

BSc and MSc thesis booklet

Food Quality and Design
2024 - 2025



WAGENINGEN
UNIVERSITY & RESEARCH

BACHELOR - MASTER FOOD TECHNOLOGY

Important preamble please read carefully!

This booklet contains all the thesis topics available at the department of Food Quality & Design (FQD). For each thesis topic, you can find the following information: BSc/MSc topic, required MFT/MFQ specialisation, indicated prerequisite courses, supervisor name(s), and content. Most thesis topics are part of ongoing research projects, they will be adapted and defined in detail when you will start writing your research proposal.

Each thesis topic has place for one student. Some thesis topics may accept two students. In rare cases, more than two students can be allocated to a thesis topic. The number of student places per thesis topic is flexible and depends on the number of student applications and supervisor availability.

The type of supervisor differs between supervisors. There is one general rule: a topic proposed by a PhD or a postdoc will have closer daily supervision than a topic that is directly supervised by staff members. Working on a PhD topic means that you have less freedom to decide the direction of your thesis. If you prefer to work more independently, do not be afraid to choose a topic supervised by the staff.

Table of Contents

GENERAL INTRODUCTION TO FOOD QUALITY AND DESIGN GROUP.....	4
RESEARCH THEME 1 - FOOD DESIGN.....	5
RESEARCH THEME 2 - FOOD DIGESTION AND HEALTH	26
RESEARCH THEME 3 - QUALITY ALONG THE CHAIN.....	51
RESEARCH THEME 4 - CONSUMER & FOOD QUALITY MANAGEMENT	65
RESEARCH THEME 5 - DAIRY SCIENCE AND TECHNOLOGY.....	72

GENERAL INTRODUCTION TO FOOD QUALITY AND DESIGN GROUP

Take a look at the thesis topics we offer and join the FQD group! If you are interested in a food science full immersion, FQD is the right place for you. As a food technology student, you have already learned a lot about the chemical, physical, microbial, and technological properties of food. That knowledge is essential to go into the design of new foods and ingredients. In many of the FQD thesis topics, you should be able to integrate and connect your knowledge from various disciplines. The perception of food quality is the result of the interaction between foods and humans. In some of our projects, you also have a connection with social sciences: perception, consumer behaviour, quality management.

With our multidisciplinary studies, we aim to contribute to the grand mission of WUR: to improve the quality of life.



Vincenzo Fogliano



Kasper Hettinga

Research theme 1 – Food Design

In this research theme, the design of food products and food ingredients is approached holistically from a nutritional, technological, and consumer science point of view. You will find here many different topics that have in common the design of food final products or food ingredients. Ingredients and foods investigated in the topics of this research theme are designed to improve the sustainability of food products, biodiversity of the food products, and the health of the general population. Some topics also target specific categories, such as people affected by celiac disease, diabetes, and obesity.

In this research theme, you will also find topics that aim at

- fighting malnutrition: large groups of the population in transition countries do not have access to foods and cannot meet their daily requirements of macro-and micronutrients (for instance essential amino acids, iron, zinc, and vitamins like vitamin A, B);
- implementing the use of non-conventional protein sources: plants and insects are valuable potential alternatives for the well know and commonly used animal sources;
- improving the food system in transition countries: from raw materials and production to storage and transportation.

The demand for protein will rise in the future due to the increase in the world population. In addition, in many transition countries, large groups of the population do not have access to foods and cannot meet their daily requirements of macro-and micronutrients (for instance essential amino acids, iron, zinc, and vitamins like vitamins A and B). With respect to sustainability and food security, we are urged to explore the potential of alternative, non-conventional protein sources. These could function as a replacement or addition to improve the quality of food products, especially in transition countries. Plants and insects could be potential alternatives for the well know and commonly used animal sources. Alongside the change in protein sources, the food system should be improved as well (from raw materials and production to storage and transportation). Local sourcing should be considered for these transition countries and in general taking into account the sustainability aspect.

The healthiness of food is investigated in some topics by processing/changing the ingredients and checking specific quality parameters (such as micronutrients and macronutrient concentrations and accessibility).

FQD-0100 B/M Healthy plant food design and potential health effect

Title	Healthy plant food design and potential health effect
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Teresa Oliviero

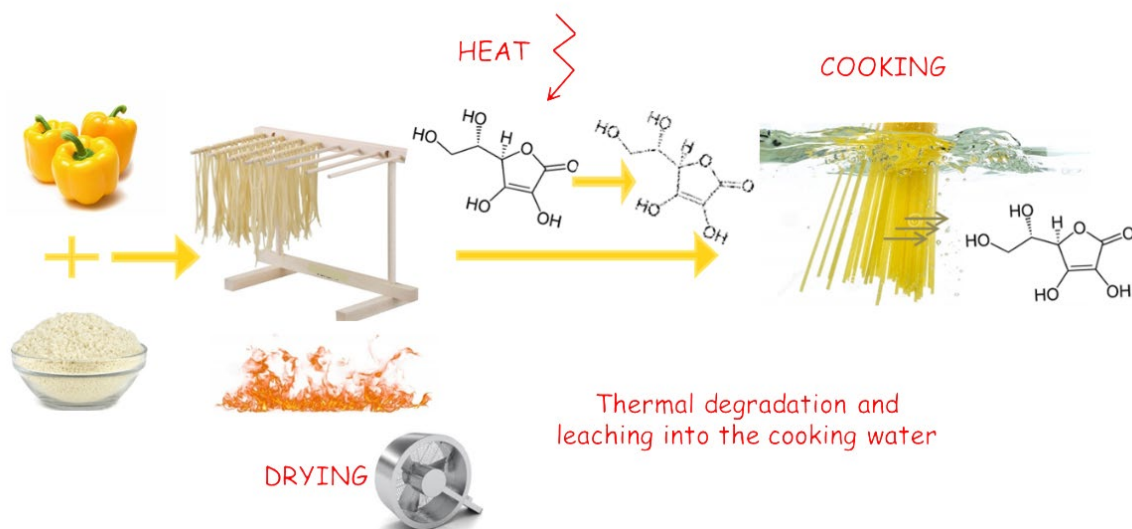
Description

The raising consumer awareness that a diet rich in plant-based food is health-beneficial urges companies to develop plant-based foods products (e.g., soups) and food products enriched with plant-based ingredients (e.g., pasta enriched with vegetables, veggie-burgers etc.).

The production of those products often implies processing that can negatively or positively affect the content of healthy–beneficial bioactive compounds (such as vitamins, carotenoids, polyphenols, etc.), reducing or improving the potential beneficial effect of the consumption of those products.

Objectives/aims. The aim of this topic is to study the changing in concentration of health-beneficial bioactive compounds during the production of products made with plant-based food ingredients (vegetable, legumes, etc.) and to investigate strategies to retain or to promote the formation of health promoting bioactive compounds in order to design healthier food products. In some cases, the effect on the bioactivity of those compounds will be part of the aim.

Approach. First, the student will select the vegetable/fruit/ legume, the corresponding target bioactive compounds, and the product to be investigated. Then, the student will investigate which steps of the production process can affect the concentration of this bioactive compounds and which strategies can be used (based on scientific hypothesis) to prevent losses or to promote the formation of those compounds (see the example in the figure). The student will make the product, and depending on the target compound/s, different analytical and instrumental technics can be used to analyse the compound/s, or to test the bioactivity of such compound/s.



