undergo a thawing process, thus allowing them to maintain their quality, texture, and nutrients while extending their shelf life. The fabricated device successfully maintained perishable meat products and fruits in a supercooled state at around -4 ~ -7°C, and their original freshness could be kept intact for transportation and storage purposes. A microcontroller-based supercooling control unit was designed and fabricated to achieve a stable supercooled state using a combination of pulsating electric fields and oscillating magnetic fields. General performance of the supercooling unit was examined via supercooling beef steak at an ambient freezer temperature range of -8 to -10°C. An internal beef temperature of -4°C, approximately two degrees below its freezing point, was maintained for up to two weeks. Quality assessment factors such as color, lipid oxidation, drip loss and texture of supercooled beef samples were evaluated and compared with those of refrigerated (at 4°C), frozen (at -18°C) and fresh samples. Similar procedures were repeated and validated for highly perishable fish and pineapple samples.

Characterization of soybean oil treated with high voltage atmospheric cold plasma treatment and hydrogen gas

Ximena YEPEZ[1], Hanna GRACZ[2], **Kevin KEENER**[3]

[1] *Purdue University, West Lafayette, Indiana, USA*
[2] *North Carolina State University, Raleigh, North Carolina, USA*
[3] *Iowa State University, Ames, Iowa, USA*

Abstract

Traditionally produced partially hydrogenated oils (PHOs) are characterized by a high content of trans-fatty acids (TFA). The consumption of TFA are associated with a high risk of cardiovascular diseases. The objective of this study is to analyze the effect of high voltage atmospheric cold plasma (HVACP) treatment in the chemical structure of soybean oil, using hydrogen gas, as a non-thermal processing aid to partially hydrogenate soybean oil. As well as to identify parallel reactions that may occur during HVACP hydrogenation of soybean oil.
Soybean oil (15g) was treated with HVACP with times up to 6h, by triplicate. Plasma reactive species interact with the sample producing three fractions: liquid, gel, and solid. Fatty acid composition, FTIR, ^{1}H-NMR, 2D-NMR, thermal properties, and peroxide value, was used to characterize their chemical structure.
Results of fatty acid composition showed a decrease of 24.9% in polyunsaturated fatty acids, an increase of 22.9% in saturated fatty acids, and a low content of isomers. A hexane non-soluble fraction was identified as a cross-linked polymer, corresponding to a 30-40% of the 6h treated samples. It was proposed that plasma species collide with double bonds of unsaturated fatty acids, producing two main reactions: polymerization and hydrogenation.
This technology has the capability of modifying the chemical structure of soybean oil, creating a stable oil with less double bonds and a cross-linked polymer. The results of this project may open paths towards additional new applications. Investigation is suggested for further exploration of this technology to obtain bio-based gelators, plasticizers, or greases.

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Physical, textural, and microstructural properties of extruded puffed products affected by inclusion of high biological value proteins

Ingrid CONTARDO[1], Pedro BOUCHON[1]

[1]*Universidad Católica de Chile, Santiago, Chile*

Extrusion-cooking technology involves high-temperature during short-time by a combination of moisture, pressure, and mechanical shear, resulting in molecular transformations and chemicals reactions in foods. Cereal-based blends produce ready-to-eat extruded products with poor protein content and quality. In addition, amount or/and type of protein affect physical and textural properties of extruded products. The aim was to characterize physical, textural, and microstructural properties of rice-based extruded products influenced by inclusion of proteins, generating protein enriched extrudates.
Extrudates were prepared from rice flour (RF) blends enriched with chickpea flour (CKF) and whey protein isolate (WPI) (24% moisture, w.b.) using a twin-screw extruder (16mm Ø), five temperature-controlled zones (40/50/80/110/120°C), and constant screw-speed (400 rpm). Four protein contents were added to blends (0, 14, 20, 24% d.b.).
Physical characterization was performed determining expansion rate, bulk density, and water absorption and solubility index. Textural properties involved hardness and crispness analysis; and microstructure was examined using micro-CT.
Chickpea and WPI proteins can be included up-to 24%. The maximum expansion rate was showed by CKF-20 (2.3 diameter sample/die), which in turn exhibited the least hardness (11 N), and a wall-thickness distribution of matrix comparable with control sample (RF-0). The microstructure analysis suggested that final moisture and protein level of extrudates are directly related to physical (e.g. expansion or hardness) and structural characteristics (e.g. wall-structure thickness and size pores). Inclusion of high biological value proteins (CKF and WPI) in extruded rice-rich products enhances their nutritional attributes and it possible to obtain an adequate textural quality comparable with their low-protein counterparts.

Microstructural characterization of vacuum-fried matrices and its influence on the starch bioaccessibility

Ingrid CONTARDO[1], Pedro BOUCHON[1], Bryony JAMES[2]

[1]*Universidad Católica de Chile, Santiago, Chile*
[2]*University of Auckland, Auckland, New Zealand*

During vacuum frying, relevant structural changes are induced (e.g. porosity, oil absorption, or starch gelatinization), which could affect the accessibility of amylolytic enzymes to the site of action. In accordance, to differentiate the effect of starch gelatinization over the effect of structural changes on starch digestibility, the aim of this work was to characterize the microstructure of fried starch-based products with a similar degree of starch gelatinization (~60%) and evaluate its influence on the starch bioaccessibility during *in vitro* digestion, comparing samples fried under vacuum (9.9 kPa, $T_{water\text{-}boiling\text{-}point}$=45°C) or atmospheric fried dough (170°C).
Microstructure was examined using x-ray micro-computed tomography (micro-CT), confocal laser scanning microscopy (CLSM) and environmental scanning electron microscopy (ESEM). *In vitro* starch digestion was studied determining rapid available glucose levels and unavailable glucose levels. Vacuum-fried matrices had a much higher oil content (~51.3% dry basis) than their atmospheric counterparts (~20.3% dry basis), as confirmed through micro-CT and CLSM. The quantitative analysis of micro-CT images showed that vacuum-fried samples had less air porosity (36.6% air-filled pores) than atmospheric fried ones (49% air-filled pores), whereas, no differences were found with respect to total porosity. Vacuum-fried samples exhibited significantly lower rapid available glucose levels (36%) and higher unavailable glucose levels (60%), compared to those found in atmospheric-fried samples (40 and 46%, respectively). Since all matrices contained a similar starch gelatinization degree, this difference may be attributed to the structure developed under vacuum conditions, particularly high oil content within the matrix, which could be promoting hydrophobic interactions and slower digestibility.

Improved quality of Freeze-dried blueberries by applying CO2-laser technology.

Pablo MUNZENMAYER[1], Marlene PINTO[1], Cristian RAMíREZ[1,2], Pedro VALENCIA[1], Ricardo SIMPSON[1,2], Sergio ALMONACID[1,2.]

[1]*Universidad Técnica Federico Santa María (UTFSM), Valparaíso, Chile*
[2]*Centro Regional de Estudios en Alimentos Saludables (CREAS), Valparaíso, Chile*

Abstract

Nowadays, society has growing interest in the incorporation of pro-health foods, as one of the main agents for maintaining and improving health, life quality and well-being.
The main problem is to extend its shelf life and safe availability, with minimum impact on its quality characteristics.

Freeze-drying processing has been recognized to be the most expensive process for manufacturing dehydrated products. T In the primary drying of lyophilization, it is characterized that the drying is limited by mass transfer. Being the skin of blueberries an important limiting factor in this process.
Numerous attempts have been made to reduce drying time in freeze drying process, however, most of them fail when they are extended to industrial applications. The use of CO2-laser technology to make manageable micro-perforations in food systems, could improve the transfer of mass in a controlled.

The general objective of this study is to develop scientific and technological resources to apply a novel combination of technologiesto reduce primary-drying time and to improve the quality of the freeze-dried blueberries.

To achieve the objective, experiments were carried out with blueberries; without micro-perforations, without skin and with 1, 3, 6 and 9 micro-perforations. The lyophilization process is carried out with 40 [°C] shelf temperature and a pressure of 0,3 [mbar].

The micro-perforation does not influence significantly the primary-drying time, but it does improve the final quality of the blueberries. The percentage of blueberries without defects improves from 50% without micro-perforation to 90% with 9 micro-perforations at and 51% at the same processing conditions.

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Beyond Blockchain – an overview of useful digital technologies for the food industry

Serafim BAKALIS[1], Richard HYDE[2], Christian WAGNER[3], Peter J. FRYER[4], Nicholas WATSON[1], Qian YANG[5], Oliver MILES[3], Martin FLINTHAM[3]

[1]Department of Chemical and Environmental Engineering, University of Nottingham, Nottingham, UK
[2]School of Law, University of Nottingham, Nottingham, UK
[3]School of Computer Science, University of Nottingham, Nottingham, UK
[4]School of Chemical Engineering, University of Birmingham, Birmingham, UK
[5]School of Biosciences, University of Nottingham, Sutton Bonington, UK

Abstract
There are a number of white papers and documents discussing the potential of digital technologies to disrupt the current Food Chain. However, it is unclear what are these “digital” technologies are; how they could “disrupt” the food chain; whether these technologies are complementary or conflicting; what benefits will result from these technologies and whether they will pose risks that require management. Whilst Blockchain, i.e. an open distributed ledger, has been welcomed as a panacea to re-build consumer trust to a complex food supply chain, a wide-ranging set of innovations in hardware, software and data-driven business models have the potential to fundamentally alter the food chain.

In this paper we will provide an overview of the potential of different digital technologies to disrupt parts of the food chain. We will discuss: (1) The potential and limitations of data in ensuring traceability and underpinning communication between stakeholders (2) The effect of new remote and inexpensive sensing on increasing manufacturing efficiencies, e.g. reducing energy (3) Use of digital technologies, e.g. augmented reality to evaluate consumer choice in realistic conditions (4) the potential of connected devices, e.g. Internet of Things, to create new ways to understand consumer needs and provide new consumer products and experiences using data driven approaches (5) the use of digital technologies to enhance and personalise existing products, e.g. digital wrapping.

Effect of high hydrostatic pressure on cellulose acetate film incorporated or not with oregano essential oil

Sheyla GONÇALVES1,3, Davy CHÁVEZ1,2, Nathália MELO3, **Amauri ROSENTHAL1**

1*Embrapa Food Technology, Rio de Janeiro, Brazil*
2Federal Rural University of Rio de Janeiro, Rio de Janeiro, Brazil
3*Federal Fluminense University, Volta Redonda, Brazil*

Abstract
The combination of technologies such as high hydrostatic pressure (HHP) processing and antimicrobial active packaging represents an innovative concept for food preservation. Cellulose acetate (CA) films Incorporated or not with oregano essential oil (EO) were evaluated for possible structural and functional alterations resulting from HHP application.

Level of essential oregano oil (50% p/p) and/or HHP treatment (200, 300 or 400 MPa for 5 or 10 min.) were evaluated in a complete factorial experimental design study. Differential scanning calorimetry (DSC), X-ray diffraction (XRD), Scanning electron microscopy (SEM), mechanical and optical analyses were performed as response variables. For CA films, a simple incorporation of EO (without HHP treatment) caused reduction of tensile strength (TS), Young modulus (YM), glass transition temperature (Tg) and relative crystallinity (CR), in addition to changes in its morphology, optical properties and Increased elongation at rupture. High positive and negative correlations were more present in CA films when compared to CAEO films due to HHP treatment. From the pressure-time binomial, only pressure was significant to determine the changes present in the HHP-treated films. Results also indicated that the alterations caused by HHP on CAEO
films were more tenuous when compared to CA films.

Therefore, the film containing EO could be more apt to support the HHP application, being possibly more appropriate for industrial application. Furthermore, CAEO film could be potentially used as an hurdle technology associated with HHP for food preservation, due to its antimicrobial properties.

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Evaluation of shape memory properties of gelatin-cellulose nanofibers composites.

Patricia GONZALEZ[2], **Javier ENRIONE[1]**, Franck QUERO[3], Paulo DIAZ[1], Cristina PADILLA[1]

[1]*Biopolymer Research & Engineering Laboratory (BIOPREL), Facultad de Medicina, Universidad de los Andes, Chile*
[2]*Facultad de Ingeniería y Tecnología. Universidad de San Sebastián. Chile*
[3]*Departamento de Ingeniería Química, Biotecnología y Materiales. Universidad de Chile*

Shape memory polymers are responsive materials which can undergo controlled deformation upon an external stimulus. Gelatin natural molecular configuration can be used as switching point by its glass transition temperature for shape fixing and the crystalline fraction (triple helices) as hard net points to generate a permanent shape. In addition, cellulose nanofibers with high crystallinity and stiffness are excellent candidates for effective reinforcement of composites. This work studied the shape memory response of bovine gelatin-cellulose nanofibers (NFC) and bacterial cellulose nanofibers (BC). Gelatin, gelatin-10% NFC and gelatin-10% BC composites films were characterized by SEM. Thermal and mechanical properties were determined by DSC and DMA respectively. Shape memory properties were determined at 30˚C by changes in moisture content (22-12%). SEM analysis showed that both NFC and BC were dispersed in the gelatin matrix, but some agglomerations were identified. Mechanical analysis evidenced more reinforcement of gelatin by the FCN nanofibers with respect to BC. DSC data showed a decrease in Tm and ΔH with the addition of nanofibers, being the lowest in the case of Gelatin-10% BC. Tg was higher in the case of Gelatin-10% BC with respect to gelatin, but not in the case of NFC composites, were the value was not significantly different. Memory shape properties showed that Gelatin-10% BC had better percentage of shape recovery (97%) with respect to NFC composites (58%), probable due to differences in nanofiber dimensions in its integration within the gelatin matrix.

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Controlling starch digestion through formulation (Arial, 12pt font, bold, left aligned, Sentence case)

SYAHZIRAL MUTTAKIN[1,2]; OURANIA GOUSETI[3]; THOMAS MOXON[1]; ALEXANDER LAMOND[3]; ANJA JANSSEN[4]; REMKO BOOM[4]; RUUD VAN DER SMAN[4]; ALISON LOVEGROVE[5]; PETER SHEWRY[5]; PETER J. FRYER[1]; **SERAFIM BAKALIS[3]**

[1]School of Chemical Engineering, University of Birmingham, Birmingham, UK
[2]Indonesian Agency for Agricultural Research and Development, Jakarta, Indonesia
[3]Department of Chemical and Environmental Engineering, University of Nottingham, Nottingham, UK
[4]Department of Agrotechnology and Food Science, Wageningen University Research, Wageningen, Netherlands
[5]Rothamsted Research, Harpenden, UK

Abstract
The development of staple food products which reduce the risks of food-related diseases such as obesity, type 2 diabetes and heart disease is a significant challenge for the food industry . However, to date the mechanisms that control starch digestion and how they impact on health are not fully understood.

In this work, we first developed starch-based foods (bread; white rice) structured with hydrocolloids which are similar in appearance and acceptable alternatives to the controls to a non-trained consumer panel. We then used in vitro methods to study the gastric (bolus breakdown) and small intestinal (bioaccessibility) digestion of the developed products. The boluses broke down in a process involving swelling and disintegration, the latter being determined by the rates of surface erosion and bulk collapse. High fibre formulated foods showed increased swelling and slower bolus disintegration compared to the control products. Further structuring resulted in reduced glucose bioaccessibility compared to the standards, which may be attributed to factors such as slower gastric digestion, increased chyme viscosity, and reduced gelatinisation (visualised in a rice grain cross section).
We further developed mathematical models to predict the moisture content and pH distributions inside the bolus over time and relate them to bolus breakdown and intestinal bioaccessibility. The mathematical models were compared with the experimental results, showing good agreement.

Overall, this work demonstrates the potential to design healthy starch-based foods by understanding how formulation affects the rate and extent of starch digestion via experiments and modelling.

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Mechanism of industrial fouling elucidated through deconstructing ultra- high temperature deposits during clean-in-place

David M. PHINNEY1, **Holly A. HUELLEMEIER**1, Dennis R. HELDMAN1

1The Ohio State University, Columbus, Ohio, USA

Abstract
Fouling in ultra-high temperature (UHT) processing of dairy products presents a significant challenge in food manufacturing. Understanding fouling and cleaning mechanisms promotes food process optimization. The aim of this study was to create a commercially relevant UHT foulant, and characterize its chemical and composition changes during clean-in-place (CIP). Fouled stainless steel coupons were generated in the holding tube during UHT processing of non-fat dry milk (9.5 % wt./wt.) at 143 °C, and 3.5 L min-1 flow rate. Coupons were extracted at several stages throughout CIP and analyzed with multiple instruments to elucidate the deposit's chemical
identity. Water rinse, short caustic, long caustic, short acid, long acid, and clean control coupons were analyzed using X-ray photoelectron spectroscopy (XPS), atomic force microscopy (AFM), surface profilometry, confocal microscopy (CLSM), and gel electrophoresis (SDS-PAGE). SDS- PAGE illustrated the deposit layer closest to bulk fluid flow consists mainly of casein proteins. XPS analysis of long caustic coupons showed the remaining film after chlorinated caustic cleaning to be composed primarily of organic (>90.0 %) and very low inorganic (0.5 %) elements.
Profilometry and AFM results indicated significantly less surface roughness (α = 0.05) in long caustic coupons compared to clean control. CLSM of long caustic coupons revealed a film layer with a thickness of 60 ± 25 µm and fluorescence with a proteinaceous dye (Texas Red). The mechanistic results of this multi-analytical study present the sequential formation and removal of two separate organic fouling layers during UHT processing and cleaning, respectively.

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FOOD4S - Towards a European Master of Science in Sustainable FOOD SystemS Engineering

Monika POLANSKA[1], Paula BOURKE[2], Enda CUMMINS[3], Wolfram SCHNÄCKEL[4], Vasilis VALDRAMIDIS[5], Jan F.M. VAN IMPE[1]

[1]*KU Leuven, BioTeC+ & OPTEC, Gent, Belgium*
[2]*Technological University Dublin, Dublin, Ireland*
[3]*University College Dublin, Dublin, Ireland*
[4]*Anhalt University of Applied Sciences, Bernburg, Germany*
[5]*University of Malta, Msida, Malta*

Abstract
Modern higher education in engineering needs to focus more on challenging societal issues (globalization, environment, climate change, employment, …). Economic, social, scientific and technological advances should result in educational frameworks intertwining knowledge generation with application-driven research, thus more closely linking academic quality and employability.

The food industry, specifically, is facing challenges due to globalization of food production and distribution, growing food demand and price volatility, increasing importance of environmental sustainability (also in view of water scarcity and climate change), rapid technological innovation as well as competing claims, including the need for animal feed, fibre for clothing and biofuels.

On the one hand, awareness of consumer and product safety has never been higher. Food safety and energy sustainability have become priority research areas worldwide. On the other hand, the food chain has significant environmental impacts due to CO_2 emissions and enormous food waste, among others. In recent years, quantitative modelling and engineering tools are being developed to better cope with these challenges at the level of all stakeholders involved, including industry, government and regulatory agencies. For example, Life Cycle Assessment (LCA) and related concepts (such as carbon or water footprints) are being exploited within a multi-objective food chain optimization framework.

A well-balanced pan-European MSc program “Sustainable Food SystemS Engineering” (FOOD4S “*food force*”), embedded within a worldwide network of associated partners, will fill in the need for the requested competence profiles, also by providing ample opportunities for study and work experience abroad, recognizing that international mobility enhances employability of its graduates.

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Recent developments and future innovation challenges in Radio frequency (RF) assisted heating of food products

Tesfaye BEDANE[1], James G. LYNG[1], Francesco MARRA[2]

[1]*School of Food Science and Agriculture, University College Dublin, Dublin, Ireland*
[2]*Dipartimento di Ingegneria Industriale, Universita degli studi di Salerno, Fisciano, SA, Italy*

Abstract

In the food processing industry, reducing spoilage and eliminating pathogenic microorganisms during processing are major considerations to ensure the safety and quality of food products. On the other hand, the time required to treat the food product also has a significant impact on the quality, flavor and product shelf life. Innovative heating methods such as radio frequency (RF) heating reduces heating time significantly and allows elevation of food temperatures to target levels much faster than conventional heating methods. RF treatment has become interesting in various sectors of the food industry due to its potential to reduce heating time and improve power efficiency and reduce adverse heat induced effects on the quality of end products. However, RF heating of food products is a complex process due to the range of parameters affecting heating and the complex nature of food composition and its interaction with electromagnetic fields. This makes the improvement of heating uniformity a key challenge. Recently, the use of powerful computer simulation packages has greatly assisted the design and optimization of RF systems and processes.

The present review will provide fundamental information on applications of RF heating in food processing and innovative strategies used to improve heating uniformity during RF assisted processing. It will also provide an overview of current developments and challenges in the areas of RF tempering/thawing, pasteurization and sterilization with particular reference to the production of high quality and safe food products.

Key words: Radio frequency, pasteurization, sterilization, tempering, thawing

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Effectiveness of cleaning-in-place (CIP) using ozonated water for cleaning of biofilms

Ariel GARSOW1, David PHINNEY1, Walaa HUSSEIN1, Dennis R. HELDMAN1

1*The Ohio State University, Columbus, The United States of America*

Abstract

Biofilms proliferate in food processing environments making them difficult to clean. Investigating alternative cleaning methods allows for increasingly environmentally friendly practices and provides cost savings to manufacturers. The goal of this study was to evaluate the ability of ozonated water to act as a cleaning agent against a commercial biofilm. A multi-species biofilm of predominantly *Methylobacterium* sp. and *Cupriavidus* sp. was built on the surface of 304 stainless steel pipe sections. Rinsing with sterile water removed sessile cells. Single-pass cleaning trials were completed through exposing pipe sections to ozonated water with concentrations between 0 and 9 ppm, for treatment times between 0.5 to 3 minutes. Automated 5 step hot caustic CIP trials using chlorinated alkali and nitric acid were also conducted. Heterotrophic plate counts were used to determine viable cell counts. The adenosine triphosphate (ATP) levels in the samples estimated the amount of residual organic material. The results revealed that all concentrations of ozone reduced the microbial load as well as the ATP levels ($P>0.05$). The reductions obtained with ozonated water were not as significant as the reduction accomplished with normal CIP cleaning. The differences in reduction of microbial counts and ATP levels at the three concentrations of ozonated water were not significant ($P<0.05$). The biofilm colony forming units were reduced by more than 90% at all ozone concentration levels. The results based on ATP levels showed similar trends. These results suggest the microbial reduction from ozonated water occurs within 0.5 minutes of exposure at all 3 ozone concentrations.

How the sucrose particle size influences the sweetness perception and sensory properties of sugar-reduced rotary-moulded biscuits

M. Teresa MOLINA[1], Katherine ALLEL[2], Michela LAURIOLA[2], Sandra M. VAZ[2], Pedro BOUCHON[1]

[1]*Pontificia Universidad Católica de Chile, Santiago de Chile, Chile*
[2]*Nestlé Development Center, Santiago de Chile, Chile*

Abstract (250 words including references)

Dietary concerns about the consumer's high sugar intake is driving the biscuit industries to reduce it, so the sugar particle size may be relevant to modulate the sweetness perception in biscuits. The aim of this study was to understand the effect of sucrose particle size on sweetness perception during chewing and sensory properties of sugar-reduced rotary-moulded biscuits.

The biscuits were prepared using soft wheat flour, sucrose, fat, salt, bulking agents and water. Five concentrations of sucrose (from 10 to 40%) and two particle sizes (granulated or powdered) were selected. The sensory attributes (aeration level, noise intensity, hardness, and grittiness) were measured using monadic profile (n=2), and the sweetness perception was done using a discrete-point time intensity test (n=3) with 9-trained panelists. In addition, the presence of sugar crystals in the biscuit's microstructure were characterized using x-ray computed microtomography (MicroCT).

The results show that aeration level, hardness and grittiness were perceived less intense when the sucrose content was reduced. In addition, the sucrose particle size produced differences in the overall noise intensity. Biscuits with granulated sucrose were perceived noisier than those with powdered sucrose, but this difference disappeared when sucrose was lower than 19%. During chewing, all the samples got the maximum point of sweetness perception at 15-20 s, but sucrose particle size did not produced difference in sweetness intensity. MicroCT analysis showed sucrose crystals in the surface of biscuits formulated with granulated sucrose (27 or 40%), allowing to understand how the noise intensity is affected by the presence of crystals.

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Purification of salmon gelatin methacryloyl solutions by diafiltration.

Cristina PADILLA[1], Vanessa CAMPOS[1], Felipe SCOTT[2], Javier ENRIONE[1], **Paulo DIAZ[1]**

[1] *Faculty of Medicine, Universidad de los Andes, Chile.*
[2] *Faculty of Engineering and Applied Siences, Universidad de los Andes, Chile.*

Abstract
In recent years, there is interest in obtaining gelatin-derived materials from marine sources for food and biomedical applications because of its simple production, processing and sustainability. Specifically, gelatin modified by methacryloyl side groups (GelMA) can form photopolymerized hydrogels through ultraviolet irradiation in the presence of a photoinitiator, improving its mechanical properties and stability. One of the main limitations of GelMA production is the purification process by dialysis, which could take up to 4 days with protein loss of about 20%. The objective of this work was to develop a scalable purification system for salmon GelMA (SGelMA) using a diafiltration system. SGelMA with different functionalization degrees were produced with 2, 5 and 8%v/v of methacrylic anhydride (MA) during the reaction. A Sartorius SartoFlow® Smart system was used. The protocol used was established by evaluating protein concentration in the retentate and filtrate solutions. The gelatin was characterized by molecular weight and mechanical/viscoelastic properties. Results showed that SGelMA purification is feasible using the diafiltration system with a 10kDa cut-off membrane. Moreover, the total purification time was reduced to 8h or less. SGelMA showed higher gel strength, viscosity, G' and gelling temperature in comparison with a dialysis purification, probably due to an increase the average molecular weight of the diafiltrated samples. Also, SGelMA 2%MA showed 98% protein retention. In the case of the 5% and 8%MA the retention was 92% approximately. Due to SGelMA properties, these results could contribute to the development of scalable production of novel food coatings and packaging at an industrial scale.

Analysis of heat transfer and residence time distribution in tubular heat exchangers used for pasteurization of fruit juices

Guilherme RUSSO[1], Nilo H. M. FORTES[1], Fernanda G. DITCHUN[2], **Jorge A. W. GUT[1,3]**

[1]*University of São Paulo, Dep. Chemical Eng., Escola Politécnica, São Paulo, Brazil*
[2]*Faculdade de Tecnologia Termomecanica, São Bernardo do Campo, Brazil*
[3]*FoRC – Food Research Center, University of São Paulo, São Paulo, Brazil*

Abstract

Pasteurization of fruit juices is usually accomplished using heat exchangers to heat the product flow up to the processing temperature and then to cool it to storage or packing temperature, while the process lethality on microorganisms or enzymes is achieved in the intermediary holding step. However, the heating and cooling steps can contribute with lethality and also with quality changes. To evaluate such changes, the time-temperature history of the product in the heat exchangers needs to be determined either from experimental measurements or from process modeling. The history depends on heat transfer coefficients and on the velocity profile. In this work, two heat exchangers (coiled tube in shell) that are part of a small scale pasteurization unit (0.5-1.0 L/min) were studied. Work fluid was water, as the unit is used to process low viscosity products such as apple juice or coconut water. Residence time distribution was determined using an ionic tracer and a deconvolution technique for flow rates between 0.5 and 1.1 L/min. Active volumes were determined from the mean residence times and the velocity profile was modeled as generalized convection. Heat transfer experiments for processing temperatures between 60 and 120 °C and flow rates between 0.4 and 2.0 L/min were made and temperature data was used to calculate overall and individual heat transfer coefficients, which were correlated with Reynolds number. Combined results of heat transfer and residence time distribution could be used to predict the time-temperature history of the product along the heat exchangers for various conditions.

INFLUENCE OF THE SLICES THICKNESS AND TEMPERATURE ON DRYING OF *Curcuma longa* L.

Maritza PHILCO-BALVÍN, Oscar MENDIETA-TABOADA[1], **Mari MEDINA-VIVANCO[1]**

[1]*Universidad Nacional de San Martín, Tarapoto, Perú*

ABSTRACT

Curcuma longa L. (turmeric, cúrcuma, azafrán, palillo, etc.) is a plant of Asian origin that has expanded to Latin America, is appreciated for its culinary and medicinal use. The objectives of the present work were: 1) To determine the influence of the immersion time (10, 15 and 20 s) and the concentration of NaOH (4, 5 and 6% w/w), in the peeling of rhizomes, at 100°C; 2) To evaluate the influence of temperature (40, 50 and 60°C) and slices thickness (2, 3 and 4 mm) in the kinetics of drying, color and water diffusivity.

The rhizomes of Curcuma longa, with average length, diameter and weight, 5.92 cm, 1.57 cm and 45.3 g, respectively; with moisture content of 83.80% (w.b.), were washed, chemically peeled, washed, drained, cut, dried, ground, sieved and packed.

Two DCA were used with a 3x3 factorial arrangement with three repetitions. The analysis of variance (ANVA) indicated that, in the studied levels, the concentration and immersion time presented a significant influence ($p \leq 0.05$) on peeling percentage. On the response surface, an increase in percentage of peeling was observed with the increase of NaOH concentration up to, approximately, 5.3% (w/w), from which it tended to be constant.

For a drying time of 5 hours, the ANVA indicated significant influence ($p \leq 0.05$) of temperature, thickness and interaction of both variables on the moisture content and the color. The water diffusivity values fluctuated between 1.09×10^{-8} and 2.24×10^{-8} m^2/s, for 40 and 60°C, respectively.

Key words: condiments, turmeric, air drying, rhizomes.

Optimization of ultrasound assisted extraction of bioactive compounds with maximum antioxidant capacity in cold brewed black tea

Sonali RAGHUNATH[1], Kumar MALLIKARJUNAN[1]

[1] *Department of Food Science and Nutrition, University of Minnesota, Twin Cities, USA*

Black tea, one of the most consumed beverage with caffeine worldwide, is high in polyphenols and antioxidant activity. With the increase in tea consumption due to its health promoting effects, it is more important to maintain the bioactives during the brewing process. Brewing of tea in hot water has been an ancient tradition but leads to degradation of bioactive compounds and also imparts astringency due to the release of bitter tasting compounds. Brewing at cold temperatures preserves the flavors and results in a controlled release of bitter compounds, owing to a better flavor and taste but the technique is limited due to longer extraction times. However, ultrasound assisted extraction (UAE) can be used to maximize the efficiency of extraction in combination with cold brewing to decrease the extraction time.

In this study, response surface methodology was used to optimize extraction conditions (sonication times, amplitudes and solvent volume) for maximum phenolic and antioxidant activity. All the experiments were carried out at 4°C with 0.5g of sample and analyzed for total phenolic content using Folin-Cioacalteau assay and antioxidant activity using ABTS and DPPH radical scavenging.

The predicted optimum conditions for higher phenolic was found to be 70% amplitude, 75 ml of solvent volume and 40 min of sonication time with a TPC value of 86.4 mg GAE/ g of black tea and a maximum antioxidant activity of 35% with DPPH and 58% ABTS. UAE increases the extraction with higher efficiency within shorter duration of time.

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Ultrasound assisted cold brewing of chamomile tea- A kinetic approach

Sonali RAGHUNATH[1], Kumar MALLIKARJUNAN[1]

[1]*Department of Food Science and Nutrition, University of Minnesota, Twin Cities, USA*

Chamomile tea is considered as one of the best medicinal tea worldwide due to its potential health benefits with a rich source of bioactive compounds. Brewing has been a tradition method of processing tea however cold brewing results in better taste and natural release of bioactive compounds but this technique is not being opted due to longer extraction times. In combination with cold brewing, ultra-sonication can be used to improve extraction efficiency and decrease extraction times.

The effect of ultra-sonication (70% amplitude, 10 minutes, solid to solvent ratio of 1:100) on extraction kinetics of phenolic compound was evaluated in combination with cold brewing of chamomile tea at two different temperatures (21 and 7°C) with water and methanol as solvent. The kinetic study was done by measuring the total phenolic content (TPC) using the Folin-Ciocalteau assay over a range of time from 0 to 280 minutes for each treatment done.

The cold brewing of Chamomile tea in general was shown to follow a pseudo second order kinetics and the ultra-sonication process did not affect the order of the reaction. The rate of the reaction ranged from 0.01 to 0.6 $(mg/g)^{-1}min^{-1}$ for the experimental conditions. The time and temperature for the extraction as well as amplitude and sonication time (UAE) were reported as the critical parameters in the extraction of phenolic with respect to cold brewed chamomile tea. The kinetic study explains the rate of the reaction to extract phenolics and can be used as a method to design the brewing system.

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Using digestion models to develop healthier bread formulations

Ourania GOUSETI[1], Amalia YANNI[2], Konstantinos KARAVASILIS[3], Irene PATERAS[3], Nikolaos TENTOLOURIS[4], Vaios KARATHANOS[2], Serafim BAKALIS[1]

[1]University of Nottingham, Nottingham, UK
[2]Harokopion University of Athens, Kallithea, Greece
[3]Elbisco S.A., Pikermi, Attica, Greece
[4]Athens Medical School, University of Athens, Athens, Attica, Greece

Abstract

Food related diseases such as obesity have reached epidemic levels demanding from the food industry to produce a new generation of food products with advanced health benefits. Carbohydrates constitute the most important dietary energy source for humans and bread is, among carbohydrate-rich foodstuffs, the most frequently consumed. White bread induces rapid starch digestion and glucose absorption (GI>70), thus it is an unfavorable food choice for diabetics. The strategies for reducing the GI of breads are based in the addition of ingredients such as beta-glucans and resistance starch to retard glucose absorption.

In this work in-vitro and in-silico models were used to optimize white bread formulations. Ingredients added to improve GI included beta-glucans and resistant starch. A design of experiments approach was and formulations included beta-glucan, resistant starch, wheat gluten, and sugar. Starch hydrolysis was studied using the in-vitro digestion protocol of INFOGEST with minor modifications. In-vitro estimated GI of formulated breads ranged between 60 and 95 (with reference to commercial white bread, which was allocated a GI of 100). Mathematical models were used to extrapolate results and identify optimal bread formulations with GI lower than 50. Two bread formulations were produced at industrial scale and GI was determined in ten healthy individuals. Plasma glucose was determined at 0 (before consumption) 15, 30, 45, 60, 90, 120 and 180 min postprandially. Results on GI agreed well with the model predictions (<15%) and resulted on a formulation with a significantly lower GI (<50) compared to the control.

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Application of pulsed electric fields to improve product yield and waste valorization in industrial tomato processing

Varvara ANDREOU[1], George DIMOPOULOS[1], Efimia DERMESONLUOGLU[1], Nikolaos STOFOROS[2], **Petros TAOUKIS**[1]
1. School of Chemical Engineering, National Technical University of Athens, Athens, Greece
2. School of Food, Biotechnology and Development, Agricultural University of Athens,Athens, Greece

Tomato industry faces challenges in the production, in terms of yield, product losses and high energy demands that could benefit from novel approaches. The tomato industry strives to maximize product yield, keep energy costs and waste effluents to a minimum while maintaining high product quality. Pulsed Electric Field (PEF) processing increases plant cell permeability through electroporation and could be applied to facilitate peeling, increase juice yields and enhance the valorization of tomato waste.

PEF was applied to three steps, of industrial tomato processing. In the first step, PEF treatments (0.5-1.5 kV/cm, 0-8000p.) applied to whole tomatoes improved peeling, reducing the work of peel detachment up to 72.3%. In the second step, PEF (0.5-2.5 kV/cm, 0-4000p.) applied to chopped tomatoes, increased tomato juice yield up to 20.5%. PEF was applied to the residues of the first juicing comprising seeds, peels and a fraction of tomato flesh to further increase juice yield with the overall yield reaching 90.2%. In the third step, the effects of PEF on the extraction of high added value compounds from juicing residues were studied. Carotenoid extraction yield increased up to 56.4%. Lycopene extraction increased from 9.84 mg lycopene/100 g to 14.31 mg/100 g tomato residue at 1.0 kV/cm for 7.5 ms. The concentration of extracted total phenolic compounds doubled (56.16 mg gallic acid/kg) at 2 kV/cm and 700 pulses. The increased antioxidant capacity was correlated to carotenoid concentration.

Overall, PEF pretreatment effectively applied at targeted steps of industrial tomato processing increase productivity, byproduct valorization and energy efficiency.

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New concepts in food engineering education

Myriam LOEFFLER[1], Jochen WEISS[1]

[1]*University of Hohenheim, Stuttgart, Germany*

Abstract
EIT Food is a European Knowledge and Innovation Community which was set up to transform our food ecosystem by connecting partners from leading businesses, start-ups, universities, and research centers as well as institutions across 13 countries in Europe and from the entire food value chain. The current presentation aims to introduce a new concept of food engineering education with students taking a step ahead to bring academic knowledge into real food solutions. Two case studies are presented in which international, multidisciplinary student teams have developed innovative and sustainable food products while tackling both the challenge of food waste reduction and the valorization of side streams. The first competitive project focused on the utilization of bananas, potatoes and bread that otherwise would have been wasted. Whereas the goal of the second project was to develop new fiber-enriched dairy products. During the 12-month project the students worked together with partners from industry, enabling a contemporary industrial upscaling of the products and/or technologies initially developed at the universities. From an educational point of view students gained knowledge in project management, product development and processing while developing first entrepreneurial skills. Moreover, the EIT projects enabled students of Food Science and Bio-economy to study the entire value chain of a product - from an idea to the product- and packaging development (ensuring food safety) to the presentation of a valid business case.

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Quality-based life cycle assessment of protein dietary sources

Shreya SAHASRABUDHE, Christopher CHENG, Maria SALAZAR, **Jen-Yi HUANG**
Department of Food Science, Purdue University, West Lafayette, USA

Abstract

A growing population is causing a greater stress on planet's natural resources, and sustainably supplying food to 7.7 billion people has thus become a major challenge. Protein is an essential macronutrient in human diet, especially the one containing all essential amino acids. However, its production and supply can cause negative impacts on environment. Since nutrient delivery is the primary function of protein, incorporating its quality into environmental performance evaluation is a more appropriate approach. Here, Life Cycle Assessment (LCA) was conducted to compare the environmental profiles of ten different animal- and plant-based protein sources. Instead of using weight or volume (De Marco et al., 2016; Heller et al., 2013), we developed three new functional units (FU) based on the most common protein quality indicators (protein efficiency ratio, protein digestibility corrected amino acid score, and biological value). The product systems studied included all the main stages in the foods' life cycle, from resource generation to harvest/slaughtering. Results showed, except for beef, the midpoint environmental impacts (acidification, eutrophication, global warming) of all protein sources calculated using quality-based FUs were higher than those calculated based on their protein contents. Although plant-based proteins are commonly considered more sustainable, we found that some of the animal-based proteins, like pork and egg, in fact produce lower environmental impacts than soybean when protein quality is considered. This quality-based LCA model can help recommend healthy protein diets at reduced environmental costs, allowing the public to understand the associated impacts and take action to improve their eating habits.

