



Food Quality and Design

BLT MFT Thesis 2014-2015



material



production



product



consumer

primary product

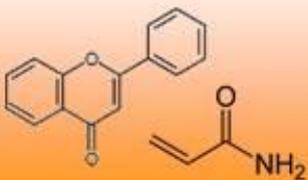
supermarket

Quality in Food Chains

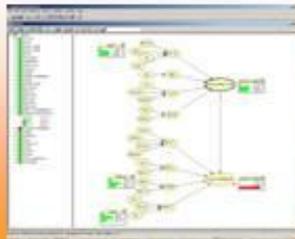
process

consumer

components



toolbox



international



management



MASTER FOOD TECHNOLOGY

MFT

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Be aware that the projects are on-going, new projects can start, companies contact us for specific topics, etc., so always contact one of us to get an up-to-date overview of possible projects.

GENERAL INTRODUCTION TO FOOD QUALITY AND DESIGN GROUP



We invite you to take a look at the topics that we offer and to embark with us on the exciting journey towards a better understanding of what Food Quality & Design (FQD) actually means!

If you are interested in a full immersion in food quality, FQD is the right place for you. As a food science student, you have already learned a lot about the chemical, physical, microbial properties of food, and you have learned how to process them. That knowledge is essential to build upon when discussing food quality and going into the design of new foods. But there is more to it! To play with food quality & Design, you should be able to integrate and connect your knowledge from various disciplines. Food quality is a broad, very dynamic and real life concept. It is obviously related to the properties of the food and the technological conditions it is subject to, and the integration required here is to connect the various disciplines of food technology, but, depending on the topic, perhaps also with plant and animal sciences. Next, it is important to realize that the perception of quality arises due to an interaction between food and humans. So, there you have a connection with social sciences: perception, consumer behaviour, psychology, ethics.

So an effective food design is also determined by the way people handle food all over the food chain. Here you have another connection with social sciences, now more on the managerial level. To summarize, the research and education at FQD is characterized by integration of those scientific disciplines that are needed for a certain quality problem and you can distinguish three different kinds of integration:

1. On the product level (integrating disciplines that are relevant to understand product quality attributes and design new foods with relevant nutritional and healthy attributes)
2. On the food chain level (integrating disciplines that are relevant to describe and understand what happens to a product on its way through the food chain)
3. On the techno-managerial level (integrating technological and managerial disciplines to describe and understand behaviour of people with respect to design, control, assurance, policy, in relation to the applied technology).

Hence, FQD studies are really multidisciplinary and in this way, FQD contributes to the mission of Wageningen UR: For Quality of Life.

Research theme 1 - Design of healthy foods

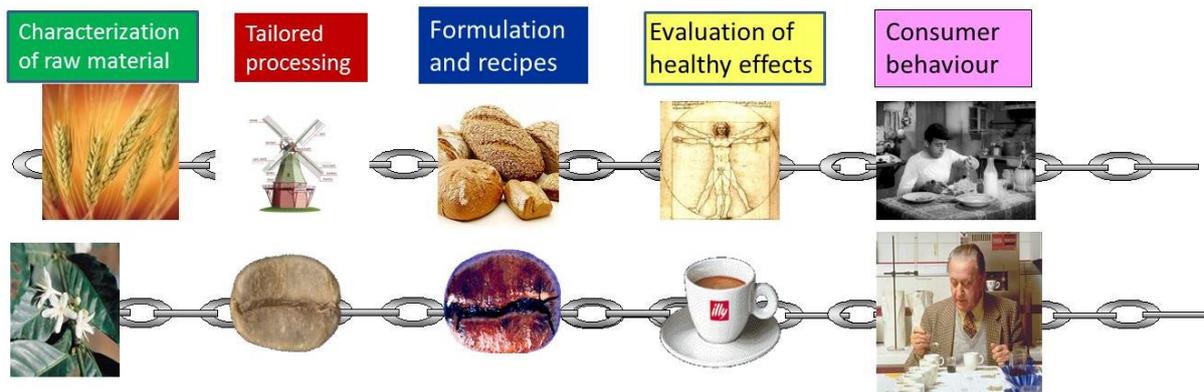
Introduction

In this research theme the design of healthy foods is approached in a holistic way from the nutritional, technological and consumer science point of view to find out the more suitable strategies to create value at the different points of each food chain.

Food healthiness is one of the main driver in the creation and marketing of new food products. Different strategies can be pursued to design healthy foods such as the adoption of new ingredients having potential health benefits or the implementation of production processes to optimize the formation of desired compounds and to reduce the formation of those potentially harmful. Also foods targeted at specific categories can be designed: children, pregnant women, elderly, sportsman, students population. Finally foods intended for the prevention of specific pathological conditions can be developed: foods for weight management, osteoporosis, gut health, mental performance and so on.

Objective

- To design healthy foods looking at the different point of the production chain from raw materials to consumer satisfaction.
- To use formulation and processing strategies for the development of foods tailored for different health benefits
- Evaluate the possibility to introduce new ingredients having additional health functionality over those already claimed
- To develop in vitro models for the systematic design of functional food for the benefit of gastrointestinal tract
- To control the development of Maillard Reaction minimizing the formation of potentially dangerous products and increasing the formation of desired ones



Project 1.1 Modulation of flavour development during storage of tomato products: The role of Amadoriase

Target: BLT MFT

Supervisors

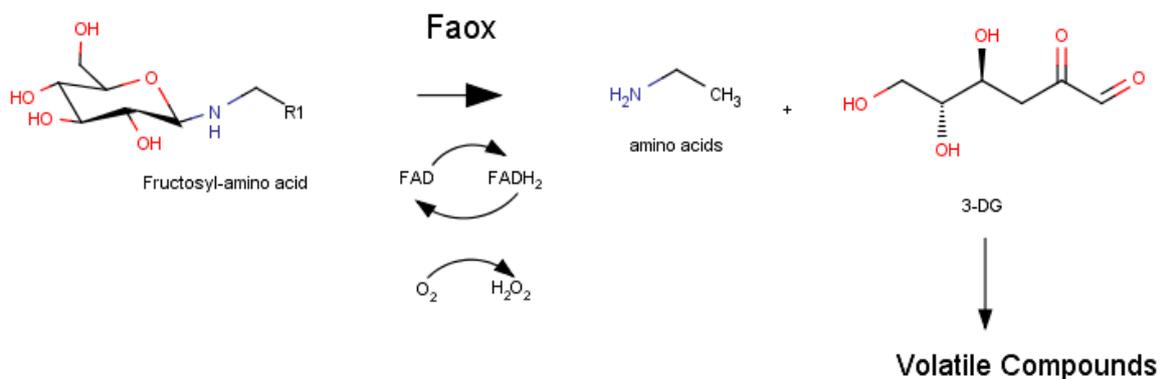
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Short Description

Maillard reaction can favor the formation of desirable color and flavor, but also the loss of nutritional value and the formation potentially toxic molecules.¹ The problem is particularly evident not only in milk products,² but also in other food such as tomato juice. Amadoriase is a Fructosyl amino oxidase (Faox) able to convert the Amadori products to free amino acids and deoxyglucosone.³ Faox represents a smart tool to finely tune the extent of the initial steps of the Maillard reaction in tomato products.



Research questions

Question 1: In which way, does the Faox exert its activity in tomato juice?

Question 2: Is it possible to create a link between Amadori products and volatile compounds in presence of this enzyme?

Question 3: Are the aroma key odorants influenced by the presence of Faox?

Proposed approach

In this research project the application of the enzyme during the production and storage of tomato juice will be investigated.

The study will start with the setup of the model system that will be incubated (40°C) for different days with and without the Amadoriase.

Markers of Maillard reaction development such as Amadori compounds and volatile compounds will be measured in order to assess the efficacy of the enzyme in tomato juice.

References

1. Yaylayan, V. A.; Huyghuesdespointes, A., Chemistry of Amadori Rearrangement Products - Analysis, Synthesis, Kinetics, Reactions, and Spectroscopic Properties. *Crit Rev Food Sci* 1994, *34*, 321-369.
2. Troise, A. D.; Dathan, N. A.; Fiore, A.; Roviello, G.; Di Fiore, A.; Caira, S.; Cuollo, M.; De Simone, G.; Fogliano, V.; Monti, S. M., Faox enzymes inhibited Maillard reaction development during storage both in protein glucose model system and low lactose UHT milk. *Amino acids* 2013.
3. Wu, X.; Palfey, B. A.; Mossine, V. V.; Monnier, V. M., Kinetic studies, mechanism, and substrate specificity of amadoriase I from *Aspergillus* sp. *Biochemistry-U.S.* 2001, *40*, 12886-95.

Project 1.2 Fighting diabetes: assessing the practical significance of starch hydrolysis inhibition by polyphenols

Target: BLT

Supervisor

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It is well known that several Polyphenols (PP) exhibit in vitro inhibitory activity against alpha-amylase and amilo-glucosidases which can have notable effect on starch hydrolysis and reducing sugars absorption. This effect can have potential application for the control of post-prandial glycaemia and the development of functional food designed for subjects with type II diabetes. However, when one looks at the scientific literature, it is surprising to notice that this inhibitory activity has only been tested under simplified in vitro conditions which does not simulate the physiological conditions in the gastrointestinal tract (GIT). Moreover, most of the study have however focused on single compounds and/or mixture of compounds extracted from food sources. The modulating effect of food matrix or meal composition on the supposed inhibitory activity has not been explored, e.g. the effect of co-ingested proteins might reduce the inhibitory effect by competition between PP and proteins or digestive enzymes and food components, e.g. dietary fibres. The inhibitory activity may therefore be of marginal significance when PP are co-digested under physiologically relevant conditions along with other food.

Aim

The aim of this study would be to get insight on the practical significance of the well known effect exerted by PP on starch hydrolysis and glucose formation in in vitro models, i.e. whether and to which extent this effect is retained when PP are co-digested with other food components, and with or within real food, i.e. under realistic conditions.

Approach

Purified PP and mixture of PP (e.g. extracts from natural sources) will be selected based on the known effect on post-prandial glycaemia as reported in the scientific literature. The effect will be tested under in vitro digestion conditions. A static in vitro model of digestion which simulates the gastric and the duodenal digestive phase will be used. The effect of the food matrix will be assessed by co-digesting the gelatinised starch and or other starchy food (bread and pasta) and selected PP with proteins and dietary fibres from different sources and the kinetics of starch hydrolysis/glucose, maltose and dextrins formation will be assessed.

Some references:

Q. He et al. Effects of tea polyphenols on the activities of a-amylase, pepsin, trypsin and lipase. *Food Chemistry* 101 (2006) 1178–1182.
McDougall, GJ and Stewart, D. 2005. The inhibitory effects of berry polyphenols on digestive enzymes. *BioFactors*, 23, 189–195

Project 1.3 Exploring the effect of Dietary fibre on digesta viscosity and starch hydrolysis

Target: MFT

Supervisor

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Soluble dietary fibre (SDF) can potentially reduce the postprandial glucose absorption and related glycaemia through several mechanisms. One of the most likely mechanism is the increase of the viscosity of the digesta which would slow gastric emptying, negate the propulsive and mixing contractions generated by peristaltic and segmentation movement of the small intestine, retard the diffusion and adsorption of amylase onto solid starches, increase the thickness of the unstirred water layer in the gut, thus increasing the resistance to transport of glucose.

Aim

In this project we will explore how viscosity of solutions of single SDF, mixture of SDF or combination of SDF with other biopolymers affect the viscosity of the digesta and the starch hydrolysis rate.

Approach

DFs will be selected based on the known effect on post-prandial glycaemia as reported in the scientific literature. The effect will be tested under in vitro digestion conditions. A static in vitro model of digestion which simulates the gastric and the duodenal digestive phase will be used. The effect of the food matrix will be assessed by co-digesting the gelatinised starch and or other starchy food (bread and pasta) with DF, mixture of DFs, mixture of DF and proteins and DF- and proteins-containing solid model systems, the kinetics of starch hydrolysis/glucose, maltose and dextrans formation will be assessed and correlated with rheological properties of the digesta, i.e. viscosity.

Some references:

Dartois, J. Singh, L. Kaur and H. Singh, *Food Biophys.*, 2010, 5, 149–160.

T. Sasaki and K. Kohyama, *Food Chem.*, 2012, 133, 1420– 1426

A. Bordoloi, J. Singh and L. Kaur, *Food Chem.*, 2012, 133, 1206–1213.

Project 1.4 Bio-accessibility of process contaminants

Target: MFT

Supervisors

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Neo-formed contaminants (NFCs) are compounds forming during heating or preservation processes and exhibiting possible harmful effects to humans. Among the several NFCs described in literature, Acrylamide and 5-hydroxymethylfurfural (HMF) have attracted the attention of the scientific community in recent years. Both acrylamide and HMF are considered as probably or potentially carcinogenic to humans or might be metabolized by humans to potentially carcinogenic compounds. So far epidemiological studies have failed in finding clear associations between consumption of NFCs rich food and the increased risk for certain diseases. This may depend from the inaccurate assessment of the actual amount that is absorbed by the human body. One of the reasons may be that exposure to those NFCs is usually regarded as equal to their concentration in the food product. However, the conditions those compounds are exposed to in the digestive tract are substantially different compared to the food itself, i.e. they might be unstable under those conditions and their actual bio-accessibility (the amount that is released from the matrix and is available for absorption) may be much different from their concentration.

Aim

In this study we will investigate the stability of common process contaminants (acrylamide, HMF and the like) under physiological digestion conditions and their bio-accessibility from real food matrixes and mixtures with food components.

Approach

Process contaminants will be selected based on their relevance from a toxicological perspective. The food matrix effect will be tested under in vitro digestion conditions. A static in vitro model of digestion which simulates the gastric and the duodenal digestive phase will be used. The effect of the food matrix will be assessed by co-digesting the selected NFCs with pure compounds (e.g. proteins or dietary fibre) and using real food matrixes (bread and bakery products, potato-based products, coffee, and the like). The bio-accessibility of each target NFCs will be assessed by measuring its concentration in the water soluble fraction of digesta at different stages of digestion.

Some references:

Capuano E & Fogliano V. 2011. Acrylamide and 5-hydroxymethylfurfural (HMF): A review on metabolism, toxicity, occurrence in food and mitigation strategies. *LWT-Food Science and Technology*, 44, 793-810.

Parada J & Aguilera JM. Food Microstructure Affects the Bioavailability of Several Nutrients. *Journal of Food Science*, 72, R21-R32.

Project 1.5 Modelling Maillard reaction under non-ideal conditions: molecular crowding

Target: MFT

Supervisor

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Molecular crowding is the effect exerted by nominally inert molecular cosolutes (crowders) on target solutes (probes), with the crucial term 'inert' meaning that the only interaction between the crowder and the probe is an excluded-volume (i.e. steric) interaction. Because of mere presence of crowders, a significant part of the volume is unavailable to the probe molecules and as a result their thermodynamic activity and diffusivity strongly deviates from those in ideal (aqueous) model systems and surprisingly large quantitative effects on reactions equilibria and kinetics are expected (see figure). This effect has been for long studied in the biochemistry domain but its impact on kinetics and thermodynamics of food related chemical reactions has not been explored yet.

Aim

In the present research we will investigate the effect of molecular crowding on the evolution of maillard reaction. the Maillard Reaction (MR) is of utmost importance for quality of foods, more in particular for heated foods. It induces browning of foods, it has also a large effect on flavour, has an effect on nutritive value (loss of essential amino acids, impact on protein digestibility), and can have toxicological implications (such as the formation of acrylamide or other heat-induced toxicants), but can also produce antioxidant components.

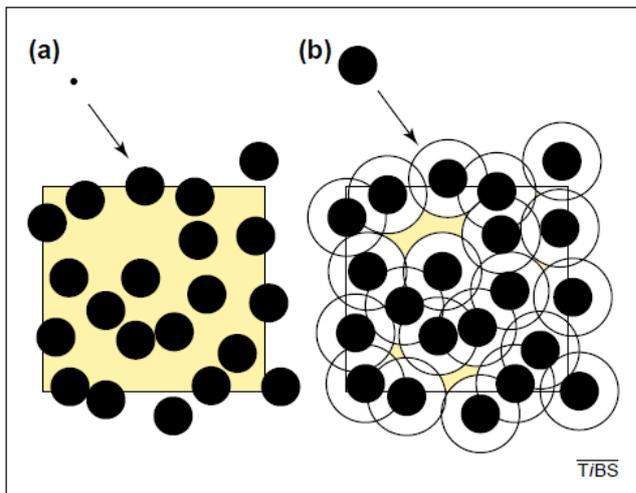


Fig. 2. The importance of size in volume exclusion. The squares define volumes containing spherical macromolecules occupying ~30% of the available space. (a) The centre of an introduced small molecule has access to virtually all of the remaining 70% of the space, indicated in yellow. (b) The centre of an introduced molecule similar in size to the macromolecules is excluded from most of this 70% as it cannot approach these macromolecules to a distance less than that indicated by the open circles. Reproduced, with permission, from Ref. 9.

Approach

the effect of crowding is investigated in in vitro model systems. The system under investigation will be a mixture of reducing sugar and protein. The model systems will be heated at different temperatures in order to establish the temperature-dependence of rate constants. A simplified reaction network will be build and the rate of degradation/formation of key intermediates/end products will be monitored. The experimental approach will entail the use of in vitro model systems where the pure compounds are exposed to a wide range of crowding conditions by varying concentrations and types of macromolecules. In this way detailed information is gained on the effect of the size, the shape and the fractional volume occupancy of background molecules on the behaviour of the test molecules. These macromolecules will includes the reactant protein itself and/or inert polysaccharides such as PEG and ficolls.

Some references:

Ellis RJ. 2001. Macromolecular crowding: an important, but neglected aspect of the intracellular environment. *Current Opinions in Structural Biology*, 11: 114–119

Hall D and Minton AP. 2004. Macromolecular crowding: qualitative and semiquantitative successes, quantitative challenges. *Biochimica et Biophysica Acta*, 1649: 127– 139.

Van Boekel, MAJS. Kinetic aspects of the *Maillard* reaction: a critical review. *Food/Nahrung*, 45 (3), 150-159.