FQD-0101 B/M Analysis of the physico-chemical properties of Brewer's Spent Grain and their influence on its techno-functional behavior

Title	Analysis of the physico-chemical properties of Brewer's Spent Grain and their influence on its techno-functional behavior
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Pien Schouten

Introduction

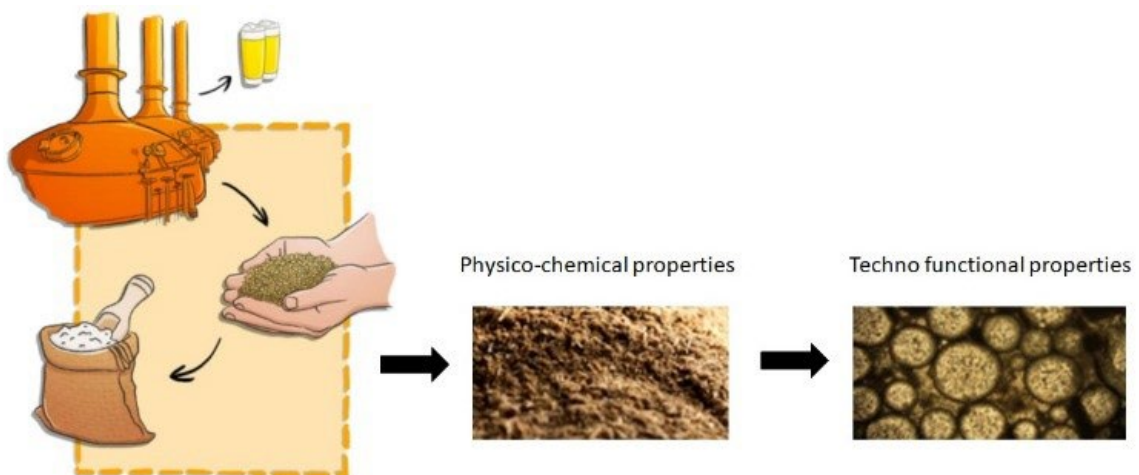
Brewers' spent grain (BSG) is the main by-product of the brewing industry. The starch in the malt is converted to sugars which remain in the liquid wort. The remaining BSG is rich in fiber and protein. Currently its main application is animal feeding. However, it can be a valuable ingredient in human nutrition. The findings of this research contribute to controlled processing of BSG to improve its functionality, allowing BSG to be valorized as attractive ingredients in the food and beverage industries.

Aim

Aim of this research is to extend the knowledge on the physico-chemical properties of BSG and to determine how these properties influence the techno-functional properties.

Activities

- Physico-chemical analysis of BSG e.g. composition, density, particle characterization, structural properties
- Techno-functional analysis e.g solubility, water- and oil binding, emulsifying- and foaming behaviour.



FQD-0102 M Designing functional ingredients by upcycling tomato industry by-products

Title	Designing functional ingredients by upcycling tomato industry by-products
Thesis	MSc
Specialisation(s)	MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Vincenzo Fogliano, Nicoletta Pellegrini
Co-supervisor	Trang Anh Nguyen

Introduction

The circularity in food production is a must to improve the sustainability of the food system. Tomato industries produce high amounts of several by-products from the lines manufacturing tomato paste and other tomato-based products. Under the collective name of Tomato Pomace, we mainly found tomato peels and tomato seeds which are still containing bioactive compounds such as lycopene.

Aim

The first aim of this thesis is to explore the ability of various technologies to extract valuable material from these by-products.

The second aim is to formulate these extracts into an ingredient that can be used in different food products.

Activities

In this thesis, the student will mainly work in the laboratory by extracting, chemically characterizing, and formulating the extract from tomato by-products.

Extraction techniques like Supercritical Fluid Extraction (SFE), Enzyme Assisted Extraction (EAE), High-Pressure Homogenization (HPH), and others will be used.



FQD-0103 M Unlocking the potential of Coconut byproducts to produce Arachidonic Acid

Title	Unlocking the potential of Coconut byproducts to produce Arachidonic Acid
Thesis	MSc
Specialisation(s)	MFT: A, C
Prerequisite courses	-
Chair group	FQD
Supervisor	Thisun Ranpatabendi (PhD)
Co-supervisor	Vincenzo Fogliano

Description

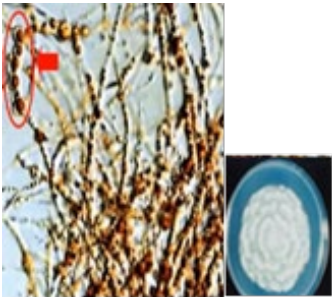
The coconut industry primarily focuses on producing coconut oil, coconut milk, and desiccated coconut, but it also generates numerous by-products with significant potential for value addition. These by-products contain proteins, residual oil, sugar, and polysaccharides, including fibres, making them ideal substrates for upcycling through microbial fermentation. Despite this potential, there is limited literature available on utilizing coconut by-products to yield omega-6 fatty acids, which possess notable bioactive potentials. *Mortierella alpina*, an oligogenic fungus approved by the European Union and FDA, is capable of producing omega-6 fatty acids.

Objective/aim

This project aims to leverage fungal fermentation *Mortierella alpina* to produce omega-6 fatty acids using various coconut by-products. Solid-state fermentation will be employed, with a focus on optimizing the combination of different coconut by-products to create an ideal substrate for omega-6 fatty acid production. Additionally, the project will investigate external factors to optimize growth and the production of the target fatty acid.

Approach

As an initial step, different byproducts will be combined based on their nutritional composition to meet the nutritional requirements of the fungi. External factors will be adjusted to determine the most effective strategy for inducing the accumulation of omega-6 fatty acids. Total fat content, fatty acid profile, protein content, antioxidant capacity, and phenol profile characterization will be conducted before and after fermentation at specific time points to comprehend the changes.



FQD-0104 M Upcycling of food by-products and production of vitamin K2 by fermentation approaches

Title	Upcycling of food by-products and production of vitamin K2 by fermentation approaches
Thesis	MSc
Specialisation(s)	MFT: C
Prerequisite courses	-
Chair group	FQD
Supervisor	Xin Wei (PhD)
Co-supervisor	Melania Casertano, Oscar van Mastrigt, Vincenzo Fogliano

Introduction

Every year, the global food industry produces a significant number of by-products from a variety of sources that are often discarded, due to their undesirable characteristics, resulting in the loss of valuable resources such as dietary fiber and other bioactive compounds like polyphenols, carotenoids, and glucosinolates. To advance towards a circular economy, which emphasizes waste reduction and efficient waste management, there has been a growing interest in the valorization of by-products.

Fermentation is one of the innovative approaches that can be used to upcycle food by-products into a valuable functional ingredient with enhanced nutritional profiles. By employing food-grade bacteria such as *Bacillus subtilis* and *L.lactis cremonis*, known for producing vitamin K, mainly MK-8, MK-9, and MK-10, fermentation shows a dual advantage for sustainability and nutrition.

Objectives/aim

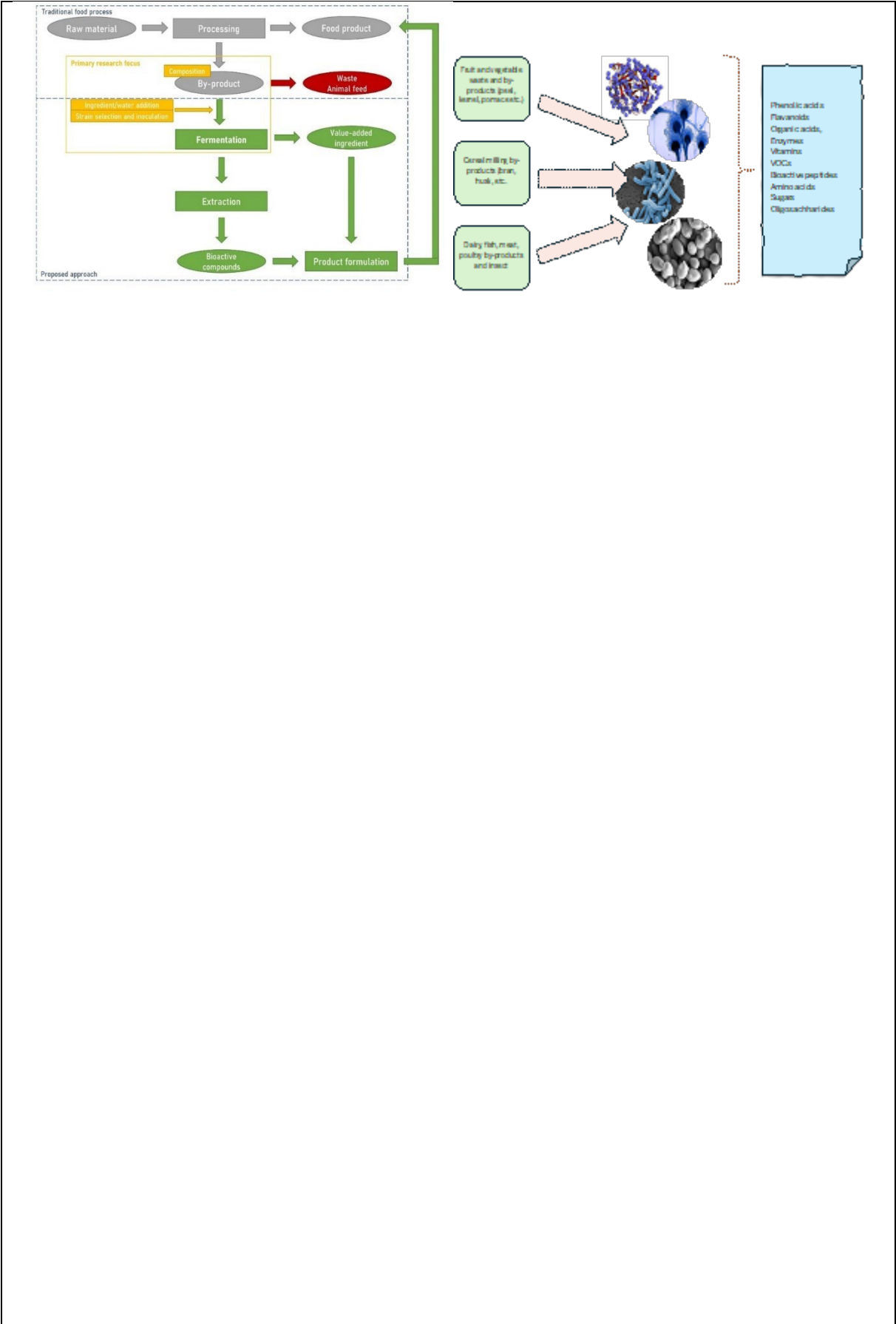
The objective of this topic is to upcycle several food by-products into a high-value food ingredient by using a fermentation approach.