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Modelling of Ohmic heating and kinetics of texture change of solid food products

Aberham Hailu, FEYISSA, Felix RABELER

Food production Engineering, Technical university of Denmark, Lyngby, Denamrk

Abstract

Heating of solid and semi solid foods using the conventional technologies is time-consuming due to the fact that heat transfer is limited by internal conduction within the product. Ohmic heating is potentially solving this problem by allowing volumetric heating of the product and thereby reducing or eliminating temperature gradients within the product, and however, the impact of ohmic process on the quality (texture) is not well understood. Therefore, the aim of the current work is to model and develop the ohmic heating technology for processing of meat products and to investigate its impact on texture changes. .

A mathematical model of coupled heat transfer and electric field during ohmic heating of meat products has been developed. These coupled with kinetics of texture changes and the resulting coupled model equations were solved using the Finite Element Method (COMSOL Multi-physics® version 5.2). The experiments were carried out at different process conditions. The temperature profiles and current were continuously measured inside the product. The texture of the products was measured at different time and kinetic model was developed. The model has been validated using the experimental data. Good agreement was achieved between model predictions and the experimental values. The model has been utilized to predict the temperature distribution and texture changes to control and optimize the Ohmic process. The conclusion is that Ohmic heating is a favorable technology for heating of meat products, and the developed model can be used in the design and optimization of the ohmic heating for the meat products.

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Prediction of millet extrudates properties using response surface modelling and artificial neural networks

Kasiviswanathan MUTHUKUMARAPPAN, Gabriela John SWAMY

South Dakota State University, Brookings, SD, USA

Abstract

Millets are a good source of phenols and flavonoids, contributing to their antioxidant activity. The aim of the proposed research project is to develop new ready-to-eat finger foods for infants from sprouted millets by applying extrusion technology and optimize the process variables using ANN and RSM. Proso millet seeds were soaked and germinated for various times. The flour was processed in a single and twin-screw extruder. Effects of germination time (0-96hrs), feed moisture content (15–25 %), screw speed (100–200 rpm) and temperature (90–140°C) on the physical characteristics of the extrudates was investigated using response surface methodology and artificial neural networks. The physical properties measured were color, bulk density, unit density, water absorption index (WAI), water solubility index (WSI), texture and expansion ratio. A significant color difference was observed between the sprouted and unsprouted extrudates. The gamma aminobutyric acid was highest for the extrudates with a germination time of 72 hrs. The hardness of extrudates ranged from 160 to 251 N with minimum hardness recorded at the lowest moisture condition. Extrudates produced in a single screw extruder at high feed moisture (25%), average screw speed (150 rpm), and average barrel temperature (115°C) showed good physicochemical properties and higher protein and starch digestibility. The results showed that properly trained ANN model is found to be more accurate in prediction as compared to RSM model. Developing a novel, healthy, extruded food product from millet will provide a nutritious snack for infants.

Camel milk fouling and its comparison with bovine milk

Bruce Yizhe ZHANG, Shihan XU, Jorge Augusto VILLALOBOS SANTELI, Jen-Yi HUANG
Department of Food Science, Purdue University, West Lafayette, IN 47907, USA

Due to superior nutritional value, digestibility, antimicrobial and therapeutical properties (Khalesi et al., 2017), camel milk is gaining attention in functional food and dairy industries. Fouling is a severe problem in dairy processing and bovine milk fouling has been studied extensively (Bansal and Chen, 2006). However, knowledge on fouling of camel milk is still very limited. In this study, we used a lab-scale spinning disc apparatus to investigate the fouling behavior of reconstituted freeze-dried raw camel milk under controlled temperatures (95, 105 and 115 °C) and shear stresses (6.4−33.4 Pa). By monitoring the thermal resistance, we found that fouling grew significantly by 66−101% when temperature increased from 95 to 105°C, but further increase to 115 °C only showed slight effect (8−23%). Furthermore, the fouling decreased with increasing shear stress. Comparing with raw bovine milk, camel milk had a 68% lower fouling resistance, however, the masses of their dry deposits were not significantly different. Composition analysis showed that fat (53−60% DM) and protein (30−37% DM) were the major constituents in both deposits. SDS-PAGE analysis indicated that camel casein, α-lactalbumin and serum albumin were the major proteins contributing to the deposition of camel milk, while β-lactoglobulin and casein were responsible for bovine milk fouling. Micro-CT was also performed to analyze the structural properties of both deposits, which were found associated with their difference in thermal resistance.

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Preliminary assessment of consumer exposure to trihalomethanes by consumption of IV gamma products

Cátia SIMÕES[1], Susana MENDES[1], Alice MARTINS[1], **Maria M GIL[1]**

[1]*MARE – Marine and Environmental Sciences Centre, ESTM, Instituto Politécnico de Leiria, Peniche, Portugal*

Abstract

Due to the current demand for healthier food, the IV gamma product industry has grown over the years. Additionally, it is well known that chlorine is the most widely used disinfectant in IV gamma product industry. However, the risk assessment associated with the formation of carcinogenic by-products from this halogenated disinfection has not been widely studied. The aim of this study was to assess the trihalomethanes (THMs) exposure through the consumption of IV gamma products, more specifically, salad mix, and potential health risk in portuguese population using a deterministic method. The quantification of THMs in 15 samples of salad mix was performed by gas chromatography coupled to mass spectrometry (GC-MS). The THMs exposures were estimated by combining the THMs concentration data with a salad mix consumption survey (case study applied in the Lisbon and Vale do Tejo area; n=271). The results were evaluated against the Reference Dose 0,07mg/Kg (RfD). The concentration of THMs in all samples was below the limit of quantification of the equipment, and this limit was used for the evaluation of the exposure. It was found that it is very small for the consumption pattern of these products in the studied population categories, suggesting that there is no risk for consumers due to the halogenated disinfection process.

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Impact of mixer geometry on dough structure and aeration

Alain Le-BAIL[1,2,3]**,** Joran FONTAINE[1,2,3,4], Dominique DELLA-VALLE[1,2,3], Joëlle GRUA-PRIOL[1,2,3], José CHEIO[4]

[1] ONIRIS, BP 82225, 44322 Nantes– France
[2] UMR GEPEA CNRS 6144, 44307 Nantes – France
3 UBL (Université Bretagne Loire), France
4 VMI, 85600 Saint Hilaire de Loulay – France

Abstract
Dough mixing, the first step of bread making, has a strong impact on the final structure of the bread. It aims at (1) distribution and homogenization of dough ingredients, (2) hydration of flour particles and (3) development of an isotropic gluten network and embedment of gas cells in the dough. The gluten-network plays a major role in the gas holding capacity and final bread volume. This study aims at exploring the impact of the mixing conditions and mixer geometry on dough aeration and rheology.

A 10 liters Spiral-dough-mixer (SPI11-VMI/France) was used with power counter which was used to follow the evolution of the gluten-network during mixing. A maximum of consumed power was observed for a "t_{PEAK}" time, over which overmixing occurs with negative impact. An experimental design was used considering a sandwich-bread dough and three parameters; spiral-tool rpm, bowl-tool nip and bowl-tool speed (rpm) ratio. Dough aeration was the response.

It was found that t_{PEAK} was strongly correlated with the number of tool revolutions, the temperature increase and the specific energy, indicating that these parameters can be used to follow dough development. Tool speed, bowl speed and the nip control the shear rate of the mixer that have a strong effect on dough aeration, mixing time, structure and rheology, showing the importance of mixer geometry on dough properties. Imaging of the gluten network (CLSM+ rhodamine/B) was done to monitor the gluten-network structure and connectivity of the gluten strips.

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Optimization of tempering process for a frozen protein-based on the basis of food physical properties simulation

Shengyue SHAN1, David M. PHINNEY1, Dennis R. HELDMAN1
1*The Ohio State University, Columbus, USA*

Abstract

Tempering of a frozen product involves equilibrating it to a temperature below its freezing point. In the muscle food industry, tempering is usually required prior to slicing or other. This research presents suggestions for improving tempering efficiency in both terms of process efficiency and product quality. A transient heat transfer model was established in MATLAB using finite element method, one- and two-dimensional heat transfer analysis were made on cylindrical and rectangular product, respectively, to generate temperature distribution histories. The thermophysical properties of the frozen product have been predicted based on product composition and are temperature-dependent. The physical properties of the protein-based product were measured by Dynamic Mechanical Analysis (DMA) over a temperature range from -20 °C to 4 °C. The mathematical model provides an illustration of the temperature distribution history of the product. The temperature histories were coupled with the relationship between temperature and physical properties defined from DMA to develop distribution histories of the product's physical properties. Time-to-temper is defined as the time when the physical properties across the product

reaches a uniformity. The influences of the tempering medium, flow characteristics, product geometry, and dimensions on time-to-temper have been discussed. The simulation results provided directions for the experimental measurements to be conducted, and insights needed for scale-up of the tempering process. It has been concluded that time-to-temper can be reduced significantly when heat transfer coefficient increases approximately from 10 to 200 W/(m2·K), and ambient temperature near product freezing point will lead to the longest time-to-temper.

Analysis of vertical compression of corrugated fiberboard tubes using digital image correlation

Celia KUEH[1], Karl DAHM[2], Kelly WADE[3], John BRONLUND[1]

[1]*Massey University, Palmerston North, New Zealand*
[2]*Callaghan Innovation, Lower Hutt, New Zealand*
[3]*Scion, Rotorua, New Zealand*

Abstract
Headspace is an important consideration in the design of corrugated fiberboard packaging for non-load-bearing food products. The headspace needs to be sufficient to avoid product damage arising from compressive loads when palletised.
Recent analysis of whole box compression tests using Digital Image Correlation (DIC) (Kueh, Dahm, Emms, Wade, & Bronlund, 2019) characterised the separate contributions of box folds and panel compression strain to the overall vertical compression of the box. Displacement of the box horizontal folds was found to have the largest contribution to vertical compression during a box compression test.
The present study extends this work by investigating the influence of packaging properties and boundary conditions at the box folds on box vertical compression.
Compression tests with DIC 3D motion measurements were conducted on two designs of corrugated fiberboard tubes, derived from commercially manufactured boxes through removal of flaps. The two box designs were made of different corrugated flute types and paperboard constituents.
Comparisons of the vertical displacement for the tubes and boxes of the same design show the tubes to have vertical stiffness 50% to 155% higher than the apparent vertical stiffness of the boxes for the two respective designs. This indicates the important role displacement of box flaps plays during the failure process, and hence the need to consider this factor during packaging design.

Kueh, C., Dahm, K., Emms, G., Wade, K., & Bronlund, J. (2019). Digital Image Correlation analysis of vertical strain for corrugated fiberboard box panel in compression. *Packaging Technology and Science, In Press*.

ICEF13 ABSTRACT TEMPLATE

Effects of technological treatments on dietary fiber structure, digestion of plant proteins and bioaccessibility of amino acids: cooking extrusion of brewer's spent grains

Emilie KORBEL[1], Didier DUPONT[2], Claire GUYON[1], Christophe COUEDEL[1], Lucas VADAINE[1]
[1]*ONIRIS, UMR 6144 GEPEA CNRS, Nantes, France*
[2]*STLO, INRA-Agrocampus Ouest, Rennes, France*

Abstract

The craft brewing industry has seen a rapid expansion in many countries over the last few years. Wet brewer's spent grains (BSG) are the residuals after grain mashing and extraction of starch and sugars and represent the main byproduct of the brewing process. The annual production of BSG is estimated to approximately 30 million tonnes worldwide.
In the same time, the evolution of the world population leads to an increase in the demand for proteins. With the objective of food waste reduction and search for new sources of protein, the idea is to design a sustainable food system based on circular economy, in which BSG are valued in the production of fiber and protein-enriched foodstuff.
Despite their complete amino acid sequence, which is interesting from a nutritional point of view, the protein of BSG are not very accessible. In addition, their high insoluble fiber content limits their acceptability from an organoleptic point of view.

This study allowed the identification of temperature and humidity as parameters inducing changes in the matrix, changes in fiber structure and affecting protein digestion during the treatment of BSG by extrusion cooking. The digestion protocol used is derived from the INFOGEST international consensus (Minekus et al., 2014) that mimics the digestive process of healthy adults. The modification of the fiber structure according to the parameters of the process has also been highlighted.

Minekus et al. 2014. A standardised static in vitro digestion method suitable for food - an international consensus. Food Funct. 2014 Jun;5(6):1113-24. doi: 10.1039/c3fo60702j.

Enhancing clean-in-place efficiency through microbubble pre-rinsing

Monique Mi Song CHUNG1, Jiakai LU1, Jen-Yi HUANG1

1Department of Food Science, Purdue University, West Lafayette, United States

Abstract
Fouling is an important concern in food industry, especially dairy processing, in which thermal processes promote accumulations of whey proteins and minerals on heat transfer surfaces of equipment. Currently, clean-in-place (CIP) procedures with alkalis and acids are used to remove fouling deposits, which can negatively impact production costs and environmental footprint (Zouaghi et al. 2018). Microbubbles (MB) have unique interfacial physicochemical properties, including (a) low buoyancy forces which provide them with a longer residence time in liquid, (b) hydrophobic interface which organic substances tend to attach to, and (c) large specific surface area which intensifies mass transfer efficiency (Gurung et al. 2016; Wang et al. 2018). Therefore, this study aimed to use MB-infused water as a pre-treatment of CIP to enhance the removal of dairy fouling on stainless-steel. The MB-infused water was generated using a Nikuni centrifugal pump with average bubble size of 2.32 ± 0.07 μm, and air volume fraction of 0.38 ± 0.48 %. Foulant of curdled milk was formed on stainless-steel plates and rinsed by MB-infused water for 20 min. The MB-infused water removed 60.71 ± 2.03% of the milk foulant and was 5% higher than the control treated by water without MB. Our results show that use of MB-infused water as a pre-rinse step can be an effective method to enhance the efficiency of foulant removal, and thus decrease the chemical usage during CIP in dairy processing plants.

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Wang, S., Zhang, Y., Meredith, J. C., Behrens, S. H., Tripathi, M. K., & Sahu, K. C. (2018). The dynamics of rising oil-coated bubbles: Experiments and simulations. Soft Matter, 14(14), 2724–2734. doi:10.1039/c7sm01603d

Zouaghi, S., Abdallah, M., Andre, C., Chihib, N. E., Bellayer, S., Delaplace, G., et al. (2018). Graphite-based composites for whey protein fouling and bacterial adhesion management, 86, 69–75. doi:10.1016/j.idairyj.2018.07.004

Systematic study on the extraction of phycoerythrin from *Gracilaria gracilis* for natural food colorants

Tatiana PEREIRA[1], Sónia BARROSO[1], Susana MENDES[1], Teresa BAPTISTA[1], **Maria M. GIL**[1]

[1]*MARE – Marine and Environmental Sciences Centre, ESTM, Instituto Politécnico de Leiria, Peniche, Portugal*

Abstract
The substitution of artificial dyes by natural colouring agents is among the top concerns of food industry to fulfil current consuming trends, justifying the prospection of natural sources of these compounds. Phycoerythrin is the major light-harvesting pigment protein in red algae and is nowadays widely used as a fluorescent probe in biotechnological applications. In addition, it has had substantial economic impact due to its potential as a natural food colorant. The macroalgae of the Gracilaria genus are valuable resources for industrial and biotechnological applications as they are a great source of R-phycoerythrin and other economically valuable compounds such as phycocolloids and bioactive metabolites. In this work, maceration and ultrasound-assisted methods (considereed green and sustainable) for the extraction of phycoerythrin from *Gracilaria gracilis* collected in Figueira da Foz (40°º07'56.5''N, 8°º50'35.9''W), Portugal, were demonstrated and optimized. Response surface methodology (RSM) considering a central composite rotatable design (CCDR) was carried out to optimize the extraction conditions, including extraction time (t), phosphate buffer concentration (C), biomass:solvent racio (R) and homogenization time (H). Additionally, a second-order polynomial fit was performed to fit the experimental data used to determine optimal extraction conditions. The extraction yield was used as response criteria. The developed models were successfully fitted to the experimental data and used to determine optimal extraction conditions. Maceration assisted extraction was the most efficient method yielding 3.7 mg phycoerythrin / g seaweed under optimal conditions (t=10 min, C=0.1M, R=1/50, H=10 min). The extraction yield presented a high positive correlation with t and C.

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Using agricultural residues and side streams of food processing for the conversion of biomaterial into high value food supplements

R. SEVENICH[1*], C. RAUH[1] and D. KNORR[1]
[1] *Technische Universität Berlin, Department of Food Biotechnology and Food Process Engineering Königin-Luise-Straße 22 14195 Berlin, Germany*

Abstract

Biological plant based materials, which accumulate during the tilling of agricultural landscapes or during the processing of food along the process chain still obtain high amounts of valuable components, such as proteins, anthocyanins, polyphenols, vitamins etc.. Therefore, efforts need to be made to reduce these losses and intensify the use of side streams of the agricultural and food processing and add a value on these by producing co-products e.g. extract highly bioactive compounds or other compounds of nutritional value or transform the whole by-product into a high-quality co-product without any residue. However, these compounds are enclosed in the cellular tissue and need to be extracted for further use. This could be accomplished by integrating emerging technologies, like ultrasound, pulsed electric fields and high-pressure processing, in bioeconomic chain. These technologies offer potential as low waste generating technologies. Especially to sustainably increasing productivity and resilience and resource use efficiencies at the agricultural system scale, which explore and exploit refinery concepts for multiple use of biomass.

The innovative treatment and the side streams used; could allow reducing the need for chemical solvents; increases the profitability of the farmers land; reduces waste; is sustainable; generates high quality products without the exploitation of the environment and answers to one of the consumer main demands for more natural and sustainable agricultural products. The talk will focus on the mentioned technologies and how they can be implemented and used in the industry to produce high quality products out of side-streams.

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An Intestine-on-a-chip for Studying Anti-inflammatory Properties of Food

Chiara A.M. FOIS[1,2], Thi Y.L. LE[1,2], David F. FLETCHER[1,2], Fariba DEHGHANI[1,2]

[1]*The University of Sydney, School of Chemical and Biomolecular Engineering, Sydney, Australia*
[2]*The University of Sydney, Centre for Excellence in Advanced Food Enginomics, Sydney, Australia*

Abstract

The human gut is the key organ for the absorption of food, acting also as an important barrier against external agents. Due to multiple factors, the intestinal barrier can be impaired, increasing the chance of developing inflammations. Western diet has often been related to the development of such conditions. With the gastroenterologists' community in agreement that food plays an important role in the homeostasis of the human gut, diet options are often proposed for the remission of the symptoms. However, it is indeed, important to improve the knowledge of how food could potentially help in this regard. The *in vitro* standardised studies and animal models are not always fully representative of the human conditions, due to physiological and morphological differences among species, and require ethics approval. Given these premises, we have developed an intestine-on-a-chip platform, as an alternative approach for the study of anti-inflammatory nutrients and compounds efficacy on gut epithelial cells. The microfluidic chip consists of two chambers, 150 µm high and 1 mm wide, separated by a porous membrane to guarantee fluid exchange between the two compartments. The epithelial layer, acting as the intestinal barrier, was represented with Caco-2 cells, whilst pro-inflammatory M1 macrophages were used to model inflammation. Overall, our platform is cost-efficient. The use of such a small device reduces the consumption of reagents, cell numbers and the time required for analysis, allowing a faster polarisation of the epithelial cells, with the final aim of testing nutrients for human health.

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High-pressure-based pasteurization and sterilization as tools to create safe and healthy foods

Robert SEVENICH[1], Cornelia RAUH[1], Jana HAJSLOVA[2], Beverly BELKOVA[2]
[1] *Department of Food Biotechnology and Food Process Engineering, Technische Universität Berlin, Germany*
[2]*Department of Food Chemistry and Analysis, Institute of Chemical Technology, Prague, Czech Republic*

Thermal treatments are the most common and widespread application in food production. It is considered a versatile method to obtain durable and shelf-stable foods. However, with the distinct disadvantage of destruction of valuable compounds and an infringement of characteristic sensorial product attributes. This is particularly the case for high value foods, e.g. baby foods and others. Here, the high thermal load, caused by inhomogeneous heating processes and the associated temperature peaks, can lead to an unacceptable infringement of the desired product characteristics, bioactivity, and the emergence of harmful compounds. The demand for minimally processed low acid food and acid foods in recent years gives further rise to find an alternative for thermal processes. The numerous previous studies that have already been carried out largely contribute to the overall good maturity of the high-pressure processing. High Pressure Processing (HPP) technology is widely used in the food sector in comparison to high pressure thermal sterilization. For both technologies it can be said that further research is needed to understand the exact impact on nutrients, food processing contaminants, food structure, microorganisms and spores in real foods to guarantee safe and healthy foods and to drive both these promising technologies forward. Therefore, the presentation will merge the safety and quality aspects while applying high pressure. Further, the talk will try to give insights into the influence of pressure on chemical reactions as well as the retention of nutrients. An outlook on future developments and challenges will be included in the presentation as well.

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The investigation of electro tolerance development of *Escherichia coli* by RFEF in Saline water

Adel REZAEIMOTLAGH[1], Francisco TRUJILLO[1]

[1]*University of New South Wales, Sydney, Australia*

Abstract
The application of high intensity electric fields such as radio frequency electric fields (RFEF) has been introduced as a novel alternative to thermal food processing technology to ensure the microbiological safety of food products as well as preserving their quality and nutritional attributes. The death of microorganisms, occurring once the critical electric field is applied, is believed to be due to irreversible electroporation phenomenon.
With regards to novel food processing technologies, sub-lethal injuries which could take place due to non-uniform processing may become a challenge because microorganisms may develop tolerance against subsequent RFEF or other chemical or physical preservation treatments, posing a health risk to consumers.
In this research, the possibility of electro tolerance development in *E.coli* at various electric fields was investigated. For this purpose, microorganisms were constantly treated, cultivated and re-cultivated and the level of microbial inactivation for each cycle was determined. The treatment consisted of various constant electric fields as well as interchangeable treatments which expose *E.coli* to sever electric fields. In order to observe any modifications in microbial DNA or prevent possible contamination, PCR experiments were carried out during the study. In case of any electro adaptation phenomenon being developed, responsible molecules within the microorganism were identified. Additionally, scanning electron microscopy (SEM) was utilized to detect any changes in the morphology of *E.coli*.

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Mechanisms to functionalize or restructure alternative proteins for future application in meat-based products

Corina L. REICHERT[1]**,** Jochen WEISS[1]

[1]*University of Hohenheim, Stuttgart, Germany*

Abstract
Substitution of animal-derived proteins by alternative proteins, for instance, plant-based, microalgae, or insect proteins has a growing impact on the food research. This is based on the need to provide the growing global population with sufficient amounts of proteins essential for good health. By physically modifying alternative proteins, new structures can be created that can further be used in food applications such as in meat-based products. In this presentation, we will focus on the mechanisms to functionalize or restructure alternative proteins to disperse them in food matrices.

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Release of carvacrol from nanoemulsions: effect of nanoemulsions formulation

Eugenio MAURIELLO[1], Giovanna FERRARI[1,2], **Francesco DONSÌ[1]**

[1]*University of Salerno, Fisciano, Italy*
[2]*ProdAl scarl, Fisciano, Italy*

Abstract
Essential oil (EO) nanoemulsions as antimicrobial agents in foods have attracted considerable attention in the last years. However, despite the increasing number of studies focused on their application to different matrices, only a few studies addressed the fundamental issues related to the correlation between formulation, EO release and antimicrobial activity.
In this work, antimicrobial nanoemulsions were formulated with carvacrol, as a model essential oil, in blends at different weight fractions with sunflower oil, and different types of emulsifiers (Tween 80, whey proteins, and whey proteins microgels).
The different nanoemulsions were characterized in terms of mean droplet size, ζ-potential, as well as release rate of carvacrol, as a function of the compositional parameters. In addition, the resulting antimicrobial activity was determined against gram- bacteria *Pseudomonas fluorescens*, gram+ bacteria *Staphylococcus epidermidis* and yeast *Saccharomyces cerevisiae*.
The results showed that carvacrol release rate was significantly dependent on nanoemulsion formulation, with the main parameters being the ratio of carvacrol to sunflower oil, which affected the partition in the aqueous phase, followed by the type of emulsifier through the emulsifier micelle-mediated mass transfer. In particular, the nanoemulsions prepared with Tween 80 exhibited the lowest release rate of carvacrol, followed by the whey protein nanoemulsions and Pickering emulsions. The antimicrobial activity tests clearly showed that the antimicrobial activity can be well correlated to the release rate of carvacrol, rather than to the nanoemulsion mean droplet size or ζ-potential, suggesting that the mechanism of antimicrobial action of the nanoemulsion relies on the release of the EOs.

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Modelling Trade-offs in Nutrition-sensitive Processing of Common Beans

Ebenezer M. Kwofie, Ogan I. Mba, **Michael O. NGADI**
McGill University, Department of Bioresource Engineering,
21111 Lakeshore, Ste-Anne-de-Bellevue, Québec, H9X 1V9, Canada

Abstract
Common beans are considered an important source of nutrients globally with a significant health benefits. The primary limitation to consumption is the prolonged cooking time and high fuel use. Losses along the value chain are evaluated in this study. The nutritional implication of losses in key trace elements and bioactive compounds present in common beans was evaluated through related nutrient trade-off analysis. The nutrients considered were calcium (Ca), iron (Fe), Zinc (Zn), and total phenolic compounds (TPC). The results show that the maximum decline observed along the value chain were 31%, 65%, 31% and 60% in Ca, Fe, Zn and TPC, respectively. The results also indicated that soaking beyond 8 hours resulted to 15 min gain in cooking time but led to 4-11% loss in Ca, 5-45% loss in Fe, 1-9% loss in Zn and 5-19% TPC compared to cooking without a softening technique. Cooking in a 5% potassium carbonate (K_2CO_3) solution significantly reduced the cooking time up to 115 minutes and a relatively higher mineral retention capacity.

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Safety and quality degradation of dairy foods stored in residential refrigerators

J. Antonio TORRES[1], Veronica Rodriguez-Martinez[1], Gonzalo Velazquez[2], Fabian Fagotti[3], Jorge Welti-Chanes[1]

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[1]*Tecnologico de Monterrey, School of Engineering and Sciences, FEMSA Biotechnology Center, Monterrey, NL, Mexico*
[2]*Instituto Politécnico Nacional, CICATA-IPN Queretaro Unit, Santiago de Queretaro, QRO Mexico*
[3]*Embraco Mexico S de RL de CV, Apodaca, NL, Mexico*

Abstract
This presentation briefly overviews regulations covering the performance of home refrigerators, and then focuses on using predictive models to estimate food quality and safety losses of selected refrigerated products. While current standardized tests focus on energy consumption, refrigerator manufacturers are also interested in food preservation. However, any future test to assess manufacturers' claims will need to be validated before implementation as official standard. Peer-reviewed predictive models describing microbial growth and other product degradations, could be combined with energy efficiency evaluations when seeking to balance energy consumption and food preservation. While mathematical models are available, much of past research has focused on temperature abuse and thus published model parameters are not in the temperature range of properly-operated refrigerators limiting this work to products for which model parameters were available. This presentation will highlight a predictive microbiology analysis of product temperature values as affected by room temperature ($T_{Chamber}$, simulating 21 and 32 °C homes), refrigerator load (low/high), door (closed/opening cycle), compressor operating mode, temporary room exposure (simulating consumer product removal), and fixed refrigerator temperature setting (5 °C). About 50 million time/temperature values were collected for commercial samples of liquid eggs, orange juice, strawberries, lettuce, ground beef, chicken breast, fish fillet, fresh cheese, and ham stored in the refrigerator's door shelves, and the center refrigerator drawers and shelves. This information was transformed into estimated microbial counts increases after 48 h () for *Listeria monocytogenes*, *Pseudomonas putida* and other microorganisms. These values showed the need for improving the control of the refrigerated product temperature.

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Novel applications of hydrostatic pressure technology in the food, pharmaceutical and biotechnology industries

J. Antonio TORRES[1], Viridiana Tejada-Ortigoza[2], Jorge A. Saraiva[3], Jorge Welti-Chanes[1]

[1]*Tecnologico de Monterrey, School of Engineering and Sciences, FEMSA Biotechnology Center, Monterrey, NL, Mexico*
[2]*Tecnologico de Monterrey, Campus Querétaro, QRO, Mexico*
[3]*QOPNA, Department of Chemistry, University of Aveiro, Portugal*

Abstract
High hydrostatic pressure (HHP) processing of foods is now widely accepted by commercial processors because of its nearly-uniform, almost-instantaneous effects, and short processing times and high consumer-acceptance. The work of several HHP research groups exploring new HHP applications with commercial value will be reviewed in this presentation. For example, HHP can change the structure and functionality of phospholipids, proteins, polysaccharides, dietary fiber components, and other important biomolecules and biopolymers of interest to the food, pharmaceutical and biotechnology industries. HHP can also modify the action of enzymes widely used commercially such as pectolytic enzymes increasing fruit juice yield and clarity, glucose oxidase and catalase removing glucose from egg white, and lipases employed in the production of pharmaceuticals, cosmetics, and natural flavors among many other applications. Hyperbaric storage (HS) under 100 MPa, shown to preserve food at room temperature, has emerged as an alternative to low-temperature storage with a large carbon footprint and energy use. Finally, microbial fermentations performed under sub-lethal pressure can increase fermentation rates and yields and induce the formation of different compounds.

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Modeling the microbial inactivation by high pressure homogenization

Francesco DONSÌ[1], Giovanna FERRARI[1,2]

[1]*University of Salerno, Fisciano, Italy*
[2]*ProdAl scarl, Fisciano, Italy*

Abstract

The efficiency of the microbial inactivation by high-pressure homogenization (HPH) significantly depends on the type of equipment used, the operating conditions, the process fluid, as well as the microorganism resistance. The lack of predictive tools for process performance, especially during industrial scale-up, therefore, limits the industrial application of the process.

Our previous work contributed to demonstrate that the cell disruption by HPH is a purely physical process, which is mainly controlled by the fluid dynamics developing in the homogenization valve.

In this work, we have analyzed the microbial inactivation data obtained in our lab using an orifice valve and a piston valve homogenization units, at varying simulated fluids, and for different microorganisms, and compared with literature data using different experimental conditions.

The results show that the elongational stresses, together with turbulence, appear to control cell break-up for low-viscosity fluids. However, at higher viscosities, the shear stresses become increasingly important. On the basis of these observations, an artificial neural network was applied to develop a predictive tool, fed with the fluid dynamic dimensionless number of operation of the homogenization valve (Reynolds, Capillary, Weber and Cavitation numbers), the main operating conditions (pressure, number of passes and inlet temperature).

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Application of emerging technologies for the extraction of antioxidant compounds from seaweed

Orla P WALSH[1], Gaurav RAJAURIA[2], Amit K JAISWAL[1], Marco Garcia VAQUARO[2], John V O'DOHERTY[2], Colm O'DONNELL[2] and **Brijesh K TIWARI**[3]

[1]*Technological University Dublin, Dublin, Ireland*
[2]*University College Dublin, Dublin, Ireland*
[3]*Teagasc Food Research Centre, Dublin, Ireland*

Abstract

Seaweeds are a rich source of bioactive compounds employed as functional ingredients in food, cosmetic, nutraceutical and pharmaceutical applications. This study investigated the potential of hydro-thermal (HT), high-pressure (HP), ultrasound (US), microwave (MW) and a combination of ultrasound and microwave (US+MW) for the extraction of bioactives from *Fucus vesiculosus* brown seaweeds. Extraction solvent (50% ethanol) and time (10 min) were kept constant while extraction parameters of each technology treatment (100°C and 0.1 MPa for HT, 600 MPa for HP, 26 kHz frequency & 100% amplitude for US; 250 W power for MW, and a combination of 250 W and 26 kHz for US + MW) were selected. Crude extracts were tested for total phenol (TPC), total flavonoid (TFC), total tannin (TTC) and total sugar content (TSC) while antioxidant activity of crude extracts was determined by DPPH radical scavenging and ferric reducing antioxidant power (FRAP) methods. Extracts obtained using emerging extraction technologies exhibited significantly higher ($P<0.05$) phytochemical content and antioxidant activity compared to traditional solvent extraction. US treated samples showed the highest TPC (59.98 mg/g gallic acid equivalent) and TFC (28.63 mg/g quercetin equivalent) while HT treated samples exhibited the highest TTC (20.54 mg/g catechin equivalent) and TSC (22.57 mg/g glucose equivalent) per gram of dry seaweed. However, antioxidant activity measured in terms of DPPH and FRAP was higher in MW (17.23 mM trolox equivalent/g of dry seaweed) and US+MW (287.86 mM trolox equivalent/g of dry seaweed) treated samples respectively.

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Production of Bioactive Peptide-Loaded Double Emulsions: Influence of Emulsification Devices, Concentration of Bioactive Peptide and Type of Hydrophilic Surfactant on Droplet Stability

Yeon-Ji JO[1], Dasol CHOI[2]

[1]*University of Alberta, Edmonton, Alberta, Canada*
[2]*University of Wisconsin-Madison, Madison, Wisconsin, United States*

Abstract
The objective of this study is to formulate stable double emulsions of water in oil in water ($W_1/O/W_2$) type containing bioactive peptide (BP). The influence of the following parameters was investigated: the emulsification devices (high speed homogenizer:HSH, ultrasonicator:US, microfluidizer:MF, combined with HSH and US or MF), BP concentration (0-10%), and the hydrophilic surfactants for outer water phase (Tween 80, chitosan, and mixture of Tween 80 and mixture) on the droplet stability of double emulsions during storage periods. Double emulsions produced with different devices showed large droplet sizes in order HSH>MF>HSH+US>US>HSH+MF. For BP concentration, the droplet size of double emulsion had a range of 1.64 □m and 2.40 □m, and 0, 1, 5% BP-loaded double emulsions showed higher uniformity than 10, 20% BP-loaded double emulsions. Double emulsions stabilized by surfactant-Tween 80 layers had the best droplet stability without separation, but lower BP retention than the other outer stabilizers. Whereas, double emulsions stabilized by surfactant-chitosan layer had positively charged droplets and thick membrane of the outer layer. Especially, double emulsion stabilized by surfactant-mixture of Tween 80 and chitosan showed bi-modal size distribution without interaction on each Tween 80 and chitosan. The information obtained from this study is useful for preparing stable functional food or cosmetic products from double emulsions using BP.

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Seaweed and sweet potato: key ingredients for promoting a healthier diet in processed foods

Gonçalo COSTA[1], Susana **MENDES**[1], Frederica SILVA[1], Maria M GIL[1]
[1]*MARE – Marine and Environmental Sciences Centre, ESTM, Politécnico de Leiria, Peniche, Portugal*

Abstract

For several centuries, there has been a traditional use of seaweeds as food in Asian countries. More recently, consumption has recently been disseminated as functional food in western countries because seaweeds have been highlighted as an excellent source of biologically active compounds such as dietary fibers, essential fatty acids, minerals, vitamins and phenolic compounds. Not only the interest in seaweed has been increasing, but also the interest and consumption of sweet potatoes. Sweet potatoes are high in fiber, vitamin C, potassium, pantothenic acid (vitamin B5), niacin (vitamin B3), vitamin B6, manganese, magnesium, and copper. When compared to white potatoes, *they also have a mildly lower glycemic index score.* This makes them slower to digest. The aim of this work was to design a new food product combining *Himanthalia elongata* seaweed (class Phaeophyta or Phaeophyceae) and sweet potato (*lira* variety) – a healthy seaweed mashed sweet potato (lactose free and no added salt). Response surface methodology was used to investigate the effects of the independent variables (*Himanthalia elongata* and rosemary concentrations) and to determine the optimum level on sensory properties (namely, appearance, colour, aroma, texture, taste and sea flavour). For each response, second order polynomial models were developed using multiple linear regression analysis. The optimum values for *Himanthalia elongata* and rosemary concentrations were 0.94 and 0.04 (g/100g), respectively, showing that seaweeds can be used for salt replacement. The product acceptance by the consumers was evaluated by focus group. The participants classified the product, in general, as being easy to prepare and with pleasant taste.

Keywords: Development of new products; seaweeds; sweet potato; salt free; healthy mash; response surface methodology

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The development of adaptive response in *E. coli* O157:H7 associated with UV and GA-based antimicrobial treatments

Qingyang WANG[1], Rohan V. TIKEKAR[1]
[1]*Department of Nutrition and Food Science, University of Maryland, College Park, USA*

Introduction: Foodborne pathogens can develop adaptive responses toward the sublethal stresses encountered in the environment, affecting the inactivation efficacy of following food process interventions.
Purpose: The purpose was to investigate the development of adaptive response of *E. coli* O157:H7 towards two GA and UV light-based treatments on exposure to sublethal environmental stresses.
Methods: E. coli O157:H7 stationary growth-phase cells (37 ^{0}C, 22h) were exposed to sublethal stresses including heat (42 ^{0}C, overnight), acid (pH 4.5 by glucose fermentation, overnight), NaCl (4.5%, 3h), and H_2O_2 (0.2 mM, 3h). Then, the bacterial cultures were treated either simultaneously by GA and UV-A light (UVA+GA), or by GA with an enhanced antimicrobial activity by previous UV-C light irradiation (UVC-GA).
Results: E. coli O157:H7 with previous exposure to heat stress showed significantly ($P < 0.05$) lower sensitivity to subsequent antimicrobial treatment of either UVA+GA (1.27±0.20 fold) or UVC-GA (3.51±0.41 fold) treatments compared with controls. On the contrary, bacteria pre-exposed to NaCl and H_2O_2 showed increased sensitivity towards both UVA+GA and UVC-GA treatments. Interestingly, pre-exposure to acid due to overnight fermentation of glucose induced resistance of bacteria towards UVA+GA treatment ($P < 0.05$, 2.04±0.26 fold), but sensitivity towards UVC-GA treatment ($P > 0.05$, 1.38±0.53 fold). Production of enzymes and general stress response regulator were likely to be associated with the adaptive response development.
Significance: Common stresses encountered during food processing and environment could confer cross-stress response in *E. coli* O157:H7. Sublethal conditions should be considered when assessing the microbial safety of non-thermal food processing technologies.

