Hosted by FOOD Aarhus University
June 21st - 25th, 2021

DELIVERING WITH DAIRY:

From Primary production to Primary purpose

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WELCOME TO:

DAIRY SCIENCE AND TECHNOLOGY SYMPOSIUM

DELIVERING WITH DAIRY:
From Primary production to Primary purpose

What is the role of dairy in future diets?

Key for maintaining the role of dairy in sustainable and healthy diet is ensuring holistic views which cover the entire food system.

Any future food system will only function if it leads to diets that are not only healthy and sustainable, but also affordable, safe for all, and accepted.

This conference aims to bringing the dairy science community together, as the future food system will need to be created with input from many disciplines to future proof the role of dairy in this future food system, where the primary aim is to supply nutrition to billions of consumers world-wide via a balanced nutrient rich diet.

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PROGRAM OF THE WEEK

June 21-25, 2021

The conference Delivering with dairy: from primary production to primary purpose' will focus on recent innovations in the field of dairy science and technology viewed from a central perspective of milk and dairy products as a means of supplying nutrient-rich products to billions of consumers all over the world.

SESSIONS	TITLES
SESSION 1	THE ROLE OF MILK AND DAIRY PRODUCTS IN HEALTHY AND SUSTAINABLE DIETS
SESSION 2	DELIVERING NUTRITION WITH DAIRY: MATRIX EFFECTS
SESSION 3	PROCESSING OF MILK AND DAIRY PRODUCTS FOR SAFE, STABLE AND NUTRITIOUS PRODUCTS
SESSION 4	MILK: DESIGNED TO DELIVER
SESSION 5	PRIMARY MILK PRODUCTION: BREEDING AND FEEDING FOR A HEALTHY AND SUSTAINABLE DIET

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SESSION 1

Monday 21st of June

TITLE

THE ROLE OF MILK AND DAIRY PRODUCTS IN A SUSTAINABLE AND HEALTHY DIET

Sustainable Healthy Diets are dietary patterns that promote all dimensions of individuals' health and wellbeing, have low environmental pressure and impact are accessible, affordable, safe and equitable and are culturally acceptable. Unfortunately, in the public debate, this is often reduced solely environmental impact on product level, thus ignoring the dietary level, as well as economic and social factors. Holistic approach on sustainable and healthy diets, particularly when include circular rather than linear food systems, clearly highlight importance of milk and dairy products in a sustainable and healthy diet. Key aspects in this are the nutrient density, the high digestibility and bioavailability, but also the affordability and social acceptance, combined with an ever-decreasing footprint. The role of milk and dairy products in a sustainable and healthy diet should, as such, be the foundation of a demand driven dairy chain.

CHAIR

THOM HUPPERTZ

Professor, Friesland Campina & Wageningen University, NL

SESSION 1

Monday 21st of June

15:00 CET	SESSION START
Keynote talk	**How can the planet nourish the population; What role for Dairy?** **PROF. JEREMY HILL** Professor of Sustainable Nutrition, Riddet Institute, Massey University and Chief Science & Technology Officer, Fonterra, NZ
Flash presentations	**Protein quality: From single ingredients to meals stresses the importance of milk proteins** **Shiksha Adhikari**, Food Quality and Design, Wageningen University & Research, The Netherlands
	Innovative prediction of milk fraud associated to digital imaging photometry **Anna Flavia de Souza Silva**, Center for Nuclear Energy in Agriculture, University of Sao Paulo, Brazil

SESSION 1

Monday 21st of June

Keynote talk

Dairy's value in a sustainable food system for nutrition and health

GREGORY D. MILLER, PHD
Chief Science Officer, National Dairy Council and Sector Lead Nutritional Security, Global Dairy Platform, USA

Flash presentations

Bioactive peptides occurring in Tulum cheese during ripening

Hale İnci Öztürk, Konya Food and Agriculture University, Turkey

The effect of supplementation of milk and biscuits on stunting children's growth aged 12-23 months in Limo Subdistrict, Depok City

Elmina Tampubolon, Center for Nutrition and Health Studies, Faculty of Public Health, University of Indonesia, Indonesia

SESSION 1

Monday 21st of June

Keynote talk	**Substantiating the role of dairy in sustainable food systems** **ANNA-KARIN MODIN-EDMAN, PHD** Senior Sustainability Manager Corporate CSR, Arla Foods, DK
Flash presentations	**Greek raw goat milk for the production of healthy and nutritious foods** **Chryssi Kounenidaki,** Laboratory of Dairy Research, Department of Food Science and Human Nutrition, Agricultural University of Athens, Greece
	Nutritional content, protein quantity, protein quality and carbon footprint of plant-based drinks and semi-skimmed milk in the Netherlands and Europe **Cécile M. Singh-Povel,** FrieslandCampina, Stationsplein 4, 3818 LE Amersfoort, the Netherlands
Panel discussion	**JEREMY HILL, GREGORY MILLER, ANNA-KARIN MODIN-EDMAN AND THOM HUPPERTZ**
17:00 CET	**SESSION END**

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SESSION 2

Tuesday 22nd of June

TITLE **DELIVERING NUTRITION WITH DAIRY: FOOD MATRIX EFFECTS**

Nutritional sciences have taken some steps in the last decade changing focus from reductionistic component-based approaches to more holistic product-based approaches, wherein the (potential) interaction between constituents and a product and the influence of the structure of the food products is also considered. This has been key in e.g., the saturated fat discussion, where is has been clearly shown that findings from studies on saturated fatty acids in isolation cannot be translated to effects observed in a dairy matrix like cheese, but also for e.g., chocolate or red meat. However, also for other concepts this applies. Consider e.g., the (lack of) cariogenicity of milk and dairy products, due to lactose as a low-cariogenic carbohydrate source combined with the protective effects of the caseins and milk salts.

CHAIR **ULF ANDERSEN**,

Senior Research Scientist, Arla Foods Amba, DK

SESSION 2

Tuesday 22nd of June

15:00 CET	SESSION START
Keynote talk	**The cheese matrix: control of techno-functionality and impact on nutritional and physiological effects** **PROF. SYLVIE TURGEON** STELA Dairy Research Center and Institute of nutrition and functional foods (INAF), Laval University, CA
Flash presentations	**Digestion of dairy proteins: A matter of gastric re-structuring** **Ana-Isabel Mulet-Caberoi**, Quadram Institute Bioscience, Norwich, UK
	The impact of thermal processing on the physicochemical and biochemical properties of lactoferrin **David A. Goulding,** School of Food and Nutritional Sciences, University College Cork, Ireland

SESSION 2

Tuesday 22nd of June

Keynote talk

The Food Matrix: Does it influence the health effects of dairy fats?

PROF. IAN GIVENS
Director, Institute for Food, Nutrition and Health, University of Reading, UK

Flash presentations

Olfactory discrimination of fat content in milks is facilitated by differences in composition of volatile odor compounds rather than aroma intensity

Shuo Mu, Division of Human Nutrition and Health, Wageningen University, Wageningen, the Netherlands

Delivery of bioactive fatty acids in yoghurt

María Ayelén Vélez, Instituto de Lactología Industrial (INLAIN, Universidad Nacional del Litoral/CONICET). Santa Fe, Argentina

SESSION 2

Tuesday 22nd of June

Keynote talk

A gut feeling about dairy matrix effects – pursuing a mechanistic understanding

ANDREAS BUCH MOELLER
Nutrition Scientist, Arla Foods Amba, DK

Flash presentations

Processed milk and our tummies: How do they team up?

Natalie Ahlborn, Riddet Institute, Massey University, Private Bag 11222, Palmerston North, New Zealand

Vitamin degradation kinetics of heat-treated bovine milk

Shruti Lalwani, Department of Food Technology, Engineering and Nutrition, Lund University, Sweden

Panel discussion

SYLVIE TURGEON, IAN GIVENS, ANDREAS BUCH MOELLER AND ULF ANDERSEN

17:00 CET	**SESSION END**

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SESSION 3

Wednesday 23rd of June

TITLE

PROCESSING OF MILK AND DAIRY PRODUCTS: FOR SAFE, STABLE AND NUTRITIOUS PRODUCTS

Within the dairy chain, processing of milk plays an extremely important role. First and foremost, it is required to improve the safety and extent the shelf-life of products, thereby ensuring that products can be safely distributed all over the world. This shelf-life extension can be achieved through heat treatment, but also through fermentation or drying. In addition, processing is also important to ensure that a dairy matrix is created which is preferable by consumers, which can be digested and from which nutrients bioavailable. Such processing can include similar steps as for shelf-life extension, but also other processing techniques, including e.g., non-thermal processing.