Project 1.6 Functional pasta enriched with vegetables

Target: BLT

Supervisors

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Pasta can be considered as a staple food because it is eaten routinely and in such quantities that it constitutes a dominant portion of the diet on many populations worldwide

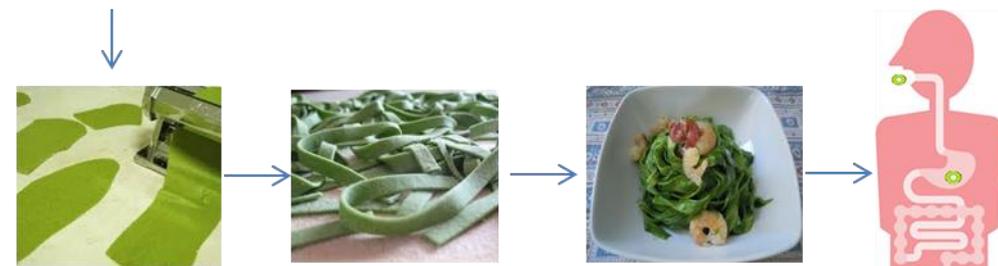
Pasta enriched with vegetable can be a good strategy to increase the vegetables intake, because (1) pasta is routinely consumed (2) dry pasta is a perfect carrier to stabilize phytochemicals that otherwise are easily degraded.

These attributes make pasta a perfect matrix for functional food development.

Objectives



The aims of this project are to study the effect of pasta formulation and pasta-making process on the leaching of phytochemicals into the pasta cooking water.



For this purpose, the effect of (1) pasta formulations (different concentration of vegetables) and (2) dry processing on stability and leaching into the cooking water of phytochemicals will be investigated. During this project students will prepare the sample by making and cooking pastas differently formulated. Then, the pasta samples will be analyzed to monitor phytochemicals concentration (HPLC). The leaching of these compounds into the cooking water will be also analyzed.

Project 1.7 Integrated Optimization of Product and Process Design of Dried Tropical Fruit and Its Products for Different Health Attributes

Target: BLT MFT

Supervisor

Ita Sulistyawati (ita.sulistyawati@wur.nl)



The quality perception of dehydrated and/or dried tropical fruit products by consumers differs from one type to another end product, such as dried fruit as a single product, mixed with nuts or breakfast cereals, within snack or confectionery.

An integrated optimization of product and process design of dried fruit and its products for different health attributes will be done through several experimental research and modelling, as followed:

1. A mathematical modelling to derive kinetic parameters as function of T and a_w in order to optimize the drying processes of fruit.
2. Study on product quality changes of dehydrated and/or dried fruit products during proper storage.
3. The effect of selected packaging techniques for some dried fruit products (i.e. Modified Atmosphere Packaging) on the alteration of key quality variables of dehydrated and/or dried fruit products during proper storage.

Project 1.8 In vitro digestion of functional pasta enriched with broccoli and β -glucan

Target: MFT



Supervisors

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Pasta can be considered as a staple food because it is eaten routinely and in such quantities that it constitutes a dominant portion of the diet on many populations worldwide

Pasta enriched with vegetable can be a good strategy to increase the vegetables intake, because (1) pasta is routinely consumed (2) dry pasta is a perfect carrier to stabilise phytochemicals that otherwise are easily degraded.

These attributes make pasta a perfect matrix for functional food development.

Some of the breakdown products of glucosinolate, secondary plant metabolites of Brassica vegetables, show anticarcinogenic bioactivity on many types of cancers. β -glucans are water-soluble fibre that occurs in cereals. β -glucans are the only dietary fibre currently recognized by the European Food Safety Authority (EFSA) to be able to reduce a disease risk for instance by reduction of blood cholesterol concentrations. The aim of this topic is to investigate the effect of (1) pasta formulations (different concentration of glucosinolate and β -glucans) and (2) dry processing on in vitro digestion to study how the different formulation and drying process affect the bioaccessibility of glucosinolate. During this project students will prepare the sample by making and cooking pastas differently formulated. Then, the student will set up the in vitro digestion to digest the pasta samples. Pasta samples and digested pasta samples will be analysed mainly by measuring glucosinolates (HPLC), breakdown product (LC/MS and GC/MS).

Project 1.9 In vitro digestion of functional pasta with β -glucan and spinach

Target: MFT



Supervisors

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Vincenzo Fogliano (vincenzo.fogliano@wur.nl)

Pasta can be considered as a staple food because it is eaten routinely and in such quantities that it constitutes a dominant portion of the diet on many populations worldwide

Pasta enriched with vegetable can be a good strategy to increase the vegetables intake, because (1) pasta is routinely consumed (2) dry pasta is a perfect carrier to stabilise phytochemicals that otherwise are easily degraded.

These attributes make pasta a perfect matrix for functional food development.

Spinach are rich in flavonoids , secondary metabolites with antioxidant activity. β -glucans are water-soluble fibre that occurs in cereals. β -glucans are the only dietary fibre currently recognized by the European Food Safety Authority (EFSA) to be able to reduce a disease risk for instance by reduction of blood cholesterol concentrations. The aim of this topic is to investigate the effect of (1) pasta formulations (different concentration of flavonoids and β -glucans) and (2) dry processing on in vitro digestion to study how the different formulation and drying process affect the bioaccessibility of flavonoids. During this project students will prepare the sample by making and cooking pastas differently formulated. Then, the student will set up the in vitro digestion to digest the pasta samples. Pasta samples and digested pasta samples will be analysed mainly by measuring soluble flavonoids by LC/MS and the antioxidant activity (QUENCHER method on solid material, ABTS or DPPH as probe).

Project 1.10 Design of functional white chocolate

Target: BLT MFT

Supervisors

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Chocolate is a food product that is loved by many because of its desirable qualities. These qualities include a smooth texture that becomes apparent only when the chocolate melts in the mouth. There is however a problem with chocolate in summertime and in most warm tropical countries: chocolate melts. Cocoa butter, the main fat constituent in chocolate, melts at 33.8 °C when cocoa butter crystals are in the stable form.



In the literature some strategies to produce heat resistant chocolate have been outlined. Conventional chocolate manufacture consists of the multiple steps: after harvesting, fermentation and sun drying, cocoa beans are then roasted and ground. The resulting chocolate liquor is then mixed with sugar, extra cocoa butter, milk solids ingredients, emulsifiers, and flavors. The final chocolate should contain around 30% fat, 20% cocoa powder and 50% sugar. If a white chocolate is to be produced, cocoa solids are replaced with whole milk powder or something similar which introduces milk fat and milk solids non-fat into the chocolate.

This thesis project will deal with the step of white chocolate formulation testing different strategies to increase its melting temperature. Study will be designed to test in

a systematic manner various hydrocolloids

as well as protein and fat sources in order to obtain white chocolate to be used as ingredients in confectionery and bakery sector.



Project 1.11 Vegetable pasta

Target: BLT MFT

Supervisors

Elke Scholten (elke.scholten@wur.nl)

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Background

Incorporating dried vegetable powder in pasta has been shown to be possible. Such products can help in increasing vegetable consumption. The retention of health promoting compounds during preparation could be improved by optimisation of the product formulation and processing. Also the bioavailability of such compounds might be enhanced by specific changes in the product.



Aim

Designing vegetable pasta products with specific health benefits

I. Developing broccoli pasta with less leaching of glucosinolates during preparation.

II. Developing broccoli pasta with increased ITC formation during mastication.

Project 1.12 Modelling Food Digestion in Relation to Health

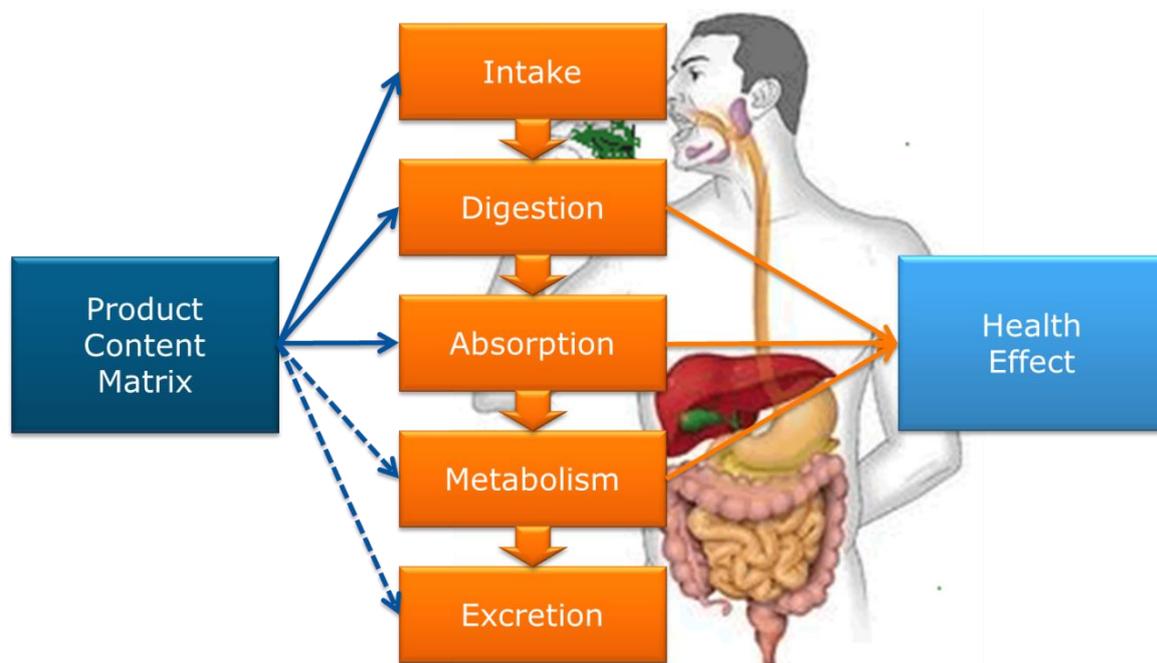
Target: BLT MFT

Supervisor

Matthijs Dekker (matthijs.dekker@wur.nl)



Digestion of food products consists of the degradation of the food structure by mechanical and enzymatic action. By this process nutrients become available for absorption. Health aspects related to digestion are e.g. the conversion and absorption of phytochemicals from plant sources, the uptake rate of simple sugars from the digests, etc. Studying the effect of the food product properties on these health aspects can be done by *in vivo* or *in vitro* digestion studies. In addition to this also *in silico* digestion models can be constructed to describe changes of the food in the human body. Such a model might be linked in the future with food properties related to health. Also the understanding the results of by *in vivo* or *in vitro* digestion studies can be improved by comparing it to the parameters of such an *in silico* model. In literature not many mechanistic physiological models have been developed for this purpose. This project aims at describing the state of the art in literature on digestion modelling and on further developing such models for the purpose of healthy food design.



Project 1.13 Vegetable Pasta: Effect of Processing on Leaching Kinetics

Target: BLT MFT

Supervisors

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Teresa Oliviero (Teresa.oliviero@wur.nl)



In previous projects pasta has been developed in which large quantities of vegetable powder have been incorporated. These vegetables contain phytochemicals that are important for human health. During the cooking of these pastas part of the low molecular compounds leach into the cooking water. In this project it will be investigated how the pasta preparation conditions, in particular the geometry and the drying step, can affect the leaching rate of certain phytochemicals by changing their effective diffusion rates in the pasta. The project consist of an experimental part on preparation of the pastas and performing the leaching experiments and a theoretical part in analyzing the data with diffusion models. By this research the retention of these compounds after cooking can be optimized.



Project 1.14 Barriers for Reformulating Food Products for Health

Target: MFT MFQ

Supervisors

Matthijs Dekker (matthijs.dekker@wur.nl)

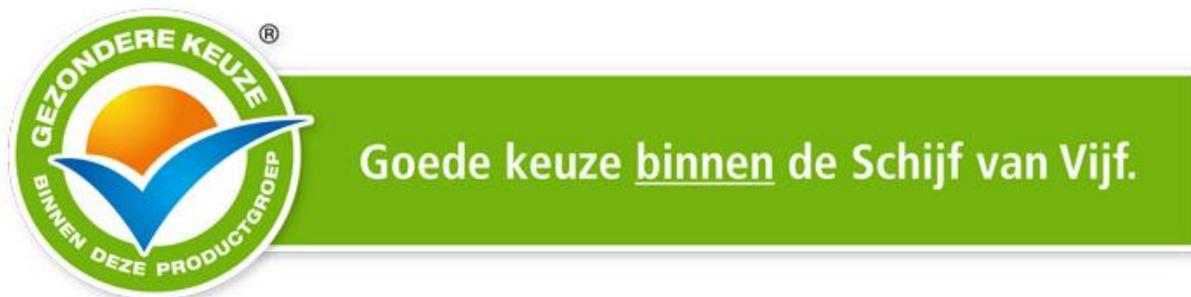
Teresa Oliviero (Teresa.oliviero@wur.nl)



Many consumers have an interest in healthy/healthier food products. In order to make product purchase choices for consumers easier with respect to health aspects of foods health logos have been developed, e.g. in the Netherlands by the Choices logo or “Vinkjes”. In order to put such a logo on the front of pack of products, they have to meet strict criteria for e.g. salt, added sugar, fat composition, fiber content and energy density. This logo aims at enabling healthier food choices for consumers, but also at stimulating food companies to develop healthier products that meet the requirements of these logos.

This project aims at understanding the technological and other barriers that companies perceive when implementing these criteria in various product categories and to compare this with possible solutions by looking at the state of the art in the scientific literature and other solutions e.g. related to regulation.

The project will be in collaboration with the Choices logo foundation.



Project 1.15 Food for Mood

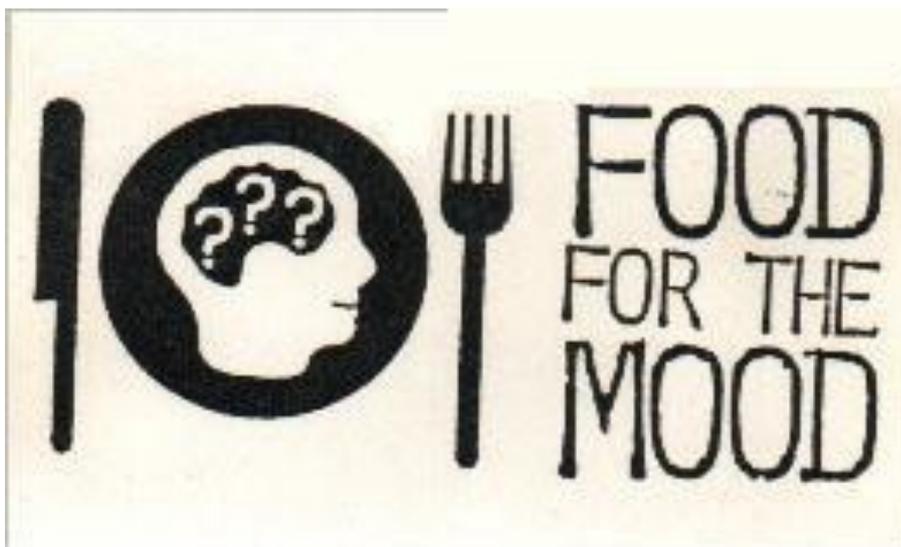
Target: BLT MFT

Supervisor

Matthijs Dekker (matthijs.dekker@wur.nl)



Food products can have an impact on mood, mental cognitive functioning and mental disorders. E.g. caffeine or taurine are stimulating compounds already widely applied in energy drinks. However there are much more (possible) relations between our food and our mood. Some of the effects seem well investigated and documented, while others are perhaps more speculative in nature. This project aims at evaluating and making an overview of the scientific literature on effects of food components on mood or cognitive functioning. The found effects have to be translated into criteria for the technological design of possible food products that can be suitable for this purpose.



Project 1.16 Control of Maillard reaction in nanoemulsion systems

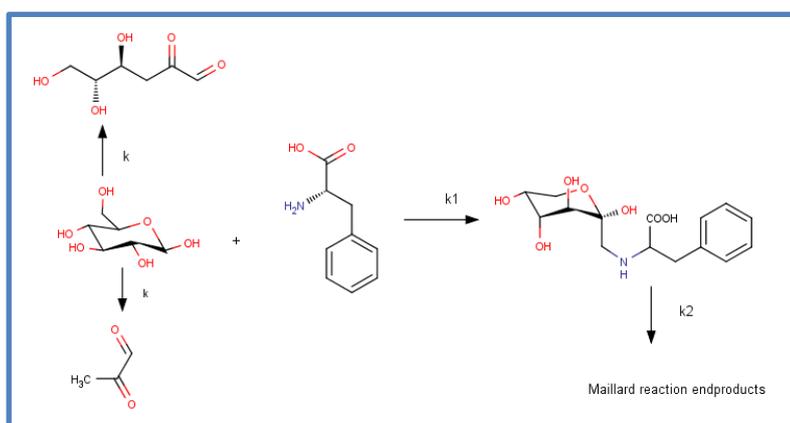
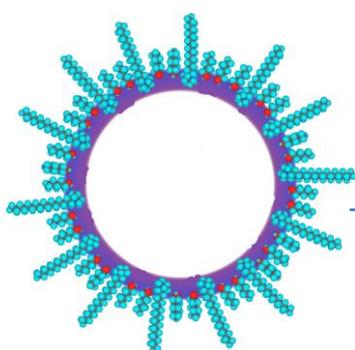
Target: MFT

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The Maillard reaction (MR) is characterized by a complex network and reactants location is a crucial point in the definition of the reaction mechanism.¹ A considerable number of natural and processed foods consists either partly or wholly as emulsions which directly influence the extent of MR.² Micellar solutions and nanoemulsions can work as food reactors,³ but according to the droplets dimensions it is possible to develop new MR tuning strategies in dressing and other emulsion-based foods.



Research questions

- Question 1: What is the development of MR in nanoemulsion systems?
- Question 2: Is it possible to establish an interplay between MR and lipid oxidation in these systems?
- Question 3: How does reactants location influence the reaction mechanisms?

Proposed approach

- The study will be focused on the characterization of the nanoemulsion system with different dispersed phase and continuous phase.
- Different combinations of reagents and reaction environments will be tested to verify the reaction pathways in dispersed system.
- Markers of Maillard reaction development such as Amadori compounds, volatile molecules and other Maillard reaction end-products will be measured in order to highlight the underneath behavior of Maillard reactants in these systems.
- Physical properties of the system which can influence consumer perception (turbidity, color, viscosity, etc.) will be assessed.

References

1. Yaylayan, V. A.; Huyghuesdespointes, A., Chemistry of Amadori Rearrangement Products - Analysis, Synthesis, Kinetics, Reactions, and Spectroscopic Properties. Crit Rev Food Sci 1994, 34, 321-369.
2. McClements, D. J., Food emulsions : principles, practice, and techniques. CRC Press: Boca Raton, FL, 2005.
3. Fanun, M.; Leser, M.; Aserin, A.; Garti, N., Sucrose ester microemulsions as microreactors for model Maillard reaction. Colloid Surface A 2001, 194, 175-187.