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Effect of power ultrasound on skim milk coagulation kinetics

Bhavya PANIKUTTIRA[1], Norah O'SHEA[2], Noel MCCARTHY[2], John TOBIN[2], Brijesh K TIWARI[3], Colm P O'DONNELL[1]

[1] *University College Dublin, Dublin, Ireland.*
[2]*Teagasc Food Research Centre, Moorepark, Fermoy, Co.Cork, Ireland.*
[3]*Teagasc Food Research Centre, Ashtown, Dublin, Ireland*

Power ultrasound is a novel non-thermal technology that can be employed for a range of food processing applications. The objective of this study was to investigate the effect of power ultrasound on the coagulation properties of unpasteurised skim milk. Unpasteurized skim milk was treated with ultrasound (67 W, 20 kHz) for 5 and 10 min treatment times and subsequently stored for 24 hours at 5 °C. Ultrasonicated samples were evaluated after treatment and after 24 hours storage. Non-ultrasonicated skim milk was used as control. The *tcut* (time required for renneted milk to reach a storage modulus (G′) of 20 Pa) was recorded using oscillatory control stress rheometry. Casein micelle size, pH, zeta potential and SDS PAGE measurements were carried out on all samples. Samples sonicated for 5 and 10 minutes resulted in *tcut* of 34.2 and 32 min respectively compared to control (37 min, $P < 0.05$)). However, after cold storage there was no significant effect on *tcut* observed between ultrasonicated and control samples (38 min; $P > 0.05$). This study indicated that sonication induced changes had a temporary effect on the coagulation properties of skim milk. It can be concluded from this study that ultrasonication is a potential pre-treatment which may be employed to increase skim milk coagulation kinetics in rennet casein and cheese manufacture.

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Role of bacterial cellulose fibrils on the retrogradation of starches with different amylose content

Belén ASTORGA[1], Daniela MEDINA[1], Javier ENRIONE[1,2], **Paulo DIAZ-CALDERON[1,2]**

[1] *School of Nutrition and Dietetics, Faculty of Medicine, Universidad de los Andes, Chile.*
[2] *Biopolymer Research & Engineering Laboratory (BIOPREL), School of Nutrition and Dietetics, Faculty of Medicine, Universidad de los Andes, Chile.*

Bacterial cellulose fibrils (BCF) have been described as a biomaterial with wide applications in food engineering. The goal of this work was to perform a preliminary analysis about the effect of BCF on the retrogradation of starches with different amylose concentration.

BCF were provided by Vuelo Pharma (Brazil), which was blended with commercial wheat starch (□25% amylose) and waxy-maize starch (<0.5% amylose). Starch-BCF based gels were obtained after complete gelatinisation of starch (90ºC, 30min) and then stored at 4ºC 24h. BCF was added at concentrations between 0.5-10%w/w. Gel strength was measured using a texture analyser measuring three times with five replications. Viscoelasticity of blends starch-BCF was evaluated using a rheometer in both temperature ramp and frequency sweep considering at least five replications per condition.

Our results showed that addition of BCF conducted a significant decrease in gel strength in wheat starch but only slighltly increase in gel strength in waxy-maise at higher BCF levels, suggesting changes on the retrogradation of starch are amylose-dependent. These results are consistent with the viscoelastic behavior: presence of BCF reduced significantly the G’ in wheat starch, but only slighltly increased G’ in waxy-starch. Interestingly, the contribution of BCF on the gel viscosity (G’’) was higher in both starches which was well depicted by tan-□ parameter, with starch-BCF gels showing values higher than 1, suggesting a less crystalline system.

Therefore the addition of BCF does not promote higher association of starch polymer, which could be explained by an effect of phase separation previously reported on these same starchy systems(1).

- P. DÍAZ-CALDERÓN; B. MACNAUGHTAN; S. HILL; T. FOSTER; J. ENRIONE and J. MITCHELL. 2018. “Changes in gelatinisation and pasting properties of various starches (wheat, maize and waxy maize) by the addition of bacterial cellulose fibrils”. Food Hydrocolloids 80: 274- 280.

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Development and validation at industry scale of a fluorescence and infrared backscatter fluorescence PAT tool to monitor rennet induced coagulation kinetics of milk

Jiani LUO[1], Carlos ESQUERRE[1], Frederick PAYNE[2], Norah O'SHEA[3], Colm O'DONNELL[1]

[1]*University College Dublin, Dublin, Ireland*
[2]*University of Kentucky, Lexington, USA*
[3]*Teagasc Food Research Centre, Fermoy, Ireland*

Abstract
Coagulation of milk is one of the most important steps involved in cheese manufacture and cutting the coagulum at optimum firmness is important to optimise the yield and quality of the cheese produced. The aim of this study was to evaluate the potential of a prototype fluorescence sensor to monitor rennet induced coagulation kinetics of milk in an industry cheese plant over a 3 month period and to develop predictions model to predict the coagulum cutting time at desired storage moduli (G′). Fluorescence and infrared backscatter profiles were recorded at wavelengths of 350 nm and 880 nm respectively. Reference rheological measurements were obtained using a control stress rheometer to determine the time required for the coagulum to reach selected G′ values. A range of time parameters extracted from the optical profiles generated during the coagulation process were used to develop prediction models to determine the cutting time at which the coagulum reaches selected G′ values.
This study showed that the investigated prototype sensor, combined with developed prediction model, can be used as an inline PAT tool for real-time monitoring of milk coagulation kinetics and prediction of cutting time in cheesemaking. The technology developed also has applicants in other dairy processing applications including rennet casein manufacture and yoghurt manufacture.

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Starch-polyurethane flexible packaging films: Synthesis, compostability and application

*Nyok L. Tai[1], Isaac MATINEZ-PARDO[1], Meharan GHASEMLOU[1], Raju ADHIKARI[1], **Benu ADHIKARI**[1]*
[1]School of Science, RMIT University, Melbourne, VIC 3083, Australia

Abstract
Plasticized starch has high potential as biodegradable and compositable packaging material. It is readily available in reasonable price and comes from renewable source. Starch-based packaging can be suitable alternative of non-degradable plastic packaging in food packaging applications provided that the disadvantages associated with starch such as poor flexibility and high sensitivity to water are overcome. On the other hand, polyurethanes (PUs) are versatile polymeric materials with tunable hard and soft segments, desirable elasticity, strength and durability. Some selected formulations of PUs are known to be biodegradable and suitable as food contact materials. Their ready reactivity with starch can be used to tailor starch-PU hybrid materials which will have the advantages of both starch and PUs. Our team has developed chemically grafted (covalent bonds) and physically mixed starch-PU materials by developing entirely new PU materials and shown that these starch-PU materials are biodegradable under composting conditions and have improved flexibility and water repelling properties. This presentation provides an overview of the physicochemical characteristics of starch-PU hybrid and composite materials when used as packaging materials. This will include synthesis, physicomechanical properties, water repellence and compostability of flexible films produced from these materials. We will present the above results in the broader context starch-PU hybrid science and comment on their future prospect as packaging materials in food applications. A more recent development of non-isocyanate polyurethane (NIPU) will also be briefly considered.

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Photopolymerization by UV and Blue Light in salmon gelatin with different molecular weight

Cielo CHAR[1], Cristina PADILLA[1], Vanessa CAMPOS[1], Javier ENRIONE[1], **Paulo DÍAZ-CALDERÓN[1]**

[1]*Biopolymer Research & Engineering Laboratory (BIOPREL), Escuela de Nutrición y Dietetica, Facultad de Medicina, Universidad de los Andes, Santiago, Chile*

Fish gelatin, unlike mammal gelatin, remains liquid at low temperatures which broadens the applications when cold processing is required. For edible films and coatings it is necessary to fix gelatin on the surface which may be performed by photo-polymerization. The objective of this work was to assess the crosslinking of salmon gelatin with different molecular weight (65, 95 and 173KDa previously extracted at pH3, 4 and 5, respectively).

Suspensions were prepared at 7 and 10%w/v with the addition of 0.025%w/w of riboflavin as photoinitiator with/without pH adjustment (pH8) and exposed to UV (360nm) or blue light (BL, 450nm) for 2 min. The rheological behavior, thermal properties by DSC and permeability by DVS were determined.

Lower Mw gelatins presented lower viscosity and G' than higher Mw gelatins. The UV notoriously increased the G' of the 7% suspensions, mostly to the higher Mw gelatins without further increase at pH8. However, the BL worked better at pH 8, increasing the G' of the suspensions. Low Mw gelatins (pH3) increased the G' only with UV; however, increasing the concentration to 10% and pH8 favored the polymerization of this gelatin with BL. The observed behavior was consistent with the higher Tºgelling for gelatins crosslinked by UV, whereas BL increased its effect at pH8 independently from gelatin Mw. The permeability was lower for samples polymerized by UV.

In conclusion, the UV and at a lower extent the BL, promoted the photopolymerization of gelatin using riboflavin. BL increased the effectivity at pH8 and higher gelatin concentration.

Sprayable Biodegradable Polymer Membrane for Agriculture Systems

Raju ADHIKARI

CSIRO Manufacturing, Bayview Avenue, Clayton South, VIC 3169, Australia

Plastics have been widely used as a mulch film to reduce soil evaporation, promote germination, increase crops yields. The future legislation is likely to the phase out of LDPE and oxo-biodegradable plastics due to their non-degradable nature and associated toxicity. Biodegradable, bio-based and compostable plastics are therefore viewed as more attractive alternatives. Recently, sprayable polymeric coatings have received increased attention due to their versatility and ease of application.

We have recently reported[1] a novel water-dispersible sprayable polymer formulation (PF) with high membrane efficacy for reducing soil evaporation. Our pot experiments have shown reduced soil water evaporation compared with bare soil (Figure 1). The PF is stable at ambient temperature and can be sprayed using existing farm equipment.

A field trial on using an optimized PF showed that the polymer membrane treatment maintained approximately the same crop yield compared to the bare soil control, but used 28% less irrigation water. We also have developed a black pigmented formulation in the PF to aid in weed suppression.

I will present an overview of physico-mechanical and degradation properties of our novel water dispersible sprayable biodegradable polymer membrane and discuss results of pot and field trials with emphasis on soil water evaporation and weed control.

- Adhikari, R., Casey, P., Bristow, K.L., Hornbuckle J., and Freischmidt G., 2015. Sprayable polymer membrane for agriculture. TW8842/WO-05102015, 1029531.

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MEGASONIC-ASSISTED AQUEOUS EXTRACTION OF CANOLA OIL FROM CANOLA CAKE

Mohammed A. Fouad M. Gaber[1, 2], Francisco J. Tujillo[1], Maged Peter Mansour[2], Pablo Juliano[2]*,
[1] School of Chemical Engineering, The University of New South Wales, Sydney, NSW, Australia
[2] CSIRO Agriculture and Food, Werribee, VIC, Australia

Abstract

The canola oil industry is interested in avoiding the use of hexane to recover the residual oil in the cake obtained from expeller pressing. Megasonic-assisted aqueous extraction was explored as an innovative alternative to cake oil extraction with hexane through parameter optimisation. Pressed canola cake was milled, dispersed in water, and treated with high frequency ultrasound (megasonics). The process parameters frequency (0.4, 1, and 2 MHz) sonication time (10, 20, and 30 min), solids concentration (10, 20, and 30 %) and temperature (60, 70, and 80 °C) were evaluated through a regression model. The model indicated that extraction of a 10% cake solids dispersion (w/w, solid loading) with 2 MHz frequency and 122.4 kJ/kg at 80 °C for 30 min, provided maximum oil recovery of nearly 50 % of the residual oil in the pressed meal, while nearly 4% oil was recovery without ultrasound. An aqueous-based emulsion breaking consisting of sodium chloride addition was then evaluated at the same conditions without and with ultrasound, giving a net ultrasound yield improvement of 31.8% (g oil/100 g dry cake) and a net efficiency of 30.6% (g oil/100 g oil in cake), when compared to the non-ultrasound control. The oil obtained after megasonic-assisted aqueous extraction at optimum conditions complied with the industrial standard values for free fatty acids, peroxide value, and chlorophyll. The current technology proposes a novel alternative for oil recovery while avoiding the use of toxic solvents.

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A continuous alginate microencapsulation technique- an innovative technology

Bhesh BHANDARI

University of Queensland, St Lucia, Queensland, Australia

An impinging aerosol process was developed to produce the alginate microgel particles in a continuous mode. In this process, two opposite streams of solutions of sodium alginate and divalent cationic cross-linking agent (eg. $CaCl_2$) are air atomised in a chamber where the mixing of alginate droplets and cross linking agent takes place. The atomised droplets of both streams are in micron size (mean size of around 30 micrometers). The micron size of both streams facilitates rapid contact and diffusion of cross linking agent in the interior of the alginate droplets avoiding longer time for complete gelation. The microgel particles are recovered at the bottom of the chamber as a suspension. This novel continuous process (patented) contains no movable parts and both streams can be atomized by using air or pressure nozzle. It is possible to mix any particulate compounds and solutions with the alginate solution for encapsulation. This includes food and pharmaceutical active ingredients. The active compounds are entrapped in alginate gel matrix during its gelation in the reaction chamber. The food ingredients successfully encapsulated are fish oil, probiotics, lactoferrin and microalgae. The pharmaceutical drugs such as ibuprofen has also been successfully encapsulated by this method. The encapsulation allows to mask the off flavor and taste and also to achieve targeted delivery of active compounds in the digestive tract. A wide range of application of this technology to encapsulate bioactive compounds is expected.

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Thermoplastic starch films modified with polyhedral oligomeric silsesquioxanes hybrids

Isaac PARDO[1], Benu Ahikari[1], Robert SHANKS[1], Raju ADHIKARI[1].

[1] *Royal Melbourne Institute of Technology, Melbourne, Australia*

Abstract
Thermoplastic starch (TPS) films appear as an alternative to petroleum-based materials. However, their water resistance needs to be improved and its rheological characteristics are difficult to model. Our approach to improve its water repellence was to create surface localized hydrophobicity using tailored nano-silica hybrids. Some hybrids were synthetized via a click reaction between mono epoxy substituted polyhedral oligomeric silsesquioxane (POS) with either Erucamide or Jeffamine.
The thermorheologically complex behavior of the TPS films was confirmed. In principle, construction of master curves for rheologically complex materials must be avoid. However, based on properties predicted by the Arrhenius and Williams–Landel–Ferry (WLF) models, we were able to establish temperature constraints where the time-temperature principle was valid.
To construct the master curves, we propose an integrational method. Also using synthetic simultaneous multifrequency scans we avoid intrinsic temperature control variances which allow us to better predict Tg and Tm. Using the temperature constrains we propose generalized time–temperature superposition models for rheologically complex materials.
In most of the films the water resistance of the films was increased by the hybrids. We found that wettability kinetics of the films were function of two distinct mechanisms, each with independent linear behavior. Using the rheology models, we conclude that addition of POS increased the internal ordering of the TPS films, leading to more compact molecular arrangement, made the films more resilient to deformation.

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A remote monitoring APP implemented in a light-weight shrimp peeler

Yi-chich CHIU[1], Ting YANG[1]
[1] *National Ilan University, Yilan, Taiwan*

Abstract

The objective of this research was to develop a remote monitoring APP implemented in a light-weight shrimp peeler. The light-weight shrimp peeler can be divided into five units: shelling, squeezing, cleaning, driving and discharging unit. The control parameters of the best peeling rate were obtained by the three kinds of shrimp in Whiteleg shrimp, Mino Nylon shrimp and Spear Littoral shrimp. In line with the development trend of Internet of Things and Industry 4.0 to develop an APP, which can be remotely monitored. Using the Android operating system of the smart phone as a controller, combined Raspberry Pi, Wi-Fi and webcam in embedded system to achieve remote monitoring capabilities, so that users can solve the emergency situation in remote locations.

A prototype of shrimp peeler has been developed in this research with the dimensions of 890 mm in length, 560 mm in width, and 920 mm in height. The prototype must be operated as one person. The experimental results showed that 73.7±2.4% in peeling rate, can process 12.9±1.5kg per hour for Whiteleg shrimps and 85.7±2.1% in peeling rate, can process 13.4±0.4kg per hour for Spear Littoral shrimp. Besides, the peeling rate of Mino Nylon shrimp is 81.6±1.9%, can process 21.5±0.9kg per hour. After the statistical analysis to find out the best control parameters and put in the APP. The Whiteleg shrimp for the swing frequency is 90 times/min, with the rotating roller 145 rpm; the swing roller frequency is 90 times / min, with the rotating roller 115 rpm for Mino Nylon shrimp; the swing roller frequency is 90 times / min, with the rotating roller 135 rpm for Spear Littoral shrimp. Therefore, users can choose shrimp options directly by phone and achieve the best peeling effect. Also it can solve the problem in times of emergency.

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Radiofrequency tempering of frozen blocks of cod

Svein Kristian STORMO, Torstein SKÅRA

Nofima, Tromsø, Norway

Abstract

During thawing of frozen blocks of fish, high temperatures are frequently used in the first stage. However, this can have detrimental effect on quality after thawing. The use of radiofrequency (RF) waves to temper frozen food is increasingly used, but uneven heat distribution due to irregular shape and low penetration (thermal runaway) may limit its use. The aim of this study was to examine the effects of different RF-processing conditions by monitoring how heat distribution and liquid loss progresses in a combined RF and water thawing procedure for frozen cod.

Blocks of vacuum packed, frozen cod samples were subjected to RF tempering prior to subsequent temperature equalization in cold water (0-2□C) for 18 hours. The control thawing process was water thawing at 6□C followed by equivalent temperature equalization in cold water. Thawing loss, drip loss during storage and hyperspectral monitoring was used to evaluate the process.

Results show that the RF energy was distributed evenly in fish block samples. The regular shape in combination with adequate shielding of the edges and corners effectively prevented local areas of overheating. When the thawing progress contained RF tempering in the first part of the process, the resulting thawing loss was reduced compared to using water throughout the whole process. Carrying out parts of the temperature equalization process in sea water further significantly decreased the drip loss through the thawing progress. Hyperspectral data clearly separated the two treatments, and this technique shows promise for additional understanding of fundamental changes in the thawing process

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Effect of High Pressure Homogenization and autolysis on the recovery of beta-glucans from yeast cell walls

George DIMOPOULOS, Varvara ANDREOU, **Petros TAOUKIS**
School of Chemical Engineering, National Technical University of Athens, Athens, Greece

Cells of the yeast *Saccharomyces cerevisiae* are the source of several compounds valuable to the food industry. Through the process of autolysis, the endogenous cellular enzymes break down the cell's macromolecules and release peptides and amino acids, producing yeast extract. The residue of the process of autolysis, the insoluble cell wall fraction of the cell is rich in polysaccharides mainly beta-glucans. Nonthermal technologies such as High Pressure Homogenization (HPH) increase the loss of intracellular materials during autolysis by increasing cellular disruption and thus have the potential of enriching the insoluble fraction in beta-glucans by enhancing loss of protein to the soluble extract. The aim of this work was to investigate the potential of using HPH to improve the yields of autolysis in terms of cell wall beta glucan.

In this study different HPH conditions (200-800 bar, 1-3 passes) were applied on yeast cell suspensions. Suspensions were then autolyzed and the progress of autolysis was monitored based on released protein, total solids, amino acids and carbohydrates. Moreover, the content of beta-glucans was determined in the insoluble cell wall fraction of autolysis.

The yield of the soluble extract was increased for all conditions studied, reaching an increase of up to 50%. In terms of the total glucan content, the process of autolysis alone causes an increase from 13% to 22% per dry weight after 48 h. HPH treatment led to an increase of beta-glucan content from 22% up to 30% at 48 h of autolysis.

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Impact of shelf life models kinetic parameter uncertainty on predictions and management of the frozen fruits and vegetables cold chain

Maria C. GIANNAKOUROU[1], **Petros S. TAOUKIS[2]**

[1]*Department of Food Science and Technology, University of West Attica, Athens, Greece*
[2]*National Technical University of Athens, School of Chemical Engineering, Laboratory of Food Chemistry and Technology, Greece*

Abstract

Published findings on kinetic data of deterioration of frozen food mainly refer to measurements of selected quality parameters at a reference frozen storage temperature at limited time points (e.g. 6 and 12 months). However, in order to be able to predict the frozen system behavior under the real, dynamic conditions of the cold chain, systematic kinetic modeling is required. Additionally the uncertainty of model parameters should be accounted for realistic shelf life estimations. Other factors that affect chemical reaction rates, such as ice formation and the evolution of a concentrated unfrozen phase which can be in a liquid, rubbery, or glassy state depending on the storage temperature of the frozen foods. One cannot overlook this complexity that influences the kinetics of quality loss during storage. Despite the importance of T_g' theory and its practical implication, the "apparent kinetics" methodological approach is most frequently used.

The aim of this work is to provide a critical assessment based on metadata analysis of the literature information on quality loss modeling of frozen foods. Common quality indices are reviewed, fundamental methodologies used to build kinetic models are assessed, and alternative approaches to improve practical applications are proposed. The main goal is to introduce the calculated uncertainty of models' parameters when assessing the remaining shelf life of the product at any point within the cold chain. This can be accomplished by implementing a stochastic approach, through a Monte Carlo scheme, and the results demonstrated the improved predictions obtained, with broader and more realistic confidence intervals.

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Milk Protein Based Encapsulation of Bioactive Components and Nutrients

Bimlesh MANN, Rajan SHARMA, Rajesh KUMAR, Ravi TANWER and Ankita HOODA
ICAR-National Dairy research Institute, Karnal, India

During last one decade researchers in the food science have been focusing on the design of new delivery system for incorporation of bioactive and nutrient into functional foods. There are number of key issues associated with incorporation of these molecules in the foods such as their physical and chemical stability in food system, interaction with other food components, solubility and dispersability which in turn affect their bioavailability and bioactivity. Encapsulation in the food industry may be used to protect bioactive components against degradation on various environments (e.g., high temperature, oxygen, extreme pH), avoid their undesirable interactions with other food components, mask undesirable flavors, and control their release at the desired time and site, and increase bioavailability. The demand for encapsulated food ingredients continues to grow as the food industry seeks to maximize the intended benefits of bioactive components delivered through foods. Formulating encapsulated food ingredients is challenging as the food industry is limited to the use of food grade and generally regarded as safe (GRAS) materials as encapsulants. Protein based delivery system is gaining momentum because of their specific structure which further determines their functionality. Milk proteins (e.g., whey proteins, caseins, milk protein isolates, and hydrolyzed milk proteins) are effective encapsulating materials for bioactive components because their good functional properties like solubility, emulsifying, viscosity building and gelling, and film-forming properties that make them suitable to be formulated with a wide range of bioactives and processed into encapsulated food ingredients with the required properties. The film-forming and emulsifying properties of milk proteins are employed to stabilize emulsion-based encapsulation systems and their ability to form gel can be used to entrap the bioactive components. Hence, dairy proteins are highly valued ingredients in the food industry and perform multifunctional roles when used in functional food applications.

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Re-Engineering Bachelor's Degree Curriculum in Food Engineering: Hypothesis and Proposal

Keshavan NIRANJAN[1]

[1]*University of Reading, Reading, United Kingdom*

Abstract

Food Engineering discipline ought to be at the heart of strategic innovation within food manufacture – which typically constitutes 25-30% of the manufacturing GDP of most countries. Unfortunately, this discipline is not playing its rightful role today: engineering has been relegated to play the role of a service provider to the food industry, instead of it being a strategic driver for the very growth of the industry. At a level of education and training, we find that the current scope and subject-knowledge competencies of food engineering are inadequate to meet the challenges faced by food manufacturers. This paper identifies: a) health, b) environment and c) security as the three key drivers of the discipline, and proposes a new definition of food engineering. This definition requires food engineering to have a broader science base which includes biophysical, biochemical and health sciences, in addition to engineering sciences. This definition, in turn, leads to the discipline acquiring a new set of subject-knowledge competencies that is fit-for-purpose for this day and age, and hopefully for the foreseeable future. The possibility of this approach leading to the development of a bachelor's degree program in food engineering is demonstrated by adopting a theme based curriculum development with five core themes, supplemented by appropriate enabling and knowledge integrating courses. At the heart of this theme based approach is an attempt to combine engineering of process and product in a purposeful way, termed here as Food Product Realization Engineering.

Spray-drying as an encapsulation process to protect lactic acid bacteria IN ENZYME PRE-TREATED MILK PROTEIN MATRIX

Claire GAIANI[1,2], Jennifer BURGAIN[1], Bhesh BHANDARI[2], Joël SCHER[1], Jeremy PETIT[1]

[1]*Université de Lorraine, Vandœuvre-lès-Nancy, France.*
[2]*University of Queensland, St. Lucia, Queensland, 4072, Australia.*

Abstract

A water-insoluble matrix to encapsulate *Lactobacillus rhamnosus* GG (LGG), a probiotic bacteria, by spray-drying was developed. The influence of matrix composition and air temperature on powder properties and bacterial survival rate was investigated. The feed solution was composed of LGG and milk proteins that were subjected to the action of a proteolytic enzyme. Different outlet air temperatures were tested.

All drying conditions led to high bacterial survival rates. Matrix composition and outlet air temperature controlled powder moisture content and rehydration properties. Only an elevated outlet air temperature allowed the production of microparticles with moisture content suitable for ensuring storage stability. Powder solubility decreased, owing to formation of water-insoluble particles, when the concentrate was subjected to the action of enzyme.

Then, the water rehydration properties of these microparticles were evaluated at 8 and 40 °C by standard rehydration protocols, Turbiscan measurements and scanning electron microscopy of particles during their reconstitution. Two behaviours were observed depending on water temperature. At 40 °C, microparticles remained compact and their solubility was low, hence bacteria stayed embedded inside the microparticles. At 8 °C, their solubility was greater since the powder was able to rehydrate, thereby releasing the bacteria in the medium. This temperature-sensitive reconstitution behaviour resulted from the action of enzyme in the feed solution prior to spray-drying. The enzymatic cleavage of milk proteins by enzyme before atomisation led to matrices presenting innovative functionalities when microparticles are reconstituted with water: solubilisation in cold water (8 °C) or dispersion in warm water (40 °C).

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Biopolymer applications in agriculture and packaging

Peter HALLEY[1], Bronwyn LAYCOCK[1], Paul LUCKMAN[1], Brenton FLETCHER[1]

[1]*Chemical Engineering, University of Queensland, Brisbane, Australia*

Abstract
This presentation will review the use of tailored biopolymers for use along the food chain, from agricultural mulch films through to food packaging. The presentation will highlight the integration of fundamental research with product development research to produce a successful long term research program leading to new technical innovations, products and start-up companies. The importance of understanding material properties, processing and scale-up will be highlighted.

ICEF13 ABSTRACT TEMPLATE

Future of agrifood industry and digital technologies that will disrupt it

Ingrid APPELQVIST[1,2], Hester DE WET[1], Roman BUCKOW[2], Amy LOGAN[2], Nicholas ARCHER[2]
[1]*Aurecon, Sydney, Australia*
[2]*CSIRO, Melbourne, Sydney, Australia*

Abstract
The global agrifood industry is a $5 trillion business and with world population growth estimated to reach 8.5 billion by 2030, it will need to at least double in size to feed everybody with adequate nutrition. The agrifood industry will be greatly impacted by global megatrends including digital immersion, which for many earmarks the 4th Industrial revolution. Industry 4.0 uses transformative technologies to connect the physical world with the digital world and includes advanced automation and robotics, sensor technology and data analytics, machine-to-machine and human-to-machine communication in manufacturing technologies. This paper will briefly discuss the megatrends and their impact on the future of the agrifood industry, identify new manufacturing technologies that are emerging and will debate how digitalisation and automation will transform and benefit the agrifood sector. Finally, the paper will highlight the advantages of integrating digital technologies into agrifood operations and production/manufacturing processes through a case study and how adoption of advanced manufacturing such as additive manufacturing, machine learning and automation, will change the agrifood landscape in the future.

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Obtaining and characterization of mango peel powder, as a functional ingredient and dual additive added in natural yogurt.

Carlos RUIZ [1] Caribbean Biotechnology Center - SENA / Regional Cesar, Valledupar – Colombia

The purpose of this research work was to obtain and characterize mango peel powder of hiliza variety (Manguifera Indica L.) and its use as a functional ingredient and dual additive. Healthy and mature fruits, with their characteristic color (yellow), of hiliza variety were used. The fruits were washed and peeled; the husks were placed in a tray and introduced in a BINDER VD 53 dryer, at an average temperature of 70ºC for 24 hours, the dehydrated husks were crushed in an IKA A 11 blade mill, then the sample was taken to a 125 μm sieve for obtaining the powder, then physicochemical analysis was carried out obtaining the following results: Humidity 2.24%, fat 0.24%, protein 1.82%, neutral fiber 10.35%, ash 4.23%, acidity 4, 82% citric acid, pH 4.69, ascorbic acid 0.032%, reducing sugars 14.25% and starch 12.80%.,We evaluated the organoleptic, physicochemical and microbiological characteristics of the yogurt for 35 days, which gave us an initial pH of 4.5 on the first day and on day 35 the pH was 4.3, indicating a variation of 2 points on the scale potentiometric. The yogurt elaborated with the mango husk presented some pleasant sensory characteristics, with mango flavor, characteristic color and a yogurt useful life about 35 days.

Key Words: Powder, Cascara Mango, Dried, Fiber.

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Pulsed-UV light treatment for inactivation of ***Salmonella*** on black peppercorn

Yen-Con HUNG[1], Jing XIE[1]

[1]*Department of Food Science and Technology, University of Georgia, Griffin, USA*

Abstract

Black peppercorn, which is one of the most frequently consumed spices in the US and has been associated with several outbreaks related to *Salmonella* spp. Pulsed UV (PUV) could be used as a nonthermal, residue-free treatment to reduce *Salmonella* on peppercorn surface. The objectives were to examine the effectiveness of using PUV to reduce *Salmonella* on black peppercorn and to examine the factors such as surface exposure and the addition of cooling time during continuous treatment on *Salmonella* reduction on black peppercorn.

Black peppercorns artificially inoculated with *Salmonella* were subjected to PUV treatment (0.2819 J/cm^2/pulse). Effect of surface exposure to PUV was studied by placing peppercorns on two different surfaces, traditional flat surface or the surface with wave shape which was designed to increase surface exposure of peppercorn to PUV. The temperature change on black pepper surface during treatment was recorded, and the addition of cooling time during continuous treatment was studied. PUV treatment for 2 pulses reduced *Salmonella* by more than 6 log CFU/ml in pure culture. Continuous PUV treatment (80 pulses on both sides of peppercorn) using wave shaped surface was able to reduce *Salmonella* by 1.9 log CFU/g; while the same treatment using flat surface reduced *Salmonella* by less than 1.5 log CFU/g. The temperature on peppercorn surface increased to 40 °C and 65 °C after 20 and 80 pulses, respectively. Adding cooling time at every 20 pulses did not significantly affect *Salmonella* inactivation (P>0.05).

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Elaboration of coastal type cheese added with Lactic Bacteria (BAL) and yeasts isolated from artisanal cheeses sold in the municipality of Valledupar Cesar and neighboring districts.

[1]**Carlos RUIZ,** [2]Carlos OSORIO
[1] National Apprenticeship Service (SENA) / Regional Caribbean Biotechnology Center Cesar,
[2] Autonomous Corporation of Cesar / Colombia, Valledupar

The purpose of this study was to elaborate coastal type cheese adding Lactic Bacteria (BAL) and yeasts isolated from traditional coastal cheeses, in the SENA CBC food plant, 10 different treatments were evaluated with the strains, the production process kept all the principles industrial processing.
The evaluation of microbiological, physicochemical and organoleptic characteristics of all the processed cheeses was carried out for 5 weeks, taking into account the current regulations. In addition, Escherichia coli was determined in the cheese samples.
The study allowed determining if there is a relationship between the yeast activity and the formation of dimples, smell, taste and texture of the cheeses. The production process was standardized for the production of pilot-scale coastal cheeses for 100 liters of milk.
It was determined that the clotting time of the curd with respect to the control decreased by 40%, contributing to a greater dynamism of the process and to decrease the production times. The best treatments according to the results of the organoleptic tests were T1, T2 with acceptance level of 72% and T3 with 100% acceptance, the latter being the best of all.

Key words: Saccharomyces cerevisiae, microbiological quality, artisan cheeses, organoleptic characteristics, shelf life.

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Multifunctional Biopolymer-Based Nanocomposite Films for Food Packaging Applications

Jong-Whan RHIM Shiv SHANKAR
Department of Food and Nutrition, BioNanocomposite Research Center, Kyung Hee University, 26 Kyungheedae-ro, Dongdaemun-gu, Seoul 02447, Republic of Korea

Concerns about environmental pollution caused by non-biodegradable petrochemical-based plastic packaging materials and consumer demand for high quality food products have increased interest in developing biodegradable packaging materials that use annually renewable natural biopolymers such as polysaccharides and proteins. However, the inherent disadvantages of natural polymer-based packaging materials, such as low mechanical properties and somewhat hydrophilic properties, are leading to major limitations for their industrial applications. One of the ways to solve the problem of bio-polymeric films is to develop nanocomposite films by combining nano-sized fillers such as nanoclays, nanometals or metal oxides, and organic fillers like cellulose or chitin nanocrystals. Polymer nanocomposites have significantly improved packaging properties due to nanometer-sized dispersion. These improvements include increased mechanical strength, reduced gas permeability, and increased water resistance. In addition, some nanoparticles-incorporated bio-nanocomposite films exhibit additional functional properties such as antimicrobial, antioxidant, and UV-light barrier properties. As a result, natural bio-polymer-based nanocomposite packaging materials with bio-functional properties have great potential for active food packaging applications.

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Engineering coffee aroma: the steam stripping of roast and ground coffee for instant coffee manufacture

David BEVERLY[1,2], Peter FRYER[1], Serafim, BAKALIS[3], Estefania LOPEZ-QUIROGA[1], Robert FARR[2]

[1]*School of Chemical Engineering, University of Birmingham, Birmingham, United Kingdom*
[2]*Jacobs Douwe Egberts R&D, Banbury, United Kingdom*
[3]*Faculty of Engineering, University of Nottingham, United Kingdom*

Abstract
Aroma is a major factor in consumer satisfaction when drinking coffee. Hundreds of compounds have been identified in coffee, spanning various chemical groups and aromatic 'notes' in the beverage. In instant coffee manufacture, aroma is extracted from roast and ground coffee, to be added back before the final drying stage, preventing evaporative and thermal losses upstream. One means of aroma extraction can be the steam stripping of a bed of wetted coffee grains to produce an aromatic condensate. We present experimental results from a lab-scale version of the process in addition to a finite difference model of mass transfer processes occurring.

The mathematical model breaks the process into four stages; bound aroma release, intra-particle diffusion, liquid-gas transfer and gaseous advection. For a water-saturated coffee bed, the model predicts different rate-limiting steps based upon physical-chemical properties, namely, octanol-water partition coefficients and Henry's constants. Aromas are either diffusion-limited, water to gas transfer-limited or limited by release from the coffee oil.

Experimental results also display varied extraction behaviour depending upon aroma chemistry, but the extraction rate is also influenced by process conditions including the addition of water to coffee and particle size.

This work demonstrates some of the factors governing aroma extraction from coffee via steam stripping. It suggests how process variables can be controlled to favour extraction of specific groups of aromas more than others, and, thus, control the sensory impact of instant coffee products.

Evaluation of barley malt rootlet extracts as natural antioxidant to inhibit lipid oxidation in corn oil

Sravanthi Budaraju*, Kumar Mallikarjunan**
*Graduate Research Assistant, Food Science and Nutrition, University of Minnesota, **Professor, Food Science and Nutrition, University of Minnesota

Barley Malt Rootlets (BMR), are germs appearing during the malting process that are separated and discarded after the malting process. Studies on BMR have shown that, these are significant source of antioxidant phenolic compounds. Currently, these are used as low value by-product feed for animal supplement. Thus, extracting phenolic compounds and studying their antioxidant activity not only provides food industries with natural source of antioxidants but also generates income. Thus, the current research aims to study the functionality of BMR extracts to prevent lipid oxidation in frying oil.

The antioxidant activity of BMR extracts at various concentrations (25ppm, 50ppm, 100ppm, 150ppm) in frying corn oil (185^{o}C for 5hrs) was evaluated. Antioxidant phenolics extracted using conventional solvent extraction (CSE), microwave assisted extraction (MAE) and by autoclave pretreatment were used. The total phenolic content and antioxidant activity of the extracts was measured. The oxidation process was followed by measuring the formation of secondary oxidation products for every hour using TBARS assay in terms of MDA equivalents (µg. ml^{-1}). The potential of the BMR extracts were compared to synthetic antioxidant BHT.

A two-way analysis of variance and Tukey-test were used to establish the significance of differences among the mean values at 0.05 significance level using JMP PRO'13 software to monitor the combined effect of various extracts on MDA equivalents and kinetics of lipid oxidation.

The results showed that, the model was significantly different (p<0.05) for all the concentrations considered for the study. It was observed that, all the data was significantly different for all the extracts chosen. Among the free phenolic extracts, autoclave pre-treated extracts exhibited highest inhibition followed by MAE extracts. Whereas, for bound phenolics MAE exhibited highest inhibition followed by autoclave and CSE extracts. These results show that, thermal treatments can increase the antioxidant potential of the phenolic extracts. In the current study, free phenolics exhibited better activity than bound phenolics. Results also showed that the changes in lipid oxidation follow first-order reaction kinetics.

These results demonstrate that, BMR could be an abundant source of natural antioxidants suitable for further development into dietary supplements and various food additives.

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3D laser scanning as a novel method for measuring heat shrinkage of meat

Rozita VASKOSKA[1]*, Minh HA[1], Ha Thi Thu TRAN[2], Kourosh KHOSHELHAM[2], Jason D. WHITE[1,3], Robyn D. WARNER[1]

1 School of Agriculture and Food, Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Parkville, Victoria, Australia
2 Department of Infrastructure Engineering, University of Melbourne, Parkville, Victoria, Australia
3 Charles Sturt University, Wagga Wagga, New South Wales, Australia

Abstract

Shrinkage during heating of meat is accompanied by irregular changes in the shape of the meat, due to the varying distribution of connective tissue and extracellular spaces. Conventional 2D based volume estimation based on caliper measurements does not account for the irregularity in the shape of heated meat cuboids. We propose 3D terrestrial laser scanning as a method to provide (a) 3D reconstruction, (b) volume estimation and (c) volume shrinkage estimation, of meat cuboids. Cuboid samples were obtained from pork loins (*longissimus lumborum*, n=12) and they were heated at 50, 60, 70 or 80°C. A front, rear and base scan of each cuboid before and after heating was obtained with a 3D terrestrial laser scanner; the scans were segmented and registered and the reconstructed 'point clouds' were used for the estimation of volume. Conventional caliper measurements were also taken on each dimension of the cuboid before and after heating and the volume was calculated. 3D laser scanning resulted in 20 % greater volume estimates than caliper measurements. Volume shrinkage estimates obtained from the laser scanning and caliper measurements were significantly different ($p<0.05$), but there was no trend evident in the differences. Samples heated to 70°C tended to show smaller shrinkage than expected across the two methods, possibly due to the intense shrinkage of meat that occurs at this temperature and therefore a more irregular shape. 3D (laser) scanning technologies should be considered by the food industry for evaluation, and quality control, of changes during food processing.