CHAIR

LILIA AHRNÉ

Professor, Departement of Food Science, University of Copenhagen, DK

SESSION 3

Wednesday 23rd of June

15:00 CET	SESSION START
Keynote talk	**Customized phase treatment for safe, shelf-stable and nutritious milk and milk products** PROF. JÖRG HINRICHS Professor, University of Hohenheim, DE
Flash presentations	**Impact of pulsed UV light treatment on microbiological, nutritional and quality parameters of milk** Ronit Mandal, Food, Nutrition and Health, University of British Columbia, Vancouver BC, V6T1Z4, Canada
	Spoilage of UHT milk by thermoresistant bacterial enzymes Miguel Aguilera Toro, Aarhus University, Foods Science Department, Denmark

SESSION 3

Wednesday 23rd of June

Keynote talk

Processing for milk protein functionality

PROF. MARIANNE NISSEN LUND
Professor, University of Copenhagen, DK

Flash presentations

Soluble complexes formation during the microfiltration combined with diafiltration of skim milk

Ozgenur Coskun, Aarhus University, Department of Food Science, Denmark

Modification of texture in cow and buffalo milk paneer by thermal treatment and milk fat content

Anne Katrine Laursen, Department of Food Science, University of Copenhagen, Rolighedsvej 30, DK-1958 Frederiksberg C, Denmark

SESSION 3

Wednesday 23rd of June

Keynote talk

Dairy processing: from interesting science to industrial relevance

MATHIAS EISNER, PHD
Yili Innovation Centre Europe, NL

Flash presentations

The effect of calcium binding components on calcium removal during electrodialysis

Emilie Nyborg Nielsen, Department of Food Science, University of Copenhagen, Rolighedsvej 26, 1958 Frederiksberg, Denmark

Residence time in the cooker-stretcher affects mozzarella cheese composition, structure and functionality

Ran Feng, University of Copenhagen, Denmark

Panel discussion

JÖRG HINRICHS, MARIANNE NISSEN LUND, MATHIAS EISNER AND LILIA AHRNÉ

17:00 CET **SESSION END**

SESSION 4

Thursday 24th of June

TITLE

MILK: DESIGNED TO DELIVER

Key in the ability of milk and dairy products to function as excellent food matrices is the fact that milk, in essence, is designed to deliver. It is the sole source of nutrition for the neonate and contains essential structural elements, e.g., in the form of casein micelles and milk fat globules, which deliver a multitude of nutrients, including salts, vitamins and proteins. In addition, colloidal stability of these structure elements in the GI tract also leads to important control of the kinetics of digestion and release of nutrients, enabling maximum utilization of nutrients from milk and dairy products. Hence, understanding of these key structure elements and their biological function, and their interaction with (micro-)nutrients is key to creating products that fit in a healthy and sustainable diet.

CHAIR

EFFIE TSAKALIDOU

Professor, Agricultural University of Athens, GR

SESSION 4

Thursday 24th of June

15:00 CET	SESSION START
Keynote talk	**Milk fat globule size; mechanism of regulation and physiological and health implications** DR. NURIT ARGOV-ARGAMAN Department of Animal Sciences, The Robert H Smith Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, IL
Flash presentation	**From cow to shelf - Influence of milk processing on barista style foam quality** Darius Hummel, University of Hohenheim, Garbenstraße 21, 70599 Stuttgart, Germany

SESSION 4

Thursday 24th of June

Keynote talk

Lactose: Milk's sweet spot

DR. JAN M.W. GEURTS
Principal Scientist Family and Adult Nutrition, Expert Team Nutrition, FrieslandCampina Innovation Centre, Wageningen, NL

Flash presentations

Binding of calcium to sugars in milk products

Yuan Jiang, Department of Food Science, University of Copenhagen, Rolighedsvej 26, DK, 1958, Frederiksberg C, Denmark

Calcium citrate speciation in milk under acidification, heat treatment and digestion

Xiao-Chen Liu Department of Food Science, University of Copenhagen, Rolighedsvej 26, DK, 1958, Frederiksberg C, Denmark

SESSION 4

Thursday 24th of June

Keynote talk	**Perspectives on Milk Protein Functionality** **PROF. THOM HUPPERTZ** Professor of Dairy Science and Technology, Wageningen University and Research, Wageningen, NL
Flash presentations	**New type of whey protein ingredient for improved quality of infant formula?** **Pernille Lund,** University of Copenhagen, Frederiksberg, Denmark
	Comparing molecular features of human and bovine milk caseins **Martin Nørmark Thesbjerg,** Department of Food Science, Aarhus University, Denmark
	3D-Printing applications for cheese and milk protein ingredients **Megan M. Ross,** School of Food and Nutritional Sciences, University College Cork, Cork, Ireland
Panel discussion	**NURIT ARGOV-ARGAMAN, JAN M.W. GEURTS, THOM HUPPERTZ AND EFFIE TSAKALIDOU**
17:00 CET	**SESSION END**

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SESSION 5

Friday 25th of June

TITLE

PRIMARY MILK PRODUCTION: BREEDING AND FEEDING FOR A HEALTHY AND SUSTAINABLE DIET

Sustainable Healthy Diets are dietary patterns that promote all dimensions of individuals' health and wellbeing, have low environmental pressure and impact are accessible, affordable, safe and equitable and are culturally acceptable. Unfortunately, in the public debate, this is often reduced solely environmental impact on product level, thus ignoring the dietary level, as well as economic and social factors. Holistic approach on sustainable and healthy diets, particularly when include circular rather than linear food systems, clearly highlight importance of milk and dairy products in a sustainable and healthy diet. Key aspects in this are the nutrient density, the high digestibility and bioavailability, but also the affordability and social acceptance, combined with an ever-decreasing footprint. The role of milk and dairy products in a sustainable and healthy diet should, as such, be the foundation of a demand driven dairy chain.

CHAIR

MILENA CORREDIG
Center Leader CiFOOD, Department of Food Science, Aarhus University, DK

NORBERT RAAK
Postdoc, Department of Food Science, Aarhus University, DK

SESSION 5

Friday 25th of June

15:00 CET	SESSION START
Keynote talk	**Designing a healthy and sustainable diet: from theory to farmer practice** JEROEN HECK Senior scientist, Friesland Campina, NL
Flash presentations	**Natural variation in Danish dairy streams – Protein profile, PTMs and DSCC** Natacha R. Róin, Department of Food Science, Aarhus University, Denmark
	Impact of farm type and sampling month on the composition and properties of bovine milk in Northern Sweden Hasitha Priyashantha, Department of Molecular Sciences, Swedish University of Agricultural Sciences, Box 7015, SE-750 07 Uppsala, Sweden

SESSION 5

Friday 25th of June

Keynote talk

Breeding for improved milk quality – what needs to happen?

DONAGH BERRY
Research Scientist, Teagasc, IE

Flash presentations

Reducing enteric methane emissions of dairy cows through animal breeding techniques

Anouk van Breukelen, Animal Breeding and Genomics Group, Wageningen University & Research, The Netherlands

Which cattle breed makes the best Cheddar?

Camilla Preece, Harper Adams University, UK

SESSION 5

Friday 25th of June

Keynote talk	**Sustainable milk production and the impact on milk quality and functionality** NINA AAGAARD POULSEN Associate Professor, Aarhus University, Food Science, DK
Flash presentations	**Linking milk fat composition and crystalline polymorphism across genetic and environmental factors** Naomi Arita-Merino, Physics and Physical Chemistry of Foods, Wageningen University, Wageningen, the Netherlands
	The effects of feeding fat, nitrate and 3-NOP on milk quality and functionality of dairy cows Gayani M.S. Lokuge, Department of Food Science, Aarhus University, Denmark
Panel discussion	JEROEN HECK, DONAGH BERRY, NINA AAGAARD POULSEN AND MILENA CORREDIG
Final remarks	ALAN KELLY
17:00 CET	**SESSION END**

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FLASH PRESENTATIONS

SESSION 1
Monday 21st of June

PROTEIN QUALITY: FROM SINGLE INGREDIENTS TO MEALS STRESSES THE IMPORTANCE OF MILK PROTEINS

Shiksha Adhikari[1] and Thom Huppertz[1]

1 Food Quality and Design, Wageningen University & Research, The Netherlands

Abstract

Even though protein quality measurements are mainly conducted on single protein sources, they are normally consumed in the form of meals containing several protein sources. We studied the capacity of dairy products to improve overall protein quality of a meal. We compared different breakfasts with combination of food products from only plant source and a mixture of plant and dairy (milk). Two cereals, cornflakes and oats, that have Lys as the limiting amino acid were used as basic breakfast ingredients and combined with either soy drink or milk. The limiting amino acid for soy drink is Val whereas for milk the first limiting are the SAA. For the combination of cereal and milk, a ~25% smaller serving of milk could provide the same amount of protein when compared to amount of soy drink. While providing similar amount of protein and calories, the combination with soy drink provided up to 25% less lysine. This shows that dairy products having the complete amino acid profile have a better potential to complement for limiting amino acid of other food items when consumed together, thereby strengthening the crucial role of dairy in plant-based but animal-optimized diets.