Project 1.17 Exploring the effect of Pulsed Electric Field (PEF) cooking on nutritional and sensory properties of food

Target: MFT

Supervisor

Edoardo Capuano (edoardo.capuano@wur.nl)



Background

Pulsed Electric Field (PEF) is a relatively new mild technology for food processing. In PEF, foods are subjected to an electric field with high field strength which causes damages to cell membranes (electroporation). The result is the inactivation of bacteria and pasteurization/sterilization of food samples with relatively low temperatures. So far PEF technology has been mainly used as a non-thermal food preservation method. Compared with traditional thermal pasteurization, it provides a better preservation of the original sensorial properties (taste, colour, texture), but also of nutrients and heat labile health-promoting functional components of foods (Soliva-Fortuny et al., 2009). Whereas PEF has been long tested for food pasteurization and sterilization, PEF based cooking is an entirely new topic. It is predicted that this technology can be used to cook food in a faster way which would considerably reduce energy besides the obvious advantage of reducing losses in nutrients and sensorial quality. PEF is also known to improve extractability of intracellular compounds from food matrices. Therefore, it can also improve the bio-accessibility of several health promoting compounds.

Aim

The aim of the present study is to assess the impact of PEF-cooking on nutritional and sensorial attributes of selected food preparations.

Approach

This study will be carried out in collaboration with Food Biobased Research (FBR). We will use an *ad hoc* developed table top Pulsed Electric Field (PEF) cooking units. This equipment is based on proprietary technology owned by a private company. The impact on healthy properties of cooked foods will be investigated under varying operating conditions (different electric field strength and/or number of pulses). Examples of nutritional relevant attributes to investigate are: retention and bio-accessibility of vitamins/phytochemicals, and starch digestibility. To test the impact on bio-accessibility and starch hydrolysis the standardised static in vitro digestion method proposed by the COST INFOGEST network (Minekus et al. 2014) will be used. Sensory analyses will be carried out to assess the effect on taste, flavour, texture and appearance of PEF-cooked food.

Some references:

Fincan, M., DeVito, F., & Dejmek, P. (2004). Pulsed electric field treatment for solid-liquid extraction of red beetroot pigment. *Journal of Food Engineering*, 64, 381-388.

Minekus, M., et al., 2014. A standardised static in vitro digestion method suitable for food – an international consensus. *Food and Function*, 5, 1113-1124.

Soliva-Fortuny, R, Balasa, A, Knorr, D., & Martin-Belloso, O. (2009). Effects of pulsed electric fields on bioactive compounds in foods: a review. *Trends in Food Science & Technology*, 20, 544-556.

Project 1.18 Food design strategies to add value to the coffee chain

Target: MFT (or MFQ depending on the specific research questions)

Supervisor

Vincenzo Fogliano (Vincenzo.Fogliano@wur.nl) plus others depending on the specific research questions



Short Description

The Coffee production is still of major importance in the trade between transition countries producing the raw beans and developed countries where most of the roasting and consumption occur. There is a continuous effort to create new business opportunity around coffee with the development of new products such as the coffee capsules for domestic consumption. Roasting and processing of coffee also offer opportunities for differentiate the products and different chemical composition can also lead to different food and health implication



Research questions

Question 1: Can dry separation technology be applied to obtain different coffee products?

Question 2: Can the addition of precursor during wetting influence the formation of melanoidins keeping the same roasting degree? Are the aroma key odorants influenced by this practice?

Question 3: Which are the key determinant of quality perceived by consumer and how this is related to previous consumption experience (i.e origin country)

Proposed approach

To answer the different research question appropriate methodologies will be used combining chemical and physical analysis with formulation strategies and new processing technique. Focus group and consumer survey will be employed to answer question 3

References

Illy, A., & Viani, R. (1995). Espresso Coffee. The Chemistry of Quality; Academic Press Ed, London.

Vitaglione, P; Fogliano, V; Pellegrini, N. Coffee, colon function and colorectal cancer, Food and Function 2012, 3, 916-922

Fogliano V, Morales MJ. Estimation of dietary intake of melanoidins from coffee and bread. Food and Function 2011, 2, 117-123

Project 1.19 Developing of a simplified model system to investigate the efficacy of preservatives and acidification agents in cream and processed cheese

Target MFT

Supervisors

Vincenzo Fogliano (Vincenzo.Fogliano@wur.nl);
Hans Zijlstra (Hans.Zijlstra@corbion.com) plus others depending on the research questions



Short Description

The scope of this research is the development of model systems for fresh, processed cheese, in order to simplify the complex cheese systems and study of the effect of natural preservatives on microbial growth, texture and flavour in cheese. These model systems need to mimic the textural characteristics and taste of a normal cheese and should qualify for all the analyses. The systems will be used in order to screen the efficacy of different antimicrobials and acidification agents.



Research questions

Question 1: Can a laboratory scale model system mimic the behavior of fresh and processed cheese during processing and shelf life

Question 2: Which is the impact of different acidification agents on the quality of the final product (firmness, spreadability, flavour profile)

Question 3: How the different chemical nature of the starting material (fresh, UHT or reconstituted milk) influenced the final characteristic of the product

Proposed approach

The work will be performed in close collaboration with Corbion which is a main producer of preservation and coagulation agents for cheese industry. Different formulation strategies will be employed combined with chemical and physical analysis to assess the quality during the process in the different model system. Kinetic modelling to foresee the behavior of the models will be also employed.

References

Bachmann H [et al.] A High-Throughput Cheese Manufacturing Model for Effective Cheese Starter Culture Screening *Journal of Dairy Science*. - 2009. - pp. 5868–5882

Fox P.F [et al.] *Cheese: Chemistry, Physics and Microbiology* [Book]. - Oxford : Elsevier Ltd, 2004. - 3rd : Vol. 1.

Fox P.F [et al.] *Cheese: Chemistry, Physics and Microbiology* [Book]. - Oxford : Elsevier Ltd, 2004. - 3rd : Vol. 2.

Project 1.20 Extraction of proteins from by-products and evaluation of their techno-functional properties

Target: MFT

Supervisors

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Gek Hoon KHOO <KHOO_Gek_Hoon@ava.gov.sg> Post-Harvest Technology
Department Agri-Food & Veterinary Authority Singapore



Short Description

Many food and agricultural wastes contains significant amount of valuable proteins that can be extracted and use in several food preparations. This project is run in collaboration with the Post-Harvest Technology Department of the Agri-Food & Veterinary Authority in Singapore a country where for logistic and environmental reason the issue of waste reduction is particularly important. The extraction of proteins will be performed using different strategies aimed at preserving the native form of the proteins or not according to the possible final destinations. The techno-functional (coloring, gelling, emulsification, texturizing, flavour masking or enhancing) as well as the nutritional (composition and digestability) properties of the extracts will be investigated



Research questions

Question 1: How the techno-functional properties of the proteins from fish waste (I.e. surimi) can be modulated by the extraction, processing and shelf life conditions

Question 2: Extraction of proteins and valuable components from barley spent grain

Question 3: How the formulation of proteins extracted from discarded plant biomass can be formulated to modify their techno-functional properties

Proposed approach

The work will be performed in close collaboration with the Singaporean partner which has a long term expertise on some of the waste stream such as fish by products. The protocols for assessing the techno-functional properties are available at FQD.

Project 1.21 Organosulfide profiles and their H₂S releasing activity on popular garlic and onion rich foods in Europe in Singapore.

Target: MFT

Supervisor

Vincenzo Fogliano (Vincenzo.Fogliano@wur.nl);
Huang Dejian chmhdj@nus.edu.sg Dept of Food Science National University
of Singapore



Short Description

The organosulfide (OS) compounds are well known for their bioactive and for their potent taste and smelling properties. The profile of these compounds in food are deeply affected by the nature of the raw material and by the processing particularly at the household level. The release of H₂S in the blood, which is different for the different compounds and it is mediated by enzyme action, it is probably one of the main mechanisms through which they exert their biological activity



Proposed approach

The research will be partially conducted at the National University of Singapore. The influence of the cooking methods on the organosulfide profiles and their H₂S releasing activity on popular organosulfide rich foods will be investigated. A comparison between the situation in Europe (and the way they are normally cooked) and that in Singapore (the way they are cooked, stir-frying for example) will be performed.

Project 1.22 Novel processing of high quality tomato products

Target: MFT

Supervisors

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Novel processing techniques, like high pressure processing and pulsed electric field treatment are used to preserve food products. These techniques are alternatives to thermal heat preservation, with minimal changes in sensorial and nutritional properties of the food, without compromising on the food safety and shelf life of the products.

More and more products pasteurized with these novel processing techniques are introduced to the market. Furthermore, high pressure sterilization becomes more and more an interesting topic to study on pilot scale.

A thesis topic can be to study the influence of high pressure processing on high quality tomato products. We would like to see what happens with the quality of tomato products when varying processing conditions or changes in the composition of the tomato products are made.

The study will start with a literature overview on tomato products produced with varying (novel) processing techniques. Subsequently or parallel, high pressure experiments with tomato products will be carried out on the lab scale and pilot scale high pressure unit of Food & Biobased Research. Variable processing conditions can be used and quality of the produced products will be evaluated (i.e. appearance, texture, shelf life, enzyme activity and sensorial aspects). Dependent on results, alternations on product composition can be made to optimize for a high quality tomato product.



Project 1.23 Functional pasta with wheat bran

Target: MFT



Supervisors

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Matthijs Dekker (matthijs.dekker@wur.nl)

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Pasta can be considered as a staple food because it is eaten routinely and in such quantities that it constitutes a dominant portion of the diet on many populations worldwide

Pasta enriched with vegetable can be a good strategy to increase the vegetables intake, because (1) pasta is routinely consumed (2) dry pasta is a perfect carrier to stabilise phytochemicals that otherwise are easily degraded.

These attributes make pasta a perfect matrix for functional food development.

Wheat bran is rich in fibre that has a positive effect on health. In fact, it is known that it improves the gut peristalsis, it has a prebiotic action and it reduces plasmatic cholesterol. Moreover, wheat bran is rich in antioxidant compounds.

The aim of this topic is to investigate the effect of (1) different concentration of wheat bran in pasta and (2) dry processing of pasta on in vitro digestion to study how the different formulation and drying process affect the bioaccessibility of antioxidant compounds. During this project students will prepare the sample by making and cooking pastas with different wheat bran concentration. Then, the student will set up the in vitro digestion to digest the pasta samples. Pasta samples and digested pasta samples will be analysed mainly by measuring the antioxidant activity (QUENCHER method on solid material (using ABTS or DPPH as probe).

Research theme 2 - System Dynamics and Food Quality Modeling

In science mathematical models are being described for use in experimental design, interpretation of experimental results, prediction of new experimental results, or scaling up from small-scale experiments to industrial-scale production plants. This modeling approach is widely used in the chemical industry since the 1960s and more and more mathematical models are proposed in the design of foods

Simplified in silico model has been based exclusively on mechanism-based equations and proved to be a useful tool for the description of bacterial behavior in the gastrointestinal tract and for the interpretation of in vivo gastrointestinal results. Several mathematical models have been derived to describe the transport and the degradation of foods in the gastrointestinal tract, to describe the fate of micronutrients and proteins in the gastrointestinal tract of humans and animals, to describe the dynamics of fermentation pattern in human colon.

In this research theme we aim at developing mathematical models that can be used to describe the physical and chemical phenomena occurring along the food production, home-processing and consumption chain

The advantages of such a modelling approach are easy to envisage: 1) It will help casting light on the physical and chemical mechanisms that are behind the process under study, 2) It will facilitate research trajectories towards new functional foods that would enhance their effectiveness 3) It will reduce the number of expensive in vivo human intervention trials.

Project 2.1 Processing jams with the microwave

Target: BLT MFT

Supervisor

Jenneke Heising (Jenneke.Heising@wur.nl)



In recent literature several articles can be found on processing of jams with a microwave. What is the effect of this new method on the quality of the jams? Many healthy compounds degrade during processing and during conventional methods fruits are heated quite severely to make a jam. A thesis topic can be to study whether microwave-processing lead to jams with a higher content of healthy compounds.



Furthermore we would like to see what happens when processing conditions or changes in the composition are made. The temperature distribution of microwave treatment differs from cooking on a heating plate. And the composition of fruits and the addition of sugar and pectin influence the texture, shelf life and sensorial properties of the jams. A thesis topic is to study the effects of changes in processing conditions and composition on quality attributes of jams.

Finally we would like to use the knowledge of different processing methods and ingredients on the quality of jams to make mathematical models. With these models we would like to predict the effects of jam composition and processing method on texture, sensorial and nutritional properties. This knowledge can be used to optimize the jam processing method and composition to obtain a high quality product.

Project 2.2 Influence of preparation on the quality of ready to-eat meals

Target: BLT MFT

Supervisor

Jenneke Heising (Jenneke.Heising@wur.nl)



In consumer observations was seen that consumers do not always prepare a ready-to-eat meal according to the instructions given on the package of the food. This could lead to quality defects and changes in the nutritional composition of the meal. For example, problems with moisture loss, burning of sauce or a large loss of healthy compounds may be seen during preparation with abnormal conditions.



One of the research topics might be to conduct a consumer research to obtain more data about the way consumers prepare the ready-to-eat meals, or to identify possible quality defects that occur during preparation.

Other research topics involve experimental work. In the lab we would like to study the effect of different processing conditions on the quality of foods, for example by studying the nutritional content or measuring quality attributes. Mathematical models might be used to describe the quality changes.

Research theme 3 - Consumer-product interactions and Food Quality

Introduction

In the production and supply chain the quality of food products is controlled to keep it at an optimal level. However after the product is purchased by the consumer, it has to be stored and prepared before actual consumption takes place. In this last part of the chain the quality can deteriorate due to product handling processes by the consumer.

Project 3.1 The Consumer's Perception and Preference toward Dried Tropical Fruit and Its Products

Target: BLT MFT

Supervisor

Ita Sulistyawati (ita.sulistyawati@wur.nl)



There is a potential market for dried fruits shown by relevant consumer studies in Europe performed by (Jesionkowska et al., 2008) and (Sijtsema et al., 2012). It is revealed that breakfast cereals were one of the most frequently consumed products containing dried fruits by Dutch, French and Polish consumers. Apart from that, cookies were popular among Dutch, muesli bar among French, and fruit tea among Polish consumers (Jesionkowska et al., 2009). It would be of interest to find out the consumer's perception and preference toward dried fruits added to various types of products.

The quality perception of dehydrated/dried fruit products by consumers differs from one type to another end product, such as dried fruit as a single product, mixed with nuts or breakfast cereals, within snack or confectionery. This is especially due to the way the product will be used (consumed in dry-state or rehydrate first) (Lewicki, 2006) and the characteristics of other ingredients.



Therefore, it will be of interest to conduct a consumer study to find out about the consumer's perception and preference toward dried fruit as a single products or when added to various types of food products. Sensory evaluation maybe used to complement the consumer study.

References

- JESIONKOWSKA, K., SIJTSEMA, S., SIMONEAUX, R., KONOPACKA, D. & PLOCHARSKI, W. 2008. Preferences and consumption of dried fruit and dried fruit products among Dutch, French and Polish consumers. *Journal of Fruit and Ornamental Plant Research*, 16, 261-274.
- LEWICKI, P. P. 2006. Design of hot air drying for better foods. *Trends in Food Science & Technology*, 17, 153-163.
- SIJTSEMA, S. J., JESIONKOWSKA, K., SYMONEAUX, R., KONOPACKA, D. & SNOEK, H. 2012. Perceptions of the health and convenience characteristics of fresh and dried fruits. 49, 275-281.

Project 3.2 Consumer Behaviour and Food Quality

Target: BLT MFT, MFQ with interest in consumer behaviour

Supervisor

Bea Steenbekkers (bea.steenbekkers@wur.nl)



Hardly any research is done on consumer handling and practices at home with food products. How are products stored and prepared and how do these practices influence the final product quality. In order to gain more insight into these behaviours, consumer research in daily life situations is needed to understand practices and motives behind these practices. The research methods used will be in home observations and interviewing consumers. With lab analysis the



influence of the consumer behaviour on the final, consumed quality can be assessed.

When these final steps in the food production-consumption chain are taken into account during product design, possible quality loss can be prevented by anticipating on the behaviour of the consumer.

This type of research needs to be done with all food products, according to the students' own preferences: e.g. vegetables (including new products like sea weeds), dairy, meat, meat replacers (incl. insects), convenience products etc. Examples of products recently studied are broccoli and carrots as part of a hot meal. Also the influence of in home behavior on the quality of ready-to-eat meals has been studied.

The aim of the project will be to generate knowledge that can be used to improve product design and/or to inform consumers about more appropriate food handling.

Project 3.3 Consumer attitudes and willingness to consume processed cape gooseberry products (Dutch case study)

Target: MFT MFQ

Supervisors

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Bea Steenbekkers (bea.steenbekkers@wur.nl)

Mary Luz Olivares Tenorio

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Cape gooseberry is a promising fruit given its functional properties and fruit characteristics, which make it a good raw material for numerous products such as juices, jam, pulp, desserts, dehydrated fruit, oil, etc. Therefore, those processed products have been entered into the market to give an added value to the supply chain. The market for these processed products, however, currently is local and despite an interest by international markets there is a need to improve the knowledge about consumer willingness to repeatedly purchase these new products.



Aim

Assess consumer attitudes of Dutch people and willingness of consumption of cape gooseberry new products.

Project 3.4 Consumer preferences and perceptions of Cape gooseberry in relation with health-promoting compounds contents (Dutch case study)

Target: MFT

Supervisors

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Bea Steenbekkers (bea.steenbekkers@wur.nl)

Mary Luz Olivares Tenorio (maryluz.olivarestenorio@wur.nl)



Cape gooseberry is an important commodity in Colombia because of its second place in fruit exports after banana and plantain. Activities to further develop export markets are essential. So far, some barriers have been identified in the chain, such as, lack of information about the fruit and its properties as well as about the processed product as well as lack of knowledge about quality-attributes, preferences and expectations of consumers. Although, studies and reviews have been published on cape gooseberry properties, there is still a considerable gap of understanding about its quality attributes. Therefore, to carry out a proper research on quality attributes definitions and preferences through the supply chain is essential.



Aim

Evaluate Dutch consumer preferences and perceptions of Cape gooseberry fruit in relation with health-promoting compounds knowledge.

Project 3.5 Preferences on quality-attributes of European (or Dutch) actor of supply chain of cape gooseberry (*Physalis peruviana* L.)

Target: MFT MFQ

Supervisors

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Mary Luz Olivares Tenorio
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The Cape gooseberry is a very important fruit for Colombia, given its international demand. The supply chain, however, still faces some barriers due to, among other factors, the lack of knowledge of consumer and buyer preferences. The market context in terms of quality attributes of the fruit and their importance in the purchase decision of chain actors is not clear. For this reason this project proposes to investigate the quality-attributes of Cape gooseberry and their importance for actors in the chain who have a purchasing role (importers, distributors, exporters, supermarkets).



Aim

Set up a list of contacts of European actor of supply chain and assess quality-attributes preference on cape gooseberry.