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Change of protein digestibility, protein availability, amino acids and antioxidant potential among digested fractions of raw, cooked and fermented soybeans

Sunantha KETNAWA[1], Yukiharu OGAWA[1]

[1]*Chiba University, Matsudo, Japan*

Abstract

In this study, protein digestibility and availability among three conditions of soybeans (raw; RB, cooked; CB and fermented; NB soybeans) at different stages of a simulated *in vitro* gastrointestinal digestion (G0; before digestion, G1; gastric digestion for 1 h, G2; gastric digestion for 2 h, G2I1; intestinal digestion for 1 h and G2I2; intestinal digestion for 2h) were represented. Changes in trichloroacetic (TCA) soluble peptides content, digested protein patterns, antioxidant activity and free amino acid compositions were also observed. Protein digestibility increased by increasing of digestion time, where NB showed the highest value (31.60-47.09%, G0-G2I2). Protein availability of NB and CB were comparable as 20.53-30.59% and 27.40-31.91% while stable in RB (23.43-23.70%). TCA soluble peptide yield increased around 46 and 62% in NB and CB after digestion. The soluble protein fractions of CB and NB during digestion were digested from big protein fractions into smaller protein sub-fractions observed by electrophoresis techniques whilst unchanged in RB. After digestion, all essential amino acid was found to remarkable increase, especially Arg ($p<0.05$) increase 6-fold and 49-fold CB and NB, respectively. Interestingly, antioxidant properties increased when digestion time was increased ($p<0.05$). The increment of antioxidant activity was 2-4 folds changing between G0 and G2I2. The highest antioxidant activity was found in fraction G2I2 of NB. These results indicated that fermented soybeans had better digestibility and antioxidant activity among raw and cooked conditions and may benefit human health due to an improvement in protein digestibility and availability, essential amino acids and bioactivity through digestion.

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A Study on the Risk Assessment and Safety Management of Food Pathogenic *Escherichia coli* in Meat and Meat Processing Products

Woo-Young Jung, Soo-Hwan Suh, Eun-Jeong Heo, Min-Ju Kwon, Se-Hoon Kim, Sun-Young Hwang, Chi-Yeun Cheung, Mi-Gyeong Kim, Hyo-Sun Kwak, Jin-Hwan Hong

Food Microbiology Division, Food Safety Evaluation Department, National Institute of Food and Drug Safety Evaluation, Ministry of Food & Drug Safety, 187 Osongsaengmyeong2(i)-ro Cheongju-si, Chungcheongbuk-do, Korea

Introduction: Mathematical predictive models, a major part in exposure assessment, are useful methods for microbiological risk assessment in industry for quality control and determination of shelf life. This has led to the development of growth prediction models of Pathogenic *Escherichia coli*, known in Korea as a main cause of foodborne diseases in Meat and Meat Processing products.
Purpose: The objective of this study was to develop mathematical models to predict the kinetic behavior of Pathogenic *Escherichia coli* Meat and Meat Processing products in South Korea.
Methods: Purchased Meat and Meat Processing products were cut into 10g portions. Bacterial cells were inoculated into samples to obtain 3 log CFU/g, and the samples were stored at 4, 10, 15, 20, 30 and 37°C. The number of Pathogenic *Escherichia coli* cells were enumerated on TC-SMAC (Tellurite Sefixime-Sorbitol MacConkey Agar) and BCIG (5-bromo-4-chloro-3indolyl-β-D-glucuronide) agar plates, and these results were used to develop a primary model (Baranyi) to calculate parameters (lag phase duration [LPD] and maximum specific growth rate [μmax]). Parameters were further analyzed with a secondary model as a function of storage temperature. To evaluate the accuracy of the model prediction, root mean square error (RMSE) was calculated by comparing the predicted data with observed data.
Results: LPD and μmax were calculated using a Baranyi model based on the growth at the each temperature, except 4°C where no growth was observed. The calculated parameters were then used to develop an equation for predicting temperature-dependent changes using secondary models (polynomial model for LPD and square root model for μmax). With the minimum growth temperature of 4°C (Pathogenic *Escherichia coli*), RMSEs (root mean square error) analyzed to validate the developed models in Meat will be about 0.2 to 0.3, respectively for of Pathogenic *Escherichia coli* while, Meat Processing products, analyzed RMSEs will be about 0.3 to 0.4, respectively for of Pathogenic *Escherichia coli* suggesting the models properly represent the actual growth of *Escherichia coli* in Meat and Meat Processing products**.** We are currently conducting experiments and interpreting results. At the time of poster presentation, we will complete the experiment and draw the exact results.

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The mechanism and application of ultrasound in food preservation and sterilization Abstract title

Donghong Liu [1], Ruiling Lv [1]

[1]*College of Biosystems Engineering and Food Science, Zhejiang University, Hangzhou 310058, China*

Abstract

Since discovered in 1880, ultrasound has developed for many decades, and investigation of ultrasound as a potential microbial inactivation method began in the 1960s, after it was discovered that the sound waves used in anti-submarine warfare killed fish. Also, the application of ultrasound in food sterilization has been developed.

Ultrasonic can accelerate the rate of food sterilization, thereby reducing the heat treatment time and intensity. The germicidal efficacy of ultrasound is mainly caused by cavitation. The mechanism of microbial killing is mainly due to thinning of cell membranes, localized heating and production of free radicals

Overall, combining other researchers' studies, we considered there might be two acting paths. As for cells situated closely to the valid distance of acoustic cavitation, physical destruction of bacteria involving the cell wall, cytoplasmic membrane and inner structure can be observed after ultrasound treatment. As for cells failing to enter into the area of acoustic cavitation, it might result in elevated levels of ROS in bacteria and triggered programmed cell death that exhibited characteristic features of apoptosis. In addition, there are almost no sub-lethal cell generated during the ultrasonic process, which can be considered an advantage of ultrasound over other non-thermal techniques.

The application of ultrasound is a non-thermal technology which contributes to the increase of microbial safety and prolongs shelf life, especially in food with heat-sensitive, nutritional, sensory, and functional characteristics. And ultrasound often assisted with other thermal or non-thermal sterilization methods, with a better lethal effect.

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Ultrasound-enhanced Mass Transfer in Food Processes

Yang TAO[1], Yongbin HAN[1]

[1]*College of Food Science and Technology, Nanjing Agricultural University, Nanjing, China*

Abstract

In the past few years, the influence of power ultrasound on mass transfer phenomenon during several food processes, including drying, extraction and adsorption processes has been investigated by our group continuously. The mass transfer mechanism in ultrasonic fields has been clarified both experimentally and theoretically. For the extraction and adsorption experiments, ultrasound was mainly used to improve the separation of phenolics from berry-fruit pomace. Meanwhile, a self-designed surface contacting ultrasound facility was utilized to accelerate hot-air drying of various fruits and vegetables. To explore the ultrasound-enhanced mass transfer mechanism, both methodologies of artificial neural network and numerical simulation were employed. In the case of numerical simulation of drying and adsorption, the mass transfer process was addressed as a moving boundary problem due to sample shrinkage and ultrasound induced disruption of absorbents. Besides, the influence of ultrasound on the product quality was also studied by means of different analytical methods. Overall, ultrasound is an efficient tool to enhance the mass transfer during food drying, extraction and adsorption. Experimental analysis coupled with mathematical modeling is effective to explain the mechanism about ultrasonic enhancement of food processes. Together with the improvement of mass transfer process, the quality of final products can also be benefited by ultrasound. More efforts will be put for the scale-up of ultrasonic equipment in our future studies.

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Gut microbiome: a new target for managing human metabolic health

Liping Zhao,
Rutgers University, Shanghai Jiao Tong University

Humans are superorganisms with two genomes that dictate phenotype, the genetically inherited human genome (25,000 genes) and the environmentally acquired human microbiome (over 1 million genes). The two genomes must work in harmonious integration as a hologenome to maintain health. Nutrition plays a crucial role in directly modulating our microbiomes and health phenotypes. Poorly balanced diets can turn the gut microbiome from a partner for health to a “pathogen” in chronic diseases, e.g. accumulating evidence supports the new hypothesis that obesity and related metabolic diseases develop because of low-grade, systemic and chronic inflammation induced by diet-disrupted gut microbiota. Due to the tight integration of gut microbiota into human global metabolism, molecular profiling of urine metabolites can provide a new window for reflecting physiological functions of gut microbiomes. Changes of gut microbiota and urine metabolites can thus be employed as new systems approaches for quantitative assessment and monitoring of health at the whole-body level with the advantage of measuring human health based on the results of interactions between the two genomes and the environment rather than just host genomic information. Large-scale population-based studies in conjunction with these whole-body level systems methods will generate pre-disease biomarkers with predictive power, thus making preventive health management of populations with rapidly changing disease spectrums possible through re-engineering of the imbalanced gut microbiomes with specially designed foods/diets.

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Effect of Dietary Protein of Foxtail Millet on Acute Liver Injury by D-galactosamine in Mice

Yongxia FU,Fan ZHANG, Mohammad Mainuddin MOLLA,Qun SHEN*
China Agricultural University, Beijing, China

Abstract

Liver is the largest metabolic organ in the human body. Protein deficiency, hepatitis virus and so on can cause liver damage and persistent liver damage eventually leads to liver failure. There are many synthetic drugs used in the treatment of liver disease, but often have side effects. Therefore, people began to pay attention to the preventive effect of food on the disease.

In this experiment we choose uncooked foxtail millet flour (UC FM), cooked foxtail millet flour (C FM), uncooked extracted foxtail millet protein (UCE FM), cooked extracted foxtail millet protein (CE FM), uncooked extracted enhanced foxtail millet protein (UCEE FM) and cooked extracted enhanced foxtail millet protein (CEE FM) to feed mice with acute liver injury induced by D-galactosamine.The results showed that UCE and UCEE FM diet can significantly reduce the body weight and increase the liver weight of mice,and serum AST, ALT, LDH, and MDA levels were significantly improved. At the same time, mouse hepatocyte necrosis and deterioration have been alleviated.

Intestinal microbial studies showed that the S.cerevisiae of the Proteobacteria increased significantly after receiving UCE FM diet, and the Akkermansia genus of the sputum micro-bacteria also showed a significant increase with UCEE FM diet in the intestine of the mice,which indicated UCE FM and UCEE FM diets may have improved intestinal barrier function.

In conclusion,uncooked foxtail millet protein have the potential to alleviate acute liver injury induced by D- galactosamine in mice. .

Key words: Foxtail millet protein, acute liver injury, serum enzyme activity, intestinal microbe

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The application of pulsed electric field (PEF) technology for food processing in China

Xin-An ZENG[1,2]

[1]*School of Food Science and Engineering, South China University of Technology, Guangzhou, China*
[2]*Overseas Expertise Introduction Centre for Discipline Innovation of Food Nutrition and Human Health (111 Center), Guangzhou, China*

Abstract
The application of pulsed electric fields on enhancing food processing, preservation, food quality control and nutrition molecules modification will be introduced in this presentation. Most important of all, the recent progress of relative treatment equipment development and industrial application will be showed. Recently, PEF technology has been emerged in some new applications in food processing, such as fruits and vegetables processing, properties modification, enhancing drying and freezing, etc. PEF based on electrical rather than thermal conductivity can be considered as a novel technology and improvement for food processing. This presentation aims to address the mechanism of PEF treatment on food molecules' structure and summarize the effect of its related properties. The application of PEF treatment on food processing by using pilot scale and industrial scale attempts to offer some examples for further product development opportunities, including potato processing and tomato peeling. Besides, the mechanism of starch modification synergized by PEF will be illustrated. When handled with PEF treatment, electric potential difference was generated during the electrodes, which can accelerate the mobility rate of reaction ions and change their moving directions resulting in more effective collision. Moreover, effective channels for intruding targeted groups and water molecules in starch granules based on electroporation theory were proposed.

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Effects of Pulsed Electric Fields Pretreatment on the Quality of Jujube Wine

Xin-An ZENG[1,2], Ling-fang XU[1,2]

[1]*School of Food Science and Engineering, South China University of Technology, Guangzhou, China*
[2]*Overseas Expertise Introduction Center for Discipline Innovation of Food Nutrition and Human Health (111 Center), Guangzhou, China*

Abstract
Pulsed electric field (PEF) accounts for one of the novel non-thermal processing and preservation technologies, which is regarded as an emerging application with the advantage of minimizing the loss of valued bioactive compounds in food processing. In this study, various PEF pulses had been applied to the jujube mash before fermentation, the fermentation kinetics, composition, volatile and sensory characteristics were investigated and compared. Results showed that the PEF pretreatment with 10 exponential wave pulses at 1.5 kV/cm, 1 Hz had remarkably improved phenolic compounds extraction, especially for caffeic acid, morin and p-hydroxybenzoic acid; 50 exponential wave pulses pretreatment enhanced 10% of the dry extract of product. Moreover, PEF pretreatment significantly enriched the floral and fruity volatile notes to jujube wine with the decrease of fusel oil. Consequently, PEF pre-processing is a promising method that can be adopted in wine making industry to promote wine quality and sensory profile.

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Food engineering and technology in humanitarian contexts

Carla MEJIA[1]

[1] *UN World Food Programme, Bangkok, Thailand*

ABSTRACT:
In 2017, there were 821 million people that were classified as undernourished, that is, about one person out of every nine in the world (FAO *et al*., 2018). Global development programs are not immediately associated with food engineering, science and technology but these disciplines are more important now, with the improvement of agricultural practices and the establishment of food standards across nations, through the FAO Codex Alimentarius activities. Food science and technology should be at the core of the Sustainable Development Goals, which aim to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture. For example, humanitarian organizations that provide crisis relief utilizing a complex network of suppliers (mostly from developing economies) collaborate with agencies and the private and public sector actors to foster environments that support the manufacture of safe, nutritious foods. This presentation will address these collaborations within the contexts of emergency situations in Low Income Countries and the implementation of projects focused on food value chain addition and food processing. We will discuss the challenges from stakeholders to assess risks and constrains related to these environments and provide examples of ongoing projects in Asia.
FAO, IFAD, UNICEF, WFP and WHO. 2018. The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition. Rome, FAO.

Abstract title Hybrid mixture theory-based framework for modeling unsaturated transport in poroviscoelastic biopolymers

Authors Pawan S. TAKHAR

Affiliations
University of Illinois at Urbana-Champaign, Urbana, IL, U.S.A

Abstract
During food processing applications such as baking, frying, drying and expansion, fluid transport is of unsaturated type due to the involvement of gas phase (air-vapor mixture). In addition, many foods undergo configurational changes at the scale of biopolymers, which affect their quality. During glass-transition, the time scale of relaxation of biopolymers is of the same order as transport time. Unsaturated transport in food materials is significantly more complex than saturated transport as the gas phase is compressible, leaks through connected pores, exchanges thermodynamic quantities (mass, momentum, energy and entropy) with other phases and results in capillary forces at the interfaces. The pore structure and material state continuously evolve in foods during processing, which further complicates the transport processes. Equations developed for simpler materials are not able to describe complex transport mechanisms in foods. This presentation will discuss the framework of Hybrid Mixture Theory used to merge unsaturated transport mechanisms with quality changes in foods. The resulting generalized Darcy's law and other modeling equations that include unsaturated transport and polymer relaxation terms will be presented. Solution of the developed equations for freezing, frying and extrusion applications will be shown. Comparison of the model predictions with experimental observations and ability of the model to elucidate underlying mechanisms, which may not be easier to observe via purely experimental techniques, will be shown.

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From innovative concept to commercialisation of high pressure processing – The Presha Fruit story

Alastair McLachlan

Preshafood, Derrimut, Victoria, Australia

Abstract
I have an innovative idea, I want it to be successful, but how?

Presha Fruit is a real world example of the successful commercialisation of an innovation.

The life cycle of competitive advantage drives the success of commercialisation.

Maintaining a competitive advantage during a company's life cycle is as important as the actual innovation.

Hear the story and maybe it will inspire you to commercialise an innovation once you know how to create a competitive advantage and maintain it.

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Prospects for Membrane Distillation and Osmotic Distillation in the food industry

Membrane Distillation and Osmotic Distillation have advantages such as minimal heat damage to feed liquids, high retention of volatile organic (aroma) compounds, concentration to high solute levels, nominal full retention of non-volatile solutes and ready utilization of low-grade heat or heat from natural sources (1). They have been considered as superior to conventional vacuum evaporation, reverse osmosis and even freeze concentration. Wide spread recognition of these advantages led to numerous research publications worldwide, however commercial-scale industrial applications have been limited.
The prospects for these processes are in many cases dependent on membrane module design and protection of the hydrophobic membrane against wet-out. These issues will be discussed along with examples of reclamation of water during space travels, production of grape juice concentrate, whole milk concentration on the farm, a membrane-based process for cane sugar factory and the utilization of renewable energy sources.

Reference

- Johnson, R.A. and Nguyen, M.H. (2017) *Understanding Membrane Distillation and Osmotic Distillation*. John Wiley & Sons, Inc. Hoboken, NJ

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Butylparaben improves the thermal inactivation rate of *Escherichia coli* O157:H7 in low-moisture foods

Qiao DING[1], Chongtao GE[2], Robert L. BUCHANAN[1,3], Rohan TIKEKAR[1]
[1]*Department of Nutrition and Food Science, University of Maryland, College Park, MD, USA*
[2]*The Mars Global Food Safety Center, Beijing, China, People's Republic of*
[3]*Center for Food Safety and Security System, University of Maryland, College Park, MD, USA*

Heat resistant foodborne pathogens have been a concern in low-moisture foods and ingredients (LMF) such as meat and bone meal (MBM). Due to the composition and thermal properties of MBM, heat treatment by itself is not efficient and may cause nutritional loss. This study investigated the enhancement of thermal treatment of MBM by inclusion of a food-grade antioxidant butylparaben (BP) as a processing aid.

Stationary phase *Escherichia coli* O157:H7 was inoculated into MBM with water activity adjusted to 0.4. Inoculated MBM containing 0 (control) or 1000 ppm BP was incubated at different temperatures for up to 5 h. Synergistic action of heat and BP was observed at 55 °C but not at 50 °C, while the inactivation rate at 60 °C was too rapid to observe synergy. Both treatments at 55 °C with or without BP demonstrated higher inactivation rates in the first one hour than the next four hours, indicating existence of potentially thermal resistant subpopulation. Although there was no significant difference in the D-values during the first one-hour treatments, treatment with BP at 55 °C presented a significantly lower D-value (2.6 ± 0.5 h) than the thermal treatment alone (4.7 ± 0.7 h) in the following four-hours period ($P < 0.05$), indicating that the addition of BP helps to eliminate the thermal resistant subpopulation.

These results suggest that addition of certain food additives can improve the thermal processing efficiency in LMF. Enhancement from other approved compounds will be investigated based on this proof of concept.

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MICROBIAL ENGINEERING OF CAROTENOIDS SYNTHESIS FROM WASTE SUBSTRATES

William CHEN

Director, NTU Food Science & Technology Programme, School of Chemical and Biomedical Engineering, Nanyang Technological University, Singapore

The oleaginous yeast *Rhodosporidium toruloides* has great biotechnological potential. It accumulates a high amount of lipids which can be used for biofuels and also produces carotenoids which are valuable in the food and pharmaceutical industry. However, the location of these two hydrophobic products in the cell membrane prohibits its efficient harvesting and separation. Here, a membrane transporter was engineered into *R. toruloides* and cultured in two-phase media containing oil. This enabled the production and *in situ* export of carotenoids into the oil and concurrent separation from intracellular lipids in the cells. Our approach represents an easy and greener extraction method which could serve to increase the yield and facilitate separation of carotenoids and fatty acids.

Recovery of bioactive compounds: from non-conventional extraction technique to biomedical and food applications.

Patrizia PEREGO[1,2], Alessandro Alberto CASAZZA[1,2], Pier Francesco FERRARI[3], Domenico PALOMBO[2,3]

[1]*Department of Civil, Chemical and Environmental Engineering (DICCA), University of Genoa, Genoa, Italy*
[2]*Research Center for Biologically Inspired Engineering in Vascular Medicine and Longevity (BELONG), University of Genoa, Genoa, Italy*
[3]*Research Laboratory of Experimental and Clinical Vascular Biology (DISC), University of Genoa, Genoa, Italy*

Abstract

Agro-food operations often lead to the production of polluting wastes. This is due to their high content of recalcitrant compounds, such as phenolic compounds. Examples of common agro- industrial wastes are olive pomace, grape marc, apple peels, corn silage, and spent coffee grounds. Olive pomace, a solid waste from olive oil industry, represents one of the most important agro-industrial wastes to be managed. It consists of a huge amount of polyphenols which, on one hand show a negative effect as waste on the biological treatment since they inhibit the microbiological growth, on the other hand possess different biological effects, such as anti- inflammatory and anti-bacterial activity. In order to recover bioactive compounds from agro-food wastes, different extraction techniques, such as solid/liquid, ultrasound assisted, microwave assisted and high pressure high temperature extraction, have been extensively studied. The olive pomace extract was biologically validated, using different cell types. The extracted bioactive compounds were able to counteract the anoxia-induced endothelial dysfunction and cellular response induced by pro-inflammatory stimulus in endothelial cells. Moreover, they were able to reduce lipid accumulation in hepatocytes, to be biocompatible with keratinocytes, to protect neurons from calcium-dependent damages and to improve cellular function in skeletal muscle cells. With the aim of protecting the extracted polyphenols from environmental stress conditions, different nano- and microencapsulation techniques were performed. Olive pomace extract was encapsulated through spray drying, layer-by-layer self-assembly technique, and supercritical assisted process. Taking into account all the obtained data, these extract could find application in the biomedical, food and cosmetic industries.

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TRANSPORT OF INTRACELLULAR WATER DURING DRYING OF FOOD MATERIAL: AN EXPERIMENTAL INVESTIGATION

Md. Imran H. KHAN*, M.A. KARIM
Science and Engineering Faculty, Queensland University of Technology (QUT),
2 George St, Brisbane, QLD 4000, Australia
*Corresponding Authors' Email: mdimranhossen.khan@hdr.qut.edu.au

Abstract
Structural heterogeneity makes the food material complex to understand the physicochemical changes that occur due to the simultaneous heat and mass transfer during drying. Food materials are porous and hygroscopic in nature that contains up to 80–90% water in different cellular environments: intercellular environment and intracellular environment. Most of the existing food drying studies have been done based on the bulk (tissue) level water transport process during drying. However, consideration of bulk level water transport ultimately increases the drying time that causes damage the product quality and increases the energy consumption. Therefore, understanding of cellular level water transport during drying is crucial for developing an energy- efficient drying system and obtaining better quality dried product. The primary aim of this work is to investigate the transport mechanism of water from intracellular region to the intercellular environment during drying. Experiments were performed on the potato tissue using 1H-NMR T2 relaxometry to uncover the mechanisms involved in intercellular water and intracellular water transportation. It is found that intracellular water migrates after the rupture of the cell membranes. It is interesting to highlight that the cell membranes rupture at different stages of drying rather than collapsing at one time. The majority of cells rupture at the middle stage of drying. The membrane collapse depends predominantly on the penetration rate of heat energy and the pressure gradient between intracellular and intercellular environments. The findings of this study will enhance the understanding of cellular level heat and mass transfer during drying and will also contribute to the prediction of deformation of plant-based food material.

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Phytochemicals and antioxidant and anti-lipid peroxidation activities of ultrasonic-assisted and ethanolic extracts of *Piper longum* Linn

Huaqiang LI, Yanzhen LONG, Feifei WU, Liangzhong ZHAO

Shaoyang University, Shaoyang, China Affiliations

Abstract

Background and objective: Natural antioxidants are widely used as dietary supplements and food additives. Components in Piper longum Linn (*P. longum*, or long pepper) fruit may have potential for inhibiting oxidative stress and anti-lipid peroxidation. This study evaluated ultrasonic-assisted extraction relative to ethanolic extraction for phytochemical analysis of *P. longum* fruit with regard to these properties.

Methods: Extracts of *P. longum* fruits were obtained by ultrasonic-assisted or ethanolic extraction. Phytochemical analyses of 1 mg/mL extraction samples were conducted using various antioxidant and free radical scavenging models.

Results: In both the ultrasonic-assisted and ethanolic extracts, the presence of alkaloids, terpenoids, flavonoids, glycosides, proteins, phenols, and steroids were detected. In addition, the presence of tannins was confirmed by ultrasonic-assisted extraction. For 1 mg/mL samples of ultrasonic-assisted and ethanolic extracts, inhibition tests for 1,1-diphenyl-2-picrylhydrazyl (DPPH) revealed, respectively, rates of 83.05% and 54.73% inhibition of DPPH radicals, while scavenging results were 38.25% and 28.42%, the superoxide radical inhibitory effects were 24.5% and 22.0%, and the lipid peroxidation inhibitory effects were 22.5% and 45.9%. The reducing power potential of the ultrasonic-assisted and ethanolic extracts was concentration-dependent and determined at 0.35 and 0.24.

Conclusions: Overall, test results showed that ultrasonic-assisted extraction was more useful than ethanolic extraction for the phytochemical analysis of *P. longum* fruit.

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An original program to train and support small food entrepreneurs in central and west Africa

Arnaud Britsch[1], Sophie Bièque[1], Dominique Bounie[2], **Jean-François Grongnet[3]**

:
[1]*IECD, Paris, France*
[2]*Lille 1 University, Lille, France*
[3]*Agrocampus Ouest, Rennes, France*

Abstract

In sub-Saharan Africa, the weak step of the food supply chain is food transformation. For years, national and international support programs have contributed to enhance the production of cereals, tubers, fruits, vegetables, meat, eggs and milk. Unfortunately, less efforts have been made to allow these commodities to get access to the developing markets in the growing big cities of Africa. Without appropriate transformation, packaging, calibration and transportation, an unacceptable proportion of these products are wasted while urban populations are not enough supplied. Facing this situation, private modest people have decided to occupy this economic sector. Quite all of them have no technical and business capacities. Quite no suitable formal education exists in the concerned countries, at the practical level concerned. So, IECD with the support of some academic institutions, has established, since 2015, the TRANSFORM program in Cameroun and Côte d'Ivoire. Based on containerized training units, TRANSFORM gathers groups of small or very small entrepreneurs, desiring to improve their practical ability in food technology, packaging, labeling, marketing, gestion. After an initial training in the TRANSFORM containerized facilities, they are assisted during six months or more if they want, by the TRANSFORM team. Today, it is possible to say that the program is a success. The entrepreneurs have improved the quality of their products. Some of them, commercialize their products in modern retail channels like hypermarkets. At the beginning quite all of them have chosen their product range on a mimetic basis without innovation. TRANSFORM has helped them to develop innovative and profitable products, able to seduce the middle-class consumers.

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Numerical modelling of food material flow and processing through a twin-screw extruder

Gerald PEREIRA[1], Paul CLEARY[1]

[1]*CSIRO, Computational Modelling, Melbourne, Australia*

Abstract
Extrusion is a highly flexible continuous thermomechanical process with high throughput. Extruders are therefore widely used in the food, polymer and other industries. However there is a lack of understanding of the processing conditions created within the device which has a variety of moving parts and develop complex laminar flow patterns which are generally very challenging to monitor experimentally. Numerical modelling is a valuable alternative method which can provide information of thermomechanical stresses and mixing characteristics that evolve in the device. Here we develop the Smoothed Particle Hydrodynamics (SPH) method for application on industrial food mixers. SPH is a non-classical particle based computational fluid dynamical (CFD) method which naturally deals with free (splashing) surfaces and motion of fluid around rapidly moving solid parts. It is therefore ideal for the food extrusion process yet, till now, it has been rarely applied to these devices. We apply the SPH method to a full scale extruder which includes two screws both with forward and backward facing elements, kneading elements, feed inlet and a simple die outlet. We consider isothermal flow of a single phase material through the device focusing on the velocity field that is generated in the extruder. We discuss extensions of this work to model not only the flow field in the device but also heat transfer and phase change of materials, when a dry granular powder is fed through the inlet together with water as is done in practice.

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Effect of starch modification in the whole white rice grains on physicochemical properties of two contrasting rice varieties

Malik Adil NAWAZ[1,2], Shu FUKAI[1], Sangeeta PRAKASH[1], Bhesh BHANDARI[1]

[1]*The University of Queensland, Brisbane, Australia*
[2]*CSIRO, Melbourne, Australia*

Abstract
The effect of acetylation of milled rice of selected rice varieties viz. TDK8 and DG on their physicochemical properties were investigated at different acetic anhydride concentrations (1 – 7 g per 100 g of milled rice samples in 225 mL of water). Results showed that the intact starch of milled grains of both selected verities could be acetylated (Acetyl % for TDK8 = 2.18 and DG = 0.89) even with 1 g of acetic anhydride. X-ray diffraction patterns showed that acetylation resulted in reduced crystallinity. Acetylation resulted in reduced peak and final viscosities and gel strength, particularly in glutinous (TDK 8) and non-glutinous (DG) rice. The thermal study showed acetylation resulted in reduced thermal transition temperatures and enthalpy of both varieties. Although the increase in retrogradation thermal temperatures was observed, the amount of retrograded starch was decreased in both varieties. Furthermore, the texture of cooked acetylated grains was less hard and more adhesive. *In vitro* digestion showed a significant decrease in GI possibly due to structural changes in the native starch during acetylation. These findings suggest a good potential of applying acetic anhydride pre-treatments in rice processing, especially glutinous varieties to control the hardness and maintain the stickiness properties of rice.

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In situ analysis of cooking properties of rice by Thermal Mechanical Compression Test (TMCT) method

Malik Adil NAWAZ[1,2], Shu FUKAI[1], Bhesh BHANDARI[1]

[1]*The University of Queensland, Brisbane, Australia*
[2]*CSIRO, Melbourne, Australia*

Abstract
A procedure for *in situ* analysis of rice cooking was developed in this study. Grain softening during soaking and cooking of selected rice varieties (fresh and aged TDK8, TDK11, and Doongara) were subjected to *in situ* analysis by using a thermally controlled sample block (TMCT) attached to a texture analyser. This technique measures the changes in the mechanical properties of intact rice grain during cooking continuously. The results obtained from the TMCT technique were validated against two standard and conventional procedures viz. analysing the pasting properties of rice flours by Rapid Visco Analyzer (RVA) and microscopic observations during the cooking of rice grains. The technique developed in this study was found valid for *in situ* analysis of rice cooking. This technique can be used for a sample size as small as 0.50 g.

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Opportunities for food loss minimisation through regional food processing hubs and mobile processing

Pablo JULIANO

CSIRO Agriculture and Food, Werribee VIC, Australia

Abstract

The world is estimated to waste about 1.6 GTons of food, where 1.3 GTons represent the edible portion of the food lost, which could otherwise be recovered and diverted into high value products. In horticulture, this translates into global economic losses of at least 320 billion dollars, as reported by the UN Food and Agriculture Organization. The fruit and vegetable chains undergo 10-60% losses before retail, depending on the country and region. A recent study completed this year in Australia estimated loses on-farm and at processing/packing house levels between 18 to 22% of the total Australian fruit and vegetable production or from 1,175,000 to 1,456,000 tonnes of fruit and vegetable. This is the first study that attempts to map and quantify the location of all fruit and vegetable losses across the Australian continent pre-retail. Efforts are underway to establish regional food processing hubs with smart specialization and Industry 4.0 technology for food loss reduction, decentralisation purposes, and as a platform to value capture through transformation into high end ingredients. The presentation will list a number of innovative food process engineering strategies to value capture underutilized biomass on farm, at the packing house and during processing. Examples of containerized facilities for mobile processing with traditional and novel technologies will be highlighted.

Keywords: food loss, horticulture, engineering solutions, regional food processing hubs

ICEF13 ABSTRACT TEMPLATE

Design and production of 3D printed food with desired textural properties

[1]**Antonio DEROSSI,**[1]Rossella CAPORIZZI,[1]Maddalena PAOLILLO, [2,3,4,5,6]Kirill GERKE,[1]Carla SEVERINI,

[1]*Department of Science of Agriculture, Food and Environment, University of Foggia, Foggia, Italy*
[2]*Schmidt Institute of Physics of the Earth of Russian Academy of Sciences, Moscow, 107031, Russia*
[3]*Institute of Geospheres Dynamics of Russian Academy of Sciences, Moscow, 119334, Russia*
[4]*Dokuchaev Soil Science Institute of Russian Academy of Sciences, Moscow, 119017, Russia*
[5]*Kazan Federal University, Kazan, 420008, Russia*
[6]*Moscow Institute of Physics and Technology, Dolgoprudny, 141701, Russia*

Abstract
Last couples of years saw a significant increase in the number of experiments to test the application of 3D Food Printing (3DFP). This technology mimics what occurs in nature when trees, biological tissues, etc. grow additively and create tailored functionality. In 3D Food Printing we formulate printable food formula to create new structures on the basis of a virtual model designed by potential users (e.g. consumers or industry). We have designed 3D virtual structures used to print cereal-based biscuits formulated by modifying the source and the amount of two nutrients: protein (wheat flour and rice flour) and fat (milk butter and vegetable oil). Internal structure of the cooked samples was studied by X-ray microtomography and thus obtained 2D and 3D images were analyzed to describe microscopic properties of biscuits by using different metrics (statistical correlation functions, CFs, and pores/solid morphology indexes). Also, the main texture properties (hardness, crunchiness, Young's modulus, etc.) of the samples were experimentally measured by using texture analyzer. Next, the changes of 3D printed biscuits for their texture were modeled as a function of microstructure data and the information that has been predominant in the explaining of the mechanical properties of the biscuits was defined. Finally, the obtained relationships have been used to design virtual models with customized texture properties and new biscuits have been printed to validate the method. Using our methodology it is possible to manufacture innovative edible structures conferring desired texture properties (e.g. fragile biscuits for elderly people).

ICEF13 ABSTRACT TEMPLATE

New insight on the use of statistical correlation functions to describe structural complexity of food and to estimate their essential properties.

[1]**Antonio DEROSSI,** [2,3,4,5,6]Kirill GERKE, [2,3]Marina KARSANINA, [1]Rossella CAPORIZZI, [1]Carla SEVERINI,

[1]Department of Science of Agriculture, Food and Environment, University of Foggia, Foggia, Italy
[2]Schmidt Institute of Physics of the Earth of Russian Academy of Sciences, Moscow, 107031, Russia
[3]Institute of Geospheres Dynamics of Russian Academy of Sciences, Moscow, 119334, Russia
[4]Dokuchaev Soil Science Institute of Russian Academy of Sciences, Moscow, 119017, Russia
[5]Kazan Federal University, Kazan, 420008, Russia
[6]Moscow Institute of Physics and Technology, Dolgoprudny, 141701, Russia

Abstract
Although the importance of food microstructure is widely recognized, the basic information used to describe it, are often inadequate. The potential of a precise characterization of food microstructure (using direct simulations) lies with the usage of this information to estimate macroscopic features – mechanical, electromagnetic, mass and heat transfer properties – as opposed to conventional comparison between samples or simple explanation of some macroscopic observations. A huge amount of microstructure information is needed for such direct physical properties estimation. Statistical correlation functions (CFs) have been fruitfully used for this aim in many fields of science, but their application in food engineering, is limited. We have analyzed two types of cereal-based structures, namely rusks and white bread. Their internal architecture was visualized by using X-ray microtomography, both in 2D and 3D. From these images, two-points and linear correlation functions were computed in orthogonal and diagonal directions to describe their microstructure. Then, stochastic reconstructions methods were implemented to create a virtual replica of the original and its quality was assessed by comparing it with the original X-ray images by means of different metrics including physical property simulations. We estimated diffusion coefficient, D_{eff}, of water – in rehydration conditions - on the basis of microstructure information and compared simulation results for both original XCT and stochastic replicas against laboratory measurements. Current results extend our previous work and aim for robust estimation of essential properties from the first principles to access their quality and for a better managing of processing, storage, transportation and shelf life, as well.

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An advanced "near real" dynamic *in vitro* human stomach system to study gastric digestion and emptying of beef stew and cooked rice

Jingjing WANG[1], **Peng WU**[1], Minghui LIU[1], Zhenkai LIAO[2], Xiao Dong CHEN[1]

[1]Soochow *University, Suzhou, China*
[2] *Xiao Dong Pro-health (Suzhou) Instrumentation Co. Ltd, Suzhou, China*

Abstract
A "near real" dynamic *in vitro* human stomach (DIVHS) system has recently been advanced in this study, based on the previous "rope-driven" *in vitro* human stomach model (RD-IV-HSM). The DIVHS mainly consists of the J-shaped silicone human stomach model fabricated with 3D-printing technology which has similar stomach morphology, dimension and wrinkled inner structure to that present *in vivo*, and the electromechanical instrument composed of a series of motors, rollers and eccentric wheels to produce peristaltic contractions. The simulated stomach system was able to generate consistent gastric emptying characteristics of both the solid and liquid fractions in the beef stew mixed with orange juice with that reported *in vivo*. By fitting the gastric retention data with a modified power-exponential model, the solid fractions showed average emptying half-time ($t_{1/2}$) of 74.1 min and lag phase (t_{lag}) of 36.3 min in the DIVHS, similar to that obtained *in vivo* where the average values of $t_{1/2}$ and t_{lag} were 75.8 min and 40.2 min, respectively. The performance of the DIVHS was further validated by showing good qualitative matches of the gastric pH, particle size distribution and emptying profiles of cooked rice with the literature *in vivo* data. These results indicate that it is a reasonable approach to perform *in vitro* gastric digestion experiments using the DIVHS, which is practically meaningful. Ongoing work are being implemented on validation and application (i.e. meal ingestion on tablet dissolution and active ingredients release in gastrointestinal tract) a more recently developed human digestion system which extends the DIVHS by integrating the stomach, small and large intestine models.

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The synergistic effect of combining low and high radio frequency electric fields on microbial inactivation of *Escherichia coli* in saline water

Adel REZAEIMOTLAGH[1], Francisco TRUJILLO[1]
[1]*University of New South Wales, Australia*

Abstract
Radio frequency electric fields (RFEF) and pulsed electric fields (PEF) are novel non-thermal processing technologies which have been introduced as alternatives to conventional thermal processing. These technologies have shown to ensure the microbial safety of the food products by inactivating microorganisms through irreversible electroporation phenomenon which can be affected by factors such as temperature, electric field strength, and treatment time. Additionally, due to their moderate processing temperature and short processing duration, the quality and nutritional attributes of the food products can be preserved.

In PEF, a synergistic effect was shown when a combination of nanosecond and microsecond pulse durations was applied, which eradicated a higher level of microbial population compared to when nanosecond or microsecond pulses were applied separately. It was assumed that microsecond pulses affect cell membrane integrity, while nanosecond pulses affect internal organization. Nanosecond and microsecond pulses in PEF are equivalent to high and low frequencies in RFEF, respectively.

A set of experiments was conducted to investigate the possible synergistic effect of combining high and low frequency electric fields on *Escherichia coli* inactivation in saline water. The experiments focused on comparison studies between different protocols of RFEF treatment including combination of high and low frequency, high frequency and low frequency electric fields separately on microbial inactivation. Supplementary studies were conducted by using electron microscopy techniques and polymerase chain reaction (PCR) tests to distinguish differences in the mechanism of microbial inactivation between the high and low frequency electric fields. Finally, experimental studies compared the energy efficiency of these treatments.