Practical relevance

Food products that are excellent source of protein (DIAAS>100) do not always have the potential for compensating for the lacking amino acid for other foods in a meal. With these results we can highlight the potential of dairy in compensating for the limiting amino acid of other food items in a meal, which is crucial in providing essential protein quality in every meal.

SESSION 1

Monday 21st of June

INNOVATIVE PREDICTION OF MILK FRAUD ASSOCIATED TO DIGITAL IMAGING PHOTOMETRY

Anna Flavia de Souza Silva[1] and Fábio Rodrigo Piovezani Rocha[1]

1 Center for Nuclear Energy in Agriculture, University of Sao Paulo, Brazil

Abstract

Milk is vulnerable to fraud, either motivated by financial issues or to mask poor hygiene conditions, in a tentative to hide the low quality of processing. Several analytical alternatives available to identify these bad practices are not widely available or present limitations to be implemented worldwide. Costly instruments, the need for highly skilled analysts, specific characteristics of milk chain in different regions of the world, complex data treatment, and the limitations of the analytical procedures are blanks exploited by fraudsters. In order to counteract these issues, novel alternatives for screening of milk quality as well as identification of fraud based on microanalysis and smartphone-based photometric detection have been proposed in my Ph.D., combining advantages of sustainability, cost-effectiveness, portability, easy execution, and compatibility with digitalization of food industries. Applications involve novel approaches for determination of protein and fat, formaldehyde and indirect pH measurements to evaluate milk hygienic quality. Some of these contributions were published on specialized journals and honored as innovative approaches in scientific events.

Practical relevance

The study presents several practical applications for fraud identification with efficiency comparable to NIR or chromatographic procedures. They are also a tailored solution for traceability (mainly during transportation), and also allow the inclusion of small producers and poor regions in the world in the digital transformation of food industries.

SESSION 1
Monday 21st of June

BIOACTIVE PEPTIDES OCCURRING IN TULUM CHEESE DURING RIPENING

Hale İnci Öztürk[1], and Nihat Akin[2]

1 Konya Food and Agriculture University, Turkey
2 Selcuk University, Turkey

Abstract
This research was conducted for determining of peptide model and functional peptides in skin bag Tulum cheeses, which was produced in the Anamur region (Turkey), during 180 days of ripening. As a result of analyses of water-soluble extracts of Tulum cheeses by liquid chromatography-tandem mass spectrometry (LC-MS/MS) system, 45 αs1-casein-(CN), 2 αs2-CN-, and 73 β-CN-derived peptides were identified. The majority of identified peptides consisted of β-CN-derived peptides, followed by αs1- and αs2-CN-derived peptides, respectively. The number of αs1- and β-CN-derived peptides increased with the progressive ripening days due to the newly formed peptides depending on proteolysis. Ten different functional activities including ACE inhibitory, antibacterial, antioxidant, anticarcinogenic, immunomodulatory, GLP-1 secretion enhancing, DPP-4 inhibitory, hypocholesteremic, brain function improving and antiamnesic have been detected using BIOPEP, EROP-Moscow, PepBank, PeptideDB, Milk Bioactive Peptide Database, and Google Scholar online databases for characterized peptides. Among these functional features, ACE inhibitory peptides were found to have higher counts.

Practical relevance
A wide variety of bioactivities were determined in the identified sequences. It appears that the consumption of cheeses ripened for a long time is more beneficial in terms of their potential health benefit, especially their bioactive peptide content. The peptidomic data obtained in this study can be used as a marker to determine the specificity of Tulum cheeses and to provide information to PDO.

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SESSION 1

Monday 21st of June

THE EFFECT OF SUPPLEMENTATION OF MILK AND BISCUITS ON STUNTING CHILDREN'S GROWTH AGED 12-23 MONTHS IN LIMO SUBDISTRICT, DEPOK CITY

Elmina Tampubolon[1]

1 Center for Nutrition and Health Studies, Faculty of Public Health, University of Indonesia, Indonesia

Abstract

Stunting is a condition of length/height less than standard for age. Direct causes of stunting are a history of illness and lack of nutrition. This study aim to analyze the effect milk and biscuit supplementation on the growth of stunted children aged 12-23 mo in Limo District, Depok City. The research design was a quasi-experimental with a pretest-posttest control group design using four groups, i.e., milk (n=24), biscuit (n=26), milk+biscuit (n=26), and control (n=26) groups. Measurement of body weight and length was carried out at the start of the study, and at 2, 4 and 6 mo after supplementation. The results showed significant effects of milk, biscuit, and milk+biscuit supplementation on children's growth. The largest change in baseline-endline LAZ (Length-for-Age Z-score) was in the milk+biscuit intervention group (0.79 cm). The change in baseline-endline LAZ in the biscuit group (0.68 cm) was slightly better than that in the milk group. LAZ change in the milk group (0.66 cm) was better than the control group (0.19 cm). The change in LAZ was higher in the third and fourth measurement. Provision of milk or biscuits or both accompanied by education as a program is recommended.

Practical relevance

Dairy plays an essential role in ensuring healthy development and reducing stunting. This study highlighted that the supplementation with milk, biscuit or a combination thereof can significantly reduce stunting in children.

SESSION 1

Monday 21st of June

GREEK RAW GOAT MILK FOR THE PRODUCTION OF HEALTHY AND NUTRITIOUS FOODS

Chryssi Kounenidaki[1], Maria Kazou[1] and Effie Tsakalidou[1]

1 Laboratory of Dairy Research, Department of Food Science and Human Nutrition, Agricultural University of Athens, Greece

Abstract

Goat milk, making 2.2% of the world milk production, is considered to have huge socio-economic importance in many areas around the globe, mainly (semi) arid regions, where it can serve as a tool to sustain food security and support economic growth. Moreover, nowadays, its unique composition and nutritional features make goat milk the dairy product of choice for many consumers. Greece has the largest dairy goat flock in the EU, producing annually 356.000 tons of milk that is almost exclusively used for cheesemaking. In this work we explored raw goat milk deriving from 13 indigenous and 10 non-indigenous goat breeds from all around Greece. Physicochemical analysis (pH, lactose, protein, fat) showed compositional variations among samples. Classical microbiological analysis along with molecular methods revealed the major bacteria (Enterococcus, Lactococcus) and yeasts (Saccharomyces, Candida) genera. Screening the bacteria strains for technological potential (acid production, proteolysis, lipolysis, exopolysaccharide production) revealed several promising strains that will be used as starters or adjuncts in (raw) goat milk cheese production.

Practical relevance

Goat milk, with unique composition and nutritional value, has great socioeconomic importance worldwide. In Greece, most of the goat milk produced is intended for cheesemaking. Thus, the study of chemical and microbial composition contributes to milk quality evaluation, while the strains' technological potential screening unveils new promising starters or adjuncts in (raw) goat cheese production.

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SESSION 1

Monday 21st of June

NUTRITIONAL CONTENT, PROTEIN QUANTITY, PROTEIN QUALITY AND CARBON FOOTPRINT OF PLANT-BASED DRINKS AND SEMI-SKIMMED MILK IN THE NETHERLANDS AND EUROPE

Cécile M. Singh-Povel[1], Martine P. van Gool[1], Ana Paulina Gual Rojas[2], Marjolijn C.E. Bragt[1], Anne J. Kleinnijenhuis[3] and Kasper A. Hettinga[4]

1 FrieslandCampina, Stationsplein 4, 3818 LE Amersfoort, the Netherlands
2 Blonk Consultants, Groen van Prinstererslngel 45, 2805 TD Gouda, The Netherland
3 Triskelion, Reactorweg 47, 3542 AD Utrecht, the Netherlands
4 Wageningen University and Research, Bornse Weilanden 9, 6708 WG Wageningen, The Netherlands

Abstract

Given the increasing consumption of plant-based drinks, it is important to compare their nutritional value with bovine milk. It is the balance between nutritional value and environmental impact that determines their place in a sustainable diet.
Nutritional information on the label was extracted for semi-skimmed milk, soy, oat, almond, coconut and rice drink from the Innova database between January 2017 and March 2020 for the Netherlands, Belgium, Germany, Spain, Italy, and Sweden. Protein and amino acids were measured and carbon footprint was calculated for a selection of Dutch products. Nutritional label information was collected for 399 products. Milk naturally contains many micronutrients, e.g. vitamin B2, B12, and calcium. Approximately 50% of the regular plant-based drinks was fortified with calcium, whereas the organic plant-based drinks were mostly unfortified. Protein quantity and quality were highest in milk. Soy drink had the best protein quality to carbon footprint ratio and milk came second.
Based on the nutrition-sustainability balance, it can be concluded that semi-skimmed milk and fortified soy drink deserve a place in a sustainable diet.