Project 3.6 Influence of preparation practices on quality of seaweed

Target: BLT MFT

Supervisors

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Bea Steenbekkers (bea.steenbekkers@wur.nl)



A combined thesis project together with a BBC/MME student is possible.

In times of global food shortage there is a growing demand to find unused food sources and use them. For the Netherlands seaweed seems to be a good choice as it is grown in the sea which is an underexploited source of food products.



It is however not known to which extent preparation practices influence the nutritional value of the different seaweed products. Research should be done on consumer preparation practices and the influence on quality of these seaweeds, to be able to give instructions for preparation that lead to the best quality of the consumed product.

Aim

Assess influence of preparation practices on nutritional value of seaweeds.



Research theme 4 - Phytochemicals in the food supply chains

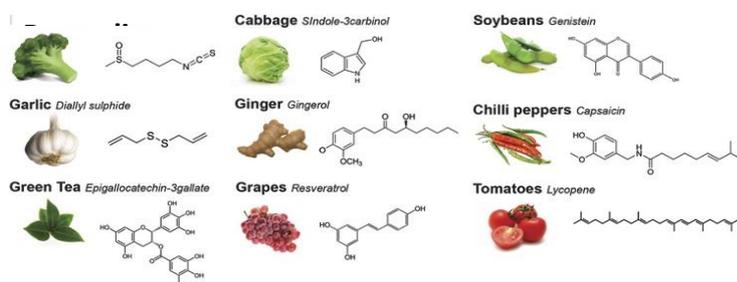
Introduction

A large variety of **phytochemicals** (phyto = "plant" in Greek) are present in virtually all fruits, vegetables, legumes, and grains and are therefore easy for people to include them in their diet. Some phytochemicals are responsible for the typical color or sensorial properties in fruits and vegetables. Moreover, they are intensively studied for their protective or disease preventive properties. Major groups of phytochemicals are polyphenols, carotenoids, and glucosinolates.



Many epidemiological studies have shown significant associations of diets rich in fruit and vegetables and reduced risk of certain cancers as well as several other chronic diseases like cardiovascular diseases and diabetes type 2 and obesity. To some extent these associations are ascribed to health promoting properties of various phytochemical actions like antioxidant, hormonal, enzyme stimulation, and anti-bacterial.

The concentration and composition of the phytochemicals in different plants, but also within a plant (e.g. in the seeds, roots or leaves), can vary greatly and also changes during plant development. Furthermore, various factors in the supply chain of vegetables including breeding, cultivation, storage and processing affect the intake and bioavailability of phytochemicals.



Glucosinolates

A specific group of phytochemicals called **glucosinolates** occur in representatives of the *Brassicaceae* family and are of particular importance in vegetables such as cabbage, Brussels sprouts, broccoli, cauliflower. Glucosinolates are

claimed to be the active components responsible for many of the physiological effects proposed for Brassica vegetables in different types of studies, including in vitro, animal, human and epidemiological studies. Processing is one of the major factors affecting changes of glucosinolate content along the production and supply chain. Also domestic cooking methods influence the glucosinolate levels in various ways. Processing changes the glucosinolate content through several mechanisms.

Each processing method involves specific conditions, which lead to various degrees of impact of the different mechanisms on the glucosinolate content. Using the underlying mechanisms that are critical for a processing or cooking method can be a valuable approach to understand the changes in glucosinolate profiles.

Overall objective

- To study mechanisms underlying changes in phytochemical content during industrial processing and domestic cooking practices
- To study the potential for increasing intake of health promoting phytochemicals, such as glucosinolates, by optimizing food processing to minimize losses.

Project 4.1 Investigating the effect of food matrix on glucosinolates thermal degradation

Target: MFT

Supervisors

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Teresa Oliviero (teresa.oliviero@wur.nl)



Glucosinolates (GSLs) are secondary plant metabolites that occur in members of the order Brassicales including Brassica crops, such as cabbage, rape, or broccoli. The consumption of Brassica vegetables is thought to be beneficial for human health because of breakdown products of the GSLs, namely isothiocyanates (ITCs). The latter being released enzymatically from GSLs by endogenous myrosinase after tissue disruption. During heat treatments (sterilisation, pasteurization, cooking) GLS are degraded yielding a large array of breakdown products including nitriles, epithionitriles, isothiocyanates and the like. It has been shown that the chemical environment GLS are in affect the rate of GLS thermal degradation which means that the same GLS will be degraded at different rates when occurring in different vegetal matrices. In addition, the relative amount of ITC and nitriles also may change according to the chemical environment.

Aim

In the present study we will investigate the effect of the vegetal matrix on thermal degradation of several GLS.

Proposed approach

In a set of experiments, different vegetables (not containing GLS) are selected, freeze dried and reconstituted with water and GLS and subjected to heat treatments for different times. In a second set of experiments GLS are dissolved in aqueous/alcoholic extracts from different vegetables and subjected to heat treatment. After heat treatments GLS and ITCs are quantified in the samples and the relative effect of different vegetal matrix compared to the broccoli matrix.

Some references:

Bones AM & Rossiter JT (2006) The enzymic and chemically induced decomposition of glucosinolates. *Phytochemistry* 67 (2006) 1053–1067.

Project 4.2 Investigating the effect of food matrix on the conversion of glucosinolates to isothiocyanates

Target: BLT

Supervisors

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Teresa Oliviero (teresa.oliviero@wur.nl)



ITCs are the product of the degradation of glucosinolates catalyzed by myrosinase upon chewing and in general upon disintegration of the vegetal tissues. ITCs are supposed to be anti-carcinogenic. For that reason the amount of ITCs in the vegetables at the moment of swallowing has a great importance. The conversion of GLS to ITC depends on the chemical environment myrosinase and GLS are in. Supposedly different chemical environment would differently affect myrosinase catalytic activity and the final content in ITCs. It is long known for instance that vitamin C affects myrosinase activity. Analogously it is known that a set of proteins exists in planta which can direct the enzymatic conversion of GLS towards specific breakdown products (nitriles, epithionitriles) rather than ITCs.

Aim

In the present study we will investigate the effect of vegetal matrix in general and vitamin C in particular on the extent of the conversion of GLS to ITCs catalysed by the enzyme myrosinase.

Proposed approach

Different vegetables from cruciferous and brassicaceae are selected and their GLS content and MYR activity is assessed in different part of the plant. After grinding of the vegetable matrix the amount of ITCs produced and the amount of residual GLS are measured. The matrix effect is established by calculating the conversion rate, i.e. the % of GLS hydrolysed (or ITCs produced) per unit of myrosinase activity. In a different set of experiments selected (part of) vegetable will be grounded after addition of variable amount of vitamin C and the conversion rate will be calculated.

Some references:

Bones AM & Rossiter JT (1996) The myrosinase-glucosinolate system, its organisation and biochemistry. *Physiologia Plantarum* 97, 194–208.

Bones AM & Rossiter JT (2006) The enzymic and chemically induced decomposition of glucosinolates. *Phytochemistry* 67 (2006) 1053–1067.

Project 4.3 Effect of meal composition on the formation and bioaccessibility of isothiocyanates from broccoli

Target: BLT MFT

Supervisors

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Matthijs Dekker (matthijs.dekker@wur.nl)

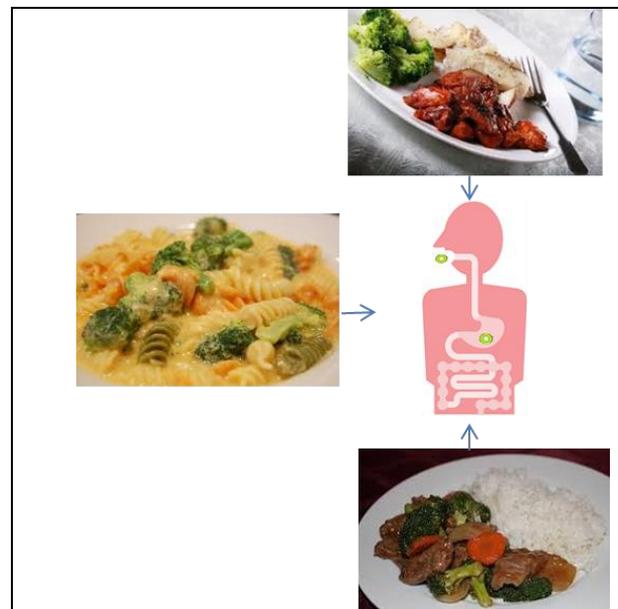


Brassica vegetables are rich in glucosinolates (GLs), phytochemicals that can be hydrolysed by myrosinase (MYR), an endogenous plant enzyme. During mastication, plant cells are damaged and MYR catalyses the GL hydrolysis forming breakdown products including isothiocyanates (ITC), with anticarcinogenic properties.

A few small studies show the effect of different meal composition on ITC bioaccessibility. For instance, proteins may interact with ITC during digestion depending on the amino acid composition and the ITC type, reducing the ITC bioaccessibility. The *in vitro* digestion can be a useful tool to investigate the ITC formation and availability when eating broccoli along with other food components.

Objectives

The aims of to investigate the effect of broccoli meal composition (like proteins, fibre, fat) on ITC formation and bioaccessibility by means of *in vitro* digestion.



The student will work on the *in vitro* digestion to digest broccoli along with different meal components. GLs (HPLC), and ITC (LC/MS) at different stage of the *in vitro* digestion will be monitored.

Project 4.4 Effect of meal composition on the formation and bioavailability of isothiocyanates from broccoli

Target: MFT

Supervisors

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Ruud Verkerk (ruud.verkerk@wur.nl)

Matthijs Dekker (matthijs.dekker@wur.nl)



Brassica vegetables are rich in glucosinolates (GLs), phytochemicals that can be hydrolysed by myrosinase (MYR), an endogenous plant enzyme. During mastication, plant cells are damaged and MYR catalyses the GL hydrolysis forming breakdown products including isothiocyanates (ITC), with anticarcinogenic properties.

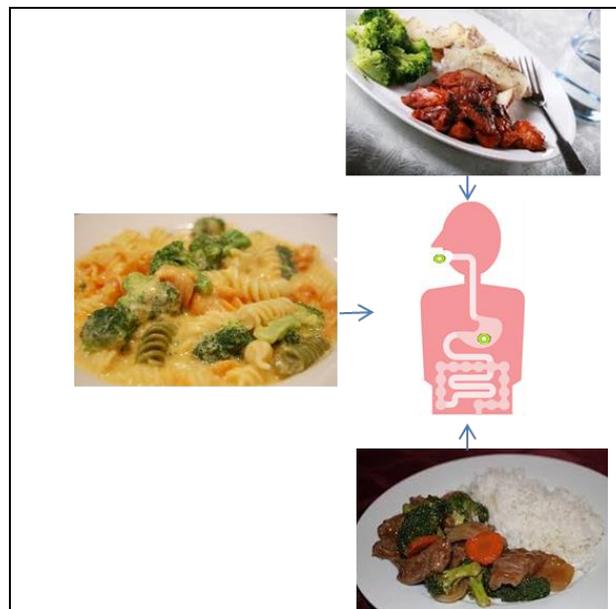
A few small studies show the effect of different meal composition on ITC bioavailability. For instance, proteins may interact with ITC during digestion depending on the amino acid composition and the ITC type, reducing the ITC bioavailability.

Objectives

The aims of to investigate the effect of broccoli meal composition (like proteins, fibre, fat) on ITC formation and bioavailability by means of in *in vivo* digestion.

The student will work on a human intervention study, in which participants

will eat different broccoli products (with proteins, fibre, fat) (GLs analyzed by HPLC) and will collect 24 h spot urines. The intake on ITC will be analyzed in the urine (LC/MS).



Project 4.5 Functional pasta enriched with broccoli - In vitro bioaccessibility of isothiocyanate

Target: BLT

Supervisors

Teresa Oliviero (teresa.oliviero@wur.nl)

Matthijs Dekker (matthijs.dekker@wur.nl)

Ruud Verkerk (ruud.verkerk@wur.nl)



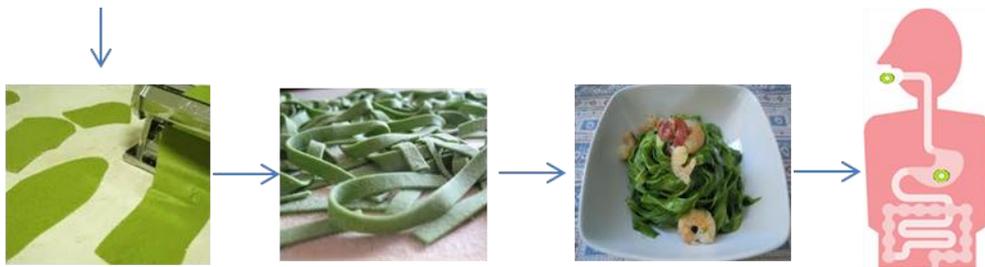
Brassica vegetables are rich in glucosinolates (GLs), phytochemicals that can be hydrolysed by myrosinase (MYR), an endogenous plant enzyme. During mastication, plant cells are damaged and MYR catalyses the GL hydrolysis forming breakdown products including isothiocyanates (ITC), with anticarcinogenic properties.

Pasta enriched with broccoli can be a good strategy to increase the vegetables intake, because (1) pasta is routinely consumed (2) dry pasta is a perfect carrier to stabilize phytochemicals that otherwise are easily degraded.

Objectives



The aims of to investigate the effect incorporation of broccoli in functional pasta on ITC formation and bioaccessibility by means of *in vitro* digestion.



The student apply the *in vitro* digestion to digest broccoli pasta. GLs (HPLC), and ITC (LC/MS) at different stages of the *in vitro* digestion will be monitored.

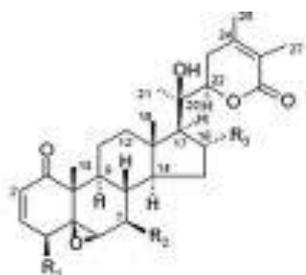
Project 4.6 Health-promoting compounds (Withanolides) in Cape Gooseberry (*Physalis peruviana* L.) fruit

Target:BLT MFT

Supervisors

Ruud Verkerk (ruud.verkerk@wur.nl)

Matthijs Dekker (matthijs.dekker@wur.nl)



	R ₁	R ₂	R ₃
1 7 β -Acetoxywithanoloide D	OH	OAc	H
2 7 β ,15 α -Diacetoxywithanoloide D	OH	OAc	OAc
3 4-Deoxy-7 β ,15 α -diacetoxywithanoloide D	H	OAc	OAc

Withanolides are a group of naturally occurring steroidal lactones which are mainly produced by the solonaceae family. Their name comes from the genera withania, that initially was considered to be the unique source. There is evidence, however, that the genus *physalis* also contains withanolides. There is high interest in these biocompounds since there is studies about their pharmacological activities, such as antitumor, anti-inflammatory, hepatoprotective,

immunomodulatory activities, among others. Studies have been done on the whole plant of *physalis peruviana* L. including fruit, suggesting that cape gooseberry also contains of withanolides, but the withanolide content of the fruits is still unknown.

A study to assess the contents of withanolides in cape gooseberry fruit and its processed product is needed to find out if this fruit and products have the special health promoting properties related to withanolides.

Aim

Set up the analytical method to identify and quantify withanolide. Apply this method to obtain the withanolide profile in cape gooseberry fruits and the effect of processing on this profile.

Project 4.7 Effect of heat treatment on In vitro bioaccessibility of β -carotene/ vitamin C in cape goose berry

Target: BLT MFT

Supervisors

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Matthijs Dekker (matthijs.dekker@wur.nl)

Mary Luz

(maryluz.olivarestenorio@wur.nl)



Previous studies of vitamin C and β -carotene on gooseberry have given evidence on important contents of this health-promoting compounds in cape gooseberry. β -carotene has shown an increase during heat treatment that could be related to the degradation of binds of carotenes with other molecules. This bind degradation can lead to increase bio-availability of vitamin C and β -carotene.

Aim

Evaluate In vitro bioavailability β -carotene y/o vitamin C degradation during thermal processing.

Project 4.8 Effect of Processing Condition, Maturity Stages, Matrix Modification and The Use of Ternary Compounds on The Quality of Osmotic Dehydrated and/or Dried Tropical Fruit

Target: BLT MFT

Supervisor:

Ita Sulistyawati (ita.sulistyawati@wur.nl)



As a healthy product but highly perishable commodity, diverse technology has been applied to extend shelf life of fruit. From the various existing processed fruit products, dried/dehydrated fruits are getting substantial attention, and recently the availability of those products in the market has increased considerably. Dried fruit is higher in energy per serving than fresh, canned, frozen fruit and most fruit juices. Their high content of dietary fibre (1.9-12.4 g/100 g) contribute to more than 7.5% of the US daily value, 25 g per serving (40 g). Most of them contain vitamins (especially vitamin A and C) and a wide range of phytochemicals.

The use of a combination of osmotic dehydration and heated drying techniques resulted in higher quality shelf-stable products to many type of dried fruits, compared to the application of only one of them. Among numerous attempts to improve the efficiency of osmotic dehydration process, the use of polysaccharide based-edible coating and food additives especially texture modifying agents (*i.e.* cell wall-modifying enzyme, Calcium (Ca) salts, phenolic compounds) shown good results.

Some of the research topics which involve experimental work in the laboratory might be, as followed:

1. Study on the effect of processing condition and maturity stages to the quality of dried fruit and its products on the physico-mechanical and chemical properties
2. Study on the behaviour of some important cell wall-modifying enzymes during the process of osmotic dehydration and/or drying of fruit as well as during storage.
3. Study on the effect of several process variables (incl. type and concentration of polysaccharides-based edible coating and texture modifying agents) to the quality of dried fruit and its products on the physico-mechanical and chemical properties.
4. Study on the effect of ternary compounds (sugars, several types of Ca-salts and weak acids) on the quality of osmotically dehydrated and/or dried fruit, especially toward the flavour release and colour degradation. This research might involve sensory evaluation.

Response Surface Methodology (RSM) will be applied to optimize important factors to have quality osmotically dehydrated and/or dried fruit according to their destined products.

Research Theme 5 - Insect-based Ingredients

Introduction

In view of the ever increasing world population the demand for protein will increase over the next decades, and new protein sources are searched for. Insects have been proposed as one of the potential future protein sources of protein. Although insect consumption is new in the western world, over 1900 insect species are consumed world-wide and appreciated for their taste.

Several reasons exist for considering insects as a promising alternative source of animal protein in this part of the world. First, the production of insects is highly sustainable in comparison to production of cattle, pork, and poultry.

Farming insects is characterised by higher food conversion efficiencies, lower environmental impact, and higher potential to be grown on waste streams. The research is focussed on generating knowledge on how to use insects in a tailored way as an alternative source of protein for human consumption, direct or indirect through the feed chain.