Integrated approaches for the valorization of by-products in small-scale dairy industries

Carlos PEREIRA[1,2], Natalí MARNOTES[1], Arona PIRES[1], Aleksandra PISKORZ[3], Marta HENRIQUES[1,2], David GOMES[1]

[1]*Polytechnic Institute of Coimbra-College of Agriculture, Coimbra, Portugal;*
[3]*CERNAS-Center for the Study of Natural Resources, Environment and Society, Coimbra, Portugal;*
[3] *West Pomeranian University of Technology, Szczecin, Poland.*

Abstract
Despite its potential as pollutant, cheese whey (CW) is considered as a valuable dairy by-product due to its nutritional, functional and bioactive properties. In large cheese plants, CW is normally valorised through the production of whey powder (WP) or dry whey protein concentrates/isolates (WPC/WPI). However, small scale dairy plants cannot use the same approach due to the high investment and operation costs associated.
Second cheese whey (SCW) results mainly from the production of whey cheeses (*e.g. Ricotta*). The typical composition of ovine SCW resulting from the manufacture of *Requeijão* (the Portuguese whey cheese) includes 6,71% dry matter, of which, 0,49% protein, 0,53% fat and 2,08 minerals. SCW is usually not recovered and substantially contributes to the negative environmental impact of the cheese plants. However, as it occurs with whey, it constitutes a natural source of valuable compounds, such as proteins, lactose, minerals and small peptides (some of which are described to perform physiological effects *in vivo*, such as antioxidant, antimicrobial and antihypertensive activities).
Therefore, this work is focused on the valorisation of CW and SCW in small scale dairy plants through their concentration by means of tangential filtration, namely ultrafiltration/diafiltration (UF/DF) and nanofiltration (NF), followed by appropriate treatments envisaging the production of symbiotic dairy beverages or salad dressings. Preliminary results indicate that CW and SCW can be valorised in small scale cheese plants giving origin to products well accepted by consumers and with potential health benefits.

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Improvement of Rheological Properties and Processing Characteristics of High Dietary Fiber Wheat Dough by Konjac Glucomannan

Authors
Pengyao SUN[1], **Bing LI[1]**, Ling CHEN[1], Xia ZHANG[1], Lin LI[2]

Affiliations
[1]*South China University of Technology, Guangzhou, China*
[2]*Dongguan University of Technology, Dongguan, China*

Abstract
As an innovative food reducing the body's absorption of sugar, high dietary fiber pasta is in urgent need of exploration in terms of improving processing performance. A new strategy was proposed in this study to reduce the deterioration of the quality of noodles caused by individual addition of insoluble dietary fiber (IDF). The combination of insoluble dietary fiber and soluble dietary fiber (SDF) can act as an improver when added in appropriate proportions in noodles. The effects of oat bran dietary fiber (OBDF, IDF), konjac glucomannan (KGM, SDF) and their combination on the farinographic, rheological and noodle-processing properties of wheat flour were revealed. OBDF reduced the development time (DT) and stable time (ST) of the flour, which were restored to the level of the control group after adding KGM and OBDF. The addition of KGM also improves the extensibility and resistance of the OBDF separately added dough, which is slightly affected by hydrothermal cooking. A significant decrease in cooking loss (CL) and swelling degree (SD) of the noodles was also observed when OBDF and KGM were added. Furthermore, the combination of OBDF and KGM contributed to higher hardness adhesiveness and gumminess of the noodles. Besides, noodles with KGM and OBDF jointly took precedence over single dietary fiber in lowering glycemic index through *in vitro* starch digestion. The results show that optimizing the proportion of SDF has a positive significance in improving the processing quality of high-fiber noodles, providing a possibility for more flexible processing technology and a wider consumer market.

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The mechanisms of hypoglycemic effect of foxtail millet based on transcriptomics

Yongxia FU,Fan ZHANG,Xin REN,Qun SHEN*
Key Laboratory of Plant Protein and Grain processing
National Engineering and Technology Research Center for Fruits and Vegetables
College of Food Science and Nutritional Engineering
China Agricultural University, Beijing 100083, China

Abstract

Our previous animal experiment have proved that foxtail millet feeding significantly improved the blood glucose metabolism in high fat diet and STZ-induced (HFD/STZ) diabetic rats. To further clarify the mechanisms of the hypoglycemic effect of foxtail millet, the difference on liver transcriptional profiles between diabetic rats, normal rats and foxtail millet feeding rats were investigated. The results shown that 4 weeks of foxtail millet feeding in this study could mitigate negative variations of liver transcriptional profile in HFD/STZ diabetic rats. Specifically, foxtail millet feeding activated the insulin-stimulated PI3K/AKT signaling pathway by up-regulating expression of IRS, PI3K and AKT in liver, which will inhibit gluconeogenesis by down-regulating expression of G6P, FBP and PEPCK, and stimulate glycolysis by up-regulating expression of GK and PK subsequently. Moreover, foxtail millet feeding inhibited NF-κB signaling pathway and reduced expression of inflammatory factors, which will weaken the inhibition of insulin signaling pathway and improve blood glucose metabolism ultimately.

Keywords: foxtail millet; blood glucose metabolism; insulin signaling pathway; NF-κB signaling pathway

Crystallization assisted by electric, magnetic, electromagnetic, MicroWaves and Radio Frequencies; a review.

Le-BAIL Alain[1], JHA Piyush Kumar[1], SADOT Mathieu[1], CHEVALLIER Sylvie[1], COUEDEL Christophe[1], CURET Sébastien[1], HAVET Michel[1], JURY Vanessa[1], ROUAUD Olivier[1], ELIASSON Lovisa[2], XANTHAKIS Epameinondas[2], HUEN Julien[3], MATULLAT Imke[3]

[1] *ONIRIS, UMR GEPEA CNRS 6144, 44322 Nantes– France*
[2] *RISE-Agrifood & Bioscience, Gothenburg, Sweden*
[3] *TTZ-BILB, Bremerhaven, Germany*

Abstract

During freezing, ice crystals formation yields mass diffusion of water towards the ice crystals whereas the solutes diffuse in opposite directions; the corresponding charges displacement induces a tiny current in the crystallization domain. Electrical double layer located at cell membranes may also interfere with ice formation. Therefore, any external causes inducing electrical charge may interact with freezing. Several innovative freezing technologies assisted by external fields (magnetic, electric, electromagnetic) have been developed to reduce the size of ice crystals. An overview of these technologies will be proposed. Some technologies are based on oscillating magnetic field which in turn induce an oscillating electric field(Lorentz law). In the case of microwave assisted freezing, two theories have been proposed, "NITOM" for Nucleation induced by Temperature Oscillation caused by Microwave) and "NIMIW" for Nucleation Induced by constant or pulsed MIcroWaves power, based on interaction between waves and hydrogen bonds, they will be debated. Regarding static electric field, two theories (free energy and initial freezing point) converge to support the observed reduction of the size of crystals in the case of freezing and crystallization from saturated solutions. Specific applications made on fruits, vegetable, meat and seafood will be presented using static electric field and electromagnetic waves (MW and RF) including a review on techniques to assess freeze damage (NMR, CRYO-SEM, XRays MiroCT, Mass diffusion, etc).

Acknowledgements

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BRICE project: solutions to monitor and to mitigate checking and breakage of dry cereal products.

Patricia LE-BAIL[1,3], Alain LE-BAIL[2,3], Chloé BAILHACHE[1,3], Marion BEDAS[1,3], Sylvie CHEVALLIER[2,3], Philippe COURCOUX[3,4], Luc GUIHARD[2,3], Benoit JAILLAIS[3,4], Camille JONCHERE [3,4], Catherine LOISEL[2,3], Jean-Yves MONTEAU[2,3], Anthony OGE[2,3], Bruno PONTOIRE[1,3] , Delphine QUEVEAU[2,3], Lucie RIBOURG[1,3]

[1] *INRA-BIA, INRA, UR-1268 Biopolymères Interactions et Assemblages, rue de la Géraudière, 44316 NANTES, France*
[2] *ONIRIS, GEPEA, UMR CNRS 6144, rue de la Géraudière, CS 82225, 44322 NANTES CEDEX 3, France*
[3] *SFR 4204, Ingénierie des Biopolymères pour la Structuration des Matrices et des Matériaux (IBSM), 44316 NANTES, France*
[4] *INRA-StatSC USC 1381, rue de la Géraudière, 44316 NANTES,*

Abstract
Dry cereal products are exposed to checking and breakage (C&B), which is caused mainly by three major reason; excess of gluten network, fast cooling rate and non-uniform water distribution within the product at the end of baking. The typical moisture is around 4%db and difference in water content as low as 0.5/1% within the product suffices to trigger C&B. Other aspects such as formulation, external mechanical shock may also contribute to C&B. C&B remains one of the major quality issues for dry cereal products.

The overall objectives of BRICE are i) to develop knowledge to better understand C&B, ii) to develop tools and analytical means allowing a better on line or at line control of the status of the products and iii) to develop process-based solutions in order to mitigate C&B in industry.

The main outcomes are:
-Audits made at industry and laboratory levels to monitor kinetics of C&B apparition
-A visible+hyperspectral imaging bench to track moisture distribution in link with the apparition of C&B after process
-A hydro/thermal dilatation bench to measure coefficient of hydro and thermal expansion; this is combined to an hydro-thermal mechanical model.
-Development of process-based solutions to mitigate C&B based on thermal process at end of baking using RF/MW and conventional thermal processes.

This presentation will propose an overview of the main outcomes of the project with application on different biscuits with specific shape, thickness and water content.

Acknowledgments: BRICE project is co-funded by Région Pays de la Loire, INRA, ONIRIS and industry partners.

Aerated food products are of interest for food industry due to consumers' liking of mousse-like/ creamy or sponge-like textures in a wide product range. However, dispersing of gas in a liquid to generate small bubbles by conventional methods is generally combined with high energy dissipa-tion due to viscous friction in dispersing flow fields and high critical Capillary numbers required for breakup of bubble interfaces. Such energy dissipation leads to fluid heating which in turn restricts interfacial stabilization and supports bubble coalescence. Consequently, stable food foam genera-tion with foam bubbles below 10-20 microns is very rare, if possible at all.

Accordingly, we have developed a minimal energy dissipation approach from which novel aeration technologies were derived for the two classes of (i) lower and (ii) higher viscous fluid systems and proved the efficient generation of foam bubbles with diameters down to ca.1-2 microns.

For viscosity class (i) fluids, dynamic membrane aeration can fulfill the low energy dissipation and improved gas filament/bubble breakup requirements due to the pronounced elongational deforma-tion of such filaments/bubbles when still fixed to the membrane pore while the wall shear stress of the cross-flow field along the membrane surface is acting. For viscosity class (ii) fluids, high pres-sure extrusion, coupling gas dissolution, bubble nucleation and controlled foam expansion has proved to be quite successful even for bread doughs.

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The use of oil-in-water emulsions for controlled lipid release is of interest to the food and pharma-ceutical industries in the development of poorly water-soluble nutrients or drugs and also has gained major interest in the treatment of obesity. We focused on the relevant in vitro parameters reflecting gastric and intestinal digestion steps to reach a reliable in vitro - in vivo correlation for lipid delivery systems. We found that (i) gastric lipolysis determines early lipid release and sensing. This was mainly influenced by the emulsion stabilization mechanism. (ii) Gastric mucin influences the structure of charge-stabilized emulsion systems in the stomach leading to destabilization or gel formation, which is supported by in vivo magnetic resonance imaging in healthy volunteers. (iii) The precursor structures of these emulsion modulate intestinal lipolysis kinetics in vitro, which is reflected in plasma triglyceride and cholecystokinin concentrations in vivo. For (i-iii) the gastric mixing flow characteristics is of crucial impact on the interaction of Simulated Gastric Fluid (SGF) and the included mucin with the differently stabilized emulsion interfaces and resulting gelation and/or drop coalescence behavior. Related laminar and dispersive mixing flow characteristics in a stomach model were investigated applying Ultrasound-Doppler flow mapping, visualization experi-ments and CFD simulations.

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Bacteria, mould and yeast spore inactivation studies by scanning electron microscope observations

Siti Nadjiha MOHD ROZALI[1] Elham MILANI[1], Rebecca DEED[2], **Filipa SILVA[1]**

[1]*Chemical and Materials Engineering Department, The University of Auckland, New Zealand*
[2]*School of Biological Science, The University of Auckland, New Zealand*

Abstract

Spores are the most resistant form of microbial cells, thus difficult to inactivate. In this study, thermal sterilization and high-pressure processing (HPP) were used to inactivate the spores. Although previous studies demonstrated the effectiveness of thermal and non-thermal spore inactivation, the in-depth mechanisms of spore inactivation are yet unclear. Live and dead forms of two food spoilage bacteria, a mould and a yeast were examined using scanning electron microscopy before and after the inactivation. Spores of the four microbial species were thermally inactivated. Yeast spores were observed in the ascus and free form after thermal and HPP treatments. Different forms of damage and cell destruction were observed for each microbial spore. Thermal treatment inactivated bacterial spores of *A. acidoterrestris* and *G. stearothermophilus* by attacking the inner core of the spore. The heat first altered the membrane permeability allowing the release of intracellular components. Subsequently, hydration of spores, physicochemical modifications of proteins, flattening and formation of indentations occurred, with subsequent spore death. Regarding *N. fischeri*, thermal inactivation caused cell destruction and leakage of intracellular components. Both thermal and HPP treatments of *S. cerevisiae* free spores attacked the inner membrane, altering its permeability, and allowing in final stages the transfer of intracellular components to the outside. The spore destruction caused by thermal treatment was more severe than HPP, as HPP had less effect on the spore core. All injured spores have undergone irreversible volume and shape changes. This current study contributed to the understanding of spore inactivation by thermal and non-thermal processes.

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Atomization behaviour of juice-fibre suspensions in a two-fluid nozzle during a spray drying process

Siti Nadjiha MOHD ROZALI[1], **Tony PATERSON[1]**, Jason HINDMARSH[2], Lee HUFFMAN[3]

[1]*School of Engineering and Advanced Technology, Massey University, New Zealand*
[2]*Institute of Food Science and Technology, Massey University, New Zealand*
[3]*The New Zealand Institute for Plant & Food Research Ltd*

Abstract

Spray drying of fruit juices from liquid to powder is desirable as the powders are easier to handle, especially for storage and transportation. Commercially, maltodextrin is added to the juices as a drying aid to increase the efficiency of the spray drying process. In this project, an alternative drying aid, which is pomace fibres that originated from the fruit itself, was used. The addition of micro-sized fibres to fruit juices affect the rheology and subsequent atomization behaviour during the spray drying process. The first part of this study focuses on the determination and characterization of the rheology of juice-fibre suspensions, to ensure a high efficiency of powder production by enabling good atomization of the suspensions. Juice-fibre suspension is a shear thinning liquid with significant extensional resistance (viscoelasticity). Results show that the shear and extensional behaviour of the fibre suspensions depend on several factors which include fibre fraction, size or aspect ratio. The second part of the study involves the atomization of the fibre suspensions using a two-fluid nozzle. The atomization behaviour of the fibre suspensions discharging in the air was photographed using a backlit setup to visualize the atomization pattern of the viscoelastic fibre suspensions. The effect of the extensional resistance or viscoelasticity is to delay the droplet formation by forming filamentary structures that link successive droplets together. Consequently, droplets of viscoelastic fibre suspensions are usually bigger than Newtonian droplets. Increasing the atomizing air velocity in a two-fluid nozzle yields better atomization by forming smaller droplets.

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Sustainable use of *Hermetia illucens* insect biomass for feed and food: extensive Life Cycle Assessment

Sergiy SMETANA[1], Eric SCHMITT[2], Alexander MATHYS[3]
[1] *German Institute of Food Technologies (DIL e.V.), Quakenbrück, Germany*
[2] *Protix, Industriestraat 3, 5107 NC Dongen, The Netherlands*
[3] *ETH Zurich, Institute of Food, Nutrition and Health, Laboratory of Sustainable Food Processing, Zurich, Switzerland*

Abstract

The lack of protein sources in several parts of the world is triggering the search for locally produced and sustainable alternatives. Insect production is recognized as a potential solution. This study is a life cycle assessment (LCA) of food industry side streams transformation via *Hermetia illucens* into intermediate products applicable for feed and food purposes. It relies on attributional modelling for the estimation of the most impacting stages of insect production and on consequential modelling for the estimation of potential benefits or risks for the agri-food system. Consequential LCA included effects on the market, associated with upstream increase in feed (increase in commercial feed production) or downstream availability of insect product (substitution of fertilizer, protein concentrate for feed or chicken meat). Attributional and consequential LCA is followed by sensitivity analyses, which identify the most promising directions towards sustainable insect production and estimate the magnitude of impact reductions if those directions are pursued by the industry. Analyses of the existing pilot process largely correspond with other findings in the literature, indicating fresh insect biomass almost twice more sustainable than fresh chicken meat. Produced at pilot scale, protein concentrate (insect meal) while being competitive against animal-derived (whey, egg protein, fishmeal) and microalgae, has higher environmental impacts than plant-based meals. Further scenarios illustrate strategies for more sustainable use of environmental resources providing guidance for producers and funding agencies to direct the industry to an impact profile that is lower than many existing protein sources.

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ICEF13 – Abstract proposal

Modeling of UV light processing of liquid products and surfaces

Tatiana KOUTCHMA

Agriculture and Agri-Food Canada, Guelph (ON) Canada

Abstract

Ultraviolet (UV) processing holds promise as a lower cost non-thermal alternative to treatment of beverages and surfaces of fresh produce or finished products. The commercial application of UV technology for liquid products and surfaces is still limited mainly due to the lack of the established approaches for systems and process development and validation. Currently low-pressure (LP) sources at 254 nm are used but new alternative sources at multiple wavelengths such as light emitting diodes (LEDs) are emerging.

The computational fluid dynamics (CFD) was used (1) to evaluate UV fluence distribution in low UVT liquids based on modeling of flow patterns and UV irradiation; (2) to predict the efficacy of microbial inactivation using the kinetic models by coupling with transport phenomena; (3) to calculate the optimal dimensions of the UV reactors by taking into account physical and optical properties of liquids and required reactor performance; and (4) to validate reactor performance through biodosimetry. The critical input parameters to CFD will be discussed and summary of the modeling results of UV inactivation in laminar, turbulent, Dean and Taylor-Couette flow for single and multiple lamp concentric reactors are presented. Additionally, the results of modeling of UV inactivation on surfaces at multiple wavelengths using LP lamp and LEDs will be discussed.

The results demonstrate that mathematical modeling is an effective tool to improve the efficacy of UV treatment of liquids and surfaces by simulating and optimizing process performance and can provide evaluation of UV dose and optimal design of UV systems with matching irradiation sources.

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Inactivation of beer yeast by pressurized carbon dioxide microbubbles and its mechanism analysis

Fumiyuki KOBAYASHI, Sachiko ODAKE

Nippon Veterinary and Life Science University, Musashino, Japan

Abstract
Yeast in unfiltered beer (UFB) was inactivated by pressurized carbon dioxide microbubbles (CO_2MB) and the quality of its treated beer were evaluated. Additionally, intracellular acidification and damage of cellular membrane on the inactivation of *Saccharomyces pastorianus*, a beer yeast, by CO_2MB were investigated. Five log reductions of yeast in UFB were able to be achieved by CO_2MB treatment at 50°C for 5 min, although not by the heat treatment at 80°C for 5 min. The CO_2MB was recognized to have less influence of materials in beer than heat treatment on the beer quality by sensory evaluation and component analysis. Therefore, CO_2MB showed a promising technique for inactivating yeast in UFB. In addition, the surviving number and intracellular pH (pH_{in}) of *S. pastorianus* cells decreased and propidium iodide (PI) uptake ratio increased by CO_2MB at 40°C. Furthermore, the decrease of the surviving number and the pH_{in} and the increase of the PI uptake ratio of *S. pastorianus* cells were significantly induced by increasing the temperature of CO_2MB to 45 and 50°C. Therefore, the inactivation of *S. pastorianus* by CO_2MB was suggested to be induced by the damage to the cellular membrane at 45 and 50°C, and by the lowering of the pH_{in} at 40°C. Additionally, intracellular acidification of *S. pastorianus* by CO_2MB was due to the cell penetration of extracellular H^+ associated with the temperature increase, and the inactivation was suggested to be induced by the combined factors of temperature-increasing, pH_{in}- and extracellular pH-lowering and high dissolved CO_2 concentration.

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State diagram of non-starch polysaccharides isolated from overripe bananas (*Musa cavendishii*)

Bianca MARQUES[1], Carmen TADINI[1]

[1]*Universidade de São Paulo, São Paulo, Brazil*

Abstract

The aim of this work was to characterize non starch polysaccharides (NSP) obtained from overripe bananas, using differential scanning calorimetry (DSC), and vapor sorption isotherms, in order to build a state diagram, and select the best usage and storage conditions. NSP samples were obtained using overripe bananas puree. The sugars were extracted using ethanol, resulting in an insoluble, NSP-rich fraction. This process was carried out under six different combinations of temperature (25 °C or 65 °C) and extraction time (30, 60 or 90 min). For comparison, pure arabinoxylan (AX) and galacturonic acid (PGA) samples, which are NSP components of banana, were also analysed. After the extraction, thermal analysis was carried out in aluminium pans, under nitrogen atmosphere. Samples were cooled up to -60 °C, then heated up to 90 °C, at a 5 °C/min rate. Sorption isotherms were obtained by Dynamic Vapor Sorption (DVS) method, at room temperature, from aw = 0,10 to aw = 0,95. Tests with low moisture contents resulted in no crystallization peaks, but glass transitions occurred. To build state diagrams and mark their zones, Gordon- Taylor and Chen models were, respectively, adjusted to glass transition and fusion onset data. Sorption isotherms had type III formats. The monolayer moistures calculated using the GAB model were between 6 g/ 100 g sample and 16 g/ 100g sample (dry basis). The shelf life, at 25 °C in polyethylene bags containing 1 kg of NSP, was estimated between 304 and 789 days.

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Transformational strategies to address current protein challenges

Prof Brijesh K Tiwari
Teagasc – Irish Agriculture and Food Development Authority, Dublin, Ireland
brijesh.tiwari@teagasc.ie

Abstract

Global protein production faces unachievable demands due to population growth along with other socio-economic challenges unless alternative strategies are adopted. There are many strategies available to respond to growing global protein demand which span alternative sources of protein, reduction in protein losses and technological advancements. Novel unconventional sources of protein and improved protein recovery from food processing streams while employing novel biotransformation techniques will facilitate a bridging of the gap between protein supply and demand. Novel sources of protein require the development of new value chains, and attention to issues such as production costs, food safety, scalability and consumer acceptance. A range of existing and novel protein sources in terms of their potential to sustainably deliver protein, considering drivers and challenges relating to nutritional, environmental, and technological issues will be discussed in this paper. Also eco-innovative extraction technologies which emerged mostly as alternative approaches for conventional technologies will be outlined. Their main aim is to enable the production of safe, nutritious and chemical-free proteins with preserved techno-functional properties. Although some of these technologies have been investigated extensively for the recovery of protein, the majority of them require further development prior to commercial adoption.

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Improving glycemic control with foxtail millet foods and how to get them in the marketplace

Fan Zhang[1], Yongxia Fu[1], Xin Ren[1 2], Qun Shen[1]
[1] *China Agricultural University, Beijing, China*
[2]*Beijing Technology and Business University, Beijing, China*

The study was to investigate the effect of foxtail millet on glycemic control in subjects with impaired glucose tolerance (IGT). 82 subjects with IGT were separated into two groups for a 12-week foxtail millet diet intervention test, among 18 subjects was control group and others were experimental group. Subject was asked to take foxtail millet-derived products containing 50 g of foxtail millet each day for 90 days. The blood glucose, blood lipid, blood pressure, kidney function, cytokines and other body indexes were fully investigated at week 0, 6, and 12, respectively. The intake of 50g of foxtail millet per day after 12 weeks significantly decreased fasting blood glucose compare with the very beginning (5.74 ± 0.12 at week 0 vs 5.30 ± 0.09 at week 12), 2h-glucose after oral glucose tolerance test (OGTT, 10.21 ± 0.33 at week 0 vs 9.36 ± 0.28 at week 12), HOMA-IR (4.16 ± 0.33 at week 0 vs 3.34 ± 0.25 at week 12) and obesity degree (110.03 ± 1.90 at week 0 vs 108.33 ± 1.73at week 12) and significantly increased leptin concentration (8.30 ± 0.82at week 0 vs 9.55 ± 0.89 at week 12) in subjects with IGT. The intake of 50 g of foxtail millet also has trend to lower the blood lipid and pressure, and increasing kidney function, bone density and body inflammation. Foxtail millet diet significantly improved the glycemic control, especially the postprandial glucose, by increasing insulin sensitivity and leptin concentration and alleviating inflammatory condition in subjects with IGT.

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Tuning the intrinsic stress tolerance of probiotic cells for enhanced survival ratio in spray drying for production of active dry probiotics

Nan FU[1], Fan HAO[1], Yuwen SU[1], Xiao Dong CHEN[1]

[1]*China-Australia Joint Research Center of Future Dairy Manufacturing, School of Chemical and Environmental Engineering, College of Chemistry, Chemical Engineering and Materials Science, Soochow University, Suzhou, Jiangsu Province, China*

Abstract
Producing active dry probiotics using spray drying could substantially lower the product cost and increase the production capacity compared to the conventional freeze drying approach. The main challenge lies in the preservation of the viability, activity, and functionality of probiotic cells during spray drying. Several approaches have been employed in the literature to increase the survival ratio of spray dried probiotics, including the preadaptation to increase the intrinsic stress tolerance of the cells, utilization of protective agents as carrier(s), and modification of spray drying conditions. Rather than adopting an additional preadaptation stage, we attempted to modulate the stress tolerance of probiotic strains during the culturing stage and the feed preparation stage. By growing cells under less favorable conditions, *Lactobacillus rhamnosus* GG, *Lactobacillus acidophilus* NCFM, and *Lactococcus lactis* ssp. *cremoris* all demonstrated enhanced resistance in heat treatment and increased survival ratio after spray drying. The degree of enhancement varied according to the growing conditions and specific strain used. We further compared several methods for mixing cell pellets with protectant agents, because the mixing step may cause osmotic stress which would be one of the main detrimental factors during spray drying. The results showed that the method of mixing also impact the survival ratio of spray dried cells. Generally speaking, by increasing the stress tolerance of cells during culturing stage and adapting cells to osmotic stress prior to spray drying, it is possible to improve the survival ratio of probiotics cells by 2-4 fold after spray drying without additional preadaptation operations.

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Impact of heat pump drying on quality of Arabica green coffee

Fareeya KULAPICHITR[1], **Chaleeda BOROMPICHAICHARTKUL[1]**, Inthawoot SUPPAVORASATIT[1], Keith CADWALLADER[2]

[1] *Department of Food Technology, Faculty of Science, Chulalongkorn University, Bangkok, Thailand*
[2]*Department of Food Science and Human Nutrition, University of Illinois at Champaign-Urbana, West Pennsylvania Avenue, Urbana, Illinois 61801, United States*

Abstract
This study aims to investigate the effect of heat pump drying on physicochemical properties of coffe. The wet parchment coffee, processed from Arabica coffee cherries were dried in a heat pump dryer at 40, 45, 50 °C. Moisture content, water activity (a_w), color, total phenolic content, DPPH radical scavenging (%) and reducing antioxidant powered by FRAP assay were determined. Head Space Solid Phase Micro Extraction/Gas Chromatography Mass Spectrometry (HS-SPME/GC-MS) were applied to investigate volatile profile of dried coffee. The result showed that application of heat pump drying at 50 □C could dry coffee to the safe moisture content <12 % (w.b.) with a_w less than 0.6 and shortest drying time at 11 hours. In term of color, all heat pump dried sample gave the brighter color than tray dried and sun dried coffee. Heat pump dried coffee at 50 □C gave the highest total phenolic content and reducing antioxidant power at 53.19±4.67 mg GAE/g coffee bean and 652.67±22.93 mg Trolox/g coffee bean, respectively. Hence, this condition of heat pump drying was selected to determine the volatile profile compared with tray dried (50 □C) and sun dried coffee. Volatile analysis indicated the similar profile of heat pump dried coffee compare with the others drying method in this study but heat pump dried coffee had more development in total aroma components. Sixteen key odorants contributed to character of coffee gained their intensity more in heat pump dried coffee when compared with tray dried and sun dried coffee.

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Relationship between structure and oil absorption in cereal fried batter and dough

Oluwatoyin ONIPE[1], Daniso BESWA[2] and Afam I. O. JIDEANI[1]
[1]*University of Venda, Thohoyandou, South Africa*
[2]*University of South Africa, Florida Campus, South Africa*

Abstract
Oil absorption in a food matrix is dependent on product formulation and processing conditions that may affect its microstructure, physical and chemical state. To reduce oil absorption in food, the mechanism of uptake in relation to food structure is vital for regulation and reduction in cereal fried foods. Two types of a cereal fried snack (*magwinya*) were produced from a batter and dough which were deep-fried under atmospheric conditions to a bubble end point, maintaining a thermal driving force of 70°C (T_{oil} -$T_{boiling\ point\ of\ water}$). Moisture loss and oil distribution based on the food structure were analysed viz: surface oil (SO), penetrated surface oil (PSO) and structural oil (STO). Fried dough (FD) had a harder crust, compact and fine crumb which accounted for lower moisture and oil uptake compared to fried batter (FB) with a softer crust and porous crumb structure. Results indicate that moisture loss was significantly lower ($p < 0.05$) in FB (10.31%) than FD (11.47%). Multivariate analysis revealed that linear effect of initial moisture content of the dough significantly ($p<0.0001$) influenced the dependent variables. FB showed higher PSO (62%) and STO (23%) and lower SO (15%) than FD counterparts (which presented 14% STO and 43% each for SO and PSO, respectively). A STO<SO<PSO trend was observed in FB while FD followed a STO<SO=PSO trend. Results show that product (dough/batter) formulation is useful for measurement, modelling and regulation of moisture loss and oil absorption in cereal-fried foods.

Keywords: food structure, oil absorption, cereal-fried-snack, *magwinya*

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Modeling and simulation of temperature and lethality distributions in a unit for continuous flow pasteurization of mango puree

Tamires K. OISHI1, Guilherme RUSSO1, Jorge A. W. GUT1,2

1*University of São Paulo, Dep. Chemical Eng., Escola Politécnica, São Paulo, Brazil*
2*FoRC – Food Research Center, University of São Paulo, São Paulo, Brazil*

Abstract
Continuous thermal processing of liquid foods must provide the desired lethality level to guarantee food safety with minimum degradation of quality attributes (sensorial and nutritional characteristics) and energy consumption. However, over-processing is usual because of the assumptions used to simplify the process design (negligible changes during heating, cooling and isothermal holding at minimum residence time). In order to provide an important tool for
evaluating the impact of thermal processing in a food product, the aim of this work was to develop and test a mathematical model for a continuous flow pasteurization of a non-Newtonian liquid in laminar flow through helical coils and microwave heat exchangers taking into account heat and mass dispersions, velocity profile and heat losses. The model comprises a set of differential equations for heat and molar balances applied to the heating, cooling and holding tube sections. The model was discretized for both axial and radial components and solved using finite difference approximation, supplied in the software gPROMS. The model was used to simulate the thermal processing of mango puree (power law fluid) and its results showed a significant effect of the model assumptions, and the model proposed is reliable to predict temperature and lethality distribution on the equipment. The technique was useful to analyze the process performance, for instance, it is expected that this study can contribute with the design of continuous thermal process of liquid foods in order to optimize equipment design and operational conditions.

Effect of non-thermal processing on the aromatic profile of Cantaloupe melon juice

Radoslav GEORGIEV[1,3], Joel PEREIRA[2], Joana F. FUNDO[1], Fátima A. MILLER[1], Teresa R.S. BRANDÃO[1], Vesela I. CHALOVA[3], **Cristina L.M. SILVA[1]**

[1]*Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Porto, Portugal*
[2]*Universidade Católica Portuguesa, CINATE, Escola Superior de Biotecnologia, Porto, Portugal*
[3]*University of Food Technologies, Department of Biochemistry and Molecular Biology, Plovdiv, Bulgaria*

Abstract

Consumers demand for fresh-like and nutritious food products have launched research to alternative and milder non-thermal processes, which have gained particular importance in fruit juice segments. Aroma plays a dominant role in flavor and can be considered a key indicator for evaluating juices quality. Ultraviolet-C (UV-C) radiation and ozone-based treatments are alternatives to the conventional thermal pasteurization, avoiding the negative impact of high temperatures on flavor characteristics.
The objective was to apply those treatments to melon (*Cucumis melo* var. *reticulatus*) juice and assess 34 key aroma volatiles (acetate and non-acetate esters, aldehydes, alcohols, and sulfur compounds).
UV-C radiation (13.4 W/m^2) was applied for 5 and 20 minutes (UV_5, UV_{20}), gaseous ozone treatments (~7.0 g/L) for 10, 30 and 60 minutes (O_{3-10}, O_{3-30}, O_{3-60}) and pasteurization (72 ºC) for 15 seconds. Aroma volatiles were evaluated by gas chromatography-mass spectroscopy.
Fresh juice had mainly non-acetate volatiles (70%), alcohols (25%) and acetates (5%). Remaining volatiles were detected as residual traces. Non-acetate volatiles were dramatically reduced after all treatments applied. Alcohols content was detected in considerable amounts after all treatments exposure, higher than in fresh juice. Aldehyde volatiles increased significantly with O_{3-30} and O_{3-60} (43% and 65%). Acetates increased 9 times with pasteurization and UV_5, and 7 times with O_{3-10}, and, as the treatment time increased, the values were similar to the ones detected in fresh juice.
Compounds such as ethyl butanoate and ethyl 2-methyl butanoate that are important aroma contributors even in low amounts were reduced to non-detectible threshold, after all treatments applied.

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Food Engineering in China – Highlights and Concerns

Xiao Dong Chen

School of Chemical and Environmental Engineering, Soochow University, Jiangsu Province, People's Republic of China

Abstract

The immense size, scope and diversity of Food Engineering in China is challenging. While it is difficult if not impossible to furnish a thorough overview of Food Engineering and its status in China, a number of developments can be identified. This presentation will reveal a few key contributions made by Chinese Food Engineering researchers in academia and in industry. It is important, for example, to observe some of the trends in food markets in China, including the adaptation of modern consumer technologies. There is no doubt that a paradigm shift in Food Engineering is occurring in China. If not being totally innovative, a trend towards recognition the serious concerns of health and psychological matters of the populations is obvious. The speaker sometimes refers to such trend as the Food Engineering 'above the neck line' and that 'below'. Food safety is still a major issue which is affected primarily by the environmental pollution and sometimes the fear on genetic manipulations (all affecting the perceived origins of the food products). Food Engineering practice in China captures a large number of smart young people in both education sectors and commercial sectors. It is also exciting to see the multi-scale approach like those in other engineering disciplines also prevails now in food area. In addition, supposedly as in other developed countries, big data and intelligent processes are emerging in China - Big Time.

DEPTH CAMERAS AS A MEANS OF DETERMINING SPATIAL DEFORMATION DURING BOX COMPRESSION TESTING

Gabe REDDING[1], Kelly WADE[2], Eli GRAY-STUART[3], Kate PARKER[2], John BRONLUND[3]

[1]*Massey Agritech Partnership Research Centre, Palmerston North, New Zealand*
[2]*Scion, Rotorua, New Zealand*
[3]*Department of Chemical and Bioprocess Engineering, Massey University, Palmerston North, New Zealand*

Abstract
Box compression testing is an important tool for evaluating the compressive strength of corrugated fibreboard packaging. The utility of such testing can be enhanced when coupled with digital image correlation (DIC), which enables the measurement of full displacement and strain fields.
Unfortunately, DIC can be both expensive and cumbersome to implement. Therefore this work examined the feasibility of using commercially available depth cameras as a potentially inexpensive and convenient alternative to DIC for measuring spatial deformation during box compression.
Box compression tests were carried out and monitored with both a DIC setup and an Intel RealSense depth camera to produce point clouds sampled at a rate of at least 10 Hz. The DIC served as the ground truth data to which the depth camera results were compared.
The results showed that the depth camera was able to record deformation patterns consistent with those collected from the DIC setup with a depth accuracy of ± 7 mm when the depth camera was positioned 60 to 65 cm from the fibreboard, which improved to as good as ± 2 mm when positioned at closer distances of 20 to 25 cm. These results suggest that for some applications depth cameras may represent a suitable alternative to DIC for monitoring the spatial deformation of box compression. For such applications depth cameras have the substantial advantages of being easier to setup than DIC, since box speckling is not required, and relatively inexpensive.

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Drying of 'Phulae' Pineapple by Impingement Technique

Lamul WISET[1], Nattapol POOMSA-AD[1]

[1]*Mahasarakham University, Maha Sarakham, Thailand*

Abstract
The research aims to study the effects of temperature and nozzle hole diameter by impingement drying technique on drying kinetic of Phulae pineapple, energy consumption and color of the product. The pineapple was sliced at a diameter of 6 cm and 0.5 cm thick. The specific air flow rate was fixed throughout the experiment at 0.555 kg s^{-1}/ kg of product. Temperatures of 45, 60 and 75 °C and nozzle hole diameter of 0.75, 1.50 and 3.00 cm were the condition to be used in this study. The results showed that drying at 75 °C with nozzle hole diameter of 1.50 cm had the highest drying rate and the lowest specific energy consumption. The drying time and specific energy consumption were 500 min and 0.23 kWh/kg of evaporated water. However, when consider in color, it was found that the optimal condition was drying at 60 °C with 1.50 cm nozzle hole diameter.

Food Engineering in China –Highlights and Concerns

Xiao Dong Chen

School of Chemical and Environmental Engineering, Soochow University, Jiangsu Province, People's Republic of China

Abstract

impossible to a thorough of in China.   reveal a few key contributions made by Chinese researchers in academia and in industry. It is to some of the trends in market in China including the adaptation of modern consumer technologies. There is no doubt that in China not being totally innovative, a trend towards the serious concerns health and psychological matters of the populations. The speaker sometimes refers as the 'above the neck line' and that 'below'. Food safety is still a major issue which is affected primarily by the environmental pollution and sometimes the fear on genetic manipulations (all affecting the perceived origins of the food products). Food practice in China captures a large number of smart young people in both education sectors and commercial sectors. It is also exciting to see the multi-scale approach like those in other engineering disciplines also prevails now in food area. In addition, supposedly as in other developed countries, big data and intelligent processes are emerging in China - Big Time.

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Improving fat encapsulation in spray-dried dairy powders

Cordelia SELOMULYA
Department of Chemical Engineering, Monash University, Clayton, Australia

Abstract
Powdered products extend shelf life and ease of transport, and are commonly produced via spray drying. Our previous works demonstrated that the amount of surface fat tends to be over-represented in dairy powders, regardless of formulation (low fat or fat-filled emulsions) and the atomisation process [1, 2]. The adverse effects of surface fat include off-flavour due to oxidation, poor wettability, and reduction of shelf stability. This talk will provide an overview of several strategies to improve fat encapsulation in spray-dried powders, including by adding surfactants [3] or anionic polysaccharide [4] in the emulsion, or by mild heat treatment to induce Maillard reaction [5, 6] prior to spray drying.