Practical relevance

Given the increasing consumption of plant-based drinks and their positioning as milk-alternatives, it is important to study their nutritional value and balance this with their enironmental impact. The balance between nutritional value and environmental impact, will determine their place in a sustainable diet.

SESSION 2

Tuesday 22nd of June

DIGESTION OF DAIRY PROTEINS: A MATTER OF GASTRIC RE-STRUCTURING

Ana-Isabel Mulet-Cabero[1], Alan Mackie[2], Pete Wilde[1] and André Brodkorb[3]

1 Quadram Institute Bioscience, Norwich, UK
2 School of Food Science and Nutrition, University of Leeds, Leeds, UK
3 Teagasc Food Research Centre, Moorepark, Cork, Ireland

Abstract

The aim of this study was to unravel the mechanisms of the digestion of caseins and whey proteins by which they are denominated as 'slow' and 'fast' proteins, respectively. Formulations were designed differing in the ratio of caseins to whey proteins at 8% total protein with and without the addition of lipid. The samples were digested in a semi-dynamic adult digestion model, which simulated the main dynamics of the human stomach. Selected emptied aliquots went through an in vitro small intestinal digestion while nutrient absorption was assessed by the ex vivo methodology of Ussing chamber, using murine intestinal tissue.

The casein-rich samples showed the formation of mozzarella-like coagula that were persistent throughout gastric digestion. In contrast, whey proteins presented soluble aggregates that dissipated over time resulting in a clear solution by the end of the gastric digestion. This intragastric behaviour was supported by a preliminary human study, using capsule endoscopy. The different gastric re-structuring of the milk proteins critically modulated the nutrient emptying and the subsequent amino acid bioaccessible and absorbed.

Practical relevance

The modulation of gastric behaviour can be further exploited to develop food structures with tailored rates of nutrient digestion, exerting specific physiological functionalities. For instance, foods with fast protein uptake will promote protein synthesis, which can be beneficial for sports nutrition or treating sarcopenia in the elderly.

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SESSION 2

Tuesday 22nd of June

THE IMPACT OF THERMAL PROCESSING ON THE PHYSICO-CHEMICAL AND BIOCHEMICAL PROPERTIES OF LACTOFERRIN

David A. Goulding[1], Jonathan O'Regan[2], Nora M. O'Brien[1] and James A. O'Mahony[1]

1 School of Food and Nutritional Sciences, University College Cork, Ireland
2 Nestlé Development Centre Nutrition, Wyeth Nutritionals Ireland, Askeaton, Co. Limerick, Ireland

Abstract

Lactoferrin (LF) is a bioactive iron-binding glycoprotein. When thermally processed, LF undergoes significant physicochemical changes. The link between such changes and the bioactivity of LF is not well characterised. In this work, thermal processing (72, 80, 85 or 95°C for 15 s) of LF solutions (1%, w/v, pH 7) was simulated. Heat-induced disulfide-linked aggregates were formed. This was accompanied by increases in surface hydrophobicity, ζ-potential and changes to the secondary structure of the protein. The red colour of LF was also lost. LF samples were irreversibly denatured, with endotherms detected at 58.7°C (apo-LF) and 89.6°C (holo-LF). Using the same samples, it was shown that LF and heat induced LF aggregates were largely resistant to simulated infant gastric, but not intestinal, digestion. Also, the efficacy of LF bactericidal activity, and inhibition of lipopolysaccharide-induced NF-κB activation were negatively impacted by thermal processing. LF physicochemical structure and bioactive efficacy was affected by the extent of heat-induced changes in protein structure whereby processing conditions of least severity (i.e. pasteurisation) had the least impact on bioactivity

Practical relevance

To avoid thermal processing with other formula components, LF is typically dry blended into infant formula. Thermal processing is typically required for manufacture of LF ingredients suitable for dry blending to infant formula. This research conveys the link between processing intensity and LF structure, digestion, and bioactivity. Pasteurisation retains LF bioactivity causing least impact.

SESSION 2

Tuesday 22nd of June

OLFACTORY DISCRIMINATION OF FAT CONTENT IN MILKS IS FACILITATED BY DIFFERENCES IN COMPOSITION OF VOLATILE ODOR COMPOUNDS RATHER THAN AROMA INTENSITY

Shuo Mu[1], Sanne Boesveldt[1] and Markus Stieger[1]

1 Division of Human Nutrition and Health, Wageningen University, Wageningen, the Netherlands

Abstract

Previous studies indicated that humans have the ability to detect fatty acids by their odor and to discriminate olfactorily between milks differing in fat content. Researchers argue that volatile aroma composition may contribute to the discrimination, but the detailed mechanisms behind this remain unknown. The aims of this study were (a) to compare olfactory fat discrimination capability of pasteurized and UHT milks (0.5, 1.5, 3.5% fat content) and (b) to link volatile aroma composition (volatile odor compounds) to olfactory fat discrimination capability. Triangle tests were performed (n=33) to determine olfactory fat discrimination capability. Aroma intensity and liking were quantified using line scale ratings (1-100). SPME-GC-MS analysis were performed to quantify volatile composition of the headspace of milks. Participants were capable of discriminating the smell between all fat levels for pasteurized milks (significant differences ($p<0.05$) between 0.5 vs. 1.5%; 0.5 vs. 3.5%; 1.5 vs. 3.5%). In contrast, participants were not capable of olfactory discriminating between any fat levels for UHT milks. When comparing milks with same fat content, aroma intensity.

Practical relevance

This study indicated why people can or cannot distinguish fat content in pasteurized and UHT milks. The mechanism can be applied to optimize the flavour of pasteurized and UHT milk products. Besides, this result also can be helpful when keeping the consistency of milk flavour.

SESSION 2

Tuesday 22nd of June

DELIVERY OF BIOACTIVE FATTY ACIDS IN DAIRY MATRICES

María Ayelén Vélez[1], Erica Rut Hynes[1], María Cristina Perotti[1]

1 Instituto de Lactología Industrial (INLAIN, Universidad Nacional del Litoral/CONICET). Santa Fe, Argentina

Abstract

Addition of beneficial unsaturated fatty acids into dairy food provides relevant health properties. However, they are unstable and susceptible to environmental conditions such as oxygen, light, temperature, pH and ionic charge, and can decrease both food functionality and quality. Our research focuses on two approaches to achieve stability of bioactive fatty acids: encapsulation and homogenization. For the first approach we have studied liposome delivery, formulating CLA-liposomes as ingredients for dairy applications. We characterized the vesicles morphologically (TEM microscopy), in size (by DLS), for encapsulation efficiency (GC) and resistance to freeze-drying. Besides, we assessed the performance of the liposomes as an ingredient in yoghurt. They showed resistance to thermal treatment, oxidation stability and high CLA recoveries. No detrimental effects were found. For the second approach, we used a homogenization step to incorporate CLA in yoghurt milk. We studied the effect of CLA at two levels on fermentation, particle size distribution, CLA content, fatty acids profiles, oxidative stability and physicochemical properties. We successfully increased CLA in all formulations.

Practical relevance

Our research is an innovative and feasible option to produce functional foods with high bioavailability of beneficial fatty acids. Liposomes are versatile vesicles, with high biocompatibility and biodegradability which makes them suitable for diverse fields. As for homogenization, it is a technology commonly applied in dairy industry and could be easily adapted to prepare biolipid-enriched foods.

SESSION 2

Tuesday 22nd of June

PROCESSED MILK AND OUR TUMMIES: HOW DO THEY TEAM UP?