Last but not least the research aim at creating highly palatable products which provide not only nutritional benefits, but also sensory satisfaction. The major challenge to solve is that consumers often do not choose their foods from an ecological, sustainable or nutritional perspective alone, but are disgusted by the notion of eating insect containing foods. The research determines therefore the underlying mechanisms and product factors that give rise to the aversion towards eating novel protein containing foods. Based on this knowledge, design rules will be delivered for the formulation and processing of novel protein foods with excellent sensory performance and consumer acceptance.

Overall objectives - with a view on defining pathways towards insect-based food consumption - are:

- Processing of whole insects in order extract proteins, fats in relation to functional aspects of the fractions obtained-
- Consumer acceptance in relation to processing and sensory quality
- Chain interactions between partners in the insect production chain

Project 5.1 Towards a sustainable insect production chain

Target: BLT MFT

Supervisor

Catriona Lakemond (Catriona.Lakemond@wur.nl)



Short Description

Insects are considered to be a future alternative protein source.

Literature supports that rearing insects is sustainable in comparison to traditional meat sources.

Insects are already offered as a whole on the market. Another foreseen development is bio fractionation of insects into a protein, a fat and a chitin rich fraction. In order to be able to offer insect fractions as being sustainable to the public, it is important to use sustainable processing technology and handling along the food chain. This research will identify sustainability criteria in food supply chains and will develop a tool to analyse levels of sustainability.



One of the topics that will be studied is chitin. Chitin is, after cellulose, the most abundant polysaccharide found in nature. It is present in cell walls of bacteria and fungi, and in the exoskeleton of crustaceans and insects. Chitin is a non-toxic, water-insoluble biodegradable linear polymer. It is converted into chitosan upon deacetylation, a degree of deacetylation below 50% causes it to become soluble in aqueous media. Industrial use of chitin and its derived products include medical applications, as in wound healing, and usage in cosmetic products, i.e. in hair and skin care products. In view of these industrial applications chitin is extracted from its matrix using harsh conditions; an acid hydrolysis step (e.g. 2M HCl....) is required for demineralisation, an alkaline treatment (1 M NaOH...) for deproteinisation, and usage of organic solvents for elimination of lipids and colour. The current methodology used is expensive, environmentally unfriendly and, therefore, not seen as sustainable, which legitimates the search for more sustainable processing methods for using chitin-rich side streams.

Project 5.2 Extraction and characterization of high quality proteins from insects

Target: BLT MFT

Supervisors

Renske Janssen (renske.janssen@wur.nl)

Catriona Lakemond (Catriona.lakemond@wur.nl)



To use the insect proteins as a food ingredient, it is necessary to maintain their techno-functional properties. For this, protein extraction from the whole insect under mild extraction conditions is essential to preserve the characteristics of the native protein.

In this research, optimization of extraction and characterization of water-soluble proteins from insects will be investigated. This will be done by setting up an extraction method. Subsequently, the extracted proteins will be characterized with different methods, like Dumas.



Project 5.3 Nutritional quality of indigenous edible insects of Zimbabwe

Target: MFT MFQ

Supervisors

Faith A. Manditsera (faith.manditsera@wur.nl);

Dr. ir. Catriona Lakemond (Catriona.lakemond@wur.nl)



Indigenous edible insects of Zimbabwe are one of the underutilised natural resources that can help to reduce the problems of food insecurity. The FAO reported that nutrients found in insects have a potential of reducing nutrient deficiencies in a population consuming them, thus directly contributing to food security. Indigenous edible insects can also be used as fortified blended foods, mainly because of their protein and micronutrient content. However, there is a high variability in the nutritional value of insects. The nutritional value of insects depends, amongst others, on the type of species, type of feed, insect stage, habitat, origin, and method of cooking. Knowledge of the nutritional value of insects is important to have a clear understanding on how insects can be used in filling dietary gaps in malnutrition. Eulepida species (mandere) also known as chaffer beetles and *Henicus whellani* (majenya) also known as monster/king cricket are amongst indigenous edible insect species that are consumed in Zimbabwe. The protein content of mandere and majenya are 52.2% and 53% respectively.

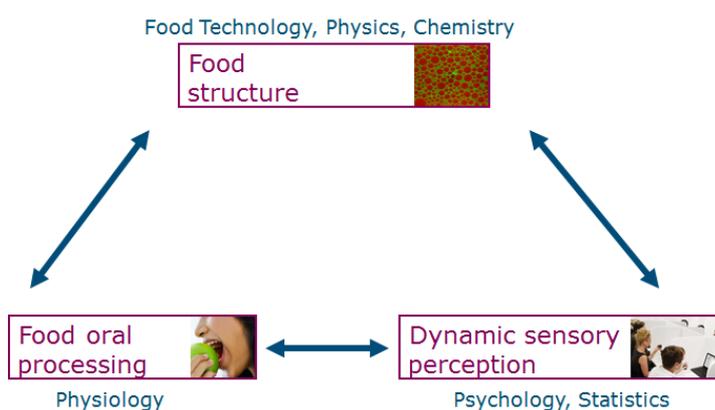
The thesis will focus on determining the current state of the art in the insect value chain with respect to the protein quality of indigenous edible insects harvested from different regions. In-vitro protein digestibility and amino acid determination will be carried out to determine the protein quality of the insects.

Research theme 6 - Food structure - food oral processing – dynamic sensory perception

The aim of the research theme is to deliver the scientific knowledge on how food structure is converted into dynamic texture perception by food oral processing. This knowledge is needed by the food industry to develop healthier and tastier foods. The research theme addresses the following questions:

- How can we understand fundamental physical and perceptual concepts determining texture?
- How do changes in food structure couple with changes in oral behaviour and sensory perception?

Food texture is perceived during the conversion of the initial food structure into a bolus through a complex series of oral manipulations including ingestion, oral processing and swallowing. To obtain insights into the perception of complex textural attributes, the research employs traditional, static descriptive and recently developed, time resolved sensory methodologies. Sensory attributes are perceived in a certain order during oral processing and depend on both food structure and oral movements. Texture attributes evaluated during early stages of the mastication cycle (first bite properties) are by far better understood and have been successfully related to food structural and mechanical properties. In contrast, texture attributes perceived during later stages of the mastication cycle and after swallowing are difficult to explain and less understood, although they contribute largely to food quality and acceptance. Due to the dynamic nature of oral processing, food structures and surfaces are continually changing, making assessments of texture perceived at later stages of the mastication cycle more challenging. By addressing the question what structural changes are perceived as textural properties, the understanding of texture perception is advanced.



Eating is not a simple process of food breakdown, but a highly sophisticated process involving physiological, psychological and neurological human responses to the changing properties of foods. Eating and oral processing behaviour have been investigated using various experimental techniques including measuring electrical activities of masticatory muscles

(electromyography), jaw movements (jaw tracking) and observation of tongue movements (videofluorography). Current experimental techniques do not provide us with the information about oral processing that we need to have to understand texture perception. New experimental technologies to track tongue and jaw movements in the oral cavity during food consumption are developed. Thus, the research links food properties such as mechanical and sensory properties to oral processing behaviour.

Project 6.1: Extraction and characterisation of quinoa protein

Target: BLT MFT

Supervisor

Geraldine Ruiz (Geraldine.Ruiz@wur.nl)



Quinoa is a newly re-discovered grain from the Andean region in Southamerica. It is high in good quality protein and has been introduced to the Western diet for its health properties. It is also seen as a more sustainable derived products and has recently received a lot of attention (2013 was the international quinoa year). It has become so popular and widely accepted in the Western diet that several European countries have started growing it, including the Netherlands (WUR is large-scale production).



As the world demand for protein is rising and sustainable solutions are searched for to meet this demand, quinoa could be one of the solutions. To make more efficient use of the protein in quinoa and add value to existing foods, we are looking into the extraction of the protein to enrich daily life food products with it.

Little research has been done on this and knowledge on the protein properties and its behaviour in potential applications is missing. As protein properties and functionality is very dependent on the production method, we would like to know how extraction conditions (focussing on pH) affect protein properties, while focussing on the structure-forming ones (denaturation, solubility, aggregation and gelation/viscosity). We also know that the extraction pH affects the quantity of protein being extracted. Therefore, the aim is to find the relation between extraction pH, protein yield and protein properties to have better control over the properties of final quinoa protein concentrate or isolate and possibly customise it to food or beverage applications.



Project 6.2 Influence of protein on oral coatings of oil in water emulsions

Target: MFT

Supervisors

Sara Camacho (sara.camacho@wur.nl) ,
Markus Stieger (markus.stieger@wur.nl)



Oral coatings are residues remaining on oral surfaces after the consumption of foods and beverages. Oral coatings have long been hypothesized to significantly influence the perception of taste and mouthfeel attributes. However, a mechanism describing the formation of oral coatings is not known. There is only very little information available on the composition and structure of oral coatings despite its influence on sensory perception.

In recent years we have been using in vivo fluorescence to further study the deposition and clearance of oral coatings, mainly focusing on lipid deposition.

Aim

The aim of this subproject is to determine the role of protein in the formation of the coating using oil in water emulsions as a beverage model, and a large group of subjects to account for well-known inter-individual differences. The relationship between removal of oral coating due to salivation which differs between subjects is determined and linked to taste perception.

Approach

A first approach will be to request subjects to drink a model sample with a food grade dye, and measure the fluorescence on the tongue after spitting the sample. The relation between the fluorescence intensity and the amount of protein on the tongue will be drawn by using different amounts of the oil in water emulsions spread over well-defined pieces of pig's tongue. The different points of concentrations/fluorescent intensity will be used for a calibration curve.

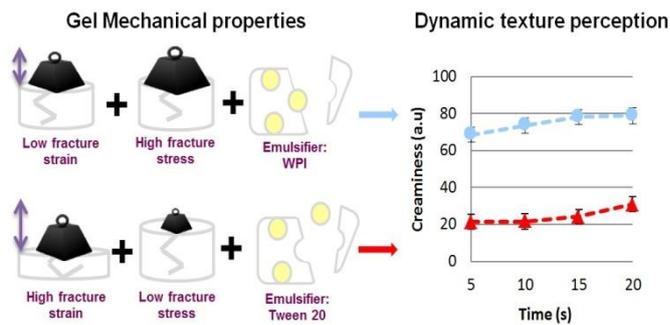
Project 6.3 Designing food structures to understand texture perception

Target: MFT

Supervisors

Marine Devezeaux (marine.devezeauxdelavergne@wur.nl)

Markus Stieger (markus.stieger@wur.nl)



Sensory attributes of food that are perceived at late stages of oral processing depend on food properties and on physiology of eating. These attributes are important for consumer appreciation of foods and the mechanisms of their perception are not well known. Creaminess is generally perceived at the end of mastication of solid foods and is an

attribute valued by consumers. In order to understand this complex attribute, structure and properties of food have to be controlled effectively. Model food systems such as gelled foods can be designed to obtain a desired structure and to investigate the effect of a single parameter on the perception of creaminess.

Objective: The objective of this thesis project is to design gelled structures with controlled properties in order to investigate further the mechanisms of creaminess perception.

Approach: Formulation of gel recipes, characterization of gels (rheology, dry matter, melting) for a BSc + sensory test (TDS or progressive profiling) and test on spit-out gels (e.g. Texture Profile Analysis) for MSc

Research theme 7- Food authenticity and traceability

Introduction

Food authenticity and integrity refers to the genuineness and intactness of food products. The series of food fraud incidents – melamine, horse meat, organic eggs, cardboard stuffed dumplings – is demonstrating that the vulnerability of food fraud incidents reaches to every dinner table in the world nowadays. Food fraud is a major concern not only for consumers, but also for producers and distributors. Food adulteration has been practiced forever, but has become more sophisticated in the recent past. These illicit activities result in considerable monetary losses worldwide and eroded consumer confidence. Foods or ingredients most likely to be targets for adulteration include those which are of high-value and which undergo a number of processing steps before they appear on the market. To understand why fraud possibilities are seen as opportunities fraud risk assessments are required. Since the perceived risk of detection is one of the factors, and food adulteration is advancing more and more, novel analytical methodology are pivotal to uncover food fraud.

Objectives

The main objectives are to elucidate economic/criminological risk factors contributing to food fraud vulnerability, and to discern markers which substantiate the identity of food products. Both information on vulnerability and detection options will help to set up food fraud management systems.

Detailed objectives are:

- To explore food fraud risk factors from product and business perspectives
- To develop analytical methodology to ascertain the authenticity of food product constituents
- To advance detection techniques to substantiate the history of food products, i.e. the production system (e.g. organic, halal), provenance (geographical origin), and processing.



Project 7.1 Chocolate: linking sustainability to flavour composition and release

Target: MFT

Supervisors

Saskia van Ruth (saskia.vanruth@wur.nl)

Valentina Acierno (valentina.acierno@wur.nl)



Novel analytical techniques are able to measure naturally occurring compositional characteristics of chocolate which in turn may demarcate the place and way of production/processing of sustainable chocolate and chocolate ingredients. This will ultimately improve the traceability of sustainable chocolate.

In this student project you will examine the release of volatiles from chocolates during consumption, in order to examine differences due to origin and production system (e.g. organic, sustainable). Volatile release will be measured by Proton Transfer Reaction Mass Spectrometry in the nose of volunteers while they are consuming the chocolates. You will set up a method to measure adequately in the nose of people. Subsequently, a representative set of chocolates will be analysed. Data will be subjected to statistical analysis in order to examine the different patterns observed and to link origin/production of chocolate to their flavour (volatile) characteristics.



Project 7.2 How to detect fraud with spices?

Target: MFT

Supervisors

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Isabelle Silvis (isabelle.silvis@wur.nl)



Herbs and spices are costly commodities, vulnerable to adulterations. An example of food adulteration is the blending of the spices with lower value ingredients to increase own economic benefit. In this case, other parties in the chain and consumers are deceived. Saffron is a spice derived from the flower of *Crocus sativus*. Prices of saffron may be go up to €7,500 per kg, which makes the spice susceptible to adulteration. Typical adulterations include mixing in extraneous substances like beets, pomegranate fibers, red-dyed silk fibers, or the saffron crocus's tasteless and odorless yellow stamens. To support saffron production and genuine trade, measures against deliberate adulterations are required. The general project aims at improvement of non-targeted analytical fingerprint methods which could be used for screening for anomalies.

In this student project you will develop methodology to analyse different grades and adulterations of saffron. A fingerprint type method based on mass spectrometry will be used and adapted for saffron. The method will be compared with the colorimetric ISO method for grading saffron which is based on spectroscopy. Eventually, retail samples will be collected and tested with the newly developed method.



Project 7.3 Meat fraud control

Target: MFT

Supervisor

Saskia van Ruth (saskia.vanruth@wur.nl)



Food ingredients are sourced globally nowadays, with price being the main governing feature. The food supply chain network has become very extensive, which increased its susceptibility to fraud. Food fraud covers issues with composition, processing, shelf-life, geographical origin as well as production practice (e.g. organic). Recently, cases of meat fraud received considerable media attention (e.g. horse-meat scandal). Fraud may relate to the species of meat and the meat content in a product, but also processing (injection of water; defrosted meat sold for fresh), the geographical origin, and production practice (organic). Rather than looking at specific incidents, a system analysis approach is preferred in order to prevent fraud in the future. The overall objective of the study is to get insight in technological and social (people) factors increasing the risk on fraud in meat supply networks by development of an analytical research framework (for system analysis) based on in-depth theory analysis and expert interviews. In this student project, the possibilities for fraud with beef will be inventoried, the beef meat chain mapped and analysed, people factors in fraud studied, as well as market economics providing fraud opportunities. The study is a collaboration project between FQD and RIKILT.



Project 7.4 Development of DNA-based screening and identification methods for (food) authentication

Target: MFT

Supervisors

Prof. Saskia van Ruth (saskia.vanruth@wur.nl)

Dr. Esther J. kok (esther.kok@wur.nl)

Alfred J. Arulandhu, MSc. (alfred.arulandhu@wur.nl)



Currently, food/feed authentication is one of the upcoming topics around the world. Processed food/feed products are more vulnerable to adulterations and ensuring its authenticity is really challenging. DNA-based screening and identification methods is one approach to identify the raw materials used to obtain the processed/complex product, but the applicability of advanced DNA methods has so far not been fully investigated. DNA-based screening methods can be based on identifying known or unknown genomic sequences. Identifying the endangered species in complex mixtures could be achieved by using DNA-based screening approaches for the known sequence that is specific for this endangered species. Overall, more than 33,000 species of flora and fauna are categorised as endangered species. Although international trade agreements are being implemented, illegal trading and the use of (parts of) endangered species are still common practice. Usually, visual inspection (microscopy, etc.) is the initial approach to identify the endangered species in the customs offices. If the product is more complex or processed, visual inspection will not be sufficient. In those cases, DNA-based methods may be more appropriate to detect and identify the endangered species that may be present in the sample.

To identify genetically modified organisms (GMOs), including unauthorised genetically modified organisms (UGMOs) a similar DNA-based approach can be used to characterise the unknown genomic sequence, adjacent to known GMO sequences. GMOs need to be assessed for their food/feed and environmental safety prior to market introduction. In recent years, the number of incidents related to the presence of UGMOs and (UGM) derived products (food and feed) have globally increased. DNA-based enrichment strategies are applied to identify the unknown adjacent sequence of the known GMO elements to positively identify also unknown UGMOs that have not (yet) been assessed for their safety.

This project is aimed to understand how advanced DNA-based methods can be applied for food/feed authenticity issues related to the potential presence of endangered species and UGMOs. The PhD project aims to evaluate advanced DNA methodologies (including Next Generation Sequencing (NGS)) in terms of applicability and sensitivity for authenticity purposes. To this end simple reference materials will be used, as well as well-characterised complex mixtures and real-life samples that may contain endangered species and UGMOs, respectively.

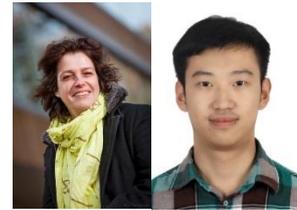
Project 7.5 Understanding intrinsic characteristics and their origin

Target: MFT

Supervisors

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Ningjing Liu (ningjing.liu@wur.nl)



Organic food brings more benefits to environment and humans.

However, the organic products are retailed at a higher price, which makes them susceptible to fraud. Taking organic milk as an example, since the organic dairy system is very complex and restrict, some people utilise the difficulty of authenticity detection to make the adulteration. Organic milk is the production of the organic system, including organic farming and organic rearing. All the feed for cows should meet the requirement of organic farming discipline, which means the chemical fertilizer and pesticide are not allowed, no matter for the silage or fresh grass. To ensure the authenticity of organic milk and regular the organic milk market, the internal relationship between organic feed and organic milk and identification methods need to be studied.