This will include:

- Characterization and investigation of various food by-products suitable for fermentation-based upcycling
- Optimization of the fermentation conditions (time, temperature, and inoculum concentration)
- Investigation of the natural long-chain vitamin K2-producing capacity in different bacteria
- Assess the nutritional properties of the fermented product

FQD-0105 M Sustainable approaches to upcycle food waste stream

Title	Sustainable approaches to upcycle food waste stream
Thesis	MSc
Specialisation(s)	MFT: A, B
Prerequisite courses	-
Chair group	FQD
Supervisor	Melania Casertano, Ruth Ngadze
Co-supervisor	Vincenzo Fogliano
<p>Description</p> <p>Global food production generates substantial by-products annually, often discarded due to their undesirable traits, wasting valuable resources like dietary fiber and bioactive compounds. To address this issue and move towards a circular economy, there's growing interest in upcycling by-products. Specifically, green technologies, such as fermentation and enzymatic treatment emerge as key solutions, offering enhanced nutritional profiles and sustainability benefits, either by achieving a good production of bioactive compounds by the inoculated microorganism (e.g. production of SCFA) or by transforming the product to a functional ingredient (e.g. fiber degradation to produce oligosaccharides, achieving good values of bacterial biomass...).</p> <p>Additional technological processes could be applied before fermentation to improve this process. Ongoing research is being made in the fermentation of fruit peels as a by-product from juice production, spent coffee grains, or tea residues.</p> <p>Aim</p> <p>Investigate the applicability of fermentation strategies to by-products of food production to create value-added products with enhanced nutritional profiles and sustainability benefits.</p> <p>Approach</p> <ol style="list-style-type: none"> Literature research to understand how physical treatments, enzymatic treatments, fermentation, etc. influence the properties of the obtained ingredients Identification of the possible side-streams from food production with high annual processing volumes. Come up with realistic ideas on food fermentation. Our approach encompasses: <ul style="list-style-type: none"> <u>Microorganism Diversity</u>: We explore a wide array of species and subspecies of microorganisms, considering their suitability for fermentation and their potential to enhance the bioactive compound profile of the final product. <u>Bioactive Compound Production</u>: Our focus extends to the production of diverse bioactive compounds such as short-chain fatty acids (SCFA), exopolysaccharides (EPS), and oligosaccharides, aiming to maximize the nutritional and functional benefits of the fermented products. <u>Integration with Process Technologies</u>: We synergize fermentation with other process technologies to optimize the overall production process. 	



FQD-0106 B/M "Unlocking Cocoa Flavor: Navigating the Maillard Reaction Pathways for Sustainable Alternatives"

Title	"Unlocking Cocoa Flavor: Navigating the Maillard Reaction Pathways for Sustainable Alternatives"
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Riccardo Bottiroli
Co-supervisor	Vincenzo Fogliano

Background

The surging global demand for cocoa has led to deforestation as cocoa plantations expand rapidly. To address this environmental issue and reduce cocoa consumption, offering consumers a non-tropical, cocoa-flavored substitute is a promising strategy. However, replicating the natural and premium cocoa flavors presents a significant challenge due to the complex nature of cocoa's aroma profile. The central reaction responsible for creating the cocoa aroma profile is the Maillard reaction. Thus, replicating the cocoa flavor profile requires designing specific Maillard reaction pathways.

Aim

The main objective of this study is to develop a cocoa-based beverage alternative composed of non-tropical ingredients that can provide a sensory experience akin to traditional cocoa products.

Approach

To achieve this goal, the initial step involves creating a model Maillard reaction system using basic ingredients. These ingredients will provide both the body of the beverage and serve as precursors for the Maillard reaction, which is crucial for flavor development. The process begins with a small number of precursors and gradually increases the system's complexity by adding more reactants to produce targeted volatile compounds. Various pH levels and roasting conditions will be applied to replicate the distinct cocoa volatile profile. The most effective formulations will be used to create the final cocoa alternatives.

Major skills/techniques

- Model Maillard reactions establishment
- Spectral analysis (Fluorescence spectral and UV scanning)
- Analysis of volatiles (GC-MS or PTR-MS)
- Statistical modelling (e.g. PCA).

In summary, this research project aims to create a cocoa-based alternative using non-tropical ingredients while focusing on understanding and controlling the Maillard reaction, the fundamental process for cocoa flavor development.

FQD-0107 M The Maillard Reaction in Food: Balancing Flavour and Safety in Alternative Food Production

Title	The Maillard Reaction in Food: Balancing Flavour and Safety in Alternative Food Production
Thesis	MSc
Specialisation(s)	MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Vincenzo Fogliano
Co-supervisor	Burçe Ataç Mogol (Hacettepe University Ankara)
Location	Thesis proposal, report writing, and examination: FQD, Wageningen, The Netherlands Thesis experimental part and data collection: Ankara, Turkey

The experimental part and data collection will be performed at Hacettepe University Ankara, Turkey therefore select this topic only if you are interesting in doing the thesis abroad

Description

Do you enjoy consuming biscuits, breads, coffee, potato chips, French fries, or chocolate? Then, this is your topic!

Many of us love these foods due to their nice colour, taste, and aroma. The nice characteristics of these foods come from the Maillard reaction. However, this reaction could also be responsible for the formation of some hazardous compounds, such as acrylamide. Many researchers and producers are changing the formulations of foods or processes to prevent acrylamide formation. But if we interfere with the standard food production or formulation, the Maillard reaction and, eventually, the nice aroma of the food could be affected. So it would become a challenge for both the scientists and the producers to keep the food as nice as it is.

On the other hand, new emerging trends, such as enriching foods with alternative protein sources, e.g. plant-based proteins or insect protein, would again affect the nice aroma of the food due to interfering with the Maillard reaction.

Being a food technologist, some questions arise:

- How will the addition of plant-based materials (pea flour, flaxseed, hemp seed, or sesame seeds etc.) affect the acrylamide formation in bakery products, also considering Maillard aroma compounds?
- How may the green aroma of plant-based proteins could be manipulated by the addition of MR-promoting ingredients (amino acids, sugars etc.)?
- How will the addition of insect flours affect the acrylamide formation in bakery products and how to manipulate the formulation or process to keep Maillard key aroma compounds?
- ...