Natalie Ahlborn[1,2,3], Carlos Montoya[1,3], Aiqian Ye[1,2], Linda Samuelsson[3], Nicole Roy[1,4,5] and Warren McNabb[1,4]

1 Riddet Institute, Massey University, Private Bag 11222, Palmerston North, New Zealand
2 School of Food and Advanced Technology, Massey University, Palmerston North, New Zealand
3 Smart Foods Innovation Centre of Excellence, AgResearch Ltd, Te Ohu Rangahau Kai, Palmerston North, New Zealand
4 High-Value Nutrition National Science Challenge, Auckland, New Zealand
5 Department of Human Nutrition, University of Otago, Dunedin, New Zealand

Abstract

Milk is a worldwide staple food, consumed from infancy to late adulthood. Globally, bovine milk is mainly processed using heat and pressure to improve safety and preservation. Differences in processing can affect nutrient structural assemblies, with downstream implications for gastric digestion. Growing pigs (n=180) were fed either raw or processed (pasteurised-homogenised, pasteurised non-homogenised and ultra-high-temperature) bovine milk for ten days. Gastric contents were collected at six timepoints postprandially to analyse rheological and microstructural properties of the gastric curd, and the gastric emptying rate. Preliminary data analysis showed that heat treatment and homogenisation of bovine milk decreased ($P<0.05$) the curd strength and influenced pH of the curd over time, while ultra-high temperature treatment resulted in a faster gastric empty rate during the first two post-prandial hours. In conclusion, this data indicated that both heat treatment and homogenisation impact in vivo gastric digestion. Ongoing analyses will determine the impacts of varied curd and whey fraction formation on the release and absorption of amino acids and lipids from the small intestine.

Practical relevance

This work will add to our understanding of how the digestion and absorption of processed milk contribute to their nutritional outcomes. The knowledge gained from this work can then be used to develop milk-based foods able to deliver superior nutritional value to consumer populations with specific requirements, such as the elderly, athletes or the ill.

SESSION 2

Tuesday 22nd of June

VITAMIN DEGRADATION KINETICS OF HEAT-TREATED BOVINE MILK

Shruti Lalwani[1], Andreas Håkansson[1], Marie Paulsson[1] and Maria Glantz[1]

1 Department of Food Technology, Engineering and Nutrition, Lund University, Sweden

Abstract

Consumer trends are focused on minimal processing of milk. Process technologies for heat treatment used within the dairy industry today probably have smaller effects on the nutritional quality and functionality of milk than older technologies that are the basis for the calculations of nutritional values declared to consumers. This PhD-project focuses on what effects different heat treatments have on the nutritional quality and functionality of milk and dairy products. In a first study, the temperature gradient of fluid was investigated in a lab-scale setup, both experimentally and with Computational Fluid Dynamics (CFD) simulations, to get unbiased kinetic parameters of fluids when heat-treated. When a fluid is subjected to heat, an axial temperature gradient will be formed as a consequence of free convection. This temperature gradient will have no effect on water-soluble vitamins, however effects may arise for fat-soluble vitamins in milk. Further, HPLC methods are developed for the simultaneous elution and quantification of vitamins. Degradation of vitamins present in heated milk are quantified and reaction kinetics of the vitamins during heat treatment is evaluated.

Practical relevance

The results have practical implications for studies aiming to estimate the degradation kinetics parameters for vitamins in milk. The data resulting from the project will be further used to develop new calculation models for the nutritional quality of milk which could further be applied to various processing technologies used in the dairy industry.

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SESSION 3

Wednesday 23rd of June

IMPACT OF PULSED UV LIGHT TREATMENT ON MICROBIOLOGICAL, NUTRITIONAL AND QUALITY PARAMETERS OF MILK

Ronit Mandal[1] and Anubhav Pratap-Singh[1]

1 Food, Nutrition and Health, University of British Columbia, Vancouver BC, V6T1Z4, Canada

Abstract

Pulsed UV light (PL) treatment is a light-based non-thermal process for food decontamination. For designing a PL process for liquids, sample clarity is an important factor governing process efficacy. Thus, it would be interesting to study the treatment of opaque liquid foods like milk. Milk (0%) and distilled water were inoculated with Escherichia coli ATCC 29055, Listeria innocua 33090 and Clostridium sporogenes 7955 and treated in continuous mode by UV254 dose of 22.22-322.22 J/L in annular reactor and 36.36-1148.63 J/L in coiled reactor. Milk (0% and 3.25% fat) were treated under same PL condition and tested for color, vitamin B2 and C, protein and lipid oxidation. Inactivation was higher in coiled reactor, where milk (0%) showed >3, ~ 3, and up to 3 log10 CFU reduction of E. coli, L. innocua and C. sporogenes, respectively. Sample clarity effect was evident as, for water, almost a 3-fold inactivation was achieved in all cases compared to milk. The color parameter b* decreased with treatment intensities. Vitamin B2 decreased significantly with treatment. Vitamin C reduced by ~35 % for both types of milk. However, there was no significant lipid and protein oxidation.

Practical relevance

Pulsed UV light process is still in infancy. Optimizing the treatment conditions for treatment of milk will help in gaining regulatory approval and therefore wide commercialization by food industry alike other non-thermal processes like High-pressure processing.

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SESSION 3

Wednesday 23rd of June

SPOILAGE OF UHT MILK BY THERMORESISTANT BACTERIAL ENZYMES

Miguel Aguilera Toro[1], Valentin Rauh[2], Yinghua Xiao[2], Lisbeth Truelstrup Hansen[3], Nina Aagard Poulsen[1], Lars Wiking[1] and Lotte Bach Larsen[1]

1 Aarhus University, Foods Science Department, Denmark
2 Arla Foods, Denmark
3 Technical University of Denmark, Food Microbiology and Hygiene Research Group, Denmark

Abstract

One of the main problems in UHT milk is its spoilage by exogenous enzymes. Enzymes produced by Pseudomonas (proteases and lipases) are considered the lead cause, due to their production at low temperatures and the resistance against high-temperature treatments.

In order to gain knowledge about the intricateness of the process, enzyme-producing strains have been cultured on a minimal medium with the presence of UHT milk to induce enzyme secretion. The enzymes were later extracted from the culture medium and inoculated into UHT semi-skimmed milk. These samples were exposed to a shelf-life storage experiment where their pH, protein content, proteolytic activity, sediment/gel formation and protein profile were studied.

Results from this experiment showcased the high heterogeneity that exists between bacterial species. The enzymes from Pseudomonas panacis consistently showed the highest proteolytic activity and fastest sedimentation formation (1-2 weeks). An initial increase, and quickly decrease afterwards, of the pH curve was observed on those strains that showed increasing proteolytic activity. The next step would be to look at environmental samples and their genetic organization.

Practical relevance

The knowledge generated in this project will help to understand better the spoilage of UHT milk by bacteria. This knowledge will allow the dairy industry to be more efficient when handling, processing, storing and distributing UHT milk. Additionally, the optimization of the production of UHT milk will reduce the volume of wasted product and the overall environmental impact.

SESSION 3

Wednesday 23rd of June

SOLUBLE COMPLEXES FORMATION DURING THE MICRO-FILTRATION COMBINED WITH DIAFILTRATION OF SKIM MILK

Ozgenur Coskun[1], Lars Wiking[1], Saeed Rahimi Yazdi[2] and Milena Corredig[1]

1 Aarhus University, Department of Food Science, Denmark
2 Arla Innovation Center, Arla foods, Denmark

Abstract

With microfiltration (MF) it is possible to change the ratio of ions, lactose and soluble proteins in milk concentrates. In this study, micellar casein concentrates (MCC) were obtained with MF at 10°C, with the help of extensive diafiltration (DF) against water. Samples were brought to 2x concentration, then subjected to extensive DF, keeping the volume fraction constant. The concentration was then continued to a 4x final concentration. Total and soluble protein content quantified by Dumas. The soluble phases and permeates were analyzed by RP-HPLC. Overall, β-casein transmitted along with whey proteins in all stages of MF with a total protein transmission calculated as 62% and 34%, for whey proteins and -casein, respectively. All the main caseins, κ-, β-, α_{s1}- and α_{s2}-, were found, in the serum phase. The ratio of the individual to total casein increased with DF. Interestingly, there was no statistical difference between LDF and HDF ratios. Furthermore, the colloidal calcium concentration decreased from 1816 to 1676 mg/L after extensive DF. These molecular changes occurring during the process affected the functional properties of the MCCs.

Practical relevance

Milk protein concentrates are classified not by how they are produced, but by their total protein content. However, this work brings evidence that knowing the molecular details change depend on the processing history, can lead to a higher quality of MCCs and an increase in processing and utilization efficiency by targeting their end use.