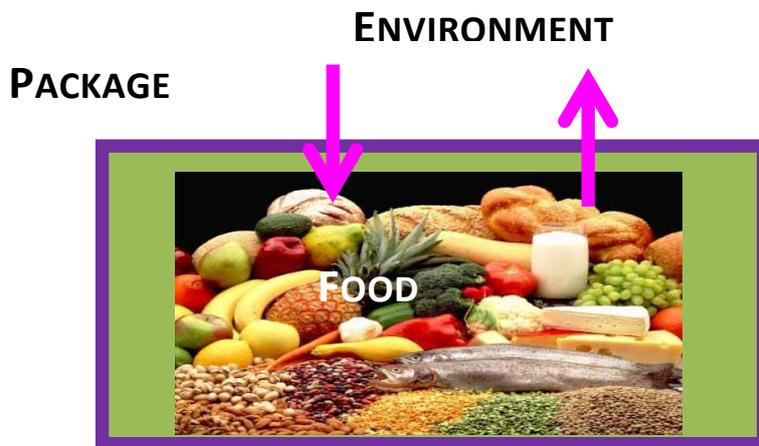
In this project, we need to study the factors which can affect the quality of organic milk, find the difference between organic milk and conventional milk and develop the detection method based on results. Finally, the traceable characteristics and the detection method can be applied for the organic milk authentication in the retail market.



Research theme 8 - Food Packaging

Within the research area of food packaging, as food technologists, we are focusing mainly on the interactions between the package, the environment and the food and we study the effects on the quality of foods. Food packaging is very important for the quality of foods, since a good package can help to improve or maintain the quality of foods and increase the shelf life of foods.

The selection of suitable packaging materials for existing or projected target foods is primarily determined by the properties and type of food being packaged. In addition, market image, costs, and environmental issues must also be considered. Therefore, it is very critical to understand not only the food itself but also the general characteristics of various packaging materials and the conditions in the supply chain.



A food package has several functions, the basic functions being containment, protection, convenience and communication. Two important trends in the field of food packaging are the development of active and intelligent packaging. Active packaging can be used to increase the protection function of the package and intelligent packaging extends the communication function of a package. Intelligent and active packaging can help to maintain food quality, increase food safety, extend the shelf life of foods, and/or reduce food waste. Another important trend in the field of food packaging is the development of biobased and biodegradable packages. This trend is driven by trends as sustainability and the desire to reduce the waste from packaging materials.

Figure: Example of an intelligent packaging that monitors the freshness of meat (left) and an active packaging with an oxygen scavenger to extend the shelf life of these packed nuts (right). Within FQD, we are studying different disciplines of food



packaging. We aim to develop new, or improve existing packages, to improve the functions of the package in order to optimize food quality. Currently we have projects within the areas of intelligent packaging, active packaging and biobased packaging.

Project 8.1 Modelling TMA in packed fish

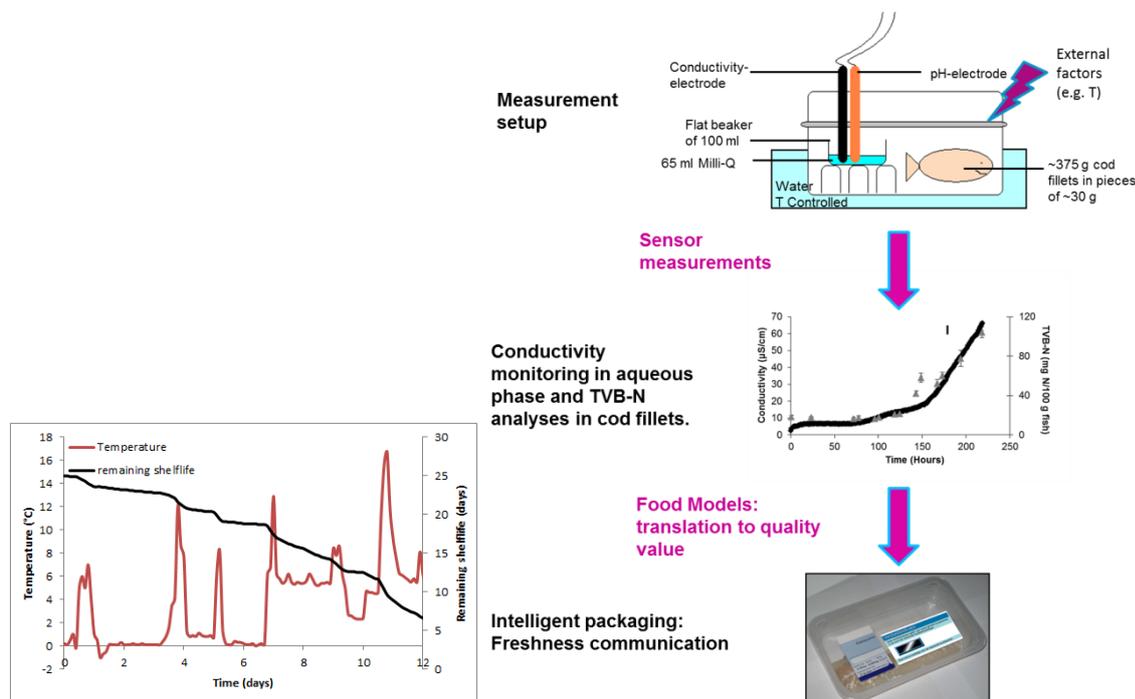
Target: BLT MFT

Supervisor

Jenneke Heising (Jenneke.Heising@wur.nl)



Freshness is the most important quality attribute of chilled stored cod fillets and the remaining shelf life can be estimated from the quality attribute TMA. TMA (trimethylamine) is a volatile compound that is produced by micro-organisms that grow on the fish and TMA is strongly correlated to the sensory rejection of fish. When the TMA is measured by a sensor on a package, one can make predictions of the remaining shelf life of this fish package.



Mathematical models have been developed for the formation of TMA. A dynamic model can be used to predict the TMA formation, but the model needs to be validated by measurements at dynamic temperatures, simulating a supply chain in which temperature fluctuations can occur.

At the same time we would like to monitor the changes in the aqueous phase in which electrodes are placed to see whether accurate predictions can be made from the sensor signal when the sensor is compared to freshness measurements in the fish.

Project 8.2 Develop an antimicrobial packaging using isothiocyanates

Target: BLT, MFT

Supervisors

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Matthijs Dekker (Matthijs.dekker@wur.nl)



Topic description

Antimicrobial packaging belong to the category of active packaging and currently many developments are taken place in this research field. Active packaging interacts with the product or the headspace in the food package. The aim of this interaction is to obtain desired conditions for a specific function or to optimize the quality of foods. Likewise, antimicrobial food packaging acts to reduce, inhibit or retard the growth of microorganisms that may be present in the packed food or packaging material itself.

Antimicrobial packaging can take several forms including:

1. Addition of sachets/pads containing volatile antimicrobial agents into packages.
2. Incorporation of volatile and non-volatile antimicrobial agents directly into polymers.
3. Coating or adsorbing antimicrobials onto polymer surfaces.
4. Immobilization of antimicrobials to polymers by ion or covalent linkages.
5. Use of polymers that are inherently antimicrobial.

In this research we will study the antimicrobial effects of isothiocyanates (ITCs) from glucosinolates. ITCs are breakdown products from glucosinolates, phytochemicals that are naturally present in brassica vegetables. In research it has been shown that glucosinolates and their breakdown products have antimicrobial effects. Therefore we would like to use these compounds to develop an antimicrobial package. We need to study the application of the ITCs on the package, so which form will give the best effects. Furthermore we need to study the release of the ICTs from to the headspace of the package and develop mathematical models for this.

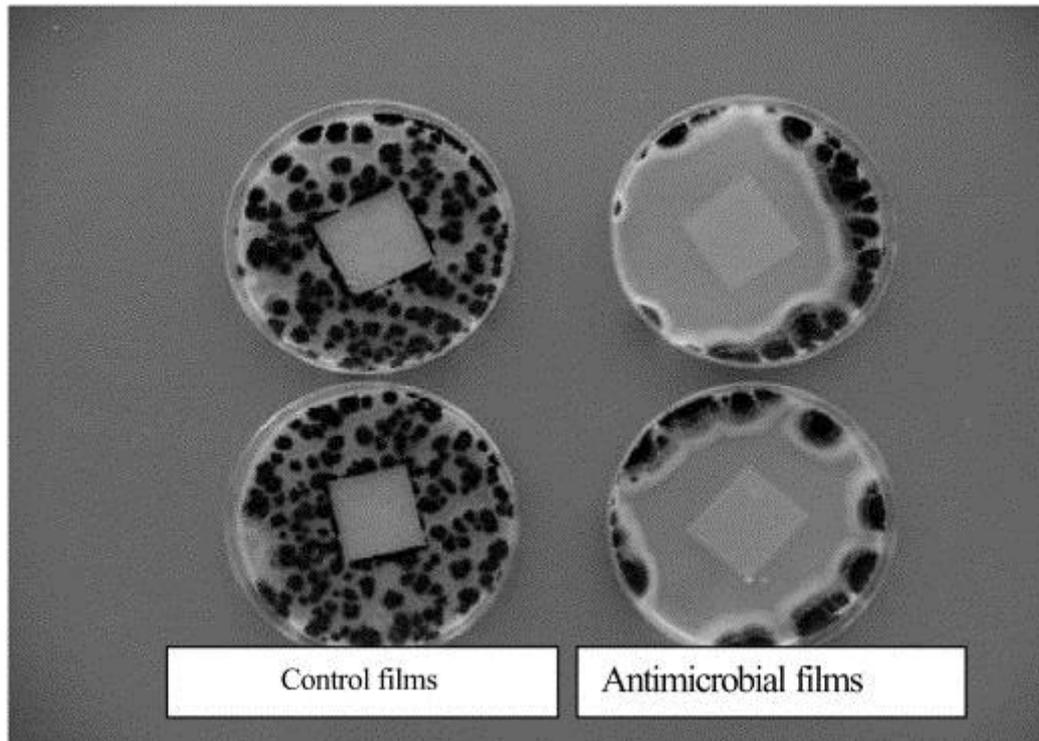


Figure: Example of the effect of an antimicrobial plastic film on *Aspergillus niger*. Agar diffusion method (from Appendini and Hotchkiss (2002) [http://dx.doi.org/10.1016/S1466-8564\(02\)00012-7](http://dx.doi.org/10.1016/S1466-8564(02)00012-7))

Research aim

The research aim is to study the antimicrobial effects of ITCs from glucosinolates and to develop models for the release of the antimicrobial compound from the package.

Research activities

The research activities in this topic consist of experimental work in the laboratory and mathematical modelling on the computer.

Project 8.3 Characterisation of a biobased and biodegradable package with graphene nano-particles

Target: BLT MFT

Supervisors

Jenneke Heising (Jenneke.Heising@wur.nl)

Matthijs Dekker (Matthijs.dekker@wur.nl)



Topic description

The increased use of synthetic polymers has led to several ecological problems. In the past years more and more attention is given to the environmental aspects of food packages. The development of biobased and biodegradable polymers for food packaging applications is therefore a popular trend in the research area of food packaging. Poly lactic acid (PLA) is a promising biobased and biodegradable polymer as food packaging material. In order to be a suitable packaging material, the package material needs to fulfil all important functions for a food package. Among other functions, the food package needs to protect the food from light, moisture, oxygen, microorganisms and other influences to prolong the shelf life of the packed food. Important packaging properties to consider in the development of a food package are the gas permeability and the moisture transmission rate of the material. But sometimes PLA can only be used for short shelf-life products because it provides a medium barrier to gasses and water vapour and it is too brittle.

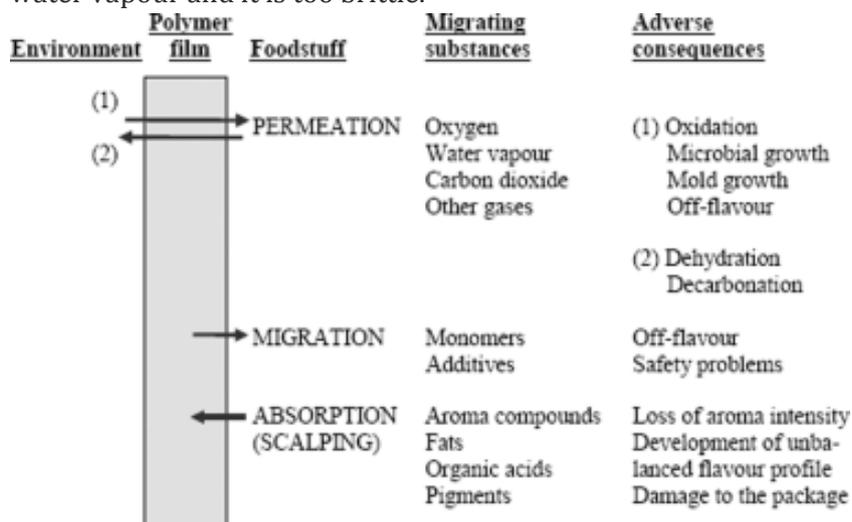


Figure: Possible interactions between foods, their package materials, and the environment, together with the adverse consequences from these interactions (Nielsen and Jägerstad, 1994).

In this research we are developing a PLA package that can be applied on foods. We are studying possibilities to improve the barrier functions of the PLA material. One approach is to apply novel graphene oxide (GO)-nanoparticles in the PLA film to improve the oxygen permeability. GO can improve the mechanical strength of the PLA film and reduce the oxygen permeability of GO. We study different ways to incorporate GO on the PLA film and study the effect on the quality of the foods. Furthermore we are looking to possibilities to use GO components to make an active packaging with antimicrobial properties.

Research aim

This research is in collaboration with NTU-Singapore that will provide us some PLA films with different graphene nanotech particle layers. Compare the properties (permeability, effect on shelf life) of some PLA films with different graphene nanoparticles and evaluate the results for the development of a suitable food package.

Research activities

The research activities in this topic consist of experimental work in the laboratory and mathematical modelling on the computer.

Research Theme 9 - Quality of fish and meat products

A PhD project entitled “The role of feed (ingredients) in the development of tailor made flavours in Pacific cupped oysters (*Crassostea gigas*) started in 2011. In the Netherlands two different species of oysters are cultured: the Pacific cupped oyster (*Crassostrea gigas*) and the native European flat oyster (*Ostrea edulis*). Nowadays there are 3 main areas in the Netherlands where oyster culture takes place. Shellfish farmers are nowadays expanding their horizon and are therefore more and more interested in land-based culturing of shellfish.

Meat lipids contain mainly saturated fats and fatty acids . From nutritional point of view, we aim to give meat products a “healthy image” by adding polyunsaturated fats, e.g fats which contain omega-3-fatty acids, such as flaxseed oil, canola oil or fish oil.

These fats contain linolenic acid and other long chain poly unsaturated fatty acids. Omega-3-fatty acids are considered as healthy, because they can prevent certain diseases, as coronary heart disease and some kinds of cancer. However, as these types of fats contain many unsaturated fatty acids they are susceptible to lipid oxidation, which may cause deterioration of the final product.

In this type of work fermented sausages are produced with ingredients, containing omega-3-fatty acids (flaxseed, canola, fish oils). De vegetable oils are pre-emulsified and encapsulated oils are directly added to the meat dough. Lipid oxidation is followed in time by measuring primary and secondary lipid oxidation products. Also some sensory evaluation can be part of the work.

Objective

- Differences between Pacific cupped oysters and European flat oysters
- Sensory properties and chemical composition of Pacific cupped oysters and European Flat oysters
- Influence of feed of the oysters on sensory properties and chemical composition
- Healthy image of fermented sausages.

Project 9.1: Volatile compounds in the Pacific cupped oysters (*Crassostrea gigas*)

Target: BLT MFT

Supervisor

Jasper van Houcke (jasper.vanhoucke@wur.nl)

Jozef Linssen (jozef.linssen@wur.nl)



Using on-land production facilities for oyster production offers several advantages in comparison with the 'normal' near-shore production in open water bodies. Besides a higher growth rate and therefore a shorter production time, more control over the diet of these oysters are an option.

Literature shows that the fatty acid profile of algae play an important role in the fatty acid profile of the oyster. Furthermore these fatty acids are known to be precursors for volatile compounds. Oxidation of different fatty acids lead to different volatile compounds with different odors. Thus, with varying the diets (algal species) of the oysters the odor profile of these oysters could be influenced.

The aim of this study is to compare the volatile compounds, to characterize the odor components in Pacific cupped oysters fed with different algae diets and to assess its relationship with the sensory quality of the product.

Experimental work (GC-MS) will be carried out at the facilities at Wageningen University with oyster samples cultivated in Vlissingen.

Project 9.2 Free Amino Acids and their role as taste compounds in the Pacific cupped oyster (*Crassostrea gigas*)

Target: BLT MFT

Supervisor

Jasper van Houcke (jasper.vanhoucke@wur.nl)

Jozef Linssen (jozef.linssen@wur.nl)



Using on-land production facilities for oyster production offers several advantages in comparison with the 'normal' near-shore production in open water bodies. Besides a higher growth rate and therefore a shorter production time, more control over the diet of these oysters are an option.

Free amino acids are known to have an influence on the taste of shellfish (including oysters). However the process of incorporating wanted free amino acids by means of diet adaptation are not yet known.

The aim of this study is to assess the influence of the free amino acids on the sensory (taste components) quality of the Pacific cupped oysters fed with different algae diets.

Experimental work (HPLC) will be carried out at the facilities at Wageningen University with oyster samples cultivated in Vlissingen.

Research theme 10 – Food Design in transition countries

Introduction

This research theme focuses on the design of improved food products for people living in transition countries, with a special emphasis on sub-Saharan Africa. In these countries large groups of the population do not have access to the foods they need to meet their daily requirements of macro- and micronutrients, for instance essential amino acids, iron, zinc and vitamins like vitamin A. Based on an assessment of consumer demands, wishes and preferences we study the production chains of locally produced foods and seek technological options to improve food quality in the local setting.



Project 10.1 Effects of the biocolorants extracted from dye sorghum leaf sheaths on the antioxidant capacity and *in vitro* solubility of iron and zinc in infant fermented starchy food.