So, here we are. Louis Camille Maillard discovered the existence of the reaction in 1912, and since then we have been working and trying to understand it. Do you take this challenge and join us to enhance our understanding of the changes in foods during reformulation and processing?

FQD-0108 B/M Maillard reaction for enhancing flavour of future food products

Title	Maillard reaction for enhancing flavour of future food products
Thesis	BSc, MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	BSc: -, MSc: Food Flavour Design (FQD37806)
Chair group	FQD
Supervisor	Bei Wang (PhD), Teresa Oliviero

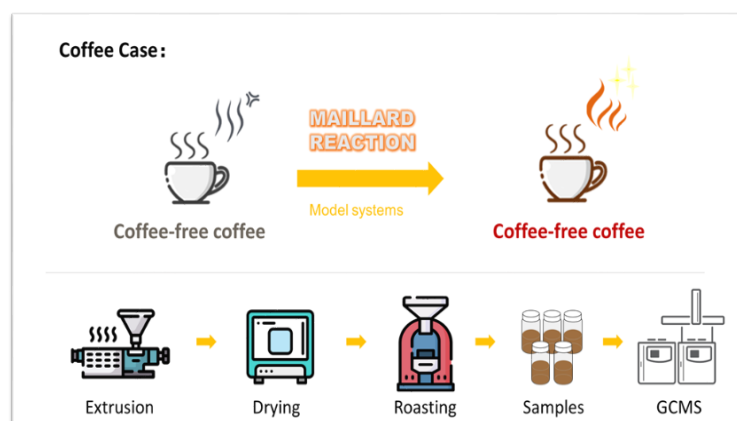
Description

Nowadays, food companies often need to replace currently and traditionally used ingredients to develop and reformulate products. This happens either because consumers ask for more alternatives to animal products or because traditional ingredients become scarce (e.g., climate change, wars, etc.). Many key flavor compounds in foods are generated via the Maillard reaction. Theoretically, by allowing certain amino acids and sugars to react under specific conditions (pH and time/temperature), several flavours can be created (e.g., bread, boiled chicken, roasted chicken, etc.). However, the exploration of Maillard-derived aroma generation commonly relies on model system solutions (buffered solutions containing reactants). A challenge in current research lies in the limited direct translation of findings from these model systems to real food. This limitation arises because these models can hardly reproduce the impact of the food matrix in Maillard reactions.

The aim of this study is to create typical flavours of specific products in replacers e.g., coffee flavour in beverage with no coffee bean and no coffee extracts. Therefore, the first aim is to create the flavour in a model system and then, to investigate if this flavour can be obtained in a real food matrix, during processing. In other words, the aim of this study is to explore the influence of both the food matrix and reactants on the development of flavor compounds in food.

Approach

To address this gap, our study aimed to establish a complex model system through extrusion. The model system will be developed using basic ingredients that provide the necessary structure and precursors for flavor formation. Various precursors and reaction environments will be explored. The optimal formulations and reaction conditions will be identified and employed in the production of the final products.



Major Skills/Techniques student will be trained on

- Model Maillard reactions establishment
- Physical characterization (colour, water activity, etc.)
- Analysis of volatiles(GC-MS)
- Extrusion technology

FQD-0109 B/M Your own barista: Optimizing home brew coffee by investigating the coffee properties.

Title	Your own barista: Optimizing home brew coffee by investigating the coffee properties
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, B
Prerequisite courses	-
Chair group	FQD
Supervisor	Vincenzo Fogliano
Co-supervisor	Nora van Os
Other supervisor	Anke Sinnema (Versuni)

Description

Coffee is the world most consumed beverage. Generally, coffee is characterized by the degree of roast and the type of coffee. In manual espresso appliances, the barista finetunes the extraction process towards the coffee, by varying the weight and the grind size to optimize extraction time and taste. In automatic espresso machines, the brew settings are typically the same for all types of coffee although possibilities exist to adapt the grind size, amount of coffee, brew temperature and pre-infusion. For consumers, it's difficult to optimize brew settings as they lack knowledge and skills. In addition, different people also have different taste preferences and might require a different result. Another aspect of coffee is the milk foam. Consumers are more and more searching for non-dairy milks as well to make these recipes. However, not all types of plant-based milk are suitable to make these drinks. One of the ways to test their suitability for these drinks, is by investigating their foaming ability and foam properties, since the quality of foams is an important parameter for good perception and taste of the drink.

Objectives

In this research, a possible aim is to find out how brew parameters of an automatic espresso device can be optimized for different types of coffee.

Another aim of this study could be to investigate the foaming ability and foam properties of plant-based milk and understand which key properties/ingredients help create a quality foam.

Proposed approach

For this project you will look into literature and investigate how different brewing methods influence the taste and quality of the coffee. The volatile fraction of coffee brew will be assessed together with other physicochemical characteristic of the obtained coffee

For the investigation of the plant-based milk foam, the techno-functional characteristics of the dairy based ingredients (or plant alternative) as function of their chemical composition will be assessed. Experiments will be performed with Philips DA devices to verify the influence of the dairy ingredients on the consumer perception of the final products.



FQD-0110 B/M Replacement of animal ingredients by plant-based alternatives

Title	Replacement of animal ingredients by plant-based alternatives
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Ruud Verkerk
Co-supervisor	Pien Schouten

Description

The trend of replacing animal ingredients (meats, eggs, gelatin) is becoming more and more popular. Reasons for this can be found in sustainability, animal welfare, and human health arguments. The field is very broad, and although a lot of research has been done already the field is still relatively young.

In many cases, the replacement of animal ingredients with those coming from a plant-based source results in the loss of important technological properties related to physical (e.g., texture, water holding capacity) and chemical (e.g., flavour profile, browning formation) properties. This will in turn influence also microbiological stability. The changes in technological properties and microbiological stability affect the product characteristics and quality. We can expect that consumers are not so compliant in accepting these potential changes. It is therefore important to maintain product characteristics and quality during the redesign of products.

Proposed approach

You will be working on the design of one specific product by testing ingredients of plant-based origin for their potentiality to replace the actual animal-based standards available on the market. Product characteristics and quality parameters will be identified and monitored in the different stages of product redesign. Key areas of interest for the student should be quality design and physicochemical analysis.

Topics

1. Alternative gelling agents.
2. Vegan cheese.
3. Bakery products (cake/cookies).
4. Create your own topic (student needs to independently come up with his/her own project).



FQD-0111 M Legumes: the sustainable way towards protein rich pasta

Title	Legumes: the sustainable way towards protein rich pasta
Thesis	MSc
Specialisation(s)	MFT: A, B, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Vincenzo Fogliano, Nicoletta Pellegrini
Co-supervisor	Trang Anh Nguyen

Introduction

Pasta is an ideal vehicle for introducing additional nutrients, particularly proteins, to the diet of many consumer categories. It is a widely consumed product, relatively cheap, and convenient to use. Moreover, unlike several micronutrients, during cooking, proteins will not leach out of the pasta into the cooking water. As an alternative to traditional pasta formulations, legume proteins are now also used in pasta manufacturing. However, the addition of legume proteins is based on an artisanal rather than scientific based approach.

Aim

This project aims to perform an extensive survey of the techno-functional consequences of the legume protein addition to pasta and to measure the effect of this addition on the nutritional quality.

Activities

In this thesis, the student will mainly work in the laboratory by preparing several pasta recipes including legume proteins. Experiments will be designed to evaluate the pasta's nutritional value and performance during extrusion drying.