SESSION 3

Wednesday 23rd of June

MODIFICATION OF TEXTURE IN COW AND BUFFALO MILK PANEER BY THERMAL TREATMENT AND MILK FAT CONTENT

Anne Katrine Laursen[1], Tijs Albert Maria Rovers[2], Richard Ipsen[1] and Lilia Ahrné[2]

1 Department of Food Science, University of Copenhagen, Rolighedsvej 30, DK-1958 Frederiksberg C, Denmark
2 Arla Innovation Centre, Arla Foods, Agro Food Park 19, DK-8200, Aarhus-N, Denmark

Abstract

Consumers are searching for possibilities to reduce their lifestyle carbon-footprint. An existing dairy-based meat alternative is the indigenous Indian heat- and acid-induced cheese type paneer. In order to investigate utilization of cow milk in the production of attractive meat alternatives cow and buffalo milk paneer were compared in terms of composition, microstructure and texture. Cow and buffalo milk standardized to a fat content of 3, 4.5 and 6% for paneer production. The milk was heated to 90°C and hold for 0, 6 or 12 min, before acidification at 85°C and pressing. Demonstrated through confocal laser scanning microscopy (CLSM) cow milk paneer showed a more open protein structure compared to buffalo. This resulted in a softer, less cohesive and resilient paneer compared to buffalo. The difference in protein content and thus calcium content had a major influence on the microstructure and texture, as a higher content of total calcium in the paneer resulted in a denser and harder gel. The hardness of both cow and buffalo milk paneer was affected more by the fat content, and thus lower protein content, than the length of the heat treatment.

Practical relevance

In terms of industrial application, this work suggest that altering the fat content and controlling calcium mobility of cow milk offers the possibility to modify paneer texture to produce attractive meat alternatives.

SESSION 3

Wednesday 23rd of June

THE EFFECT OF CALCIUM BINDING COMPONENTS ON CALCIUM REMOVAL DURING ELECTRODIALYSIS

Emilie Nyborg Nielsen[1], Leif H. Skibsted[1], Saeed Rahimi Yazdi[2], Arthur Merkel[3] and Lilia Ahrné[1]

1 Department of Food Science, University of Copenhagen, Rolighedsvej 26, 1958 Frederiksberg, Denmark
2 Arla Foods Amba, Agro Food Park 19, 8200 Aarhus N, Denmark
3 MemBrain s.r.o. (Membrane Innovation Centre), Pod Vinicí 87, 471 27 Stráž pod Ralskem, Czech Republic

Abstract

Acid whey is a side-stream from the production of skyr, Greek yoghurt, quark and cottage cheese. It contains high concentrations of valuable minerals, which are essential in the human diet such as calcium. Electrodialysis has recently shown to be an efficient way to isolate charged components from acid whey, however, its composition highly affects the demineralization degree (Nielsen et al., 2021). Acid whey contains calcium-binding components such as citrate, lactate, gluconate and sugars that have different affinities to calcium and consequently influence the removal of calcium during electrodialysis. This study investigates the removal of calcium ions in model solutions containing lactose, glucose, glucose/galactose mixture, lactate, gluconate or citrate by electrodialysis in order to identify the importance of bounded and free calcium on the efficiency of demineralization. The effect of pH and concentration are also evaluated for selected calcium binding components.

Nielsen, E. N., Merkel, A., Yazdi, S. R. & Ahrné, L. (2021). The effect of acid whey composition on the removal of calcium and lactate during electrodialysis. International Dairy Journal, 117, 8 p., 104985.

Practical relevance

Knowledge about calcium binding components effects on removal of calcium ions during electrodialysis of acid whey is important to select pretreatments of the whey and optimizing the demineralization rate during electrodialysis.

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SESSION 3

Wednesday 23rd of June

RESIDENCE TIME IN THE COOKER-STRETCHER AFFECTS MOZZARELLA CHEESE COMPOSITION, STRUCTURE AND FUNCTIONALITY

Ran Feng[1], Sylvain Barjon[1], Franciscus Winfried J van der Berg[1], Søren Kristian Lillevang[2] and Lilia Ahrné[1]

1 University of Copenhagen, Denmark
2 Arla Foods, Denmark

Abstract

To manufacture mozzarella cheese with customized functionality, the relationships between processing parameters and cheese functionality need to be identified. In this study, cooking residence time (CRT) and stretching residence time (SRT) of cheese curd in the cooker-stretcher were determined to differentiate the effect of the cooking and stretching processes on cheese properties. In the stretcher used, CRT was significantly longer than SRT, varying respectively between (62-90%) and (38-10%) depending on cheese temperature and screw speed. The residence times were correlated with cheese composition, micro- and macro-structural characteristics (microstructure, fat globule size, anisotropy and rheology) and functional properties (meltability, oiling-off, browning and stretchability). Linear correlations were found between CRT and cheese composition, anisotropy and storage modulus. In general, SRT had a less significant effect on cheese properties and functionality, which is due to the low specific mechanical energy of 0.15-0.46kJ/kg. It was concluded that CRT and SRT are promising factors to understand and control the cheese characteristics during manufacture.

Practical relevance

Understanding the effects of water temperature and screw speed, and their interactive effects, on the residence times in the cooker-stretcher. And the consequences for mozzarella cheese composition and functional properties provide relevant knowledge to produce mozzarella with customized functionality.

SESSION 4

Thursday 24th of June

FROM COW TO SHELF - INFLUENCE OF MILK PROCESSING ON BARISTA STYLE FOAM QUALITY

Darius Hummel[1] and and Jörg Hinrichs[1]

1 University of Hohenheim, Garbenstraße 21, 70599 Stuttgart, Germany

Abstract

In recent years, the frothing capacity of milk, explicitly shelf stable milk, has become more important. Beverages as latte macchiato and cappuccino - especially latte art - have become increasingly popular. The main reason for decreased frothing capacity of milk is known to be based on elevated levels of free fatty acids. They originate from mechanical shear stress and growth of certain bacteria. Regarding induced lipolysis caused by mechanical stress, various processing steps during dairy processing seem to be critical. The present study focuses on the entire process of milk processing regarding the influence of cow breed, storage time of fresh raw milk as well as variations during milk processing as septic and aseptic homogenization and their influence on the concentration of free fatty acids and frothing capacity of shelf stable milk. Furthermore, critical values for frothing of shelf stable milk were determined.

Practical relevance

Milk processing companies face the problem that some UHT milk batches show poor frothing capacities and are complained about by the retail trade. By examining the entire process of UHT milk preparation, particularly critical process steps for the quality are to be identified and critical values for the content of free fatty acids for good foaming behavior are to be defined.

SESSION 4

Thursday 24th of June

BINDING OF CALCIUM TO SUGARS IN MILK PRODUCTS

Yuan Jiang[1], Xiao-Chen Liu[1], Lilia M. Ahrné[1] and Leif H. Skibsted[1]

Department of Food Science, University of Copenhagen, Rolighedsvej 26, DK, 1958, Frederiksberg C, Denmark

Abstract

Calcium binding to lactose, inulin, fructose, galactose and glucose has been investigated using electrochemical, calorimetric and solubility methods. Calcium binding to milk saccharides was athermal and binding in 1:1 complexes accordingly entropy controlled with Ka = 10 L/mol for lactose, Ka = 8 L/mol for galactose, Ka = 6 L/mol for fructose and Ka = 4 L/mol for glucose. For inulin, binding has Ka = 35 L/mol for each of two calcium bound by each inulin in a moderately endothermic process corresponding to $\Delta H > 0$ for calcium association. Quantum mechanical calculations using Density Functional Theory show increased binding of β-anomers of lactose compared with α-anomers of lactose, which was confirmed experimentally and assigned to 3-coordination versus 2-coordination with hydroxyl groups with ΔS = 19 J/(mol·K) for the dicoordinated α-anomer and ΔS = 20 J/(mol·K) for the tricoordinated β-anomer. Calcium binding to lactose is expected to be independent of pH and lactose might accordingly prevent precipitation of calcium in the intestines and thus increase absorption of calcium as was previously found by others in human intervention studies.

Practical relevance

Understanding of the binding of calcium to the milk sugars lactose, galactose and glucose and to the plant oligosaccharide inulin often used as an ingredient in dairy products will help in a rational use of oligosaccharides in the design of novel dairy products with enhanced calcium bioaccessibility.