Target : BLT MFT

Supervisor

Ir. Folachodé Akogou (folachode.akogou@wur.nl)

Dr. Ir. A.R. Linnemann (anita.linnemann@wur.nl)



Koko is a thick fermented porridge usually obtained from *ogi*, a fermented cereal slurry (Nago *et al.*, 1998). Sorghum, maize and millet are the common cereal used in the processing of *koko* in West Africa (Kayodé *et al.*, 2005; Lartey *et al.*, 1999; Lei and Jakobsen, 2004). The colour of *koko* comes from the cereal used in the processing. *Koko* obtained from red sorghum grains is characterised by its red colour (Kayodé *et al.*, 2005). To meet consumer preference even when sorghum is not accessible, processors use maize and dye sorghum leaf sheaths as ingredients. Dye sorghum is a specific variety of sorghum grown exclusively for the red dye extracted from its leaf sheaths. Dye sorghum leaf sheaths is a rich source of phenolic compounds and thus a source of bioactive compounds. Due to its richness in phenolic compounds, the use of dye sorghum leaf sheaths in infant foods like *koko* could also decrease the bioavailability of micronutrients such as iron and zinc.



Fig.1: Maize and dye sorghum leaf sheaths before grinding



Fig.2: Fermented dyed starchy sediment



Fig.3: Dyed maize-based *koko*

Objective

The objective is to evaluate the effect of watery extract of dye sorghum leaf sheaths on antioxidant capacity and the *in vitro* solubility of iron and zinc in *koko*.

Project 10.2 Managing the hard-to-cook (HTC) phenomenon in bambara groundnut processing for resource limited communities in Zimbabwe

Target: BLT MFT

Supervisors:

Juliet Mubaiwa (MSc) (juliet.mubaiwa@wur.nl)

Dr. Ir. Anita Linnemann (anita.linnemann@wur.nl)



Bambara groundnuts are grown, harvested, and then stored under sub-tropical conditions that accelerate the development of HTC phenomenon. Cooking time of HTC legumes can be reduced by the use of different salt solutions and cell wall degrading enzymes. Salts are hypothesized to have an effect on denaturation temperature of proteins, pectin solubilisation and gelatinization temperature of starch. Salts have also been reported to affect the digestibility of starch and proteins. The aim of the study is to assess the effect of alkaline salts and cell wall degrading enzymes on nutrient solubilisation, protein denaturation and starch gelatinization leading to reduction in cooking time. In addition the effect of salts and cell wall degrading enzymes on bio-accessibility of nutrients will be assessed.

MSc Topic: Preferred Target student (FQM)

- 1. Effect of alkaline salts and cell wall degrading enzymes on nutrient solubilisation, protein denaturation and starch gelatinization in bambara groundnut cooking.**

BSc Topic: Preferred Target student (FQM)

- 2. Effect of alkaline salts and cell wall degrading enzymes on bio-accessibility of nutrients in bambara groundnut processing.**

Project 10.3 Monkey orange processing

Target: MFT

Supervisors:

Ruth Ngadze (ruth.ngadze@wur.nl)



Monkey orange (*Strychnos* sp.) fruits are well appreciated and consumed in Southern Africa due to their nutritional value (vitamin C, zinc and iron) and taste. The dried MO have a shelf life between two months to five years. Therefore, the optimization of drying processes using locally available resources and its impact on nutritional and sensorial quality of MO fruits warrants further investigation.



Figure 1. *S.cocculoides* fruit and pulp



Figure 2. *S. innocua* fruit and pulp

Topic 1. Evaluation of osmotic dehydration on MO

Osmotic agents limited to sucrose and sodium chloride are readily available cheap materials affordable to the local communities. Osmotic dehydration preserves product texture, decreases water and enzymatic activity thus reducing enzymatic browning and retaining product colour, leaching of small amounts of product-soluble compounds, minerals and vitamins. Thus the effect of osmotic dehydration in MO can be studied with the aim to: (i) assess the effect of osmotic dehydration on sensorial quality, namely texture and colour, and (ii) assess the impact of osmotic dehydration on nutritional quality, namely vitamin C and flavonoid content of monkey oranges.

Topic 2. Evaluation of hot air drying on MO

Thermal drying can result in an extremely hard, off-flavour product and nutrients sensible to heat, light, and oxygen are degraded. In other studies dried fruits contained rich and shelf stable dietary polyphenolics and anti-oxidants, explained by concentration of polyphenolic compounds during drying. Contradictory results of literature show high and low anti-oxidant activity, thus studies need to be performed to evaluate the effect of drying MO on nutritional quality and sensory characteristics. Further studies aim to: (i) assess the effect of hot-air drying of monkey orange on colour and texture and (ii) assess the effect of hot-air drying on nutritional quality, namely vitamin C and flavonoid content of monkey orange.

Topic 3. Osmotic dehydration as a pre-treatment

Osmotic dehydration as a pre-treatment to hot air drying reduces the drying time and temperature, thereby improving product sensory appeal, nutritional quality and shelf life. This research topic will therefore combine osmotic dehydration followed by hot air drying, where the drying characteristics and constants will be determined, moisture ratio compared to drying time at different temperatures will be utilized for the development of a drying curve. The aim is therefore to assess the impact of osmotic dehydration followed by hot air drying on nutritional and sensorial quality of monkey orange fruits from different varieties (*S. cocculoides* and *S. innocua*).

Research theme 11 - Effectiveness and Dynamics of Quality Management Systems

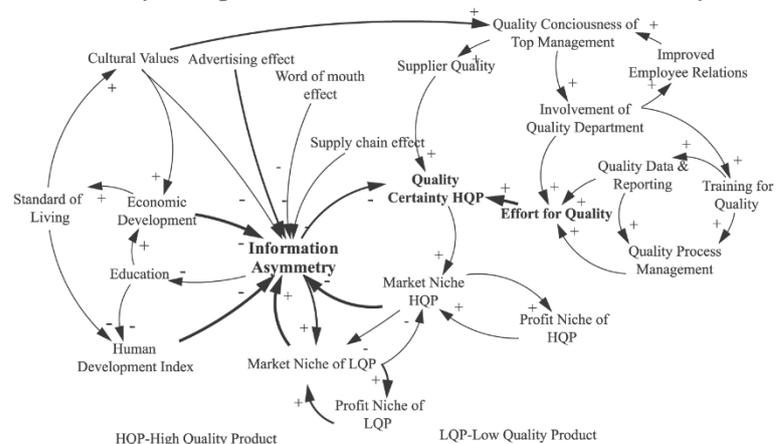
Introduction

Globalisation of trade, changes in consumption and food preparation behaviour, food security, fair trade, safety concerns, health trends, climate changes.....just to mention a few issues in society that impact food quality management in agribusiness and food industry. These pressures increased the need to design, control, improve, and assure production and preparation of healthy and palatable food that is safe, and is produced in a sustainable way.

In anticipation to these pressures from society, agribusiness and food industry have put much effort in designing and upgrading their quality/safety management systems based on a wide range of quality assurance standards (like HACCP, BRC, SQF, GLOBAL GAP, ISO22000). However, the recent food scandals and emerging food safety issues worldwide indicate that a deeper understanding of the (context) factors influencing the effectiveness of these systems is needed. In the last few years, various diagnostic tools have been developed to systematically affect the core control and assurance activities in view of the riskiness of the context wherein the systems have to operate. However, the relation between context characteristics and quality system performance and quality output is still under study. Moreover, these diagnostic tools enable an overall assessment of the current system performance in their context, but do not yet



take into account the dynamics in the system, i.e. dynamics of the food production systems and management systems. System dynamics is a research area well-known in logistics and computer science but scarcely applied in the area of food quality management. It requires a deeper understanding of the cause-effect relationships between the people operating in the system and the food production system itself.



Overall objectives

include understanding of the relationships between context characteristics and quality system (or specific parts) performance and food quality/safety, analysing influence of safety/quality (organisational) culture on variable decision-making behaviour and food quality, modelling dynamics in quality management systems and the impact on food quality.

Research Theme 12 - Quality Design: from Product to Chain Design

Introduction

Quality design focuses on relevant technological and managerial aspects that should be considered to achieve quality in developing food products, in developing food process designs, and in developing food chain designs. Quality design is very important for companies in agribusiness and food industry to remain competitive. Incorporation of quality design into the development of food products deals with, for instance, incorporation of the voice of the consumers. Whereas incorporation of quality design into the development of food processes deals with, for instance, incorporation of process variables determining optimal food quality. Similarly, incorporation of quality design into the food chains deals with incorporation of critical chain aspects, for instance, trustful customer-buyer relationships determining optimal food quality.

Objectives

The objective of research theme 3 is to find out critical quality points in developing new food products, in developing new food process designs, and in new food chain designs to establish an optimal food quality that helps companies in remaining competitive.

Research Theme 13 - Causes and consequences of milk variability

Introduction

One of the main task of dairy research is to improve milk quality by breeding strategies. To reach this aim an accurate description is needed of the desired milk composition to improve product properties. In this research theme proteins and lipid milk components will be considered in this respect.

Large variation exists in casein micelle composition due to difference in genetic variants, post-translational modifications and interaction with the milk environment. Although statistical relations have been found between variation in genetic variants, protein composition and product properties, knowledge of the underlying mechanism is missing. It is necessary to understand how product properties such as rennet coagulation time or heat stability of milk are influenced by milk composition.



Milk fat with different physical profiles and various stereochemistry structures are needed in the dairy industry in order to develop functional products. These different profiles could be obtained in a natural way by selective breeding and feeding.

Objectives

To elucidate the relation between milk composition and its properties

- How are major milk components synthesized,
- How does this influence the characteristics of milk and dairy products?

Project 13.1 Foaming behaviour of milk proteins.

Target: MFT

Supervisors

Min Chen (Min.Chen@wur.nl)

Hein van Valenberg (Hein.vanValenberg@wur.nl)

Guido Sala, Food Physics) (Guido.Sala@wur.nl)

Introduction

Foams are unstable and suffer from creaming, drainage, aggregation coalescence, and disproportionation. The role of surface and bulk components in multicomponent food systems on the formation and stability of foams is still not well understood. For example, it often happens that a certain batch of milk does not properly foam, while others do, even if they are processed in the same way. It is still unclear what causes this and how this must be solved.

Project description

Various studies have been performed on the formation and stability of dairy foams. The foamability of milk is strongly influenced by components that are naturally present in milk as well as by the production methods. The components that are naturally present in milk can influence the foamability and stability both positively and negatively. Frothed milk is mainly stabilized by the proteins at the air/liquid interface. It is known that β -casein is a good foam stabilizer. The presence of this protein in soluble form in milk will therefore have a beneficial effect on the foam formation. Fat and free fatty acids have a destabilizing effect because they are able to displace the proteins from the interface. The presence of soluble β -casein and free fatty acids in milk is dependent on factors related to the physiology of the cow, nutritional, and technological operations after milking. The cooling of the milk for example, results in increased solubility of β -casein. The pressure applied in the homogenization further affects the size of the fat globules. This parameter also has an effect on the foaming behavior of milk. Therefore, thermal history and homogenisation conditions are two important technological parameters that influence the foaming properties of milk.

Aim

Within this project we hope to increase the insights in the formation and stability of dairy foams and to find the key ingredient and process parameters that control it. This will allow industry to improve the production of milk and dairy aerated products of constant high quality.

Project 13.2 Growth of yoghurt bacteria in milk with different genetic variants.

Target: MFT

Supervisors

Elsa Antunes Fernandes. (elsa.antunesfernandes@wur.nl)

Hein van Valenberg (Hein.vanValenberg@wur.nl)

Introduction

κ -Casein has different genetic variants which are AA, AB, BB, AE. These phenotypes results in differences in degree of glycosylation of κ -casein. The AA phenotype is less glycosylated than the BB variant. The most predominantly found glycosylate is sialic acid (also called N-acetyl Neuraminic). Sialic acid is negatively charged and will therefore cause steric, hydrophilic and electrostatic interaction. Differences in growth rate and the formation of metabolites may also be caused by differences in the genetic variants of β -lactoglobulin.

Project description

Yoghurt will be prepared from milk samples with different genetic variants of κ casein or β -lactoglobulin. Normal yoghurt starter bacteria, consisting of *Str. thermophiles* and *Lb. bulgaricus*, will be used. Yoghurts can also be made using probiotic bacteria in combination with the *Str. thermophiles* and *Lb. bulgaricus*. The break-down of caseins will be studied, and the formation of lactic acids, volatiles and other metabolites.

Aim

Define the relationship of the differences between genetic variant of caseins and β -lactoglobulin on the properties of yoghurt

Project 13.3 Physical-chemical characteristics of genetic variants of milk proteins.

Target: MFT

Supervisors:

Hein van Valenberg (Hein.vanValenberg@wur.nl)

Introduction

This research will focus on the influence of genetic variants of milk proteins.

In the Milk Genomics Project relations have been studied between concentrations of genetic variants in milk and a start has been made with studying the characteristics of different genetic variants. This project is a continuation of the Milk Genomics project and consists of many projects can be done by MSc thesis students. Projects are often in collaboration with NIZO, the Animal Breeding and Genetics Group of WUR and Food Physics.

Project description

Project have been defined on the following topics.

- The influence of different genetic variants of β -kactoglobulin on the activity of endogenous milk enzymes such as plasmin and lipase.
- The formation of aggregates upon heating in samples with different genetic variants of β -lactoglobulin and κ -casein at different pH values.
- The size of casein micelles with the variant B of κ -casein is on average smaller than micelles with the A variant. This may influence the concentrations of caseins and calcium in the milk serum
- Heat stability may differ between milks with different genetic variants.
- Differences in break-down products after hydrolysis of different genetic protein variants after incubation with plasmin, pepsine or chymosin,
- The effect genetic variants on the viscosity after concentration of milk
- Other projects can easily be defined.

All experiments are done with milk samples of individual cows.

Aim

Determination Physical-chemical characteristics of genetic variants of milk proteins

Project 13.4 Influence of fatty acid composition and stereochemistry of triacylglycerols on physical properties of milk fat.

Target: MFT

Supervisors

Daylan.Tzompa (Daylan,Tzompa@wur.nl)

Hein van Valenberg (Hein.vanValenberg@wur.nl)

Introduction

Selective breeding and feeding can make a significant contribution in increasing the unsaturated fraction. It has been reported that a change in the fatty acid composition leads to a change in the physical properties (polymorphic transitions and melting behavior) of milk fat; from these reports, it can be expected that fatty acid modifications will lead to a rearrangement of the TAG molecule which will also influence the physical properties of milk fat. A shift in the stereochemistry of TAGs may also have an effect in the digestion and absorption of fatty acids, especially in new born babies.

Project description

Bovine MF is considered one of the most complex naturally occurring fats. It contains around 400 different individual FAs that can differ on length (C4-C22), level of saturation and type of double bond (cis or trans). Just 12 of them are present in amounts higher than 1 mol%, consequently they are depicted as major FA. If only the 12 major FA are taken into account, the possible FA arrangements in the TAG is 1728. Physical and chemical properties of the fat vary with the presence and arrangement of FAs in the TAG; crystallization and melting point of MF are two properties affected by the variations in TAG molecule. During crystallization, the variation in the configuration of the TAG affects the chain packing of the individual molecules, therefore the polymorphic behaviour. Crystallization affects the consistency of high-fat milk products; it influences the occurrence and rate of partial coalescence in oil-in-water emulsions, as a result churning and whipping processes also alter; crystallization also affects the mouth feel of butter-like products. Therefore, crystallization is an important characteristic in dairy technology.

Aim

The objective will be to find the causes of variation of the sn-position within the TAG molecule and the effect in the crystallization; this conclusion could be reached by analyzing MF with diverse profiles. With this knowledge, bovine MF could be modified for different needs, for instance as a source for infant formulas.

Project 13.5 The influence of shortening the dry period on processing characteristics of milk

Target: MFT

Supervisors:

Kasper Hettinga (Kasper.hettinga@wur.nl)

Ruben de Vries (ruben2.devries@wur.nl)



Introduction

Dairy cows are commonly subjected to a dry period –a period without milking the cow- of approximately 8 weeks between two lactations. This dry period length results in a high milk production in the next lactation. A shorter dry period results in a lower peak production, which is beneficial for the health status of the cow. The project focuses on the influence of a shortened dry period on composition and processing quality of the milk. Obtaining high quality milk is a prerequisite for applying a shorter dry period. Besides that, changes in milk composition can help explaining the health status of the cow.

Project description

Variations in casein composition result in different processing characteristics of milk. Previous results indicate that casein composition changes in late lactation when the dry period is shortened. It is not known how these changes influence properties of casein micelles, how they are related to other components in milk, and eventually to the processability of milk. Processes that are of interest when casein composition changes are renneting (cheese making), acid gelation and heat treatment. Techniques that can be used in this project for characterisation of the milk are a.o. RP-HPLC and casein micelle size measurements. Product characteristics can be analysed with texture analysis or rheology measurements.

Aim

Evaluate the influence of shortening the dry period of the cow on processing characteristics of milk.

Project 13.6 Changes of salt composition of late lactation milk in continuously milked cows.

Target: BLT

Supervisors:

Kasper Hettinga (Kasper.hettinga@wur.nl)

Ruben de Vries (ruben2.devries@wur.nl)



Introduction

Commonly, a period without milking the cow ('dry period') of 60 days is applied to dairy cows prior to calving. Omitting this dry period ('continuous milking') is hypothesised to be beneficial for cow health. This means that milk is obtained during the last 60 days before calving, which is normally not the case.

Project description

Processing properties of late lactation milk of continuously milked cows have not been studied before. From previous work it is known that protein contents increase and lactose contents decrease during the last weeks of lactation when no dry period is applied. Salt concentrations have not been studied in this milk. These may change in very late lactation due to e.g. changes in milk yields and mammary cell structures. Changes in salt concentrations may influence processability of milk, and therefore are important to consider before continuous milking can be applied.

Aim

Analyse salt composition of milk samples of continuously milked cows at different time points in late lactation.