FQD-0112 M Young coconut ice cream

Title	Young coconut ice cream
Thesis	MSc
Specialisation(s)	MFT: A, B
Prerequisite courses	-
Chair group	FQD
Supervisor	Thisun Ranpatabendi (PhD)
Co-supervisor	Guido Sala (FPH), Vincenzo Fogliano, Melania Casertano
<p>Description The coconut water industry primarily relies on young coconuts (6 to 7 months old), which contain higher amounts of coconut water and immature coconut meat that is rich in soluble fibre, oil, and proteins. This coconut meat is often considered a byproduct and discarded for composting. However, it holds significant potential as a functional ingredient. While some research has been conducted on using young coconut meat in ice cream production, a deeper understanding of its technological properties is needed. This project aims to explore the composition and key compounds present in green coconuts to facilitate their utilization in the ice cream industry.</p> <p>Objective/aim The objective of this project is to investigate the technological and functional properties of young coconut meat, focusing on its primary chemical compounds and its behaviour during the ice cream manufacturing process. This entails examining the physical characteristics and chemical composition of the young coconut meat to gain insights into its impact on ice cream production and quality.</p> <p>Approach The major constituents of young coconut meat will be assessed for their key techno-functional properties to determine their suitability for application in the ice cream industry.</p>	

FQD-0113 B/M Weaning foods: Dual role of food to food fortification and processing

Title	Weaning foods: Dual role of food to food fortification and processing
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Ruth Ngadze
Co-supervisor	Anita Linnemann

Background

Cereals, roots and tuber flours that are energy dense and limiting in essential amino acids and minerals are often used to make weaning and complementary foods in low and middle-income countries. Furthermore, the weaning cereal porridges have a thick and viscous consistency, which is difficult to swallow and digest for infants. In a bid to improve the textural quality the product is diluted with water to enable consumption which results in over-dilution and loss in product nutrient density and malnutrition in infants. Nowadays, food-to-food fortification is considered a cost-effective strategy to enhance the functional and nutritional quality of children's diets. A potentially promising approach to improving nutrients and thickness is to add legumes or fruit pulp to cereal porridges. Processing methods such as germination, malting and fermentation are used to improve the consistency, flavour and nutritional composition of the cereal grain porridges.

Aim

The overall aim, therefore, is to investigate the role of processing technologies and food fortification for improved textural, nutrient density and digestibility for weaning porridge. The results obtained will provide solutions for improved healthy weaning food formulations.

Approach

First, you will be identifying which processing technology can be applied to the cereal or fortificant. For that, you will have to understand the full composition of the raw material through a literature review and preliminary tests in the laboratory. Bioprocessing strategies could be applied to the product to improve energy and nutrient density and produce a functional product.



FQD-0114 B/M Design of food ingredients with lipid-rich microalgae

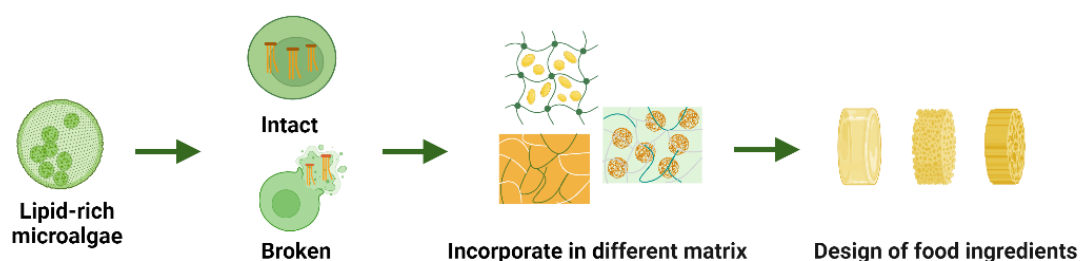
Title	Design of food ingredients with lipid-rich microalgae
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, B
Prerequisite courses	-
Chair group	FQD
Supervisor	Xuan Yang (PhD)
Co-supervisor	Maryia Mishyna, Vincenzo Fogliano

Introduction

Numerous research is currently focused on traditional food alternatives to achieve sustainable dietary goals. In particular, microalgae is a potential source of food ingredients that are highly nutritious, easy to propagate and grow without land constraints. The production of microalgae which are rich in unsaturated fatty acids (UFAs) has received increasing attention. However, there is still limited knowledge on how to incorporate lipid-rich microalgae into different food matrixes. Therefore, the aim of this project is to develop a generalized methodology for the conversion of microalgal biomass into food ingredients with various techno-functionalities.

Objectives and activities

The thesis project will focus on investigating techno-functional characteristics of lipid-rich microalgae, establishing links between composition and functionality, and designing food ingredients with microalgae.



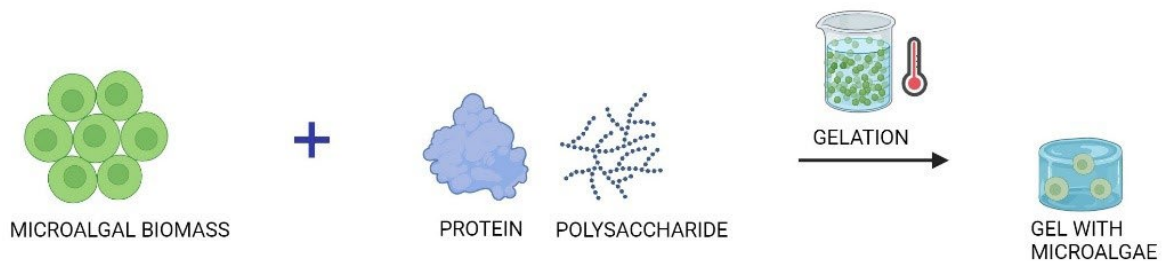
FQD-0115 B/M Design of food gels with microalgal biomass

Title	Design of food gels with microalgal biomass
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, B
Prerequisite courses	-
Chair group	FQD
Supervisor	Tijana Bjelogrić (PhD)
Co-supervisor	Maryia Mishyna, Vincenzo Fogliano

Description

Increasing global population poses significant challenges in terms of food production, that must double to meet this demand, with particular attention needed on protein sources. Microalgae have arisen as a promising sustainable alternative. Current practices involve the use of dried algal biomass, has low techno-functional properties (i.e. gelling, foaming etc.), and relies on the use of costly drying technologies, that often reduce nutritional quality of the microalgal powder. This project will, therefore, explore the properties of wet microalgal biomass as food ingredient, its interactions with other common components of food systems (proteins, polysaccharides) and using gelation, known to be a foundation for many common food products (cheese, yoghurt, sausages, puddings).

The student will perform literature research and experiments to understand if microalgal biomass has an active role in gel formation and how its addition influences the properties of the obtained gels. The student will gain knowledge on microalgal biomass, widely used food biopolymers, gels and techniques for their characterization.



FQD-0116 B/M Microbial ingredients for future food

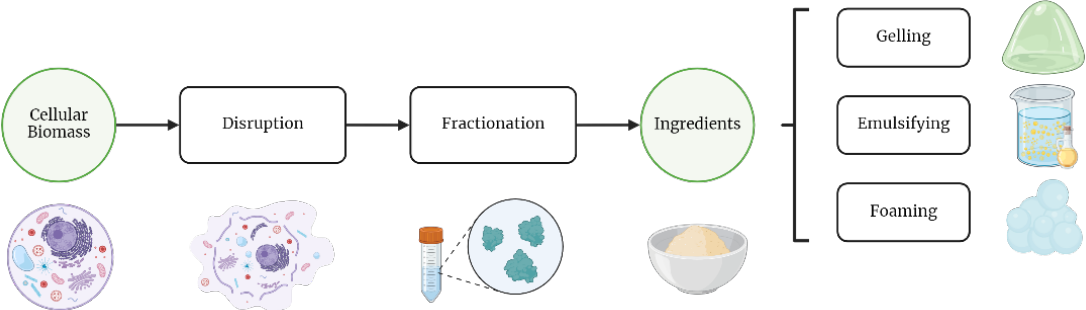
Title	Microbial ingredients for future food
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, B
Prerequisite courses	-
Chair group	FQD
Supervisor	Lucas Bozzo (PhD)
Co-supervisor	Maryia Mishyna, Vincenzo Fogliano

Introduction:

Sustainable diets are a crucial element in addressing ongoing climate change and achieving global health and sustainability. Grown in bioreactors, the growth of microbial cells is possible in any geographical location and requires limited land. Microbial biomass has therefore surfaced as an interesting alternative ingredient source. However, to make use of this source as ingredients economically feasible, a biorefinery approach where all the fractions of the microorganisms are valorised is required. Also, knowledge on the application of the complete microbial biomass or ingredients thereof is fundamental for efficient implementation. This project aim towards developing a generic approach to convert cellular biomass into techno-functional food ingredients.

Objectives and activities:

The thesis project will focus on studying the obtention and/or techno-functionality of protein-rich ingredient fractions from microbial biomass. This will be done by establishing connections between the mechanical disruption of the microbial cells, their fractionation, composition and subsequent techno-functionality (gelling, emulsifying or foaming).