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The effect of Cells Alive System (CAS)

ABI Co., Ltd. contribute to enrich human life with Cells Alive System (CAS), which enables to keep the inherent freshness and tastiness of food withholding from deterioration and enables long term preservation. CAS technology has been used for research purposes in the medical field, and has created some results. For example, (1) succeeded in cryopreservation technology of teeth, it is important for the periodontal membrane to survive in order to regenerate and transplant after extracting teeth after freezing tooth extraction, CAS succeeded in freezing this periodontal membrane without damage. (2) succeeded in cryopreservation and regeneration and transplanting experiments on of cynomolgus monkey ovaries. This made it possible to cryopreserve, regenerate and transplant without cryoprotective agent of cynomolgus monkey ovary, and without icing and freezing protective agent. (3) Regarding CAS freezing organs of female rats, CAS was highly evaluated the superiority of CAS in a point o0f histological view.The CAS provided for these medical research has been improved and evolved each time, This technology is fed back to the CAS for food stuff. Although we are receiving high evaluation as actual result of CAS, since the early CAS was still inexperienced technically. ABI has been receiving some criticisms that scientific basis of CAS could not be sufficiently proved quantitatively. Under such circumstances ABI has been accumulating data of CAS performance for 10 years in one academic institution. As a result, I would like to report the scientific basis of CAS this tine.

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COUPLED TRANSPORT AND CFD MODELLING FRAMEWORK FOR INTERMITTENT MICROWAVE CONVECTIVE DRYING of PANT BASED FOOD

Md. Imran H. KHAN*, Z. WELSH, M.A. KARIM
Science and Engineering Faculty, Queensland University of Technology (QUT),
2 George St, Brisbane, QLD 4000, Australia
*Corresponding Author's Email: azharul.karim@qut.edu.au

Abstract

Heat and mass transfer coefficients between food materials and drying medium significantly influence the drying rate. Application of microwave (MW) together with convective heat makes the interaction between food samples and drying medium very complex. Uneven MW power distribution in the drying chamber results in complex non uniform changes in the properties in the drying medium and intermittent use of MW makes the condition further complex. Due to this complexity, drying models integrating the effects of dynamic changes in drying medium properties for intermittent microwave convective drying (IMCD) of food material have not been developed yet. Therefore, the main aim of this research is to develop a comprehensive CFD integrated simultaneous heat and mass transfer IMCD model for food drying. The momentum and heat transfer were directly taken into consideration using Navier-stokes equations for turbulence flow paired with an appropriate boundary layer approach. We applied k-ω turbulence model for CFD analysis and Maxwell equations were considered for volumetric (microwave) heating. The developed model was solved using COMSL Multiphysics 4.2 finite element-based software. The test result show dynamic changes in the drying medium due to IMCD application significantly affects the drying rate and drying time. CFD analysis shows the presence of variable flow field around the sample, which results in variable convective coefficients at different locations of the sample. It is also found that microwave intermittency also significantly affects the drying kinetics. Simulation results were validated by extensive experimental investigations. The findings of this study will enhance the actual understanding of IMCD in a real drying environment.

ICEF13 ABSTRACT TEMPLATE HICKS

Abstract title: Food Security, Income Generation, through Enterprise Skills Development for Village Level Food Processing.

Author: Alastair HICKS[1]

Affiliation [1] *International Academy of Food Science and Technology IAFoST, Nonthaburi, Thailand.*

Abstract text

Abstract
Background & Objectives: Four ASEAN countries Cambodia, Laos, Myanmar and Vietnam have needs for food enterprise development, marketing skills and means of coordinating households and communities into cooperative action. The objective is to develop their capability to operate small rural food systems, for food security, income generation and poverty reduction.
Content of presentation:

- National focal persons are trained in a portfolio of technical skills, who in turn train villagers on small scale food processing. Traditional food products are upgraded in regional tourist sectors.
- Safe hygienic practices are developed for traditional food products, supply chains and packaging is upgraded. Food technology value-addition is linked to credit-oriented projects in-country.
- National food pilot sites are established as active, sustainable food enterprises, to train villagers.

Conclusions: Cambodia and Laos' rural industrialization and crop diversification programmes are active; Myanmar uses entrepreneurial skills to develop rural income diversification; Vietnam 's Occupational Community Villages (OCV's) developing economies of scale in food processing
Significance and Impact: Agriculture, together with added-value activities on and off-farm, are primary sources of income for these populations, lacking any economic safety net.
Keywords: Food Security, Village Food Processing, Value-Addition, Poverty Reduction, Vulnerable Groups Empowerment. **Conflict of interest disclosure:** The author declares no conflict of interest, in terms of scientific, financial and personal.

A SIMPLIFIED CFD NUMERICAL MODELLING OF AIRFLOW AND HEAT TRANSFER IN A VENTED PALLET OF CHEESE

Anh Thu PHAM[1 2 3], **Jean MOUREH[1]**, Denis FLICK[1 2]
[1] *IRSTEA, Génie des Procédés Frigorifiques (GPAN)*
Antony, 92160, France
[2] *AgroParisTech, Inra, Université Paris-Saclay, UMR Ingénierie, Procédés, Aliments (GENIAL)*
Massy, 91300, France
[3] *CNIEL, French Dairy Board – DirAST,*
Paris, 75314, France

Abstract

During refrigerated transport and storage, cheese generates heat via respiration of the living microorganisms. Therefore, free/mixed convection phenomena are expected to occur within the pallet and to interact with forced convection around it. The optimal ventilation system associated with a suitable design of vented packages should promote internal ventilation within the pallet. This allows cold air to flow within and around the packed product and enables warm air to evacuate.

A simplified 3-D computational fluid dynamics (CFD) model was developed with the commercial CFD code ANSYS Fluent 18.1 to investigate heat transfer and airflow patterns within a one layer of a pallet of cheese. The model takes into account the disposition and the shape of the cheese within the cardboard, the locations and dimensions of the holes and the natural convection due to the heat generation by the products. The aim is to gain a better insight on the effect of all these parameters on the local heterogeneities of velocities and temperatures within the packages.

The experiments were carried out on a scale model of a pallet of cheese in which the cheese was replaced by plaster blocs; each bloc being equipped with a heating resistance to simulate the produce heat generation. The pallet was placed in a room under controlled operating conditions for temperature and velocity. The air velocity within the pallet was measured by using the laser Doppler Velocimetry (LDV). The numerical predictions show a reasonable agreement with experimental data related to temperature and velocity profiles.

Investigation of the microwave and conventional heating effect on secondary structure and conformational change of horseradish peroxidase by FTIR and circular dichroism spectroscopy

Rodrigo N. CAVALCANTI[1,2], Amal MOHAMED[3], Jorge A. W. GUT[1,2], Carmen C. TADINI[1,2], Ashraf A. ISMAIL[3], Hosahalli S. RAMASWAMY[3]

[1] *University of São Paulo, Escola Politécnica, Department of Chemical Engineering, Main Campus, 05508-080, São Paulo, SP, Brazil*
[2] *University of São Paulo, FoRC/NAPAN – Food Research Center, 05508-080, São Paulo, SP, Brazil.*
[3] *McGill University, Macdonald campus, Department of Food Science and Agricultural Chemistry, 21,111 Lakeshore, H9X 3V9, Sainte Anne de Bellevue, Quebec, Canada*

Abstract
Nowadays, browning is still a major problem for various fruit products due to lowering of quality, safety, and nutritional value. This work focused on the investigation of the microwave and conventional heating effects on the molecular structure of the horseradish peroxidase (POD), which was determined using Fourier-transform infrared (FTIR) and circular dichroism (CD) techniques. The residual enzymatic activity gradually decreased with an increase in temperature, being almost completely inactivated at 90 °C; however, microwave heating exhibited a more effective enzymatic inactivation. Fourier self-deconvolution analysis was applied to the amide I region (1700–1600 cm^{-1}) for quantitative determination of secondary structural changes. The untreated sample had 34.39% α-helix, 24.74% β-sheet, 4.14% β-turn, 23.40% random coil and 13.33% aggregated β-sheet structures. Similar result was obtained by CD analysis where the untreated peroxidase had 41.9% α-helix, 9.9% β-sheet, 28.9% β-turn and 19.3% random coil. This indicates tertiary structure of the enzyme was predominately classified as alpha-beta conformation and the secondary structure was predominately α-helix. According to FTIR studies, α-helix, β-sheet and random coil contents decreased whereas β-turn and aggregated β-sheet structures increased with an increase in temperature. CD studies also showed a decrease in α-helix content with increasing temperature; however, an increase was observed for β-sheet and random coil instead. Both thermal treatments-induced protein denaturation at 90 °C. Although no significant differences were observed between thermal treatments with respect to the secondary and tertiary structures, more pronounced conformational changes were observed for microwave heating.

Evaluation of secondary structure and conformational change of mushroom polyphenol oxidase during microwave and conventional heating by FTIR and circular dichroism spectroscopy

Rodrigo N. CAVALCANTI[1,2], Amal MOHAMED[3], Jorge A. W. GUT[1,2], Carmen C. TADINI[1,2], Ashraf A. ISMAIL[3], Hosahalli S. RAMASWAMY[3]

[1] *University of São Paulo, Escola Politécnica, Department of Chemical Engineering, Main Campus, 05508-080, São Paulo, SP, Brazil*
[2] *University of São Paulo, FoRC/NAPAN – Food Research Center, 05508-080, São Paulo, SP, Brazil.*
[3] *McGill University, Macdonald campus, Department of Food Science and Agricultural Chemistry, 21,111 Lakeshore, H9X 3V9, Sainte Anne de Bellevue, Quebec, Canada*

Abstract
Fruits are an integral part of a healthy diet, providing essential micronutrients such as vitamins, minerals, antioxidants, phytochemicals, sugars and dietary fiber. Oxidative enzymes like polyphenol oxidase (PPO) are responsible for the deterioration of color, flavor, and nutritional value in fruit juices and purees. Thermal processes can be used to inactivate undesirable microorganisms and enzymes to enhance food safety and storage life. This study evaluated the effects of microwave and conventional heating on the molecular structure of the enzyme polyphenol oxidase (PPO) and its correlation with the residual enzymatic activity. The conformational changes were determined by Fourier-transform infrared (FTIR) and circular dichroism (CD) analyses. The residual enzymatic activity decreased with temperature increase, exhibiting approximately 20% at 90 °C for both thermal treatments. According to FTIR spectra, untreated sample and sample treated at 70 °C were similar in terms of the shape of amide I band. Fourier self-deconvolution analysis showed untreated sample contains 37.7% α-helix, 27.6% β-sheet, 14.4% β-turn, 13.8% random coil and 6.5% aggregated β-sheet structures. A progressive decrease of α-helix and β-sheet was observed with increasing temperature while an increase occurred for β-turn, random coil and aggregated β-sheet structures. On the other hand, CD analysis exhibited 38.1% α-helix, 17.0% β-sheet, 17.9% β-turn and 27.0% random coil for the untreated sample with α-helix content decreasing with the increase of temperature, while β-sheet, β-turn and random coil increased for both thermal treatments. These results indicated that both thermal treatments destroyed the native structure of PPO, resulting in the rearrangement of secondary structure.

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A call for developing a collaborative education and training platform dedicated to humanitarian food engineering

Dominique BOUNIE[1], Donna ROSA[2], Jay SELLAHEWA[3], Teodorina TIBAR[1], John VAN CAMP[4]
[1]*University of Lille, Villeneuve d'Ascq, France*
[2]*Aidtrepeneurship, Miami, Florida, USA*
[3]*CSIRO Agriculture and Food, North Ryde, NSW, Australia*
[4]*University of Ghent, Ghent, Belgium*

Humanitarian issues encompass more than emergency relief alone. They also embrace the prevention and rehabilitation phases and connect to long-term development schemes. “Humanitarian” means that answers to shocks must be human-centered before being technical, ensuring that resilient, inclusive and sustainable responses are tailored, whenever possible, to and by beneficiaries, preferably to and by donors.

Today, crises strike not only episodically, they become structural (e.g. climate and economic shocks); they unfold not only in remote countries but in developed countries too; they question our current and future growth models. Anticipating, responding to and recovering from such complex situations require holistic, multi-disciplinary and proactive approaches. Accounting for uncertainties while preparing for a secured wealth for tomorrow requires reshaping our knowledge and skills; this strongly advocates for investing on humanitarian “smart” engineering and global awareness. Therefore, educating humanitarian managers and field practitioners on these diverse issues should be one of our priorities.

Humanitarian food engineering is of particular interest when addressing the basic needs of shock-affected populations (preservation, locally processing more nutritious and safe food…). Unfortunately, it appears this discipline has been poorly covered, and implementing partners generally lack the capacity to develop relevant curricula. It is therefore up to the food engineering community to develop them.

Building on the experience gained from a short program jointly developed by the Universities of Lille and Ghent, we strongly advocate that humanitarian engineering is included in food engineering curricula and a specific interactive e-learning platform, including case-studies, be collaboratively developed and further deployed among the humanitarian community.

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A new fractional differential model for anomalous heat and mass transfer during food drying

Md MAHIUDDIN[1, 2], Fawang LIU[1], Azharul KARIM[1*]

[1]*Queensland University of Technology, Brisbane, Australia*
[2]*Dahka University of Engineering & Technology, Gazipur, Bangladesh*

Abstract

Fruits and vegetables are complex heterogeneous biological materials and hygroscopic-porous-amorphous in nature which contains 80% to 90% water in different cellular environments. This vast amount of water makes the food materials highly perishable. Demand for fresh-like dried foods with extended shelf life is increasing worldwide. However, food drying is a very energy intensive process and quality is deteriorated during drying. Fundamental understanding of heat and mass transfer during drying is important for controlling and optimizing food processing. Food engineering tends to lag behind in terms of innovations and the implementation of new mathematical theories. The applicability of classical drying models to the food materials is questionable due to the simplistic assumptions of considering fruits and vegetables as isotropic and homogeneous material. Changes in food microstructure during drying plays a major role in dehydration processes, which is not included in classical Fick's model. Since cells contain a high amount of concentrated and heterogeneous assembly of deformable, interacting and inelastically colliding diffusants, and great part of water is bounded to the solid structures, there are net solvent movements, which are not considered in the diffusion. Fractional differential scheme has great potential to overcome the limitations of classical theory by formulating state of the art diffusion and heat transfer model which will incorporate the anomalies of the transport process during drying. This paper develops a new drying model for anomalous heat and mass transfer using fractional differential equation and compare with the classical drying model. Fractional model shows better agreement with the experimental results compare to classical model.

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Effect of air plasma-activated water on the inactivation of *Salmonella* Typhimurium and *Pseudomonas fluorescens*

Javiera BARRALES ASTORGA[1], Francisco TRUJILLO[1],
[1]*University of New South Wales, Sydney, Australia*

Abstract
Cold plasma technologies particularly the use of plasma activated water (PAW) has been proposed as an alternative to non-thermal decontamination treatments to combat the rise in outbreaks of foodborne illnesses. This technology relies upon the generation of plasma at the gas-liquid interface thereby forming reactive species which when in contact with water will diffuse to form aqueous reactive oxygen species (ROS) and reactive nitrogen species (RNS). Studies have shown the role of ROS/RNS in the bactericidal effects of PAW against known spoilage and pathogenic microorganisms including *E.coli, S.aureus* and *H.alvei* [1-2] however the effects on the growth and survival of *S.*Typhimurium and *P.fluorescens* have not been previously reported.

Here, PAW was generated by exposing water to non-thermal spark discharge plasma for variable discharge times *d**(min) and used to treat bacterial suspensions for treatment times *t*(sec)*. Suspensions of *S*.Typhimurium and *P.fluorescens* were treated with PAW *d** = 30 for *t**= 30, 180 and 390 and PAW *d** = 10 for *t** = 390. PAW treatments of *S*.Typhimurium achieved a maximum log reduction at *t**= 390 of 2.24 with *d** = 30 and 0.85 with *d** = 10. Similarly, maximum log reduction in *P.fluorescens* population was achieved through treatment with PAW *d** = 30 (1.37) when compared with *d** = 10 (0.37). These findings indicate a high dependence on discharge and treatment times in the inactivation efficiency of PAW.

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ICEF13 ABSTRACT

Heating uniformity as a function of tray position in a MATS microwave food processing system

Ross COAD[1], Amir GHANDI[1], Lan BUI[1], Roger STANLEY[2]

[1]*Defence Science and Technology Group, Scottsdale, Australia*
[2]*University of Tasmania, Launceston, Australia*

Abstract
The research was to characterise the uniformity of heating of a rapid microwave assisted thermal sterilisation process (MATS), in order to minimise the heating required to achieve sterilisation and maximise the retention of food quality and nutrition. A carrier system conveys product trays through the continuous retort process. The probability of achieving commercial sterility is based on the minimum thermal treatment value achieved at the cold spot in any tray. Research is required to understand the variation in the heating uniformity across the carrier and mechanisms that affect it.

A MATS-B100 (915 Labs, CO. USA), conveyed product through the heating and cooling system with 10 trays in a 2x5 array carrier. The test substrate (dried potato flake and water, w/w 1:2.5) in a total mass of 450g per tray (158mm x 112mm x 32mm, polyethylene composite, Printpack, GA, USA). The loaded carrier was processed using a 35 min preheat at 85°C, then microwaving at 6-7kW under subcritical water at 125°C. Temperature was measured at the spatial centre of each tray.

Preliminary results demonstrate significant differences occur in measured F_0 value as a function of position ($p<0.05$) in both the x- and y-axes of the array. Causes could include leading and trailing effects of microwave exposure, and uniformity of temperature exposure from the circulation patterns of immersion water.

To maximise product quality, sterility needs to be generated at minimal thermal exposure. Further work is needed to model and correct for variations in carrier heating uniformity in the MATS-B100.

ICEF13 ABSTRACT

Effects of salt and lipids on heating parameters for the achievement of sterility in a microwave food processing system

Roger STANLEY[1], Lan BUI[2], Amir GHANDI[2], Ross COAD[2]

[1]*University of Tasmania, Launceston, Australia*
[2]*Defence Science and Technology Group, Scottsdale, Australia*

Abstract
The research was to characterise the effects of salt and lipids on heating parameters in trays processed through a microwave assisted thermal sterilisation system (MATS). The goal is to aid design of models to predict processing parameters that will achieve consistent sterilisation conditions with the minimum of thermal damage for different food formulations. Dielectric loss factors vary primarily as a function of ionic concentration at 915/922 MHz with efficient microwave heating being dependent on achieving rapid, uniform, volumetric heating of food components.

Trays in a 2x5 array carrier were passed through a MATS-B100 (915 Labs, CO. USA). The test substrate (dried potato flake, water (w/w 1:2.5), with varying amounts of salt and lipid) in a total mass of 450g per tray (158mm x 112mm x 32mm, polyethylene composite – Printpack, GA, USA). Trays were preheated to 85°C, then subjected to 6–7kW microwave energy in a thermal background of 125 °C, then cooled to 30°C. Temperature was measured at the tray spatial centre, and dielectric response factors were measured as a function of temperature (40–125°C) using an open-ended coaxial-line probe and network analyzer.

Results demonstrate that variation in salt content over the range 0–4% w/w has a major influence on the balance of thermal conduction and microwave heating conditions required to achieve thermal sterilisation at the mid-point of the tray. The impact of this is that more precise characterisation and modelling of real foods will be required to develop protocols for prediction of minimum conditions for sterilisation processing.

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Design and Development of a Non-Heated Solid-State Fermentor for Nigerian Indigenous Fermented Food Condiment

Abimbola OLOKOSHE[1], Lateef HASSAN[1], Toyin ONAWOLA[1], Gabriel WURAOLA[1], Oludayo ONATOYINBO[1], Olabisi OLOTU[1], Yemisi ASAGBRA[1], Olateju AREMU[1]

Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria

Abstract

Nigerian indigenous condiments such as ogiri, dawadawa and iru, are leguminous protein consumed by different ethnic groups serves as a nutritious non-meat protein substitute and flavoring agent in soup. Despite fermented food condiments having constituted a significant proportion of the diet of many Nigerian people, there is ambivalent attitude in terms of consumer taste and preference for these condiment as traditional production is by uncontrolled solid-state fermentation at household level with little or no consideration for good manufacturing practices (GMP) and sanitation, consequently, microbiota responsible for fermentation is often unpredictable and equipment used is rudimentary. There is prospect for industrialization of condiment due to an increase in the demand for fermented indigenous condiments by urban population in Nigeria.

The objective was to design and fabricate a prototype solid-state fermentation system that will conform to conditions required for the production of indigenous condiment such as temperature, limited aeration and are favorable for the growth of the chanced inoculated micro-organisms and the modification of the substrates The operational aim of the fermentor is to ensure digestion of the substrates at a temperature of about 36^0c-40^0c and there will be a change in volume as a result of exothermic reaction during the digestion of the substrates. The designed fermentor is ideal for Small Medium Enterprise's for hygienic, easy operation and maintenance

Keywords: indigenous condiment, solid-state fermentation, industrialization, fermentor

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Food texture evaluation of tempura by time-series data processing

Hiroyuki NAKAMOTO[1], Ninomae SOUDA[1], Futoshi KOBAYASHI[1], Yuya NAGAHATA[2], Yoriyasu HIROSUE[2]

[1]*Kobe University, Kobe, Japan*
[2]*J-oil Mills. Inc., Tokyo, Japan*

Abstract
A quantitative evaluation method of food texture of tempura is proposed. The method measures time-series data by a magnetic food texture sensor. After that, the method evaluates the time-series data by the dynamic time warping (DTW) and the DTW barycenter averaging. The magnetic food texture sensor consists of magnetoresistive elements and an inductor and measures force and vibration, respectively. The DTW calculates a similarity between two time-series data. To evaluate a specific crispness of tempura, the method makes standard data from force or vibration data by the DTW barycenter averaging. In experiments, we prepared five kinds of shrimp tempura which have different food texture. At first, we conducted a sensory evaluation and separated food textures to three food-texture expressions in Japanese. Then, we obtained force and vibration data by destructive testing of the tempura. Based on the relationship between the tempura and the sensory evaluation results, we determine standard data from some experimental data. Finally, we evaluated the similarities between the standard data and the experimental data by the DTW. The method evaluated quantitatively and appropriately the food textures of the tempura. We also confirmed that the time-series vibration data was a major factor for the crispness in the food texture of the tempura.

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Simulation-based enhancement of education: Food safety for engineers

Ashim K DATTA[1], Mayuri S UKIDWE[1], David WAY[1]

[1]*Cornell University, Ithaca, New York, USA*

Abstract
Customized, simulation-based interdisciplinary learning modules, where the learner can try "what if" scenarios using pre-developed simulations, are being developed as part of a multi-year nationwide project that will allow any engineer (not just a food engineer) to learn the concepts of food safety and risk more effectively. These simulation modules, while being multi-disciplinary (predictive microbiology, process engineering, risk analysis, food science), can effectively introduce risk-based, quantitative approaches without getting bogged down in the computational details. Defining distinct learning outcomes in food safety and risk assessment for engineers has been one of the challenges in the development of the modules. Novel software and educational pedagogies critically contributed to the module development. Encouraging learning enhancement data obtained from various courses (nearly 67% increase in the performance) implemented in nine different universities nationwide will be shared. The modules are intended to supplement existing courses (lectures or laboratories)—challenges in implementing will also be shared. Benefits of simulation-based learning, such as its individualized pace, being student-centered and active, are expected to make the modules attractive to students from diverse backgrounds. The module templates are easily extendable beyond food safety to food quality. A paradigm shift in food safety and quality education for engineers, enabled using these multi-disciplinary, active learning simulation modules, will better prepare the future workforce. Additionally, three levels of quantification, microbiological growth/inactivation, process plus microbiology, and risk assessment, serve as a framework for quantitative food safety education.

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Novel Educational Efforts to Help Sustain Food Process Modeling

Francesco MARRA[1], Fabrizio SARGHINI[2], Ashim K. DATTA[3]
[1] *University of Salerno, Salerno, Italy*
[2] *University of Naples Federico II, Naples, Italy*
[3] *Cornell University, Ithaca, New York, USA*

Abstract
Developing human resources in food process modeling (or food physics) is critical if this activity is to grow and ever reach the same status as food chemistry and food microbiology. We will share ways to address this without significant monetary investments or starting new specialized educational programs (e.g., an undergraduate degree in food engineering) for which there is little clientele. Web-based active-learning enabled courses are under development for an international audience that would bypass the need to create such courses at every university that has been plagued by the lack of enough interested students at any one place. Current state of web-based resources specifically for food process modeling will be shared along with discussions on platforms for lifelong learning. We will also share customized, universally usable, web-based simulation modules that we have developed for enhancement of education (not to teach modeling but using models) for two separate audiences of food science and engineering students. Enhanced training materials based on virtual reality and specialized food process simulation modules also will be shared. Experiences with in-class teaching of modeling in multiple countries, and those from three European summer workshops dedicated to modeling, will be shared. These workshops had an average of 35 students from 24 countries and covered from basics all the way to complex processes involving transport and solid mechanics, and included hands-on use of the software. In the future, the workshop will extend to a combination of mechanistic and data-driven models. Possibilities of scaling up such a workshop for presentation at additional locations around the world will be discussed.

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Coupling poromechanics, transport and kinetics as modeling framework for process, quality and safety

Ashim K DATTA[1]

[1]*Cornell University, Ithaca, New York, USA*

Abstract
Food products and processes are very large in number. Developing a framework is important for computer-aided engineering that can speed up food product, process and equipment design by enabling mechanistic understanding and speeding up optimization. One modeling framework considers evolution of a food product during processing in terms of multicomponent and multiphase transport together with evaporation in a solid or semi-solid (homogenized) porous medium that is also deformable/swellable. This framework has been successful in modeling many important processes, including drying that incorporates case hardening, rehydration, baking, frying, puffing, meat cooking, microwave heating, microwave puffing and freeze drying. Auxiliary relationships (e.g., evaporation rates, liquid pressures needed to model shrinkage/swelling) needed for such a framework have also been developed. Extension of this framework to quality and safety will be shared, showing how model predictions can be related to parameters of direct interest such as color or texture. This framework is broad, flexible, and easier (than other frameworks) to understand and implement in commercial software. Challenges in the framework include availability of thermophysical properties for such a wide variety of materials at wide-ranging states. Progress in predicting properties will be shared by giving examples from Darcy permeability, liquid moisture diffusivity, and vapor diffusivity. Computational challenges against universal use of this framework also will be presented together with user-friendly modules currently under development for industry and classroom use.

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Enabling easy, automated property prediction for everyone

Ashim K DATTA[1]

[1]*Cornell University, Ithaca, New York, USA*

Abstract
Easy, automated user-friendly access to data that are available anywhere and anytime could help in multiple ways. In industry, new food products/processes could be designed with fewer trial-and-error missteps. In education, students could graduate with a much deeper insight into food materials through discovery modes enabled by visualizations of property data clusters (i.e., how does composition affect various properties—does it affect different properties to the same extent?). Development currently underway of a generalized properties knowledge base (a database with predictive capabilities) will be described. In a multi-university and multi-country effort, frameworks for prediction of various properties data are being developed. Successes in prediction using literature prediction models will be shared. The database includes both the measured literature data and the prediction frameworks. Prediction equations are typically functions of parameters such as composition and temperature and make up for the void in measured data. To populate and scale-up the database in a sustained way, it is being built for crowdsourcing. This is intended to be a tool for the entire food community and beyond—product and process developers in industry, undergraduate and graduate courses in food engineering and science, and in research. To safeguard against misuse, it will be critical to develop controls in the crowdsourcing process. Audience suggestions in terms of needed properties or crowdsourcing features in such a database will be solicited at the end of presentation.

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Effect of tamarind (*Tamarindus Indica*) kernel powder on characteristic of extruded riceberry snack

Nipat LIMSANGOUAN[1,2], Masubon THONGNGAM[1], Chulaluck CHARUNUCH[2], Weerachet JITTANIT[1]

[1]*Faculty of Agro-Industry, Kasetsart University, Bangkok, Thailand*
[2]*Institute of Food Research and Product Development, Kasetsart University, Bangkok, Thailand*

Abstract

Tamarind (*Tamarindus indica*) is economically valuable and multi-purpose fruit. The tamarind major production areas are in Asian countries especially Thailand. Tamarind seed, a by-product of the tamarind pulp industry, is widely accepted as a cheap raw material for industrial purpose. The compositions of tamarind seeds usually vary among their varieties and maturity. The seed comprises with seed coat (20-30%) and kernel or endosperm (70-80%). Whole tamarind seed and its seed kernel are rich sources of (1) protein with fairly balanced essential amino acid level, (2) unsaturated fatty acids with high linoleic acid content, (3) minerals with high concentration of potassium and (4) carbohydrates with main proportion of xyloglucan. The aim of this research is to evaluate the characteristic [color (L*, a* and b*), expansion ratio, bulk density, texture (hardness and crispness), water absorption index (WAI), water solubility index (WSI), antioxidant capacity (AC) and total phenolic content (TPC)] of extruded riceberry snack fortified with tamarind kernel powder (TKP) at 0-50% under the operation condition as screw speed at 400 rpm and 12-14% of feed moisture content. The result indicated that the content of TKP significantly affected the characteristic of model snack ($p<0.05$). The increasing of TKP content also provided the raising of L*, a*, b*, bulk density, hardness, WAI and WSI but expansion ratio, crispness, AC and TPC were decreased. The outcome of this research would be beneficial to either researchers or entrepreneur who are interested in manufacturing the nutritious extruded snack and application of TKP in food industries.

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Study on hydration kinetics of selected Indian paddy varieties

Saikrishna ARUVA, **Sayantani DUTTA**, Preethi RAMAKRISHNAN, Jeyan Arthur MOSES, Anandharamakrishna CHINNASWAMY*

Computational Modeling and Nano Scale Processing Unit, Indian Institute of Food Processing Technology (IIFPT), Ministry of Food Processing Industries, Government of India, Pudukkottai Road, Thanjavur- 613005, Tamil Nadu, India
*anandharamakrishnan@iifpt.edu.in

Abstract
Paddy is one of the majorly cultivated food crops in the world. It is a rich source of nutrients and it is staple food for more than half of the world's population. Parboiling is a well-known technique of paddy processing which helps in retention of nutrients, improvement in yield, sterilization, resistance to insect attack and increased shelf life but the process is time and energy consuming; time-temperature combination in soaking of paddy plays a major role in optimization of parboiling process. Improper soaking conditions lead to white belly formation and cracks in the grain. This study aimed to understand the hydration behaviour of selected Indian paddy varieties at different soaking temperatures (30-70°C) for fixed time of 8 h. Pasting properties, thermal characterization of paddy by DSC, volume expansion during soaking at different temperatures were also studied. Results showed significant effects of each grain type on water absorption; colour analysis showed reduction in lightness value of paddy with increasing soaking temperature that implies loss in pigment during soaking. Study of diffusion coefficient and activation energy for each variety was also conducted. Peleg's model was fitted with the experimental data that showed good correlation for all the varieties. This study can provide scientific protocols for industrial applications.

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Microencapsulation of omega-3 fatty acid from chia seed oil and studies on its efficacy in food systems

Lavanya MN, Shweta M Deotale, Moses JA and Anandharamakrishnan C*
Computational Modeling and Nanoscale Processing Unit
Indian Institute of Food Processing Technology (IIFPT)
Ministry of Food Processing Industries, Government of India, Thanjavur – 613005
*Email: *anandharamakrishnan@iifpt.edu.in

Chia oil and fish oil were encapsulated using whey protein as wall material (1:1=core: wall) by varying outlet temperatures (50 to 65°C) of spray drying. EE of chia oil and fish oil were found to be 77.92±2.58-80±3.01% and 76.13±4.12- 80±4.10%, respectively. PV was found lesser in lower outlet temperature; it was varied from 1.03±0.15 to 3.89±0.44 and 1.4±0.28 to 3.75±0.57 meq/Kg of oil for encapsulated chia and fish oil respectively. Samples, sprayed at 55°C choosed for further analysis as it showed higher EE and lower PV. Particle size was 5.04-3.89 µm for both the powders; surface showed blow-holes indicating shell type and smooth surface of the particles. Fatty acid profile showed a considerable retention of essential fatty acids. The maximum release was found in intestinal condition, which proved that the powders were stable in acidic condition. Samples sprayed at 55°C was incorporated in protein rich millet-based biscuit (Finger millet). The proximate analysis of biscuits showed higher protein content of 16.34±1.10% to 18.09±1.15% for both the samples. The omega-3 fatty acid incorporated biscuits were showed higher acceptance in sensory evaluation. The incorporated biscuits were stored for 3 months and analysed for its rancidity. The PV was varied from 1.23±0.25 to 4.6±0.59 and 1.07±0.36 to 5.3±1.02 for microencapsulated chia and fish oil incorporated biscuit. The incorporation of encapsulated chia oil and fish oil in biscuits were successful without changing its taste and flavour.

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Liposome based delivery of α-linolenic acid and α-lipoic acid through food system

Pintu CHOUDHARY, Sayantani DUTTA, MOSES J A, Anandharamakrishnan. CHINNASWAMY *
Computational Modeling and Nanoscale Processing Unit
Indian Institute of Food Processing Technology,
Ministry of Food Processing Industries, Government of India
Pudukkottai Road, Thanjavur, Tamil Nadu-613005
*anandharamakrishnan@iifpt.edu.in

Abstract

α-Linolenic acid (9,12,15-octadecatrienoic acid) and α-lipoic acid (6, 8-dithiooctanoic acid) are well known for its antiageing potentials. α-Linolenic acid is plant-based essential omega-3 polyunsaturated fatty acids that must be obtained through the diet. It has proven therapeutic potential like prevention of cognitive disorders, cardiac and circulatory disorders, immune dysfunction, and prevent skin ageing where as α-lipoic acid is known for the health benefits such as aid in reduction of oxidative stress, reducing hypertension, improving lipid profile, averting risks of diabetes and prevent the ageing. However, the biomolecules are susceptible to environmental oxidation, therefore this study was conducted to encapsulate α-linolenic acid and α-lipoic acid together in liposome to protect the biomolecules as well as for sustained release of the same. The nanoliposomal encapsulation was carried out using solvent evaporation method followed by probe sonication. The encapsulation process was optimized using different amount of lipid along with different ratio of soy phosphatidylcholine (S) and Tween 80 (T). The nanoliposomes was assessed for parameters such as encapsulation efficiency, antioxidant activity, zeta potential, FE-SEM analyses and release of biomolecules. The data showed successful entrapment of the biomolecules in the range of 60-90% of encapsulation efficiency and desired attributes that indicate liposomal entrapment to be a suitable technique for encapsulation of α-linolenic and α-lipoic. The average particle size was in range of 20.0 to 40.0 nm with moderate repulsion among the particles and good monodispersity among them. The liposome has good antioxidant potency (IC50) and this nanoliposomes could be used as antiageing supplement in different food and/or pharmaceutical applications.

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Determination of glucose absorption in small intestine using dynamic human digestive model

Priyadarshini S R., Priyanga S., Sivakama Sundari S K., MOSES J A., Anandharamakrishnan CHINNASWAMY *
Computational Modeling and Nanoscale Processing Unit
Indian Institute of Food Processing Technology (IIFPT)
Ministry of Food Processing Industries, Government of India
PudukkottaiRoad, Thanjavur-613005, Tamil Nadu, India
**anandharamakrishnan@iifpt.edu.in*

Abstract

Blood glucose levels are regulated by various mechanisms in human body. There is an increasing demand for the best possible understanding of glucose absorption in the human intestine to design food for different physiological conditions. The oral glucose tolerance test conducted with humans, is considered to be the universal standard method for the determination of glucose absorption. However, conducting human trails each time pose serious ethical and feasibility constraints which can be overcome by *in-vitro* digestion models. The prime challenge is the exact replication of the absorption system in these *in-vitro* models. The aim of this study is to validate the glucose absorption pattern determined from artificial human digestive model with *in-vivo* glucose tolerance test of humans. Glucose was introduced into the intestinal section of the artificial small intestine system. The sample was collected at definite time intervals (0- 2 hours) from the simulated fluid passed from the intestinal compartment. The results from the artificial system was found to be 134.58 mg /dl at 30 mins and 101.01 mg/dl at 120 mins which can be comparable with 147 mg/dl at 30 mins and 101 mg/dl at 120 mins in the *in-vivo* oral glucose tolerance test. The values were found to be correlating with the *in-vivo* test. Therefore, the artificial small intestine system can be used as an alternative to the *in-vivo* models.

Hard grain red sorghum and cowpea based tempeh as a sustainable alternative for the future in Indonesia

Indrawati TANURDJAJA, Robert DRISCOLL and Jayashree ARCOT
Food and Health Cluster, School of Chemical Engineering, UNSW, Australia, Sydney 2052, Australia

Abstract

The beneficial impact of intercropping cereals and legumes for sustainable agriculture and their synergistic and complementary values for human nutrition have long been seen. The present study was undertaken to utilise two drought tolerant crops namely non-tannin red sorghum (cereal) and cowpea (legume), as sustainable alternative materials for making tempeh that is otherwise traditionally made from soya bean. Tempeh is a popular Indonesian indigenous mould fermented food and it is an important protein source for many Indonesians. This study has also streamlined the tempeh making process, by minimising the use of resources like salvaging the waste and enhancing the nutritional value to contribute to sustainable production. By implementing the streamlined co-processes (soaking, steaming and fermentation) for making tempeh, the waste water generated was minimised. The typical characteristics of the tempeh cake could be re-produced from a blend of 70% decorticated red sorghum and 30% cowpea. Similar results were found when 25% (equivalent to whole grain sorghum) of the residues from the decortication process were incorporated into the tempeh. Furthermore, there were synergistic effects of sorghum and cowpea on the growth of mould and complementary impacts on the physicochemical properties of tempeh.

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Effect of Surfactants and Oil-in-Water Emulsions on Reverse Osmosis Membrane-Performance

Aymen HALLEB[1], Fumio YOKOYAMA[2], Marcos A. NEVES[1], Mitsutoshi NAKAJIMA[1]
[1]*Graduate School of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Japan*
[2]*Alliance for Research on the Mediterranean and North Africa, University of Tsukuba, Tsukuba, Japan*

Abstract

Membrane technologies are commercially used in many sectors such as food industries, waste water treatment and so on. Up to now, only few studies have been reported about lipid effect on membrane performance. In this study, we selected two types (Cellulose Acetate; CA and Polyamide; PA) of reverse osmosis (RO) membranes and investigated the effects of surfactant types and olive oil-in-water (O/W) emulsions on Reverse Osmosis (RO) membrane performance. O/W emulsions were prepared using refined olive oil with different concentrations and constant concentration 1% of three types of surfactants; nonionic, cationic and anionic.