Research Theme 14- Interaction between milk composition and bacterial growth

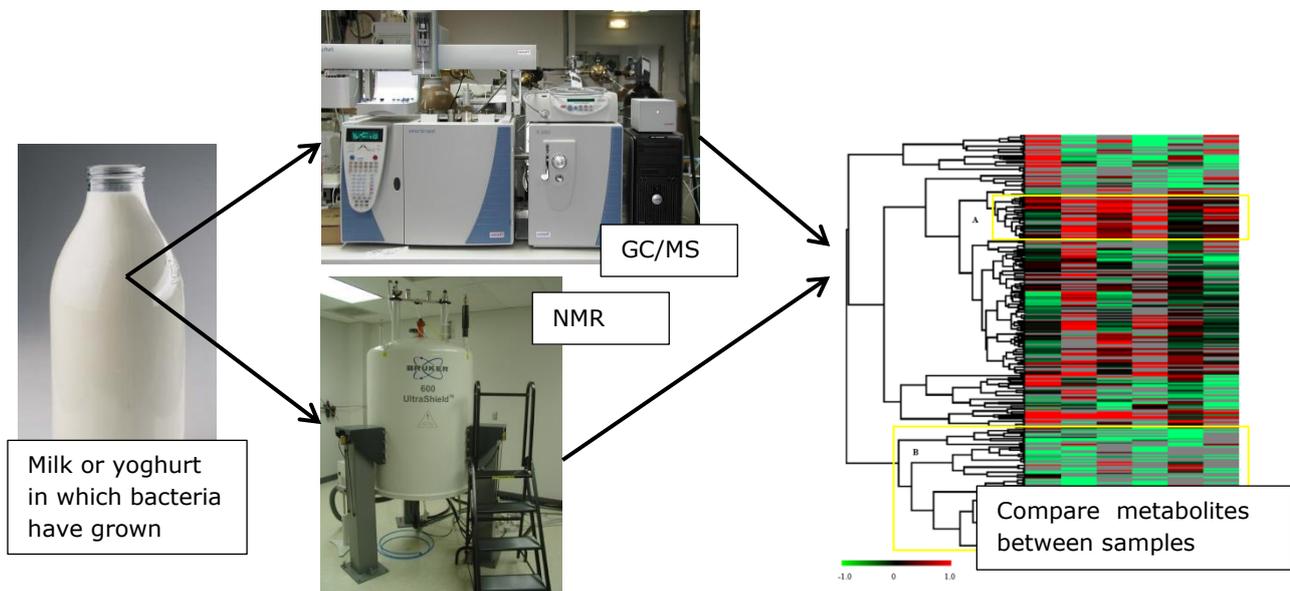
Introduction

Yoghurt quality is determined by a wide range of factors such as composition and pre-treatments of base milk, strains of starter cultures used, fermentation process and storage conditions. Proto-cooperative growth of starter cultures, *S. thermophilus* and *L. delbrueckii* subsp. *bulgaricus*, has been well recognized for the production of traditional type of yoghurt. Also other bacteria may be present in milk (both wanted and unwanted). The growth of all these bacteria results in changes in milk composition, which we characterize by the metabolites produced by these bacteria.

Objective

The main research question is: "Growth of bacteria in milk and yoghurt: what is the influence of milk composition and proto-cooperation on growth and survival of bacteria?" (joint projects with Food Microbiology)

- To study the interactions between yoghurt starter culture and probiotics
- Identification of bacteria by analyzing the metabolites produced by them



Project 14.1 Faster identification of bacteria in milk by using headspace-GC/MS

Target: BLT MFT

Supervisor

Kasper Hettinga (Kasper.hettinga@wur.nl)



Introduction

Mastitis is an inflammation of the mammary gland. Although mastitis can have different origins, it is most often associated with bacterial infections. Mastitis is the most costly disease of dairy cows. In The Netherlands, the average costs of a clinical mastitis case are estimated between €168 and €277 depending mainly on stage of lactation (Hogeveen, 2005). A range of more than 140 microorganisms may cause mastitis in cows. However, a limited group of 5 bacteria (*Staphylococcus aureus*, coagulase-negative staphylococci, *Streptococcus uberis*, *Streptococcus dysgalactiae*, and *Escherichia coli*) is responsible for approximately 80% of the Dutch mastitis cases in which bacteria could be cultured from the milk (Barkema et al., 1998; Sampimon et al., 2008).

Milk from cows with mastitis is often analyzed using bacteriological culturing to detect the pathogens causing the mastitis. Determination of mastitis causing pathogens is of great interest, both for choice of treatment of the cow as well as for possible measures that have to be taken on the farm to prevent the spread of mastitis. Bacteriological culturing, however, has the disadvantage of being time-consuming. A faster and more accurate method of pathogen identification is thus advantageous, because farmers are earlier able to choose an optimal treatment at the cow and the herd level.

Within the Dairy Science and Technology research group within the Food Quality and Design chair, several approaches for better identification of mastitis pathogens are tested, mainly using advanced GC/MS- or NMR-based metabolomic approaches. These methods may facilitate faster diagnosis of cows with mastitis, which should lead to more optimized antibiotic treatments of these cows, and in the end also the reduction of antibiotics use.

Aims

Several research questions may be suitable for thesis students within the above described framework:

- What is the effect of the presence of multiple pathogens in one sample on fast diagnostic methods?
- Can we add components to increase the rate of metabolite formation to further speed up the method?
- Potential to detect other (non-mastitis related) bacteria in milk with the previously developed methods?

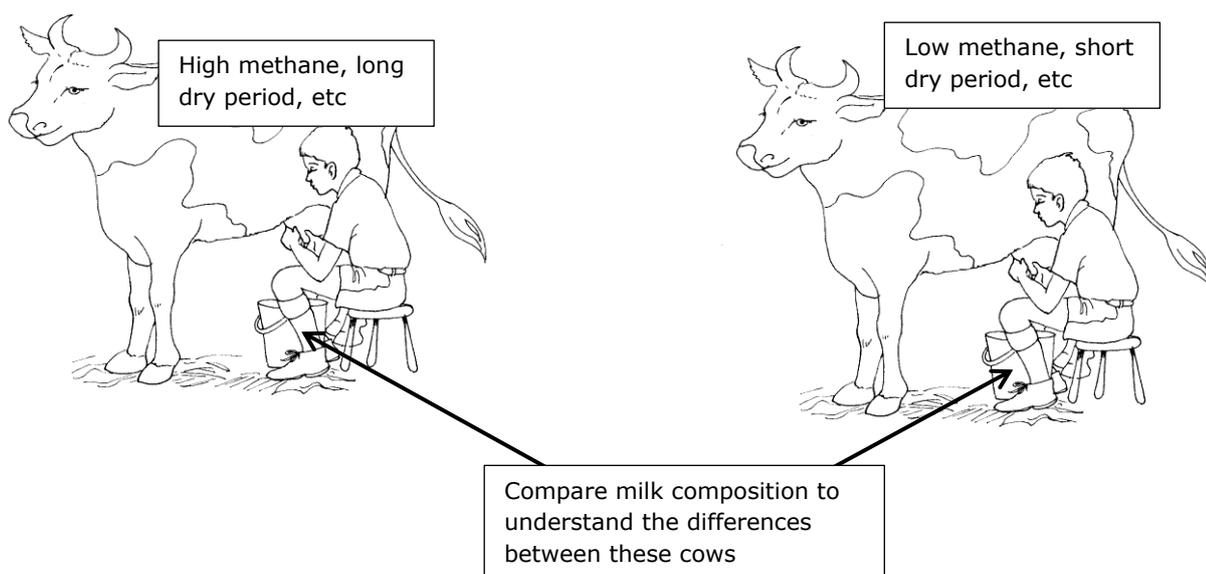
Research Theme 15 - Interaction between milk composition and dairy chain sustainability

Our research on dairy chain sustainability focuses on milk composition in relation to the sustainability aspects of the dairy chain. Dairy's position in the nutrient security debate depends on the environmental impact of the sector. Land use and greenhouse gas emissions are decisive factors in this respect and are related to the productivity of the cow. Robust, high productive cows, are needed to fulfill the growing demand and to mitigate environmental impact. Farm-based intervention in this area to optimize milk production are of high interest. However, the effect of these interventions on the composition and quality of milk is unknown. On the other hand, milk composition, may also reflect the physiological status of the cow, both with regard to health, feed conversion efficiencies and environmental emissions. We therefore aim at establishing the effect of on-farm sustainability interventions on milk composition, and finding markers for resistance of dairy cows, productivity and GHG emissions, thus, contributing to mitigating environmental impact.

The main research question is: "How can milk composition be used to improve the sustainability of the dairy production system?".

The objectives:

- To investigate the influence of a shortened dry period on composition of high and low abundant proteins in milk, and on quality aspects of milk
- Find a methane indicator in milk based on rumen fermentation metabolites or derivatives that are transferred to the milk



Project 15.1: Towards a more sustainable dairy production: Monitor, reduction and understanding of methane emission by dairy cows

Target: MFT

Supervisor

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Greenhouse gas emission, by dairy cows is of great concern. For the sustainability of dairy production in The Netherlands it is of important to reduce the emission of greenhouse gas, in particular the emission of methane, and thereby reduce the ecological footprint of milk production. The largest part of the methane is produced by the microbiota in the rumen of the cow. In the rumen of a cow, low quality feeds are fermented by microorganisms in an anaerobic environment. The end products of the microbial fermentation are short chain fatty acids (SCFAs), microbial biomass and the gasses carbon dioxide and methane (Krause et al.). The rumen metabolism responsible for the SCFAs in turn is linked to methane formation via the hydrogen potential in the rumen. Depending on the metabolic pathways in the rumen the formation of hydrogen and consequently the generation of methane will differ. Further, the odd numbered fatty acids (C15:0 and C17:0) in milk are indicative of starch- and sugarmetabolizing bacteria whereas branched fatty acids are indicative of cell wall polymer degrading bacteria. Also, SCF are precursors for de novo fatty acid synthesis of milk fatty acids (FA) in the mammary gland. Thus relationships between milk FA and methane formation have been proposed.

Objectives:

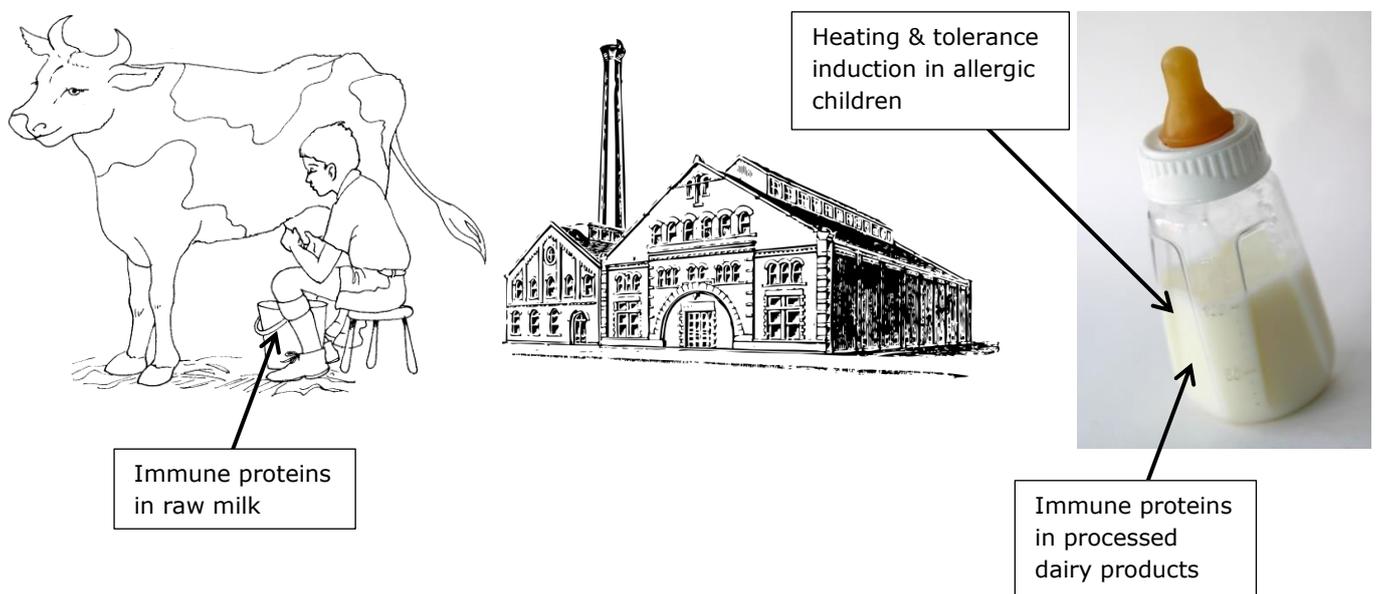
We aim at a better characterization of the rumen and milk composition (metabolome) in relation to methane emission, by using several cutting edge tecniques such as GC-MS and proton NMR. Several questions can be used in a thesis topic:

- What is the fermentation profile of the rumen thought out the time? And how can this be related to the feeding and/or genetics of the cow?
- What are the most important milk components related to methane emission?
- A previous analysis of the relationship between methane and milk fatty acid profile, has provided clear information on the potential to use fatty acids as an indicator of methane. Is it possible to increase the robustness and reliability of the indicator by using other milk components than fatty acids (e.g. volatile and soluble components)

Research Theme 16 - Milk proteome and human health

Introduction

The relation between milk components and human health is very complex. Milk not only provides nutrients, but is also important for protection and regulation. The challenge is to better understand which milk components are responsible for these effects, and the biological mechanisms underlying these effects. Two areas where we focus on are 1) the protective effect of milk proteins for the newborn, and 2) the effect of processing on composition and function of milk proteins. In the end, this should lead to new knowledge that can be used to improve infant formula.



Objectives

The main research question of this theme is: “What are the implications of the differences in the milk proteins between human and bovine milk?”

The objectives are:

- Understanding the variability in immune related proteins in milk
- Determining the effect of processing on the denaturation of immune related proteins in milk
- To investigate the influence of compounds that have been produced in intensively heated milk on the development of immune tolerance.

Projects 16.1 Transport efficiency of intensely heated antigens in the intestine

Target: BLT MFT

Supervisor

Fahui Liu (fahui.liu@wur.nl)

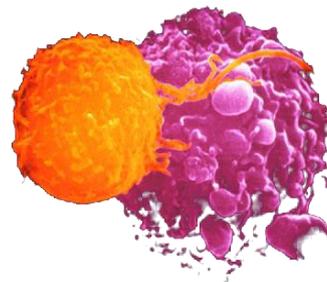


Introduction

Food allergy is an adverse health effect arising from a specific immune response. It occurs reproducibly on exposure to a given food. The prevalence of food allergy is more than 1-2% but less than 10% of the population. Cow's milk is one of the leading causes of food allergy especially in infants. However, most studies have shown the prognosis of developing immune tolerance to cow's milk to be good, with the majority outgrowing their allergy by the age of 3 years. It was reported that intensely heated (baked) milk products contribute to the development of immune tolerance to cow's milk allergens. Also the process of outgrowing CMA can be accelerated by adding intensely heated milk into patients' diets. The mechanism behind this observation and the effective compounds in heated milk that contribute to immune tolerance are largely unknown.



Intensely heated milk allergens



Tolerance to milk allergens

Short description

Heat treatment of β -lactoglobulin (BLG) in dry station resulting in aggregation of the protein. As a result, the uptake of protein allergens in intestine will be affected. This project will compare the *in vivo* transcytosis efficiency between heated and unheated samples. Different groups of samples will be labelled with FITC. Caco-2 cells will grow in lab and be incubated with labelled protein samples. Then the transcytosed proteins will be quantified.

Aim

Compare transcytosis efficiency between heated and unheated samples using Caco-2 cells.

Projects 16.2 Impact of intense dry heat treatment on the antigenicity of β -lactoglobulin (BLG);

Target: BLT MFT

Supervisor

Fahui Liu (fahui.liu@wur.nl)



Short description

The structures of BLG will be changed during dry heat treatment. Consequently, the conformational structures and epitopes of BLG will be changed. On the other hand, some of the epitopes initially hidden inside the global structure of BLG may become exposed and could be more easily approached by antibody. The effects of heat treatment on antigens vary in different allergens. This project will measure the antigenicity of heated and unheated samples using ELISA method.

Aim

Study the influence of dry heat treatment on the antigenicity of BLG.

Research Theme 17 - Immune proteins in human milk and bovine milk

Introduction

Milk is the most important food for the growth and development of the neonate because of its unique nutrient composition combined with the presence of many bioactive proteins. One of the most interesting components, the immune proteins, plays a pivotal role not only in protecting the gut mucosa against pathogens and achieving many beneficial outcomes for the immunity status of the neonate but also in the protection of mammary gland.

Although breast milk has been considered as the best food for the neonate, still a lot of babies are feeding with infant formula because of the unavailability of breast milk. Infants who were exclusively breastfed for 6 months presented lower morbidity from gastrointestinal and allergic diseases. This may be related to differences in immune proteins between human milk and infant formula. The variation in immune proteins is expected to be large, both within and between human milk and infant formula. The problem is, however, that both the extent and causes of this variation are largely unknown. Possible causes of this variation are the lactation stage, individuals and species difference. Detailed determination of the dynamics in immune proteins in human and bovine milk may help in understanding the significance and characteristic of immune proteins. This study not only contributes to our understanding of the role of immune proteins for cow and human healthy but also provides guidance on how to develop infant formulas more similar in protein composition to human milk.

Objective :

- Study the profile of the immune protein of human and bovine milk over lactation
- The effect of mammary gland inflammation on immune proteome in bovine milk
- The difference in immune proteome among individual cows and individual human
- The difference in immune proteome between species (human and bovine)

Method

1. Milk serum separation using centrifuge and ultracentrifuge
2. Filter aided sample preparation (FASP) to digest proteins into peptides
3. Dimethyl labeling for the quantification analysis
4. LC-MS/MS and Maxquant to get the identified proteome and their relative concentration

Project 17.1 The variation of immune proteins in human milk (preterm and term mothers) over 6 months lactation stage

Target: BLT MFT

Supervisor

Lina Zhang (lina.zhang@wur.nl)



Breast milk has been considered as the best food for the neonate. The WHO advises mothers to exclusively breastfeed the newborn up to 6 months of age because of the related lower morbidity and mortality. However, in certain circumstances such as prematurity, own mother's milk is not directly available. Currently breast milk is being collected by human milk bank from lactating mothers with the aim to feed another woman's babies to reduce child mortality. Breast milk may be especially important for preterm babies because of deficiencies in innate immunity associated with prematurity. However, a certain number of preterm milk have different expression levels from term milk. Higher levels of specific immunologic factors (IgA) in preterm milk has been found to protect vulnerable preterm infants. Besides, the milk from donated mother who has been breastfeeding for weeks or months doesn't perfectly match with the nutrition needs of a premature new-born. Some proteins of breast milk have been reported to express higher level in early lactation than in late lactation; while other proteins show higher abundance after 6 months lactation.

Aim

To determine the variability of the breast milk immune proteome over lactation stage from both preterm mothers and term mothers



Term

Preterm

Project 17.2 The differences of immune proteins among individual mothers

Target: BLT MFT

Supervisor

Lina Zhang (lina.zhang@wur.nl)



Breast milk is one of the richest foods, as it provides all the nutrients required for the survival of newborns. Its function has always been tied to the provision of nutrients to the offspring. However, in certain circumstances such as prematurity, own mother's milk is not (directly) available. Therefore, it would be beneficial to have another form of nutrition that has been adapted to best suit the needs of the newborn. Donor milk may be much better than infant formula based on bovine milk because of the benefits of immune proteins in breast milk which might not be present in bovine milk. Despite protein concentrations varied based on the infant's nutritional needs, they can also differ between individual mothers due to their genetic background, age, lactation number and nutrition. The in-depth study of individual difference may contribute our knowledge on the variations of human milk and thus provide guidance on the improvement of infant formula.

Aim:

Study the variation of breast milk proteome especially for immune proteome among individual mothers.



Breast milk



Infant formula