FQD-0117 B/M Edible insects: creating food of the future

Title	Edible insects: creating food of the future
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, B, G
Prerequisite courses	-
Chair group	FQD
Supervisor	Maryia Mishyna
Co-supervisor	Catriona Lakemond, Vincenzo Fogliano

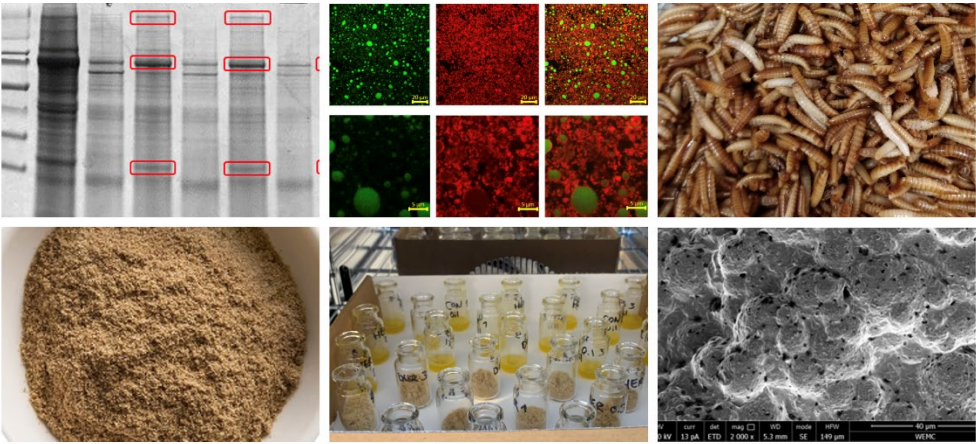
Description

Edible insects represent a novel food source in Western countries. High protein content, well-balanced amino acid composition, and a sufficient amount of vitamins and minerals make edible insects comparable to traditional plant and animal sources. Moreover, insect farming is more sustainable and has a lower negative environmental impact in comparison to conventional livestock. In order to increase consumers’ acceptance of edible insects, they can be processed into food ingredients and incorporated into familiar food products. The processing comprises various techniques including drying, fractionation, extraction, purification of proteins and fat, application of enzymes, and aims to obtain high-grade insect material or fractions with the enhanced characteristics for use as food ingredients. Although knowledge on insect processing is developing in the last decade, much is still unknown.

The research project covers various aspects of edible insects as a sustainable food source aiming to explore their potential for the food industry.

The students will work on one of the following topics:

- Techno-functional properties of insect proteins for tailored insect applications
- Texturization of insect proteins using extrusion



FQD-0118 M Iron-binding insect protein complex entoferritin for solving iron deficiency problem

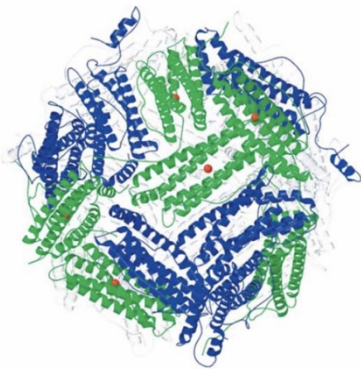
Title	Iron-binding insect protein complex entoferritin for solving iron deficiency problem
Thesis	MSc
Specialisation(s)	MFT: A, B
Prerequisite courses	-
Chair group	FQD
Supervisor	Tomer First (PhD)
Co-supervisor	Maryia Mishyna, Vincenzo Fogliano

Description

Iron deficiency is the most common micronutrient deficiency amongst humans. The prevalence of iron deficiency, alongside the lack of sustainable iron sources calls for alternatives. Recent studies have proposed edible insects as a valuable source of iron, showing high iron concentration and iron bioavailability. It is hypothesized that the high bioavailability of insect-based iron is due to the iron-binding protein complex ferritin. However, there are currently no studies that examine entoferritin of edible insects.

This project aims to add a novel ferritin purification link to the insect for food production chain, leading to a new and sustainable ferritin-based iron supplement for human consumption. The student will focus on quantification and purification of this highly valuable insect protein ferritin.

Also, another focus of this PhD project is to increase protein solubility and techno functional properties using food grade ingredients, both to improve the ability to purify entoferritin and improve insect proteins as a whole.



Research theme 2 - Food Digestion and Health

The focus of this research theme is on the fate of food matrices along the entire gastrointestinal tract and the effect that this has on gastrointestinal health and sensory perception. This theme has two sub-themes.

One sub-theme typically investigates the food-related factors affecting nutrients digestibility/bioavailability as well as the ability to modulate gut microbiota structure and metabolism. Next to that, the potential beneficial effect of food components on gastrointestinal health (e.g., effect on gut permeability, inflammation, and immunomodulation) is investigated. Therefore, the main methodologies used in these topics are the physical and chemical characterization of the food matrix/food components, *in vitro* gastrointestinal digestion/colonic fermentation, characterization of microbial metabolites/change in microbiota structure, and biological assays on cell lines. By acquiring this knowledge we could design food with optimized digestibility/bioavailability of nutrients, optimized effect on gut microbiota as well as an optimized biological effect on gut health.

The other sub-theme aims at acquiring 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. This sub-theme addresses the following questions:

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

To obtain insights into the perception of complex textural attributes, the research employs traditional, static descriptive, and recently developed, time-resolved sensory methodologies (dynamic).

FQD-0200 B/M Effect of plant cell wall integrity and/or permeability on nutrients bioaccessibility/digestibility

Title	Effect of plant cell wall integrity and/or permeability on nutrients bioaccessibility/digestibility
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Edoardo Capuano

Description

In plant tissues, cells are surrounded by a cell wall that is made up of fibre, i.e., polysaccharides that are not digestible by humans. If cells are intact at the point of swallowing, cell integrity is maintained during digestion, which may have detrimental effects on nutrients bioavailability. By modifying the cell wall before digestion, nutrient release from the cells or the accessibility of macronutrients to digestive enzymes might be controlled and the utilization of nutrients optimized. Such modifications could be physical, thermal, enzymatic, etc.

Aim

Study the effect of cell wall integrity and permeability on macronutrients digestibility in plant-based foods and any other food where cells are surrounded by a fibre-based cell wall

Approach

Nutritionally relevant "cell-walled" foods (plants, fungi, bacteria, etc.) will be selected and processed. Macronutrients digestibility or bioactive compounds bio-accessibility will be studied in relation to cell wall integrity and permeability. A combination of structural (e.g. microscopic analysis, potentially also in combination with image analysis), chemical (e.g. pectin degradation), and physical (e.g. particle size distribution) assays will be used to uncover the cell wall integrity and/or permeability. Specific strategies can be tested to modulate cell integrity and cell wall permeability and thus, nutrients digestibility. This last will be monitored using in vitro models of digestion.

References

- Capuano, E., Pellegrini, N. An integrated look at the effect of structure on nutrient bioavailability in plant foods. *Journal of the Science of Food and Agriculture*. 99: 493–498 (2019). <https://doi.org/10.1002/jsfa.9298>
- Carpita, N., Tierney, M. & Campbell, M. Molecular biology of the plant cell wall: searching for the genes that define structure, architecture and dynamics. *Plant Mol Biol* 47, 1–5 (2001). <https://doi.org/10.1023/A:1010603527077>
- Colosimo, R., Warren, F. J., Edwards, C. H., Ryden, P., Dyer, P. S., Finnigan, T. J. A., & Wilde, P. J. (2021). Comparison of the behavior of fungal and plant cell wall during gastrointestinal digestion and resulting health effects: a review. *Trends in Food Science & Technology*, 110, 132–141. <https://doi.org/10.1016/j.tifs.2021.02.001>
- Willats, W.G., McCartney, L., Mackie, W. *et al.* Pectin: cell biology and prospects for functional analysis. *Plant Mol Biol* 47, 9–27 (2001). <https://doi.org/10.1023/A:1010662911148>



FQD-0201 B/M Starch digestibility in plant-based cheese

Title	Starch digestibility in plant-based cheese
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Edoardo Capuano
Co-supervisor	TBD

Background

Plant-based cheese analogues are prepared from plant ingredients that is designed to have a similar appearance, texture, and flavour as regular, milk-based cheese. Plant-based cheese analogues are more and more common on supermarket's shelves. Their commercial success fits in the general consumer trend for food products that have a lower impact on the environment.