Experimental results of permeate flux show that nonionic and cationic surfactants did not affect the permeate flux of CA membrane. However the permeate flux of PA membrane decreased for nonionic and cationic surfactants. This decrease of permeate flux is caused by surfactant adsorption on PA membrane surface. Adsorption experiments by dipping RO membrane sheet in surfactants and O/W emulsions for 24 and 36 hours show that adsorption equilibrium was reached within this time.

For both types of RO membranes, in the concentration range less than 10 %, oil concentration in O/W emulsion had little effect on permeate flux of both CA membrane and PA membrane.

As a conclusion, this research evaluated the effect of olive O/W emulsion on RO membrane flux. The increase of oil concentration in O/W emulsions did not decrease the permeate flux. Contrarily to CA membrane, adsorption phenomena was observed for PA membrane using different types of surfactants.

[Acknowledgments]

The authors are thankful to Toray Industries, Inc. for donating the RO flat sheet membranes and Food Resource Institute for providing the RO membrane test cell.

Effect of Surfactants and Oil-in-Water Emulsions on Reverse Osmosis Membrane-Performance

Aymen HALLEB[1], Fumio YOKOYAMA[2], Marcos A. NEVES[1], Mitsutoshi NAKAJIMA[1]
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As a conclusion, this research evaluated the effect of olive O/W emulsion on RO membrane flux. The increase of oil concentration in O/W emulsions did not decrease the permeate flux. Contrarily to CA membrane, adsorption phenomena was observed for PA membrane using different types of surfactants.

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Package Design Testing through Monte Carlo Simulations for Horticultural Pre-Cooling

Jamal OLATUNJI[1], Huijian HUANG[2], Andrew EAST[2]

[1]Massey University, Auckland, New Zealand
[2]Massey University, Palmerston North, New Zealand

Abstract
Pre-cooling is a vital process for the horticultural cold chain. Pallets of freshly picked produce are stacked in refrigerated rooms, where fans are used to pull refrigerated air through the packaging structure and over the warm product, facilitating rapid cooling. This process is imperative for the preservation of fruit quality as it moves through the supply chain. Package design has a large impact on cooling performance, as the nature of the package ventilation changes the velocity profile of the refrigerated air through the system. Optimising the forced-air cooling process through physical package design testing has potential to be time consuming and costly, limiting the number of designs that can be investigated. However with an accurate mathematical model, package design performance can be rapidly assessed in a digital environment where material costs are free, and many different designs can be tested simultaneously.

In this work, a CFD model of an apple box is constructed and validated with experimental cooling data on the single box scale. A Monte Carlo loop was then initialised, where the position, size and shape of packaging ventilation was randomised. The performance of 100 randomly generated package designs were compared in terms of average cooling rate and cooling uniformity. This method offered a deeper insight into how vent characteristics impact the flow fields of refrigerated air and the subsequent levels of cooling over a very broad variety of package designs.

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Mechanistic 3D modelling of solid foods with varying shape and size using statistical shape analysis: roasting of whole chicken breast meat

Felix RABELER[1], Jacob Lercke SKYTTE[1], Aberham Hailu FEYISSA[1]

[1] *Technical University of Denmark, Kgs. Lyngby, Denmark*

Abstract

Although the changing sizes and shapes of most foods are crucial for accurate and realistic model prediction, the shape of food products has not been integrated in food process models yet. Here, we developed a statistical shape model for whole chicken breast filets and combined it with the mechanistic, heat-and-mass-transfer model of chicken meat roasting to predict the effect of the varying shape and size on the temperature and quality, such as color and texture, development.

Using a laser-light 3D scanner combined with landmark-based methods, we developed a statistical shape model for chicken breast filets. We found that 77% of the variation within the chicken filet population is determined by the size, while only 6 % by the shape. The statistical shape model was then used to generate chicken filet meshes corresponding to the ±2σ level of the shape and size, which were subsequently imported into the mechanistic model of chicken meat roasting. Using this developed mechanistic-statistical shape model, we show that the roasting time required to reach 75°C, the recommended core temperature, is considerably influenced by the size (6-22 min) as well as the shape (10-17 min) of the chicken filets. In addition, much darker surface colors and tougher texture are obtained for the larger (+2σ levels of the shape and size) chicken breast filets compared to the smaller (-2σ levels) ones.

Thus, combining mechanistic modeling with statistical shape models is a powerful tool to study the influence of varying shapes and sizes of foods on the cooking behavior.

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Effect of moisture content on the physical, mechanical and thermal properties of Jack bean (*Canavalia ensiformis*)

James Abiodun ADEYANJU[1], Adefemiwa Ayobami ADEKUNLE[2], Abimbola Abisola OLOKOSHE[3], and Ololade Zainab FASINA[1],

[1]*Department of Food Science and Engineering, Ladoke Akintola University of Technology, P.M.B.4000, Ogbomoso, Nigeria.*

[2]*Bioresources Development Centre, National Biotechnology Development Agency, Ogbomoso, Nigeria.*

[3]*Federal Institute of Industrial Research Oshodi, Lagos, Nigeria.*

ABSTRACT

Engineering properties are important tools in the design of equipment for handling, conveying, separation, drying, pasteurization, aeration, storing and processing of food materials. This study was carried out to investigate the effect of moisture content on the physical, mechanical and thermal properties of Jack bean seed (*Canavalia ensiformis*). Engineering properties such as axial dimension, seed volume, surface area, arithmetic and geometric mean diameter, sphericity, true and bulk density, angle of repose and static coefficient of friction, specific heat capacity, thermal conductivity and thermal diffusivity were determined between moisture range of 10.12% and 30.51%. The data obtained were analysed using Statistical Package for Social Science (SPSS) and the mean values were determined. The result shows that physical properties such as the axial dimension, seed volume, surface area, arithmetic and geometric mean diameter and sphericity were significant at (p<0.05). The density related properties shows that the true density increased from 0.55 to 0.94 Kg/m^3 while bulk density decreased from 0.667 to 0.376 Kg/m^3. The angle of repose ranged between 30.63^o and 37.18^o while static coefficient of friction on aluminium, plywood and glass surfaces ranged between 0.417-0.625, 0.438-0.692 and 0.357-0.459 respectively. The specific heat, thermal diffusivity and thermal conductivity increased from 0.7238 to 2.5805 kJ/kgK, 2.82 to 5.63 x 10-6 m2/s and 1.5350 to 4.9295 W/mK, respectively. Empirical models were developed for all the parameters measured and their respective high correlation coefficients indicate that they can be used to simulate these parameters within the moisture domain investigated.

Keywords: physical properties, thermal properties, Jack bean and moisture content.

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High pressure assisted gelation of potato proteins: Mechanism of gelation, rheological and functional properties

Hadas KATZAV, Libi CHIRUG, Zoya OKUN, **Avi SHPIGELMAN**

Technion – Israel institute of technology, Haifa, Isreael

Abstract
Consumer request for more natural, vegan products drives the interest in studying gelation of non-animal based proteins with minimal heat application. Potato protein isolate (PPI), a by-product of the starch industry, is a promising novel protein source with a few reported publications showing temperature induced gelation. Our main objective was to study the opportunities of obtaining PPI gels by application of high-pressure. Our results show that a protein solution in acidic conditions allows the formation of gels at elevated pressures of 300-500 MPa, yet only when the pressure is combined with a holding temperature of ~40°C. At pH=7 no gels were formed. On the other hand soluble protein structural changes during pressurization (studied by UV absorbance) where significantly more pronounced at pH=7 compared to pH=3. Likely suggesting aggregation without significant denaturation at pH=3. By studying the storage modulus of the formed gels (10%) we can conclude that physical gels were obtained, at both thermal (>55°C) and high-pressure assisted conditions. For heat-induced gels, as the temperature increased the physical interaction decreased but covalent interactions increased. When comparing thermal and pressure-assisted gels the water holding capacity of the pressure-assisted gel is lower than of heat induced gels yet with increasing pressure less protein was identified in the released water. The hardness of the first bite (TPA) was higher as pressure and temperature increased. We can conclude that the application of pressure can allow a significant reduction of the temperature required for gelation of PPI, therefore, it is a promising novel-ingredient novel-processing combination.

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Creating sustainable fresh food supply chain during transportation to reduce food waste: a conceptual framework

Reham ALSBUA[1, 2], Prasad KDV YARLAGADDA[1], Michael CHOLETTE[1], Tony PETLEY[3], Azharul KARIM[1*]

[1]*Queensland University Of Technology, Brisbane, Australia*
[2]*AL-Hussien Bin Talal University, Ma'an, Jordan*
[3]*RMIT University, Melbourne, Australia*

Abstract
Fresh food supply chains (FFSC) are increasingly confronted with globalization, growing world population and competition which have a great impact on the sustainability of the supply chain.
Resources utilized to produce fresh foods are wasted if the food produced basically for consumption is not being consumed. The way food is produced, transported, stored and consumed has a noticeable impact on food losses. Food loss has significant effect on stakeholders in the supply chain, the global warming and on the environments. It is estimated that about 45% of edible fruits and vegetables are wasted annually in the food chain from farmer to the end consumer. Therefore, proper management and optimization of resources are required to improve the efficiency of the FFSC.

Transportation is a critical part in the FFSC as large amount of food is wasted in the process. This work highlights the importance of sustainable FFSC with the focus on transportation logistics and infrastructures that should be improved in order to minimize the food losses and enhance the FFSC efficiency. A conceptual framework is developed by identifying the indicators, drivers and challenges of transportation of fresh food in order to minimize food waste. The framework developed has been validated using real FFSC data collected from local FFSC.

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Nanoparticles of palm date syrup characteristics

Alhussein AL-AWAADH[1], Ahmad S. MAABREH[1]

[1]*King Saud University, Riyadh, Saudi Arabia*

Abstract
Palm Date syrup was modified by high pressure homogenization (HPH) or double substitution (DS) using acetylation followed by esterification. HPH reduced 95.3% of the sugar agglomerates mean diameter from 2599 to 810 nm and 100% of the agglomerates from 5560 nm to 2505 nm for 25 and 45°Brix syrups respectively. DS reduced 74.1% of the agglomerates to 111.7 nm for 25°Brix. Control and modified syrups behaved as Newtonian fluids. DS significantly increased the viscosity by 52% and 80% at 25 and 45°Brix at 20°C respectively. Temperature effect on control and modified syrups was described by Arrhenius model with R^2 >0.98. DS and HPH changed the syrup color, the change can be observed by naked eye. The stability of nanoparticles formed from HPH can be improved by choosing the right low temperature, percentage of solvent, speed and duration of homogenization.

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Processing of Sri Lankan traditional yam “Raja ala” (*Dioscorea alata*) in to modified gluten-free muffin development

G.D.M.GUNASEKARA[1], B.E.A.U BULATHGAMA[1], I. WICKRAMASINGHE[1], and I. WIJESEKARA[1]

[1] *Department of Food Science and Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Sri Lanka.*

Abstract

Raja ala (Dioscorea alata) is a well-known traditional yam variety with high nutritional potential and several health benefits. With the urbanization and changing food habits most of these underutilized yams have lost their significance. The overall objective of this study was to develop gluten free muffins using “Raja ala” (Dioscorea alata) flour.
The muffins were developed according to the pre tested formulation including Raja ala flour, sugar, whole egg, baking powder, sunflower oil, and milk. The muffins were treated with pectin, xanthan gum and guar gum at 0.3% (w/w based on flour), and the mixture was baked at 180oC for 30 min. Then the developed muffins were subjected to a semi trained sensory evaluation, and the selected muffins were analysed for nutritional composition and texture profile.
The moisture, fat, protein and ash content of pectin incorporated muffins were 17.70 ± 0.50, 19.26 ± 0.51, 5.42 ± 0.38 and 2.07 ± 0.04 respectively. The most predominant mineral was found to be as Potassium in the developed “Raja-ala” muffins and it was, 431.55 ± 6.84. The obtained texture profile analysis values for the pectin incorporated muffins were found to be as; hardness 6082.3 ± 23.4 g, cohesiveness 0.35 ± 0.04, springiness 37.13 ± 1.61 mm and chewiness 657.27 ± 16.90 mJ.
According to the sensory evaluation, pectin incorporated muffin was selected to be the best among other two samples, as it had obtained the highest preference for the sensory attributes; appearance, colour, taste, after taste and for the overall acceptability.

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Process modification of tapioca pearls for bubble tea using dehydration, refrigeration, and microwave heat-moisture treatments

B.E.A.U. BULATHGAMA[1], G.D.M. GUNASEKARA[1], I. WICKRAMASINGHE[1], M.A.D. SOMENDRIKA[1]

[1] *Department of Food Science and Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Nugegoda, Sri Lanka.*

Abstract

Manihot esculanta Crantz is an important tropical food crop which has a very low utilization because of its high perishability and cyanide content. The utmost solution to overcome these problems is the industrial processing of cassava into several products, where cassava starch and flour is extracted, and several modifications are practiced to obtain altered properties in the starch. Bubble tea is a trending food in the globe, which has captured the high-end market demand. But it does not has a standard method of preparation.

Therefore in this study, the tapioca pearls, in the bubble tea was made with a modified procedure following several pre trials, using three heat moisture treatments on both tapioca starch and flour. All six samples obtained from a scientific experimental design were then sensory analyzed through a 30 member semi-trained sensory panel.

The selected Tapioca Pearls made through the Microwave Heat – Moisture Treatment of tapioca starch had a proximate composition of 17.96±0.27 moisture, 79.35±0.00 carbohydrate, 1.43±0.41 crude protein, 0.96±0.0 total fat, 0.098±0.00 total ash and 0.2±0.00 crude fiber. The developed tapioca pearls had a cyanide content of 5.454±0.059 (ppm) which is a lower value than corresponding fresh root, flour and starch.

The final bubble tea product was sensory analyzed, and Microwave treated starch sample was significantly preferred ($p < 0.05$) over the other samples by the panelists. The final tapioca pearl was also analyzed microbiologically, and found to have a 30 days shelf life in the laboratory condition.

A comparison study on the effects of radio frequency electric fields (RFEF) and thermal treatments on orange juice processing

Ernest TSE1, Adel REZAEIMOTLAGH1, Francisco J. TRUJILLO1

1*University of New South Wales, Sydney, Australia*

Abstract
Radio frequency electric fields (RFEF) processing is a novel non-thermal method for the treatment of liquid food products, which are subjected to a continuous sinusoidal electromagnetic wave between the frequency range 10 to 100 kHz. This allows processing at sub-pasteurisation temperatures to minimise changes to nutritional and organoleptic properties. This is an alternative to pulsed electric field (PEF) processing where the mechanism of inactivation is also irreversible electroporation, but is potentially more economical due to the lower capital cost of radio-frequency generators compared to pulsed generators.

Orange juice is a widely consumed beverage which is mandatorily pasteurised as enforced by national food safety organisations, including FSANZ and the FDA. These conventional thermal treatments ensure the safety of the juice but have negative impacts on its quality and nutritional attributes. Therefore, this research aimed to determine whether RFEF processing could indeed achieve a higher retention of the quality and nutritional characteristics of processed orange juice compared to thermal treatment, whilst ensuring the required microbial safety.

A 5-log-reduction was achieved using RFEF processing conditions of 20 kHz at 45 °C and 13.2 kV/cm electric field strength with five treatment stages. The comparison was performed with an equivalent heat process which also achieved a 5-log-reduction and one at 94.6 °C. The levels of vitamin C and the antioxidant capacity, total phenolic content, Brix and pH were measured. The microbial population, including total aerobic bacteria, yeasts and moulds, was also determined. These attributes were then monitored over a twelve-week-period at refrigerated storage conditions.

Effects of onion skin powder addition on chocolate truffles and peanut butter

Celale KIRKIN, Merve CINAR, Bade DERINDERE, Keri ERIKMAN, Naz ONURAL

Ozyegin University, Istanbul, Turkey

Abstract

Chocolate truffles added with 5% and 10% onion skin powder (OSP) and peanut butter samples added with 3% or 6% OSP were prepared. Samples without OSP (0%) were used as control. The effects of the OSP addition on the sensory properties of the chocolate truffles and the peanut butter samples were investigated.

The flavour, sweetness, and overall acceptance of chocolate truffles decreased as OSP content increased. The internal colour, oiliness, and texture of the control were scored higher compared to the samples added with 5% and 10% OSP. The oiliness of the control was not different than that of 5% OSP containing chocolate truffles. The addition OSP to the chocolate truffles did not affect the odour.

The odour, colour, oiliness, and texture of peanut butter added with OSP were not different than that of the control. However, the flavour, sweetness, and overall acceptance of peanut butter were higher in the control than the samples added with 6% OSP. The addition of onion skin powder up to 3% did not cause any changes in the sensory properties of peanut butter.

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Physical and textural characteristics of maize tortillas as influenced by different levels of Bambara groundnut flour

Tumelo MABODZE[1] and **Mpho Edward MASHAU**[1]

[1]*Department of Food Science and Technology, University of Venda, Thohoyandou, South Africa*

The purpose of this study was to study the effect of adding Bambara groundnut on the physical and textural properties of maize tortillas.Tortillas were produced from maize and Bambara Groundnut (BGN) flour at ratio 100:0, 95:5, 90:10, 85:15 and 80:20 respectively. The textural, functional, physical and quality properties of the tortillas were evaluated. There was a significance difference ($p \leq 0.05$) observed between the control and the tortillas containing BGN flour in the evaluation of physical and textural properties of the tortillas. The composited tortillas had lower values for hardness (547.74-499.52), springiness (0.57-0.52), cohesiveness (0.04-0.02), gumminess (20.96-11.81) and chewiness (11.79-6.12). The colour attributes of the flour, dough and tortillas in terms of L*, a* and b* values showed a significance difference ($p \leq 0.05$) across all treatments. There was a significant difference at $p \leq 0.05$ across the functional properties and physical characteristics in all the treatments. The puffing degree and rollability scores increased as more BGN flour was added.

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Biotransformation of bioactive compounds from lentils affected their antihypertensive properties

Ruann Janser Soares DE CASTRO[1], Ana Elisa MAGRO[1]

[1]*University of Campinas, School of Food Engineering, Department of Food Science, Sao Paulo, Brazil*

Abstract

Lentils are one of the most consumed legumes worldwide, and its consumption has been related to reduction of the development of neurodegenerative and cardiovascular diseases. Biological processes as fermentation, germination and enzymatic hydrolysis can be used as an efficient strategy for production of multifunctional compounds by improving biological properties on plant-based foods. The aim of the present study was to investigate the antihypertensive properties of extracts obtained from lentils after fermentation, germination and enzymatic hydrolysis. Solid-state fermentation was carried out using lentils flour as substrate and *Aspergillus oryzae* as inoculum. For germination, lentil seeds were soaked in distilled water followed by distribution in a tray with filter paper. The material was kept at room temperature in the dark and watered daily for 96 h. Enzymatic hydrolysis of lentils flour was performed using a solution of cellulase (Celluclast® 1.5L) and protease (Flavourzyme® 500L) at 50°C under shaking (100 rpm) for 2h. The extracts containing the antihypertensive compounds were obtained using distilled water from samples after the processes of biotransformation and from crude samples. The antihypertensive activity was determined through angiotensin-converting enzyme (ACE) inhibition. The extracts from fermented samples promoted up to 90% of ACE inhibition, while non-fermented samples showed 56% of ACE inhibition. Moreover, extracts from germinated samples for 96h increased the capacity of ACE inhibition from 73% (non-germinated samples) to complete ACE inhibition. Enzymatic hydrolysis, however, did not promote significant changes in the ability to inhibit ACE activity of lentils extracts.

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Effect of soybean flour on the functional and physico-chemical properties of malted finger millet weaning blend

Mapule MOLELE, **Shonisani Eugenia RAMASHIA**
*Department of Food Science and Technology, School of Agriculture, University of Venda, Private Bag X5050, Thohoyandou, 0950, Limpopo Province, South Africa. *Corresponding: shonisani.ramashia@univen.ac.za*

Abstract
Weaning is a period of transition for the infant during which its diet changes in terms of consistency and food source. The study was carried out to investigate the effect of soybean flour supplementation on functional and physico-chemical properties of malted finger millet (FM) weaning blend. FM and yellowish soy beans (SBs) were used for the development of the blend. FM was malted at 25°C for 48hrs, oven dried at 60°C overnight and milled into flour, while SBs were oven dried, roasted at 100 °C for 10 mins, decorticated and milled into fine flour. Four (4)complementary food samples (including the control) were formulated and mixed in ratios 100:0, 80:20, 60:40 and 40:60 (malted FM: SB) respectively. The samples were analysed for functional properties, proximate composition and thermal properties. Data was analysed using SPSS version 24 software programme. Results showed that protein content ranged from 10.57-46.03%, moisture 3.88-6.80%, fat (4.11 -16.67%), crude fibre (3.34-9.32%), ash (3.34-5.51%) and carbohydrate (17.56-73.19%).The physico-chemical and functional analyses showed that bulk density ranged from 0.66 - 0.69 ml/g, water absorption index 2.43 – 2.66g/g, oil absorption index (1.21–1.50 g/g), pH (5.64-6.18), dispersibility (76.00.00%), swelling power (2.53-3.42g/g), cold paste viscosity (16.67-18.67 cP) and cooked paste viscosity (284.00-1921.67) cP. Thermal properties showed onset temperature mean scores range from (70.92-106.14°C), peak temperature (78.09-115.54°C), conclusion temperature 85.02113.38°C, gelatinization temperature range 7.24-14.10°C, enthalpy ()1.24-5.29J/g and peak height index (0.09-0.73 J/g/°C). Colour measurements showed L* (54.53-76.77), a* (6.60-24.70), C* (6.43-22.80), H° (66.23-70.23), ΔE (24.20- 51.93). SB flour gradually improved the physico-chemical, functional, thermal and colour attributes of the produced blend. The study showed that there was a potential for using SB flour in cereal based complementary food.
Keywords: Finger millet, soybean, functional properties, physico-chemical properties, weaning blend

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Opportunity to design novel Indian dessert and sweets by 3D printing

Jatindra K SAHU

Indian Institute of Technology Delhi, New Delhi, India

Abstract

Milk and milk products are the part and parcel of social lives India. About 50–55% of milk produced in India is converted into a variety of milk products. Heat desiccated and heat acid coagulated milk products such as *chhana*, *khoa*, *marwa*, etc., are popular raw materials for many Indian confections. These raw materials provide the characteristic sweet taste, caramelized flavour and soft-grainy texture in the processed products which are produced in various forms and sizes. However, the technique of production of these sweets is neither well standardised nor well adopted by sweat-makers. People prepare based on their own experience where quality of the products varies widely. Moreover, these semi-solids raw materials form an ideal building material for extrusion-based 3D food printing. 3D food printing is an emerging technology providing engineering solution for customized food design by combining and merging knowledge of mechatronics, 3D industrial printing and specialized food knowledge in the areas of ingredients, formulae, texture and structure. The layer-by-layer deposition in 3D printing enables substantial reduction of sugar and fat and incorporation of functional ingredients into the final 3D printed foods. In this presentation, an attempt has been made to (i) understand basic compositions and their interactions, and manufacturing practices of popular Indian sweetmeats such b*arfi*, *peda*, *kalakand,* and (ii) to identify materials for manufacturing 3D printed sweetmeat constructs of traditional sweets derived from heat desiccated milk products and functional ingredients such as vitamins, fibres and antioxidants by investigating their flow, gel, melting and other relevant characteristics.

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The Basic Concept and Research Progress of Food Physical Processing

Haile MA
Institute of Food Physical Processing, Jiangsu University, Zhenjiang, China

Abstract

The basic concept and research framework of Food Physical Processing and related research progress of our team were introduced. Our main research work about the food physical processing include ultrasonic-assisted enzymatic hydrolysis of protein, ultrasonic-assisted fermentation, ultrasonic-assisted extraction, ultrasonic cleaning of food, ultrasonic degradation of polysaccharides, ultrasonic-assisted transesterification of triglycerides, ultrasonic-assisted osmotic dehydration of vegetable, ultrasonic-assisted aging of vinegar, magnetic-assisted fermentation, infrared blanching and dehydration of fruits and vegetable, combined Laser and UV irradiation breeding of microorganism and pulsed light processing of food, etc.

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ICT-enabled food processing technologies for short food supply chain practitioners

Dimitrios ARGYROPOULOS, Susanne BRAUN
University of Hohenheim, Stuttgart, Germany

Abstract
Short food supply chains represent one of the approaches of the Common Agricultural Policy to strengthen competitiveness of farming and food chains in Europe. Short food supply chains may act as a driver of change and a model to increase transparency, trust, equity and growth throughout the food chain. Farmers, as food producers, play a major role in wider society’s wellbeing. They face the challenge of producing healthy and nutritious food that has been grown in environmentally friendly and ethical way, while also dealing with market pressures. Within this research 18 case studies of widespread agri-food value chains with remarkable social, economic and environmental impacts on rural, peri-urban and urban communities were evaluated in terms of innovation potential on topics around food processing and close-to-farm product development. An illustrative database of existing small-scale food processing technologies including flexible equipment for various plant food products capable of responding to the seasonal character, heterogeneity and specificity of local raw materials was developed. The aim was to reflect different types of ICT-enabled food processing models, to generate more precise quantitative data as well as to capture the degree of geographical diversity across Europe. It was found that few technical details are available about the various drying technologies used for farm-based processing applications, and what details are available can be difficult to interpret by small scale or even micro growers. An overview of the capabilities and limitations of technical drying as well as the parameters affecting product quality of agricultural products will be presented.

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From Hz to GHz: electro-assisted processes in food industry

Francesco MARRA[1] and Ferruh ERDOGDU[2]

[1]*University of Salerno, Department of Industrial Engineering, via Giovanni Paolo II, 132, 84084 Fisciano SA Italy*

[2]*Ankara University, Department of Food Engineering, Ankara, Turkey*

Abstract
Electro-assisted processes used by the food industry include moderate electric field (MEF), radio-frequency (RF) and microwave (MW) processing, used in many operations involving heat and mass transfer in food products.
The market of industrial systems based on electro-assisted processes grows year after year and there is still room for their optimal design. The design of any system based on the electro-assisted processes requires expertise and multidisciplinary skills, including the ability to build virtual models, along the frequency scale, to simulate the main features of such processes and their effects on the food products. The presentation includes the description of main characteristics of electro-assisted processes and the mathematical representation of the transport phenomena occurring in the food undergoing the process. Different modeling approaches are discussed, with some insight also on the modeling of food heating by solid state MW. An overview on software and computational capabilities will be given too.

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Engineering cheese powders: effect of cheese maturation degree on stabilization of oil-in-water (O/W) emulsions

Denise FELIX DA SILVA, Kalliopi VLACHVEI, Anni Bygvrå HOUGAARD, Lilia AHRNÉ, Richard IPSEN

University of Copenhagen, Frederiksberg C, Denmark

Abstract
Increased demands from consumers for more natural and ‘clean label’ products have encouraged the substitution of synthetic emulsifiers with natural alternatives such as proteins. Caseins are flexible phosphoproteins, which have been shown to provide good emulsifying properties. However, purified individual caseins are expensive. As an alternative; we investigated the emulsifying properties of cheese powders produced from cheeses of varying maturation time (16, 30 or 45 weeks) as well as the effect of addition of ingredients during cheese powder production (2% sodium caseinate plus 2% buttermilk powder (B2S2) or 4% buttermilk powder (BMP)) on the flow properties and physical stability of oil-in-water (20:80) emulsions. Cheese powders produced without any ingredient addition (NO) were used for comparison. All emulsions showed a non-Newtonian shear-thinning behavior. The increase in cheese age lead to higher consistency index using NO and B2S2 powders, with no significant effect of ingredients addition. Higher consistency indexes were observed for emulsions containing BMP powder regardless the cheese age. Emulsions produced using cheese powder from 16 weeks old cheese showed a gradual increase in phase separation over 10 days of storage, whereas cheese powders from older cheeses (30 and 45 weeks) led to faster phase separation of the emulsions, though to a lower extent. This indicates that the maturation degree of the cheeses affects the emulsification properties of cheese powders, leading to changes in the emulsion destabilization mechanisms, and could be used for product design purposes.

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ICEF13 ABSTRACT

NIR and chemometrics for detection of starch, gum and annatto in paprika powder

Marciano OLIVEIRA[1], J.P. CRUZ-TIRADO[1], **Douglas F. BARBIN**[1]

[1]*University of Campinas, Campinas, SP, Brazil*

Abstract

Paprika powder has become one of the most widely consumed spices in several segments of the food industry, making it an attractive target for food fraud. Rapid detection of paprika adulteration using optical methods has recently been investigated. In this study, paprika samples were adulterated with potato starch, at different concentrations (0 to 36% by weight), and near infrared (NIR) spectroscopy was used for detection of adulterated samples. The mean near infrared (NIR) spectra of each mixture, in combination with the partial least squares regression (PLS), were used to predict the adulteration levels of the paprika samples. PLS was applied to all spectral data, which were collected for pure and adulterated samples. Reduced PLS models were also constructed by selecting the variables with higher modules of regression coefficients. For the models constructed from the NIR spectral data, the coefficient of prediction (R^2_p) was 0.960, and the root mean square errors of prediction (RMSEP) was 1.86. Results have shown that NIR spectroscopy combined with chemometric tools is a useful screening technique for rapid detection and/or determination of paprika adulterated with starch.

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Impact of wet-mix processing conditions on rehydration properties of powdered milk infant formula

Mariana RODRÍGUEZ ARZUAGA[1,2], **Denise FELIX DA SILVA**[2], Kataneh AAELAEI[2], Lilia AHRNÉ[2]

[1]*Latitud, LATU Foundation, Montevideo, Uruguay.*
[2] *University of Copenhagen, Frederiksberg C, Denmark*

Abstract
Production of powdered milk infant formula (IMF) by the wet-mixing process involves the rehydration of ingredients (to obtain a wet-mix), heat treatment (HT), homogenisation, evaporation and spray-drying. Working with wet-mixes with higher total solids (TS) can reduce energy costs, but rehydration and increase in the viscosity of the feed are a challenge. Furthermore, the HT step is required to reduce the microbial load. However, the whey proteins undergo heat induced denaturation and aggregation reactions that can in turn increase further the viscosity. If the viscosity is too high, the size of the droplets created during the atomisation in the spray-dryer increases, influencing the solubility of the resulting powder. The aim of this study was to assess the effects of the TS and consequent HT temperature of the wet-mix, on the rehydration properties of IMF. Model IMF were produced at a pilot scale, from low-heat skim milk powder, whey protein isolate, lactose, fructo-oligosaccharides, galacto-oligosaccharides and sunflower oil. The ingredients were rehydrated in deionised water (T=65ºC, pH=6.8) at the typical IMF ratios and TS=20, 35 or 50%. The wet-mixes were then pasteurised at 75 or 100ºC for 18s, homogenised ($P_{1st\ stage}$=13MPa, $P_{2nd\ stage}$=3MPa), and spray dried (T_{feed}=65ºC, T_{inlet}=180ºC, T_{outlet}=85ºC). The rheological properties of the wet-mix were analysed and the reconstitution properties of the powders were determined through wettability, dispersibility, solubility and low-field NMR measurements. This work provides insight about how IMF processing affects the rehydration behaviour of the powders.

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Modeling and Simulation of Smoking of Protein Based Food Products

Nikita KHOZIN[1], Dennis HELDMAN[2]

[1]*Ohio State University, Columbus, USA*
[2]*Ohio State University, Columbus, USA*

Abstract

Smoking is one of the oldest technique of food preservation, modern food processing has incorporated very little technological advances to predict completion of smoking process. This study describes a simulation model of smoking process of protein-based food product to predict the completion of smoking process. The smoking process includes three phases, first phase is equilibration of smoking conditions. Next, the second phase includes mass diffusion of smoke component within the food product. And, third phase involves drying. Throughout the process heating is controlled though forced convection. A 2D mathematical models of combined heat and mass transfer were developed from the first principles. The proposed model includes the impact of changes occurring to the thermophysical properties of protein-based food product as a function of temperature. The developed model coupled with experimental assessments used to explain the heat and moisture transport and subsequent development of quality attribute (color development) while attaining the shelf-life stable attribute. The developed model equations were solved using MATLAB and variables were predicted as a function of time and location within the food product. Finally, parts of proposed model were validated by experiments to confirm its real-time applicability.

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Design of online food engineering courses for food industry personnel

Ramaswamy ANANTHESWARAN[1]

[1]*The Pennsylvania State University, University Park, USA*

Traditional university education is limited by geographical boundaries. Additionally, it does pose an economic barrier, especially for postgraduate education. Online education offers opportunities for education and training of food engineers within the food industry across the globe. With changes in technology and regulations, there is also a need to provide continuing education for engineers within the food industry. A review of barriers, opportunities and challenges related to development of online educational programs will be presented.

Increasing number of organizations are developing online courses and degree programs. Several formats ranging from “fully online delivery” to “blended learning” exist to meet the individual needs of the learner. Online education can meet or exceed student expectations by offering a variety of self-paced learning opportunities for various learner types. A unique feature of engineering education is the related laboratory session, and availability of virtual and augmented reality technologies offers opportunities for incorporating virtual labs and plant visits.

Online course development and management is time consuming, and consultations with an instructional designer can help to focus on the pedagogy and appropriate selection of course activities. Proactive course management strategies include monitoring time spent by students on the learning management system, monitoring submission of assignments, and communicating of upcoming deadlines. Other best practices include focusing on active learning, trimming down lessons to shorter time durations, providing for self-assessment activities and fostering online discussions.

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Modeling heat transfer during hot water sanitization of a commercial mushroom disc slicer

Saurabh LELE[1], **Ramaswamy ANANTHESWARAN[1]**
[1]*The Pennsylvania State University, University Park, USA*

Thermobacteriological studies conducted at Penn State has shown that a hot water sanitization process can eliminate *L. monocytogenes* from food contact surfaces of a commercial mushroom disc slicer. In order to develop and monitor this sanitization process, it is necessary to identify the location and temperatures at the cold spot within the slicer as a function of the process parameters. The goal of our study was to model heat transfer within a commercial mushroom disc slicer during hot water sanitization.

A 3-lane mushroom disc slicer (an assembly of alternating disc blades and annular spacers stacked on two cylindrical shafts, supported by plastic bearings and gears) was used in this study. The finite element method (FEM) was used to model conjugate heat transfer into the slicer during hot water sanitization. The lumped capacitance analysis was used to experimentally determine convective heat transfer coefficients. Computational fluid dynamics approaches were also explored to predict the convective heat transfer coefficients. The model was validated by monitoring temperatures during hot water sanitization within a slicer fitted with thermocouples.

The cold spot was predicted by the model to be located at the inside surfaces of spacers within the slicer. The FEM-predicted and experimentally observed temperatures within the slicer during hot water sanitization were in good agreement. Recommendations on process parameters were developed to eliminate *L. monocytogenes* from the mushroom disc slicer.

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An application to understanding food digestion: Degradation mechanisms of phytometabolites of antibiotics

Silvia KEPPLER[1], Khang HUYNH[2], Dawn REINHOLD[2], Gail Michelle BORNHORST[1]

[1]*University of California, Davis, USA*
[2]*Michigan State University, East Lansing, USA*

Abstract
Understanding digestion is critical to evaluate the impact of novel food contaminants, such as antibiotics, on human health. Increasing environmental pollution with antibiotics leads to accumulation of antibiotics in food crops, raising concerns about unintentional human exposure. This study quantifies degradation products of phytometabolites of antibiotics during in vitro digestion to evaluate the risks associated with antibiotics as possible food contaminants.
Arabidopsis plants were grown in hydroponic cultures and exposed to the antibiotic sulfamethazine (SMT), both 14C labeled and unlabeled. In vitro oral, gastric, and intestinal digestions was performed by adding simulated digestion fluids and incubation in a shaking water bath (37°C, 100 rpm) for up to 4 h. After digestion, the liquid fraction was separated and analyzed with Liquid Scintillation Counting and Liquid Chromatography Mass Spectrometry.
Antibiotic components present in the liquid fraction may easily be absorbed into the body. After intestinal digestion, 70% more antibiotic degradation products were in the digestion liquid compared to after gastric digestion, suggesting antibiotic compounds in foods may be released into the body during digestion. SMT decreased from 400±20 ng/g fresh weight (fw) after gastric digestion to 200±5 ng/g fw after intestinal digestion. N4-acetyl-SMT and desamino-SMT were undetected during gastric digestion, but showed concentrations of 2.5±0.5 ng/g fw and 1.0±0.2 ng/g fw after intestinal digestion.
These results elucidate the fate of phytometabolites of antibiotics during the breakdown processes of in vitro digestion. Understanding these processes is necessary to build future risk assessment models for human health impacted by food contaminants, such as antibiotics.

Orange juice waste: a case study for flour production and perspectives for added value

Larissa Alves de CASTRO[1], Ana Cristina Barone MACHADO[1], Rosemary Aparecida de CARVALHO[1], **Fernanda Maria VANIN**[1]

[1] *Faculty of Animal Science and Food Engineering, University of São Paulo – FZEA/USP, Food Engineering Department, Laboratory of Baking and Dough Process (LAPROPAMA), Av. Duque de Caxias Norte 225, 13635-900, Pirassununga, SP, Brazil.*
* corresponding author: fernanda.vanin@usp.br / +55 19 3565 6866; +55 19 3565 4284

Abstract

In orange juice production, more than 50% of the fruit is considered waste. However, albedo, the main residue, is rich in dietary fiber, which characterizes it as a raw material of high nutritional value and that could add value to food production, besides reduce the ecological impact generated by its discard. Thus, this study aimed to produce a flour from the by-product of the fruit and then characterize it. Orange residue flour (ORF) was produced from selected fruits, washed, peeled, and without their juice. Material was dried in an oven at 60 °C for 24 hours, then ground in a grinder machine and sieved. ORF produced were evaluated in relation to chemical composition, dietary fiber, total phenolic, antioxidant potential by different methods (FRAP, ORAC), and water and oil absorption capacity (WAC, OAC). Chemical composition showed that the ORF had water content level as commercial flours, 10.38 g/ 100g of dry matter (DM), high carbohydrate content, 80.63 g/ 100 of DM, and lower content of protein and lipid, 5.94 and 80.63 g/ 100g of DM. Higher level of phenolic compound was observed, 534.01 mg gallic acid equivalent per 100 g DM; as higher levels of antioxidant potential. Hygroscopic parameters demonstrated high WAC, 13.28 g of water/ 100g DM, and lower OAC, 2.78 g of oil/ 100g of DM. Therefore, this results underlined that the production of ORF could be a good alternative to valorize orange juice waste, and furthermore, it could represent in important strategy to enhanced nutritional aspects of foods.