SESSION 4

Thursday 24th of June

CALCIUM CITRATE SPECIATION IN MILK UNDER ACIDIFICATION, HEAT TREATMENT AND DIGESTION

Xiao-Chen Liu[1], Jacob J. K. Kirkensgaard[1] and Leif H. Skibsted[1]

1 Department of Food Science, University of Copenhagen, Rolighedsvej 26, DK, 1958, Frederiksberg C, Denmark

Abstract

The calcium citrate complex (CaCitr-) accounts for 70% of the soluble calcium species in milk. Understanding effects of acidification and heat treatment on calcium citrate speciation in milk is accordingly crucial for process development in the dairy industry. Especially the effect of changes in pH on speciation during digestion is important for optimizing calcium absorption in intestine from functional foods based on milk, since CaCitr- prevents calcium from precipitation and formation of calcium citrate hexahydrate (CCH). Three hydrates of calcium citrate were detected during dehydration of the thermodynamic stable CCH with the enthalpies of dehydration of ΔH (hexa to tetrahydrate) = 43.6, ΔH (tetra to dihydrate) = 43.8, and ΔH (di to anhydrate) = 88.1 kJ/mol as measured by DSC. The more soluble, less stable but more robust calcium citrate tetrahydrate is not converted into the thermodynamic stable CCH with lower solubility during the pH-changes typical for digestion explaining the positive effect of citrate on calcium bioavailability, in agreement with Ostwards phase law.

Practical relevance

The effects of acidification and heat treatment on calcium citrate speciation in milk is important for dairy industry development. The effect of changes in pH on calcium species during digestion is important for understanding calcium absorption in intestine from milk based foods.

SESSION 4

Thursday 24th of June

NEW TYPE OF WHEY PROTEIN INGREDIENT FOR IMPROVED QUALITY OF INFANT

Pernille Lund[1], Mie R. Bechshøft[2], Colin A. Ray[2] and Marianne N. Lund[1]

1 University of Copenhagen, Frederiksberg, Denmark
2 Arla Foods Ingredients Group P/S, Videbæk, Denmark

Abstract
When breastmilk is not an option, newborns rely on getting their nutritional needs fully covered by infant formula (IF) and it becomes crucial to manufacture IF with high nutritional quality. The most widely used whey protein ingredient in IF is whey protein concentrate (WPC). Various processing steps are included in manufacturing of both powdered IF and WPC, which introduce protein modifications. A gently processed whey protein ingredient (SPC) was manufactured and used for production of a powdered IF, which was compared to a powdered WPC-based IF. In addition, casein ingredients were included. Structural protein modifications and Maillard reaction products were quantified in ingredients and IFs. Overall, IF processing was responsible for several protein modifications, where this contribution generally outweighed the differences between ingredients. Quantification of -dicarbonyls revealed the importance of considering other aspects than thermal processing. Surprisingly, SPC had a higher methylglyoxal level than WPC. Different trends in formation of Maillard reaction products were observed, challenging the idea of using a single marker for evaluating the Maillard reaction.

Practical relevance Quantification of protein modifications and their precursors are important for development of tailored manufacturing leading to improved IF that ensures a healthy diet for newborns. Innovative processing has allowed production of a sustainable whey protein ingredient, but it was revealed that processing steps in addition to heat load must be considered.

SESSION 4

Thursday 24th of June

COMPARING MOLECULAR FEATURES OF HUMAN AND BOVINE MILK CASEINS

Martin Nørmark Thesbjerg[1,2], Søren Drud-Heydary Nielsen[1], Ulrik Krœmer Sundekilde[1], Nina Aagaard Poulsen[1] and Lotte Bach Larsen[1]

1 Department of Food Science, Aarhus University, Denmark
2 Sino-Danish College (SDC), University of Chinese Academy of Science

Abstract

In bovine milk it has long been known that the formation of cysteine-bridges plays an important role for the tertiary organizations of the caseins and as such presumably for casein micelle organization. In bovine milk, both αs2-CN and κ-CN has two Cys residues each, which can engage in cysteine-bridges. Bovine κ-CN forms homomultimers, while αs2-CN is present as dimers, linked with interchain disulfide bridges. In contrast, human αs1-CN and κ-CN contains one and three Cys residues, respectively, and hetromultimers between κ-CN and αs1-CN have been reported. Comparing the O-glycosylations of κ-CN in human and bovine milks, the O-glycosylations on human κ-CN are more extensive and consists of larger and more complex glycans. From an analytical point of view, these features possess a set of challenges, as the caseins in human milk are tightly linked into large multimeric structures requiring specific treatments prior to proteomic analysis. As part of an ongoing PhD project, protein profiles of human milk protein were investigated by various proteomic approaches and revealed that cysteine-bridges and O-glycosylations of κ-CN play a major role in relation to analytical performance.

Practical relevance

Understanding the complexity of the κ-/αs1-CN heteromultimers in human milk is necessary for establishing Top-Down Mass Spectrometry methods for further analysis of the proteomic footprint in relation to e.g., genotypes and other biologic variation in profiles of the major human milk proteins.

SESSION 4

Thursday 24th of June

3D-PRINTING APPLICATIONS FOR CHEESE AND MILK PROTEIN INGREDIENTS

Megan M. Ross[1], Shane V. Crowley[1], Alan P. Morrison[2], Jorge Oliveira, Suzanne Crotty[3] and Alan L. Kelly[1]

1 School of Food and Nutritional Sciences, University College Cork, Cork, Ireland
2 School of Engineering and Architecture, University College Cork, Cork, Ireland
3 BioSciences Imaging Centre, Department of Anatomy and Neuroscience, BioSciences Institute, University College Cork, Cork, Ireland

Abstract

3D printing is an Additive Manufacturing technology that is used to make complex structures and geometries using a diverse range of materials, including food. To achieve this, a greater understanding of the fundamental printability of food materials is required. The objective of this study was to develop rheological methods to characterise the 'printability' of processed cheese formulations. The pH and casein content of processed cheese formulations significantly ($p > 0.05$) affected its printability. Printing temperature had a large effect on the microstructure and texture of printed processed cheese; processed cheese printed at 65°C showed larger fat droplets and harder texture than cheese printed at lower temperatures (45°C). Subsequently, the effect of various factors (i.e., calcium concentration and printed geometries) on 3D-printed Micellar Casein Concentrate (MCC) was studied. It was found that these factors all had an effect on the structure and properties (e.g., melting rate) of 3D-printed MCC gels. In conclusion, the formulation and technology of 3D-printed dairy materials can influence its suitability as a printing material and the applications of that product thereafter.

Practical relevance

3D food printing has potential to give consumers the freedom to design personalized meals and snacks. Foods suitable for 3D food printing (e.g., dairy-based ingredients) could act as a basic structural foundation for nutrients and flavours to be incorporated into, thereby, creating a customised snack or meal to suit the nutritional requirements and personal taste preferences of individual users.

SESSION 5

Friday 25th of June

NATURAL VARIATION IN DANISH DAIRY STREAMS – PROTEIN PROFILE, PTMS AND DSCC

Natacha R. Róin[1], Nina A. Poulsen[1] and Lotte B. Larsen[1]

1 Department of Food Science, Aarhus University, Denmark

Abstract

The current investigation is part of a larger project, where variations in components are profiled in Danish dairy milk streams representing differences in production form, feeding strategy, breed, geography and season. Inherent natural variations in silo milk represent both opportunities and challenges e.g. an opportunity for improved utilization of the raw material and more differentiation into dairy products and ingredients or unwanted challenges in relation to process control and during e.g. up-concentration and fractionation. This is explored here for a number of components, including proteomic profiling of the major milk proteins and their isoforms, including, post translational modifications (PTMs) as well as enzymes and peptides relative to differential somatic cell count (DSCC). Preliminary results of the protein profile indicate differences in protein composition including variation in phosphorylation and glycosylation relative to both breed, feed and season. Peptide profiles will be determined by peptidomics using Q-ToF MS/MS to study proteolytic load also in relation to differences in DSCC.

Practical relevance

The mapping of Danish dairy milk is of great value for the dairy industry, as the composition of milk is relevant to ensure a stable and uniform production of dairy products but also when developing specialized products. Furthermore, milk proteins, PTMs and peptides are proven to impact processing qualities, whereas the possible interaction with DSCC is less explored, especially in silo milk.