Starch is one of the most commonly used polysaccharide-based ingredients in plant cheese analogues where it is used for its ability to form a viscous paste or gel upon heating (gelatinization) and cooling (retrogradation/setback), which entraps fluids and other ingredients within the 3D-polysaccharide network formed. Plant-based cheese analogues typically contain substantial amounts of fat and oils with a wide range of different fatty acid compositions depending on their botanical origin.

At the moment very little is known about digestibility of starch in plant-based cheese analogues, the effect of storage on the development of resistant starch and the effect of lipid on e.g. formation of type 5 resistant starch.

Aim

To study starch digestibility in commercially available plant-based cheese analogues including the effect of domestic or retail storage on resistant starch content and the influence of fat/oil.

Approach

You will first make an overview of existing plant-based cheese analogues available at retail. You will then select an appropriate number of samples differing in terms of type of ingredients used and/or type of starch and fat/oil. You will then assess starch digestibility with appropriate in vitro methodologies that include the INFOGEST in vitro digestion protocol as well as enzymatic kit for the determination of resistant starch. Additionally, the development of resistant starch in time can be studied by storing the selected products for different times. Additional analysis may involve the characterization of the starch gelatinization/retrogradation level or the formation of resistant starch type V with DSC.



FQD-0202 B/M Resistant starch type IV. Is it really resistant?

Title	Resistant starch type IV. Is it really resistant?
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Edoardo Capuano
Co-supervisor	TBD

Background

Resistant starch type IV is a type of starch that is produced and marketed for specific technological applications. Resistant starch type IV is produced by chemical modification of starch (e.g. acetylation) and it is claimed to be resistant to digestion. However, preliminary data collected in our department suggest that it may not be fully resistant and part of it can be actually digested, especially after the application of thermal treatments. Next to this, little is known about whether the gut microbiota can utilize this resistant starch to produce shorter chain fatty acids which have positive effects on health.

Aim

To study digestibility and gut microbial fermentability of resistant starch type IV available in the market.

Approach

You will first make an overview of commercially available resistant starch type IV in the market. After this you will study the digestibility of the starch in model systems of increasing complexity to simulate the application of thermal treatments. After treatment the starch will be characterized in terms of its thermal properties (e.g. gelatinization and retrogradation behaviour) and its digestibility. This last will be studied using in vitro models of digestion. Additionally, the fermentability of resistant starch type IV before and after the application of thermal treatments may also be studied using in vitro models of colon fermentation using human faecal inoculums.

FQD-0203 B/M Tweaking the protein and starch digestibility in a dense gluten network

Title	Tweaking the protein and starch digestibility in a dense gluten network
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Ciarán Forde / Markus Stieger / Edoardo Capuano
Co-supervisor	Gaelle Boisset (PhD)

Background

The extruded dense wheat gluten network such as present in pasta and noodles have a low starch and protein digestibility due to amongst others a strong network and its compact structure^{1, 2, 3}. On the one hand, this is beneficial since the slow starch digestion rate can impact insulin sensitivity positively. On the contrary, it can mean that the health claim “source of protein”, which multiple pasta and noodle products can get because of the high protein content of wheat, could not be in line with the amount of proteins that are bioavailable in reality.

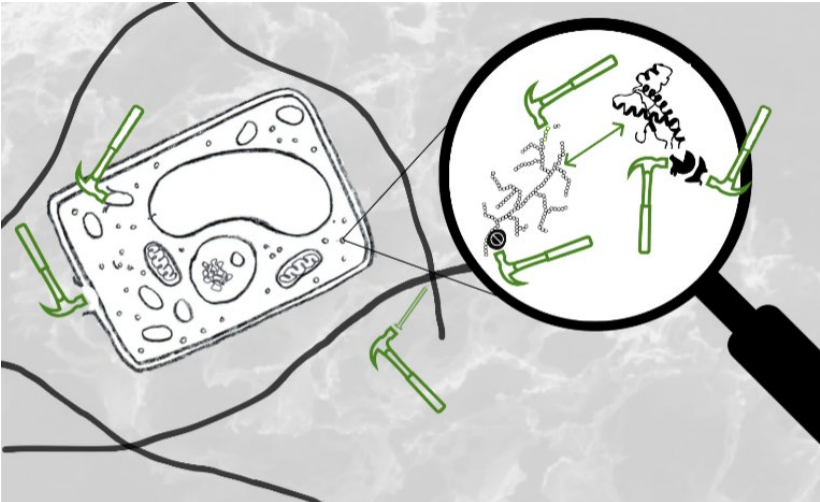
Multiple studies have shown the impact of the addition of various ingredients to the matrix on starch and protein digestibility in vitro. However, research about the addition of exogenous protein isolates and intact cells to the network and the following effect on starch and protein digestibility is limited and little research has been performed in vivo.

Objective

This project aims to investigate the relationship between the addition of exogenous proteins, intact cells and food processing on the extruded dense wheat gluten matrix, the digestibility and the metabolic responses. Would it be possible to tweak the matrix in such a way that proteins have an improved digestibility while starch is digested slowly?

Activities

Intact cells or different kinds of protein sources will be selected and used to extrude pasta. The microstructure of the protein network will be investigated and visualized by microscopy. The human starch and protein digestion will be mimicked in vitro using the Infogest 2.0 protocol.



FQD-0204 B/M Microbial metabolism and digestion of alkylresorcinols from different food matrices

Title	Microbial metabolism and digestion of alkylresorcinols from different food matrices
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Edoardo Capuano, Obaid Ul Hassan (PhD)
Co-supervisor	Josep Rubert

Background

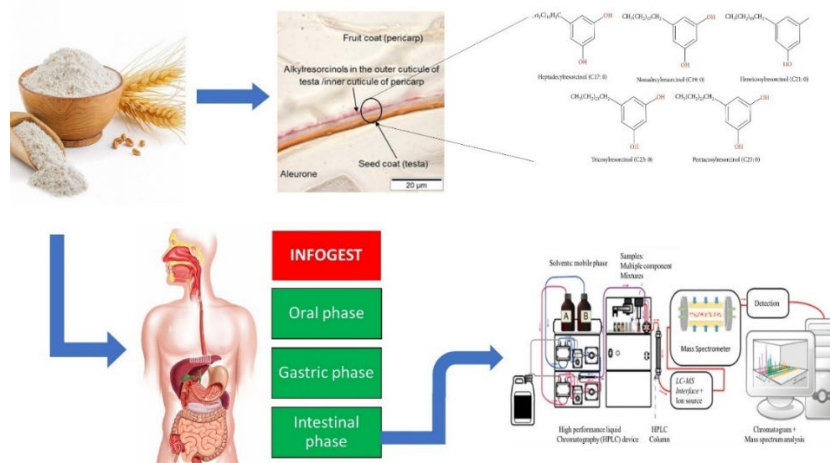
Cereals are an important source of our diet as they contain many essential nutrients and phenolic compounds for proper functionality of body. Among others, they are good source of alkylresorcinols (AR) which are 1,3-dihydroxy-5-alkylbenzene derivatives with an odd-numbered alkyl chain, usually C17 to C25. In the human diet they are found in high amounts in bran fractions of rye (360–3200mg/g DM) and wheat (317–1429mg/g) grains. In the large intestine they are metabolized into different metabolites like 3,5-dihydroxybenzoic acid (3,5-DHBA) and 3-(3,5-dihydroxyphenyl)propanoic acid (3,5-DHPPA). These metabolites are also considered as biomarker of whole grain intake and they are detected in both plasma and urine. Some AR metabolites were also found in erythrocytes membrane. Currently, little is known on the behaviour of ARs in the gastrointestinal tract (stability, incorporation in mixed micelles) and their total bioaccessibility from different cereal matrixes as well as the whole pattern of metabolites produced in the large intestine .