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Toward to a New Curricula for Food Engineering at Unicamp

Celso C. LOPES1, Ana Silvia PRATA1, Rosiane L. CUNHA1, Guilherme J. MAXIMO1, Flavia Maria NETTO1, Juliano L. BICAS1, **Priscilla EFRAIM**1

1 School of Food Engineering, Campinas -SP, Brazil

Abstract

FEA - UNICAMP, founded in 1967, is pioneered in the creation of the Food Engineering course in Latin America. In 2014, started a process of curricular reformulation motivated by the change in the profile of the professionals Also, when observing the drop in the demand in the last years and the increase of the avoidance rate, more critical reflection had been done to identify the factors responsible for the discouragement of undergraduate students. The process aimed to reduce the workload, especially in the classroom for allowing the creative time for the students; courses were revisited by encouraging the application of student-centered methodologies; an effort was made
to promote content integration by stimulating interdisciplinarity, the breakdown of learning; and the extra-curricular activities to make the formative trajectory of the student more flexible. The process was carried out in five stages: (1) construction of proposals (2) deconstruction of existing courses and regrouping related knowledge; creation of axes of knowledge (Fundamental; Operation and Processing; Quality & Safety and Food Production & Industrialization); (3) definition of the courses, (4) approval of the proposal by the collegiate; (5) implementation (in progress). Compared with the current curriculum, there was a reduction of 20% in the classroom and 15% in the number of courses. The new curriculum brings the possibility of horizontal and vertical integration between courses. The process, although extensive, allowed the effective participation of the professors. Discussions for curriculum implementation continue and have fostered more integrated actions among the faculty and the community involved.

ICEF13 ABSTRACT

Prediction of drying rate of nectarines (*Prunus persica* var. *nucipersica*) from real-time ambient weather factors during direct sun drying

Rebecca MILCZAREK[1], Diana RAMIREZ-GUTIERREZ[2], Klein ILELEJI[2,3]

[1]*United States Department of Agriculture – Agricultural Research Service (USDA-ARS), Albany, California, USA*
[2]*Purdue University, West Lafayette, Indiana, USA*
[3]*JUA Technologies International LLC, West Lafayette, Indiana, USA*

Abstract
Sun drying of fruits and vegetables is an ancient food preservation technique, and it is still in widespread use, especially in developing countries. Sun drying is inexpensive and makes direct use of renewable energy, but it suffers from a lack of predictability and user control. To address these shortcomings and enable design of modern sun drying equipment, we sought to predict the drying rate of sliced nectarines (*Prunus persica* var. *nucipersica*) based on easily-measured, real-time weather factors. Four basic and 5 derived weather factors were continuously measured during 3 drying runs, conducted under ambient conditions in Albany, California, USA. Nectarine cultivar and weather conditions varied for each run, lending robustness to the modeling. Weight change of the samples was tracked and used to determine drying rate. Partial least squares regression modeling was used to determine the factors' influences on drying rate during daylight hours; a variable importance in projection (VIP) score cutoff of 1.0 was used to determine the most important factors. It was found that solar radiation, Temperature-Humidity-Sun-Wind index, evapotranspiration, and relative humidity had the strongest influence on drying rate, with VIP scores of 1.31, 1.30, 1.24, and 1.06, respectively. The prediction error sum of squares was minimized with a 5-factor model, with a prediction R^2 value of 0.63. Such a model would only be implementable if a full weather station (including a solar pyranometer) is available; if only a simple hygrometer is available, a model with prediction R^2 value of 0.24 can still be achieved.

Transient localized changes in fresh-cut papaya microstructure as determined by Environmental Scanning Electron Microscopy (ESEM), Confocal Laser Scanning Microscopy (CSLM) and micro-Ramman spectroscopy

Gabriela CÁEZ-RAMIREZ[1], Gustavo F. GUTIERREZ-LÓPEZ[2]
[1] Universidad de La Sabana, Bogotá D. C., Colombia.
[2] Instituto Politécnico Nacional, ENCB. Ciudad de México, México

Abstract

Papaya is accepted worldwide as a fruit whit a positive health impact. Transient quality of fresh-cut papaya depends on the temperature and humidity of the environment in which it is held after cutting [1], when changes also occur in the cellular microstructure of the fruit. The aim of this work is to carry out transient monitoring of multilevel microscopy structural changes occurring in fresh-cut fruits during 4 hours by using ESEM, MRS, and Confocal Laser CLSM which is an area which has not received enough attention. Prismatic pieces from central mesocarp of papaya at two different maturity stages were visualized at several positions, coming from close to the peel up to close to the seeds [2].
Typical ESEM (27 mBar, Gaseous detector) and multifocal CSLM images described structural damage due to lack of linkage between pectins and other structural carbohydrates (OSC) that affect cell adhesion [3] and increased cell wall disruption with time and maturity. MRS and CSLM spectra showed progressive changes in self-fluorescence distribution of pectins (461 nm), cellulose and OSC (500 nm) as well as carotenes (598 nm) depending on tissue location, time after-cut and maturity. MRS reflected intensity variation in spectral lines of 1500 cm^{-1} for carotenes and 1320 cm^{-1} for low methoxyl pectin. Thus, it is possible to monitor multilevel transient senescence through ESEM, MRS and CSLM, which will determine relationships between fruit characteristics at different tissue locations and time after-cut so as to progress on the understanding of the underlying phenomena in minimally processed fruits.

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Sell-by, Best-by or Use-by? Understanding How Standardized Date Labels Can Alter Consumer Food Waste

Aishwarya BADIGER[a], Kathryn BENDER[a], Christopher SIMONS[a], Dennis HELDMAN[a], Brian ROE[a]

[a]*The Ohio State University, Columbus, United States of America*

Abstract
Confusion over date labels is the main contributing cause to consumption level food waste[1] with potential to feed 3 billion people if redirected. “Standardized date labelling” and “consumer education” are prospective solutions identified with the highest financial benefit per ton of food waste redirected[2]. Our research objective was to identify the impact of standardized date labelling language (“best if used by” for quality; “use by” for safety) and consumer education on discard intent for six different food products. An in-person, mixed design study with repeated measures was conducted; date label phrase and consumer education were between-subject variables and product and date were within-subject variables. Every person only saw one date label phrase and evaluated three products, each having packages with three dates (two past and one within the date). Changing the date label language from “sell by” or “best by” to standardized language had no significant effect on reduction of discard intent. Consumer education had a positive impact on discard reduction when the products were in date. Consumers were more likely to discard the perishable foods than the relatively shelf-stable products. Date was the strongest factor, with an extension of just a day of shelf-life causing a 50% or more reduction in discard. Since it is unlikely that the quality of food products degrades significantly in a day, policies to extend date margins could considerably reduce consumer food waste. Standardizing labels may not contribute largely to food waste reduction, but it is essential to ensure consistency in consumer education campaigns.

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The preparation and functional properties of whey protein concentrate-polysaccharides composite film modified by TGase

Shujuan JIANG, Xuan ZHANG, Lina SUN, Shengnan Jiang, Yanfeng TUO, Fang QIAN, Guangqing MU

School of Food Science and Technology, Dalian Polytechnic University, Dalian 116034, Liaoning, China

Edible film has become a new trend in the development of food packaging. Basing on the catalytic characteristic of TGase and the film-forming ability of whey protein concentrates, carboxymethylchitosan, and hydroxypropyl methylcellulose, in this work TGase was applied to explore the feasible approach for the preparation of whey protein concentrates-polysaccharides edible composite film. Results showed that compared with the whey protein film, CMC and HPMC addition can improve the tensile strength, elongation at break, and TGase can also further improve the mechanical strength of the composite film at the same substrate ratio condition. Electrophoretic analysis showed that TGase induced the crosslinking of whey protein concentrates. Infrared spectroscopy indicated that TGase could promote the crosslinking between whey protein concentrates and polysaccharides. The whey protein-based composite films developed were applied to package milk tea powder, milk candy, and instant noodle oil sauce, respectively. This study showed that the composite film has the feasibility as inner package for small solid food. This study was funded by Chinese National Natural Science Foundation Projects (31501513), and Dalian City Youth Science and Technology Talent Projects (2017RQ127).

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Nanobubble technology improves shelf life of salmon fillets

Maneesha. S. MOHAN*, *Hemangi RANE*, Pooniam CATHAN **
**Department of Wine, Food and Molecular Biosciences, Lincoln University, Lincoln, New Zealand*

Abstract
Quality and acceptability of fresh fish is greatly affected by shelf life and storage conditions. Nanobubble technology using nitrogen gas has been used by the seafood industries in Japan to extend the shelf life of fish fillets. However, there are very few published studies on the effect of nanobubble technology on the shelf life quality of raw fish. In our study, we investigated the effect of nitrogen nanobubbles on the textural and microbial quality of salmon fillets. Salmon fillets were immersed in water flushed with nitrogen nanobubbles (deoxygenated to 65% of its initial oxygen content 7.8 mg/L) for 15 and 30 min and later refrigerated (2 to 4 ^{0}C) for 0, 2 and 4 days. Each fillet was sampled for texture, microbiological and proximate analysis. The nanobubble treatment for 15 min lead to one log reduction of the total aerobic compared to the control samples after four days of refrigerated storage ($P<0.01$). The natural variation in the tissue across the fillet of salmon created differences in the textural and composition parameters of the samples. Overall, the study indicated that salmon fillets when dipped in water with low concentration of nitrogen nanobubbles for a short period of time (15 min) improves the shelf life of the fish fillets by replacing dissolved oxygen in water and retarding microbial growth. Further studies are needed to investigate higher concentrations of nitrogen over extended storage periods. There is immense possibility of using the nitrogen nanobubble technology in improving the shelf life of fresh seafood.

Habit mapping of São Paulo's city residents of bread consumption and purchase intention

Geórgia M. R. T. GIOVANETTI[1], Juliana M. V. PION[2], **Fernanda Maria VANIN**[1]

[1] *Faculty of Animal Science and Food Engineering, University of São Paulo – FZEA/USP, Food Engineering Department, Laboratory of Baking and Dough Process (LAPROPAMA), Av. Duque de Caxias Norte 225, 13635-900, Pirassununga, SP, Brazil.*
[2] *NOZ, Research and Intelligence, São Paulo, SP, Brazil*
* corresponding author: fernanda.vanin@usp.br / +55 19 3565 6866; +55 19 3565 4284

Abstract

Currently, the Brazilian bakery market has been expanding and its main product, bread, has been shown as one of the most widespread foods of the country and as a main caloric source of the Brazilian diet. The present work aimed to draw the profile of bread consumption of São Paulo's city residents, one of the biggest cities in the world.
The methodology used in this research was based a previously research. This study was carried out by means of an online questionnaire, designed to collect information on socioeconomic data, eating and eating habits, physical activity routines, and preferences regarding to bread and, especially, in relation to bread enriched with fiber. The questionnaire was made available on social networks and sent by email to be answered by people over 18 years of age living in the city of São Paulo. The total number of valid respondents was 415 people, who had preferences of consuming the product during the periods of breakfast (78%, n = 324) and lunch (35%, n = 145). The most consumed bread was whole-grain bread and traditional French bread/baguette (55%, n = 228). The results showed to be favorable for fiber-enriched breads consumption, since participants were adept at consuming fiber-enriched breads (87.2%, n = 362) and accepted to pay up to 39% of increase to the initial value for the modified product, looking like the main requirements when buying their products, mainly, texture and flavor and nutritional composition. The study showed an enormous potential to be exploited, enrichment and improvement of the diet of Brazilians.

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Modeling of fluid flow, starch digestion, and glucose absorption in the human small intestine

Karthikeyan JS[1], Deepti SALVI[2], **Mukund KARWE[1]**

[1]*Rutgers University, New Brunswick, New Jersey, USA*
[2]*North Carolina State University, Raleigh, North Carolina, USA*

Abstract

The aim of this research was to develop a fluid flow-based numerical model mimicking the human small intestine to predict the glucose absorption rate during starch digestion.

COMSOL Multiphysics® software was used to numerically simulate a two-dimensional axisymmetric fluid flow induced by peristaltic waves. From literature, the real-time intestinal geometry parameters, motility parameters, amylase enzyme kinetics were obtained (1,2). To simulate the glucose absorption process, it was assumed that the intestine is enclosed in a cylindrical cavity with an intermediate diffusive wall. To experimentally validate the numerical predictions, in vitro digestion of glucose and maltodextrin were analyzed using a gastrointestinal model (TIM-1). The gastric emptying rate was kept constant in the experimental procedure and the numerical model. In the experimental procedure, ~90% digested glucose was absorbed in the jejunal and ileal sections. In the numerical model, the thin diffusive wall parameters were optimized to achieve this 90% final glucose absorption value. With the wall thickness of 2 mm and glucose diffusivity of 2×10^{-8} m^2/s, the numerical model was able to predict the experimental glucose absorption rates with an error of less than 5%.

With known food composition, viscosity of food (which influences the gastric emptying rate), and the starch digestion kinetics, this numerical model can predict the rate of glucose absorption in the human small intestine. This model can further be developed to predict the glycemic index of a given food.

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Microbial inactivation by cold atmospheric pressure plasma: a numerical study

Ender ARSERIM[1], Deepti SALVI[2], Gregory FRIDMAN[3], **Mukund KARWE[1]**
[1]Rutgers University, New Brunswick, New Jersey, USA
[2]North Carolina State University, Raleigh, North Carolina, USA
[3]Drexel University, Camden, New Jersey, USA

Cold plasma is a novel technology that can be used as a surface treatment to produce microbiologically safer food products. Prediction and experimental validation of microbial inactivation due to reactive species in plasma are challenging because of complex chemistry of plasma. The primary goal of this study was to develop a mathematical model to understand and numerically predict the efficacy of microbial inactivation on a model system surface.

Microbial inactivation efficacy of plasma generated by a custom-made dielectric barrier discharge (DBD) plasma at three different frequencies (1 kHz, 2 kHz, 3.5 kHz) was experimentally evaluated for its inactivation of *E. aerogenes* which were spot inoculated on a glass surface. COMSOL Multiphysics® Chemical Engineering was used to numerically simulate the amount and the distribution of H_2O_2, OH, and O_3 within the DBD system. Microbial inactivation was predicted using the species concentrations and inactivation kinetics, and compared with experimental data.

The results showed that the DBD plasma treatment achieved microbial reduction of (4.6±0.2) log CFU/surface at 3.5 kHz, (5.1±0.09) log CFU/ surface at 2 kHz, and (5.1±0.05) log CFU/ surface at 1 kHz in 2 min, 3 min, and 6 min, respectively. The predicted values were 4.02 log CFU/surface, 4.10 log CFU/surface, and 4.36 log CFU/surface at 1 kHz, 2 kHz, and 3.5 kHz, respectively. Maximum one log difference was observed between numerical predictions and the experimental results which might be due to a synergistic interactions between plasma species, UV component of DBD plasma, and the electrical field.

Gastronomic Engineering: Experiences in Teaching a Flipped Class and MOOCs

Jose Miguel AGUILERA[1]

[1] *P. Universidad Católica de Chile, Department of Chemical Engineering and Bioprocesses, Santiago, Chile*

Abstract
Although food engineering courses are regularly imparted at some universities, teaching basic engineering principles using foods and cooking is seldom an elective option for engineering students. We applied the flipped classroom method to teach gastronomic engineering. Students who had reading assignments from a set of lecture notes were assessed at the beginning of each class. Most of the lecture time was used to reinforce key concepts (based on a few slides), present examples from food processing and culinary technology, asking thought-provoking questions, and performing demonstrations by chefs. Based on this successful experience we were asked to prepare a MOOC in Spanish for Coursera.

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Mono-disperse droplet spray dryer for improving spray drying based food product development

Xiao Dong Chen[1], Zhen-kai Liao[2,3], Chao Shang[1,2], Winston Duo Wu[1], Jie Xiao[1]

[1] *School of Chemical and Environmental Engineering, Soochow University, Jiangsu Province, China*
[2] *Nantong Dong Concept New Material Ltd, Nantong, Jiangsu Province, China*
[3] *Xiao-dong Prohealth (Suzhou) Instrument Ltd, Suzhou, Jiangsu Province, China*

Abstract
Spray drying technology is used widely in producing particles from liquid at the largest scales possible. It plays a vital role in our society in distributing the beneficial materials to the widest community, food particles in particular. Research on it has been extensive and a breakthrough came over a decade ago when the capability of generating mono-disperse droplets was established and coupled with drying in a spray dryer. Here we can define the inlet condition more precisely to allow much improved understanding on spray drying process (math modelling to be more precisely compared with the lab data; the microstructures made under precise drying conditions can be interpreted better as well). Computational models have been more effectively validated. In this poster, we will show the examples of the related applications.

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ElectroHydroDynamic enhancement of heat and mass transfer in food process: a review

Michel HAVET[1]**,** Erik BARDY[2], Olivier ROUAUD[1]

[1] *GEPEA, UMR CNRS, ONIRIS, 44322 Nantes – France*
[2] *Grove City College, Grove City, Pennsylvania, USA*

Abstract
Convection is the main mode of heat and mass transfer encountered in food process. In most of unit operations, from postharvest to product delivery, air is the medium that generally ensured these exchanges with the products. Conditioned air is blown at quite high velocities in order to ensure the desired treatment (cooling, drying, baking…). These forced air convection process consumes a lot of energy due to air handling unit and high flowrates. In order to reduce this energy consumption, process based on ElectroHydroDynamic (EHD) phenomena is a promising alternative. EHD investigates the flow of electrically charged fluids. An ionic wind may be generated through a corona discharge that forms in the presence of a very high voltage imposing a localized electric field, which ionizes the surrounding fluid. We firstly focus in this study on experiments (Particle Image Velocimetry combined with IR thermography) that help to get a better understanding of physical mechanisms and in designing experimental set-up. In a second stage, we present the challenges in CFD modeling on such system that required specific algorithms. Finally, we discuss on the application of EHD on food process, especially on drying. It leads to lower energy consumption at lab scale and good quality attributes but the scale-up is still an issue that will be address.

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Creamed Pomace – a new process for a new product from an old waste

Richard H. ARCHER[1], Brent DINGLE[2], John BRONLUND[1], Florencia YEDRO[1], Marzieh EBLAGHI[1], Erin O'DONOGHUE[3]
[1] *Massey University, Palmerston North, New Zealand*
[2] *Aurecon, Wellington, New Zealand*
[3] *Plant & Food Research, Palmerston North, New Zealand*

Abstract

The market for dietary fibre ingredients seems to be increasing, with products on offer generally being either insoluble fibre (often highly cellulosic), or soluble (often rich in non-starch polysaccharides such as fructan). Fruit cell wall contains both insoluble cellulosic and hemicellulosic materials, and pectins which can be hydrolysed and rendered soluble. Such material is in abundant supply as apple pomace but it comes on a campaign basis, is contaminated with pips, stalks and labels and degrades rapidly. Cell wall material can be very sharp on the mouth depending on how it is presented. Pectin materials have the potential to be useful water-binders in food systems. We set out to design a simple process, suitable as a pattern for a compact packaged plant to stand alongside a juicing facility, for rendering fresh pomace into a powdered creamed pomace product. The product would be aimed as a food ingredient offering both dietary fibre and physical functionalities: creamy texture, water-binding and thickening. Another end-use we envisage with this modified material is as a spray-drying encapsulant for high-sugar products such as fruit juice. We report here the preliminary research to characterise the kinetics of several competing reactions as pectin is released from the cell wall matrix and how the research results are being translated into process design.

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Australian Tales of the Future of Sustainable Nutrient Recycling

James SACKL[1]

[1]*Karma[3], Melbourne, Australia*

Abstract

Nutrient recapture is a foreign concept to a majority of the agriculture industry. To avoid an imminent global food catastrophe, we must turn to technologies that enable nutrients to be infinitely cycled through our food system.

Karma has engineered a process whereby human, animal and food waste is treated, ready for consumption by colonies of insects, who convert the nutrients into biomass at efficiencies beyond most any other farmed creature on the planet.

This presentation will highlight Karma's system thinking approach for nutrient recycling and examples of creative food product developments using insects. Karma has found profitable markets for its products even at an R&D scale. For new technology to be sustainable, an economic propellant is crucial.

High-pressure nitrogen injection prior to spray drying improves the solubility of milk protein concentrate powders

David J. McSweeney[1, 2], Valentyn Maidannyk[1], Sharon Montgomery[1], James A. O'Mahony[2], Noel A. McCarthy[1]
[1]Food Chemistry & Technology Department, Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork, Ireland
[2]School of Food and Nutritional Sciences, University College Cork, Cork, Ireland

High protein dairy powders, such as milk protein concentrate (MPC), exhibit poor rehydration properties. This has been attributed to inhibited water transfer in to powder particles due to protein-protein interactions and low concentrations of hygroscopic lactose. The objective of this study was to investigate the influence of high-pressure nitrogen gas (N_2) injection into liquid MPC (80%, w/w, protein) prior to spray drying on the subsequent physical and rehydration characteristics of the powder. Four different powders were manufactured using a pilot-scale Tall-Form spray dryer; regular (R), regular N_2 (RN), agglomerated (A), and agglomerated N_2 (AN) MPC. A-MPC possessed greater flowability, was more susceptible to particle breakage (i.e., more friable), and had a lower specific surface area (SSA) than R-MPC. N_2 injection in both RN-MPC and AN-MPC reduced flowability and bulk density, but increased SSA, compared to R-MPC and A-MPC, respectively. Furthermore, the injection of N_2 enhanced the dispersibility and solubility of MPC powders in water, with scanning electron microscope images showing that N_2 injection increased the sphericity and porosity of MPC powder particles. Overall, this study demonstrated that the incorporation of N_2 into high protein liquid streams prior to spray drying can improve the solubility characteristics of MPC powders.

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Potential of fluorescence-based process analytical technologies as quality assurance tools for the dairy industry

Eoin G. Murphy[*], Lisa E. Henihan[*,†], Colm P. O'Donnell[†], Carlos Esquerre[†] and Donal J. O'Callaghan[*]

[*]Food Chemistry and Technology Department, Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork, Ireland
[†]School of Biosystems and Food Engineering, University College Dublin, Belfield, Dublin 4, Ireland

Dairy ingredient and dairy product quality are largely dependent on whey protein functionality which affects key product attributes such as heat stability, solubility, viscosity etc. Analysis of protein by well-established methods (WPNI; HPLC etc) can be time consuming, especially in fast-paced processing environments. Therefore, this study looked at the potential of exploiting the fluorescent nature of tryptophan in dairy systems for use in rapid, in-line or at-line process analytical (PAT) tools. Front-face fluorescence spectroscopy (FFFS) was assessed for use as an in-line PAT tool in the manufacture of a) model infant milk formula (IMF) ingredients (skim milk powder; demineralised whey powder; whey protein concentrate) and b) model IMF powders. For dairy ingredients, PLS-DA models developed were able to discriminate with 100% accuracy based on ingredient type and pre-heat treatment applied (72, 95, 115 °C). For IMF manufacture, FFFS was able to predict pre-drying heat treatment temperatures and soluble protein content of model IMF powders with RMSECV values of 8.3 ^{o}C and 1.01 g protein/100g powder, respectively. In addition, a fluorescence-based analyser (Amaltheys II, Spectralys Innovations, France) was assessed as an at-line PAT tool to rapidly measure soluble protein (SP) and WPNI. Correlation (R^2) between the fluorescence-based analyser and reference methods was greater than 0.93 for both WPNI and SP. Overall, this study shows the potential of fluorescence-based PAT tools to provide valuable, accurate and rapid information on the effect of processing on dairy product quality.

APPLICATIONS OF HYDRODYNAMIC CAVITATION FOR INSTANT REHYDRATION OF HIGH PROTEIN MILK POWDERS

Shivani Pathania, Quang Tri Ho, Sean A Hogan, Noel McCarthy, John T Tobin
Food Chemistry and Technology Department, Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork, Ireland

ABSTRACT

The aim of this study was to evaluate the effectiveness of an in-line hydrodynamic cavitation (HC) system, for rehydration of milk protein concentrate powders (MPC) at semi- industrial pilot scale. MPC powder was dispersed in water at 50 °C at 20 % (w/w) dry matter (DM) with two commonly used high-shear powder inductors/mixers. The MPC dispersions created were then passed through the HC system to assess subsequent hydration behaviour of the MPC powders. Particle size distribution (PSD) of MPC dispersions prepared using conventional high-shear mixing indicated that complete rehydration of MPC powders was not achieved, with D_{90} and $D_{[4,3]}$ values of 21.17 µm and 5.62 µm respectively, observed in MPC dispersions. In contrast MPC dispersions subjected to HC had a PSD indicative of complete rehydration, with D_{90} and $D_{[4,3]}$ values of 0.45 µm and 0.19 µm respectively. Apparent viscosity decreased significantly (p<0.05) post HC compared to dispersions subjected to conventional high shear mixing. Phase separation profiles showed that HC treated MPC dispersions had increased stability to sedimentation compared to high-shear treated samples. Wetting, immersion, dissolution and solubilisation of high protein powders occurred instantaneously (and simultaneously) during HC. This emerging technology has the potential to achieve complete rehydration of powders in significantly less time than conventional rehydration processes employed by dairy and other industries.

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Applications of hydrodynamic cavitation for instant rehydration of high protein milk powders

John Tobin

Food Chemistry and Technology, Teagasc Food Research Centre, Moorepark, Dublin, Ireland

ABSTRACT

The aim of this study was to evaluate the effectiveness of an in-line hydrodynamic cavitation (HC) system, for rehydration of milk protein concentrate powders (MPC) at semi- industrial pilot scale. MPC powder was dispersed in water at 50 °C at 20 % (w/w) dry matter (DM) with two commonly used high-shear powder inductors/mixers. The MPC dispersions created were then passed through the HC system to assess subsequent hydration behaviour of the MPC powders. Particle size distribution (PSD) of MPC dispersions prepared using conventional high-shear mixing indicated that complete rehydration of MPC powders was not achieved, with D_{90} and $D_{[4,3]}$ values of 21.17 µm and 5.62 µm respectively, observed in MPC dispersions. In contrast MPC dispersions subjected to HC had a PSD indicative of complete rehydration, with D_{90} and $D_{[4,3]}$ values of 0.45 µm and 0.19 µm respectively. Apparent viscosity decreased significantly ($p<0.05$) post HC compared to dispersions subjected to conventional high shear mixing. Phase separation profiles showed that HC treated MPC dispersions had increased stability to sedimentation compared to high-shear treated samples. Wetting, immersion, dissolution and solubilisation of high protein powders occurred instantaneously (and simultaneously) during HC. This emerging technology has the potential to achieve complete rehydration of powders in significantly less time than conventional rehydration processes employed by dairy and other industries.

Combined prototype with ultrasounds, microwave, and spiral heat exchange in an industrial olive oil extraction plant: impact on olive oil quality and yield

Alessandro Leonea, Antonia Tamborrinob, Francesco Caponioc, Giacomo Squeoc, Roberto Romanielloa

a Department of the Science of Agriculture, Food and Environment, University of Foggia, Via Napoli, 25, 71100, Foggia, Italy
b Department of Agricultural and Environmental Science, University of Bari Aldo Moro, Via Amendola, 165/A, 70126 Bari, Italy
c Department of Soil, Plant and Food Sciences, Food Science and Technology, University of Bari Aldo Moro, Via Amendola, 165/A, 70126, Bari, Italy

ABSTRACT
An industrial combined prototype (CP) composed from a low-frequency ultrasound device, microwave apparatus and heat exchanger is employed to investigate the real possibility of introducing these innovative technologies to the olive oil extraction process and evaluating their influence on olive oil quality and yield.
Different olive paste treatments were compared in order to define the effects on the olive oil quality and yield.
The use of a spiral heat exchanger in addition to the malaxer reduced the malaxation time to 20 min, and with the microwave apparatus it was possible to obtain an entirely continuous process, without interruptions, from the milling phase to the solid-liquid separation phase.
The internal spiral aids in moving the paste from the input to output section, resulting in limited operating pressure.
Using the ICP device led to an average increase in extractability ranging from 2.30 to 3.85% with respect to the control thesis, for the Arbosana and Arbequina varieties, respectively, but this difference was not statistically significant.
Regarding the virgin olive oil (VOO) quality, the use of the ICP did not affect the marketable parameters and total phenol content, while in terms of the process efficiency, the ICP obtained a higher value than the con- ventional process and improved the extraction yield.

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Simulation and evaluation of spatial distributions of shockwaves

Henry SABAREZ[1], Kai KNOERZER[1], Aarti TOBIN[2], Roman BUCKOW[1]

[1]*CSIRO Agriculture & Food, Melbourne, Australia*
[2]*CSIRO Agriculture & Food, Brisbane, Australia*

Abstract

Hydrodynamic pressure waves or shockwaves can disrupt tissue of any biological material which has shown promising applications in the food industry such as non-invasive tenderisation of meat and seafood and enhanced extraction of bioactives from plant materials. Shockwave treatment involves the instantaneous development of pressure waves up to 1 GPa in fractions of milliseconds. These shockwaves propagate in water with high-energy and travel rapidly through fluids, causing an almost instantaneous pressure spike throughout the water and the products placed in the water. However, the intensity of the shockwave is highly dependent not only on the way it is generated (e.g. by detonating explosives under water) but also on the spatial distance from the source and acoustic properties of the material that it travels through.

A numerical model was developed using COMSOL (COMSOL Multiphysics™, Sweden) to predict the spatial pressure distribution in a pilot scale prototype machine manufactured by the German Institute of Food Technologies (DIL, Germany). This machine uses electrical discharges under water at up to 36 kV (corresponding to 14 kJ per pulse) which are shielded (and reflected) by a metal dome on top of the electrodes and approximately 20 cm from the treated food on the conveyor belt. The model was validated using pressure sensitive paper (Fujifilm, Japan).

Both, the modelled and experimental results showed that the current shockwave system gives a distribution of pressure from bottom to top that only slightly increases towards the pressure source. It can therefore be concluded that the pressure shield reflects and guides the shockwave well towards the conveyor belt and the thickness of the treated food does not significantly affect the treatment uniformity. The maximum shockwave pressure is at the centre under the pressure shield and to the lowest pressure at the edges which is still approximately 80% of the maximum pressure in the centre.

Beer and beer-based beverage containing lignans

Josef BALIK[1], Pavel HIC[1], Jan TRISKA[2], Nadezda VRCHOTOVA[2], Bo-Anne ROHLIK[3], **Milan HOUSKA**[4]
[1] *Mendel University in Brno*
[2] *Global Change Research Institute Brno, CAS, Public research institute*
[3] *The University of Chemistry and Technology in Prague*
[4] *Food Research Institute Prague, Public research institute*

Abstract
It is believed that the intake of dietary fiber such as lignan can reduce the risk of coronary heart disease and cardiovascular disease mortality. Lignans can be found in various plant-based products such as hops, which is used to produce beer and beer based beverages. However, these beverages naturally contain less than 0.3 mg/L of lignans. Using our technology, we are able to produce beer and beer-based beverages, which contain up to 200 mg/L of lignans and up to 1.0 g/L of granulated hops. Lignans, used as an additive in beer and beer beverage production, are extracted, without using organic solvents, from European spruce knot chips into boiling drinking water, and can be later diluted into ethanol. Lignan enriched beer products can be produced by adding lignan extracts at various productions stages depending on the products final properties. To produce a light flavoured beer product, lignan extracts should preferably be added during the initial stages of wort boiling, to ensure that the effect of lignans on the beer aroma and flavour is minimal. Alternatively, spruce knot chips can be directly added during the final stages of wort boiling, to ensure that the effect of lignans on the beer aroma and flavour is much more intense. Consequently, it is appropriate to add a reduced amount of hops at the end of wort boiling to develop the expected beer aroma. The product was recently patented under code WO 2016207820 A1. Registered June 23, 2016.

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High pressure processing applications in food industry and immunology - overview

Filipa Vinagre Marques da Silva[1], Roman Buckow[2], Jan Tříska[3], Ariette Matser[4], Francisco Purroy Balda[5], Jirina Bartunkova[6], **Milan Houska[7]**

[1] *University of Auckland, Auckland, New Zealand*
[2] *CSIRO Agriculture and Food*, Werribee, Australia
[3] *Global Change Research Institute CAS, Brno, Czech Republic*
[4] *Wageningen UR Food & Biobased Research, Wageningen, the Netherlands*
[5] *Hiperbaric, S. A., Burgos, Spain*
[6] *Charles University, Prague, Czech Republic*
[7] *Food Research Institute Prague, Czech Republic*

High-pressure processing (HPP) is a cold pasteurization technology by which products, prepacked in their final package, are introduced to a vessel and subjected to a high level of isostatic pressure (300–600 MPa). High-pressure treatment of fruit, vegetable and fresh herb homogenate products offers us nearly fresh products as regards the sensorial and nutritional quality of original raw materials representing relatively stable and safe source of nutrients, vitamins, minerals, and health effective components. Such components can play an important role as a preventive tool against the start of illnesses, namely in the elderly. There will be presented overview of several food products, namely of fruit and vegetable origin marketed successfully around the world. Effects of HPP and HPP + heat on key spoilage/pathogenic microorganisms including the resistant spore form and fruit/vegetable endogenous enzymes are briefly mentioned including the effect on the product quality. Part of the presentation is devoted to industrial equipment available on market aimed for factories dealing with HPP treated products.
There is mentioned also non-traditional application of HPP treatment in immunology [1]. High hydrostatic pressure (HHP) is capable to induce immunogenic cell death in human tumor cells. HHP induced the rapid expression of immunogenic cell-death markers such as heat shock proteins (HSP70, HSP90) and calreticulin on the cell surface and releases of intracellular proteins like HMGB1 and ATP.
Jinak ok The interaction of dendritic cells (DCs) with HHP-treated tumor cells led to a more rapid rate of DC phagocytosis, upregulation of CD83, CD86 and HLA-DR and the release of IL-6, IL-12p70 and TNFα. DCs pulsed with tumor cells killed by HHP induced high numbers of tumor-specific T cells. HHP acts as a reliable and potent inducer of immunogenic cell death in human tumor cells

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Novel humidity-controlled chlorine dioxide-superabsorbent polymer technologies for military textiles (uniforms, parachutes, shelters), packaging, and ballistic and blast protection

Christopher DOONA[1]

[1] U.S. Army Natick Soldier Research Development and Engineering Center, Natick, Massachusetts, United States of America

Mold growth is ubiquitous in causing problems relating to the spoilage of fresh fruits and vegetables, the degradation of textiles used in uniforms and clothing (undergarments, socks, boots), parachutes sleeves, tents and rigid-walled shelters, and vehicle mats, and even to its growth on interior metal surfaces coated with antimicrobial polyurethane. Further, humid, warm environments cause the growth of mold and microorganisms that induce rashes and irritations for clothing worn for extended periods without access to laundry or adequate hygiene facilities. To combat these issue, chlorine dioxide is a versatile disinfectant, a broad-based biocide that can be used in myriad applications, including humidity-controlled, time-released generation in the Compartment of Defense (CoD) concept originated for food packaging. The CoD can be adapted for use in other enclosed spaces, such as packaging for other goods, kit bags for parachutes, for tents and shelters, for decontamination, and as multifunctional materials for self-deodorizing uniforms with ballistics and blast protection. These concepts will be discussed including their novel use of mixed chemical - superabsorbent polymer decontamination technologies to inactivate molds and fungal spores, pathogenic cells, and bacterial spores in these and other military applications.

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Enzyme-based production of nutraceuticals from organosolv pretreated forest biomass

Paul CHRISTAKOPOULOS[1], Anthi KARNAOURI[1], Leonidas MATSAKAS[1], Saskja BUHLER[1], Eleni KRIKIGIANNI[1], Ulrika ROVA[1]

[1]*Luleå University of Technology, Luleå, Sweden*

Abstract
Prebiotic oligosaccharides are gaining recognition as important substrates for gut probiotic bacteria, with which they act synergistically to competitively inhibit pathogens and secrete metabolites with a positive impact on host physiology. Functional foods incorporating prebiotic oligosaccharides as nutraceuticals are preferred by consumers as an integral part of healthier food diets. Lignocellulosic biomass is an abundant source of oligosaccharides with prebiotic potential that can be generated from the degradation of cellulosic and hemicellulosic fraction. In this work, we present a holistic approach for the production of such compounds from forest biomass (spruce, pine), starting with pretreatment and fractionation of the material, followed by product recovery from the different streams. Organosolv pretreatment with ethanol as organic solvent was chosen for the biomass fractionation in order to achieve high lignin and hemicellulose solubilization, as well as yield a cellulose-rich pulp susceptible to subsequent enzymatic digestibility. The pretreated solid fraction was targeted towards the production of cello-oligosaccharides (COS) by designing tailor-made efficient enzyme cocktails that allow the controlled hydrolysis and promote the formation of oligomers. Moreover, after removal of the organic solvent, the hemicellulose-rich aqueous fraction was used for the direct isolation of xylooligosaccharides (XOS) with a high ratio of oligomeric to monomeric compounds. Growth tests on probiotic strains of *Lactobacillus* and *Bifidobacteria* sp. verify the prebiotic activity of both cellulose and hemicellulose-derived oligomeric compounds. Our results demonstrate that forest biomass, as a non-edible and high abundant novel resource, can be efficiently exploited for the cost-competitive production of food-grade prebiotic oligosaccharides.

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Microbial assisted production of nutraceuticals from organosolv pretreated forest biomass

Ulrika ROVA[1], Alok PATEL[1], Leonidas MATSAKAS[1], Paul CHRISTAKOPOULOS[1]

[1]*Biochemical Process Engineering, Division of Chemical Engineering, Department of Civil, Environmental and Natural Resources Engineering, Luleå University of Technology, 971-87 Luleå, Sweden*

Abstract

The global demand for essential polyunsaturated fatty acids (PUFAs) such as EPA and DHA has been growing rapidly and expected to keep on growing in the future. The largest PUFAs market segments by applications are respectively dietary supplements, nutraceuticals, infant formula and functional foods. As their production from fish oils is environmentally unsustainable and unsuitable for large vegetarian population, there is a demand for new vegetarian sources of PUFAs. Among various microorganisms, oleaginous microalgae are considered as microscopic bio-factories for PUFAs production. The aim of the present study was to establish a microalgal platform to produce nutraceutical-value PUFAs from forest residual biomass and more specifically Norway spruce (*Picea abies*), and birch (*Betula pendula* and *B. pubescens*) due to their abundance in Sweden. Based on their metabolism, microalgae can grow photoautotrophic, photoheterotrophic, mixotrophic and heterotrophic. To this end, the mixotrophic growth of the marine microalgae *Phaeodactylum tricornutum* on birch and spruce hydrolysates was compared to autotrophic cultivation. The highest EPA production (256 mg/L) and productivity (19.69 mg/L/d) were observed when this alga was cultivated mixotrophically on spruce hydrolysates (2 g/L; glucose). However, this strain doesn't have ability to grow in dark under heterotrophic condition3. Heterotrophic PUFAs production is expected to be more advantageous concerning to utilize both forest biomass hydrolysates with high concentration of glucose (up to 120 g/L), hence, optimization of high-density cultivation of two microalgae *Crypthecodinium cohnii* and *Schizochytrium limacinum* SR21 growing on these two renewable substrates from forest were studied for enhanced productivity of docosahexaenoic Acid (DHA).