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SESSION 5

Friday 25th of June

IMPACT OF FARM TYPE AND SAMPLING MONTH ON THE COMPOSITION AND PROPERTIES OF BOVINE MILK IN NORTHERN SWEDEN

Hasitha Priyashantha[1], Åse Lundh[1], Annika Höjer[2], Gun Bernes[3], David Nilsson[4], Mårten Hetta[3], Karin Hallin Saedén[2], Anders H Gustafsson[5], Monika Johansson[1]

1 Department of Molecular Sciences, Swedish University of Agricultural Sciences, Box 7015, SE-750 07 Uppsala, Sweden
2 Norrmejerier Ek. Förening, Mejerivägen 2, SE-906 22 Umeå, Sweden
3 Department of Agricultural Research for Northern Sweden, Swedish University of Agricultural Sciences, SE-901 83 Umeå, Sweden
4 Växa Sverige, Ulls väg 26, SE-750 07 Uppsala, Sweden
5 Computational Life Science Cluster, Department of Chemistry, Umeå University, SE-901 87 Umeå, Sweden

Abstract

Dairy farms in Northern Sweden were characterized to investigate the effect of on-farm factors and season on the variation in milk quality. Based on principal component analyses (PCA), two major types of dairy farming systems were observed. Type-1: Larger farms with loose housing using automatic milking system or milking parlour with predominantly Swedish Holstein (SH) breed. Type-2: Farms with a lower number of cows in tie-stalls with breeds other than SH. PCA of variation in composition and properties of the milk samples showed a tendency for the formation of two clusters based on these farming systems. The interrelated effect of the milking system and breed is likely to contribute to this distribution. Type of farm influenced the gel strength, probably reflecting differences in milk composition. Total proteolysis and casein micelle size were mainly influenced by sampling month, with smaller micelles and slightly higher proteolysis in outdoor compared to the indoor period. Season associated differences in raw milk are not merely linked to the variation in the amount of grazing, suggesting the importance of holistic and comprehensive study designs.

Practical relevance

This study was part of a full-scale cheese making trial in Northern Sweden, with the overall aim to investigate the background of variation in raw milk quality, and its effect on cheese ripening. The results are of importance to gain further understanding of the impact of structural dairy farming intensification on raw milk quality and its coagulation properties and suitability for cheese making.

SESSION 5

Friday 25th of June

REDUCING ENTERIC METHANE EMISSIONS OF DAIRY COWS THROUGH ANIMAL BREEDING TECHNIQUES

Anouk van Breukelen[1], Michael Aldridge[1], Chris Schrooten[2], Roel Veerkamp[1] and Yvette de Haas[1]

1 Animal Breeding and Genomics Group, Wageningen University & Research, The Netherlands
2 CRV, The Netherlands

Abstract
The Dutch agricultural sector is facing the challenge to reduce methane emissions. In agriculture, most methane is produced by enteric fermentation of ruminants and emitted in the air through breathing and belching. The aim of our study was to investigate if we can use animal breeding techniques to reduce enteric methane emissions of dairy cows. Methane concentrations (ppm) were continuously recorded using gas analysers, called sniffers, in the feed bin of milking robots on 14 herds from March 2019 to September 2020. In total, data from 181,597 robot visits of 1,698 Holstein cows were recorded. Genetic parameters were estimated with a univariate animal model with repeated measurements. Preliminary results show that the heritability was highest for weekly mean emissions (0.23 ± 0.02). The genetic standard deviation for weekly mean emissions was 73 ppm, indicating that the genetic difference between the 1% highest and lowest emitting cows is 366 ppm. The results indicate that there is genetic variation in methane emissions between cows, and decreasing methane emissions by selection in dairy cows is a possibility in the near future.

Practical relevance
Animal breeding offers potential to reduce enteric emissions in a way that is cost-effective, cumulative, permanent, and accessible to dairy farmers. The study showed that enteric methane emissions has a heritable component. We are constructing a larger dataset to investigate relationships between methane and other common breeding goal traits, which is needed to add methane to breeding programs.

SESSION 5

Friday 25th of June

WHICH CATTLE BREED MAKES THE BEST CHEDDAR?

Camilla Preece[1] and and Paraskevi Paximada[1]

1 Harper Adams University, UK

Abstract

Macro and micro-nutrients in milk influence Cheddar production, sensory and functionality of the cheese produced. The effect of breed on milk composition and coagulation properties have been previously investigated, although the effect of breed on the final Cheddar cheese produced has not. This study involved cheddar produced from four Dairy Cattle breeds (Jersey, Holstein Friesian, Ayrshire and Dairy Shorthorn) in the United Kingdom, where farming methods were comparable. Both milk and cheese components were tested using analytical testing methods, compared against each other and breed group to identify any differences. Significant difference between breeds ($p>0.05$) was identified in milk fat, protein values and cheese fat and protein values. Among the correlations identified between milk and cheese components, cheese fat and protein had a significant ($p=0.018$) moderately strong negative correlation. Sensory evaluation (TBA) and functionality of the cheese was also analysed, breed did not have a significant effect on functionality. The current results indicate breed has an impact on components, however, the impact on sensory and functionality of the Cheddar could be minimal.

Practical relevance

The breeds chosen have not been widely investigated in the UK, nor has the effect on the outcome of the actual cheese produced been investigated. This study investigates not only composition but the functionality and sensory of the Cheddar, as Cheddar is the most commonly eaten cheese in the UK. The outcome of the research provides insight into the topic and opportunity for further investigation.

SESSION 5

Friday 25th of June

LINKING MILK FAT COMPOSITION AND CRYSTALLINE POLYMORPHISM ACROSS GENETIC AND ENVIRONMENTAL FACTORS

Naomi Arita-Merino[1,2], Hein van Valenberg[2] and Elke Scholten[1]

1 1 Physics and Physical Chemistry of Foods, Wageningen University, Wageningen, the Netherlands
2 Dairy Science and Technology, Food Quality and Design, Wageningen University, Wageningen, the Netherlands

Abstract
Milk fat (MF) composition can be drastically affected by genetic and environmental factors. This is often observed when alternative feeding sources are used, a practice commonly driven by sustainability or productivity goals. It is known that these variations affect crystallization, but there is limited knowledge on the effect of specific components on crystal polymorphism. We investigated possible relationships between the amount of a given polymorphic phase formed and the concentration of triacylglycerols (TAG) and fatty acids (FA). We selected MF samples with diverse FA and TAG profiles, representative of different sources of variation, such as genetic variation, seasonal variation and different feeding regimes (e.g. palm, algae and linseed oils supplementation). We studied the crystallization of these samples using wide angle X-ray diffraction (WAXD) to quantify the formation of different crystalline phases (i.e. polymorphs α, β and two β'). Results showed correlations between specific TAG and FA groups and different polymorphic phases.

Practical relevance
The plasticity and melting of butter and cheese are examples of properties that are greatly affected by the complex crystalline polymorphism and phase behavior of milk fat, which in turn, are determined by its composition. The correlations found in this study can help to predict changes in crystallization behavior due to TAG and FA variation, regardless of the variation source.

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SESSION 5

Friday 25th of June

THE EFFECTS OF FEEDING FAT, NITRATE AND 3-NOP ON MILK QUALITY AND FUNCTIONALITY OF DAIRY COWS

Gayani M.S. Lokuge[1], Lotte Bach Larsen[1], Morten Maigaard[2], Lars Wiking[1] and Nina Aagaard Poulsen[1]

1 Department of Food Science, Aarhus University, Denmark
2 Department Animal Science, Aarhus University, Denmark

Abstract

The ability of nitrate and 3-nitro-oxy-propanol (3-NOP) to reduce methane (CH4) production in ruminants is accompanied by increased loss of hydrogen from the rumen. The addition of these methane-reducing additives alone or in combination with fat would lower CH4 emission, but may also affect milk composition and functionality through the modifications of rumen fermentation. The present study is an experimental animal trial determining the effects of supplementing feed with fat, nitrate and 3-NOP on milk composition and functionality. Forty-eight lactating Holstein cows were blocked according to parity and days in milk and allocated to 8 different rations (2 levels of fat (cracked rapeseed), +/- nitrate, +/- 3-NOP) over 6 periods of 21 days each, according to the incomplete Latin square design. The overall milk composition including citrate and urea was measured using Milkoscan. The fatty acid and protein compositions were determined by GC-FID and LC-MS, respectively. Furthermore, the suitability of milk in dairy products is being evaluated by means of determining a number of physical and technological properties relative to specific feed additives and their potential interactions.

Practical relevance

In terms of sustainability, the production of environment-friendly milk with improved nutritional and functional properties receives more attention. Supplementing feed with nitrate, 3-NOP, or fat are all clearly promising strategies to reduce CH4 emission. Importantly, the addition of these compounds secures the milk quality and functionality to satisfy the milk producers and consumers.

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