Aim

To study the behaviour of ARs from rye-based products during digestion and metabolism

Approach

You will study the fate of ARs from rye bran and rye-based processed foods like bread and crackers using relevant in vitro models of digestion (INFOGEST) and microbial metabolism. INFOGEST will be intended to elucidate the digestive behaviour of ARs, and in vitro batch fermentation will help to enlighten the microbial conversion of ARs. As an overview, you will characterize the behaviour of ARs in terms of stability, bioaccessibility as well as in terms of conversion in microbial metabolites by the gut microbiota using a variety of chemical, physical and microscopic techniques.



FQD-0205 M Plant industrial pomaces and digestive fate

Title	Plant industrial pomaces and digestive fate
Thesis	MSc
Specialisation(s)	MFT: A, E
Prerequisite courses	-
Chair group	FQD (WUR), BIA unit (INRAE, Nantes, France)
Supervisor	Claire Berton-Carabin (INRAE & WUR)
Co-supervisor	Edoardo Capuano (FQD, WUR)
Location	Thesis performance: Nantes, France Thesis examination: FQD, Wageningen, The Netherlands

Topic description

In sustainable food process engineering, there is a growing interest in the valorization of food by-products (issued from cereal or fruit processing) as new food ingredients. However, the fate of these fiber-rich by-products is still not fully evaluated. From different plant pomaces and model systems, we propose a multidisciplinary approach (structural plant polymer characterization, in vitro digestion, analytical chemistry) to evaluate how different fiber structures influence their sensitivity to digestive enzymes.

Project information

This is an initiative within the framework of our long-standing collaboration with dr. Claire Berton-Carabin (visiting associate professor at FPE and appointed at INRAE's research unit BIA - Biopolymers, Interactions, Assemblies; https://www6.angers-nantes.inrae.fr/bia_eng/) in Nantes, France). To strengthen the bonds between both institutes, the BIA unit offers some thesis students to conduct their MSc thesis *in Nantes*.

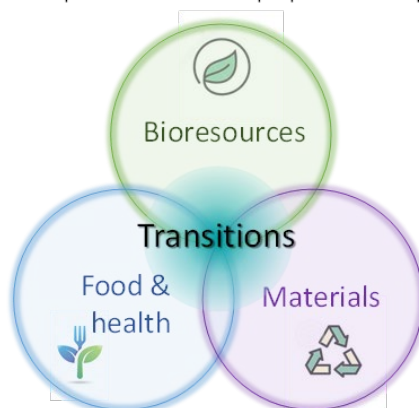
Practical information

The whole thesis project will take place in Nantes from the start. Except for the examination, which will take place at FQD in Wageningen. A dedicated department will help the student with housing, opening a bank account, and other practical arrangements in Nantes. In addition, the student will receive an allowance of 600 euros/month to cover additional costs.



Monitor and control the quality of bioresources (in particular, plant productions) to optimise their utilization and explore the functional properties of biopolymers

Design future foods while controlling their impact on health (allergenicity, nutritional quality) and the environment



Design biobased materials through an integrated value chain approach

An overview of the research focus and approach of the BIA unit (Nantes, France) of INRAE, the French National Research Institute for Agriculture, Food and Environment.

FQD-0206 M Digestion and absorption of food allergens

Title	Digestion and absorption of food allergens
Thesis	MSc
Specialisation(s)	MFT: A, E
Prerequisite courses	-
Chair group	FQD (WUR), BIA unit (INRAE, Nantes, France)
Supervisor	Claire Berton-Carabin (INRAE & WUR)
Co-supervisor	Kasper Hettinga & Tamara Hoppenbrouwers (FQD, WUR)
Location	Thesis performance: Nantes, France Thesis examination: FQD, Wageningen, The Netherlands

Topic description

The recent rise in food allergies suggests that environmental factors, such as our food consumption, are implicated. To determine how food processing and the food matrix impact food allergenicity, the digestion of the allergen-containing food and the absorption of the digested food across the epithelial barrier are key aspects. The aim of this sub-topic is thus to characterize the impact of food processing and the food matrix on the gastro-intestinal digestion of allergens (using static *in vitro* digestion) and the subsequent allergen absorption across the intestinal epithelial barrier by using Caco-2/HT29-MTX co-cultures and/or organoid cultures. Changes in allergenicity will be assessed using immunochemical methods (ELISA, dot blot, western blot) and a rat basophil cell line, making use of sera from food-allergic patients.

Project information

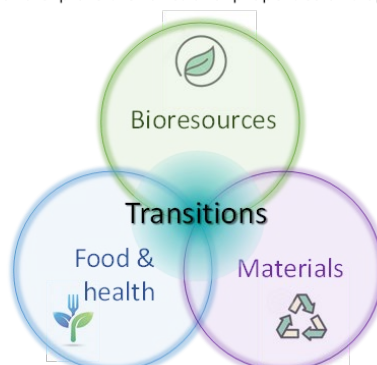
This is an initiative within the framework of our long-standing collaboration with dr. Claire Berton-Carabin (visiting associate professor at FPE and appointed at INRAE's research unit BIA - Biopolymers, Interactions, Assemblies; https://www6.angers-nantes.inrae.fr/bia_eng/) in Nantes, France). To strengthen the bonds between both institutes, the BIA unit offers some thesis students to conduct their MSc thesis *in Nantes*.

Practical information

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Monitor and control the quality of bioresources (in particular, plant productions) to optimise their utilization and explore the functional properties of biopolymers



Design future foods while controlling their impact on health (allergenicity, nutritional quality) and the environment

Design biobased materials through an integrated value chain approach

An overview of the research focus and approach of the BIA unit (Nantes, France) of INRAE, the French National Research Institute for Agriculture, Food and Environment.

FQD-0207 M Faba bean protein purification & immunoreactivity

Title	Faba bean protein purification & immunoreactivity
Thesis	MSc
Specialisation(s)	MFT: A, E
Prerequisite courses	-
Chair group	FQD (WUR), BIA unit (INRAE, Nantes, France)
Supervisor	Claire Berton-Carabin (INRAE & WUR)
Co-supervisor	Kasper Hettinga & Tamara Hoppenbrouwers (FQD, WUR)
Location	Thesis performance: Nantes, France Thesis examination: FQD, Wageningen, The Netherlands

Topic description

This topic focuses on exploring the potential of faba bean as a novel plant protein source for food applications. The research involves purifying major seed proteins (albumins, 7S & 11S globulins) and evaluating their immunoreactivity. Utilizing sequential extraction and chromatography, the purified proteins will be characterized through biochemical and physical-chemical methods. Immunoreactivity assessment, using immunochemical techniques (ELISA, Western blot), aims to determine cross-reactivity in the serum of legume- and oilseed-allergic patients to FB proteins.

Project information

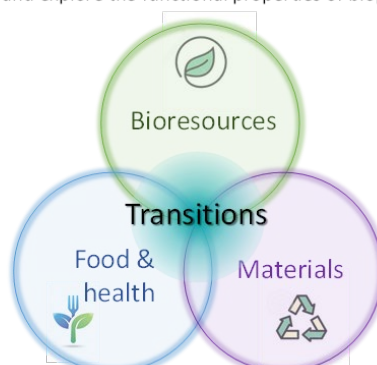
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Practical information

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Monitor and control the quality of bioresources (in particular, plant productions) to optimise their utilization and explore the functional properties of biopolymers



Design future foods while controlling their impact on health (allergenicity, nutritional quality) and the environment

Design biobased materials through an integrated value chain approach

An overview of the research focus and approach of the BIA unit (Nantes, France) of INRAE, the French National Research Institute for Agriculture, Food and Environment.

FQD-0208 M Exploring the added-value of Chinese distilled spent grain through fermentation strategies: the effect on melanoidins

Title	Exploring the added-value of Chinese distilled spent grain through fermentation strategies: the effect on melanoidins
Thesis	MSc
Specialisation(s)	MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Shiqi Yang (PhD)
Co-supervisor	Arnau Vilas Franquesa, Vincenzo Fogliano

Description

Chinese distilled spent grain (DSG) is the biggest by-product in Chinese liquor production which usually thrown away or use for livestock feeding with low value. The bioactive compounds in DSG provide new possibilities for the high value-added utilization of DSG.

Currently, microbial fermentation has proven to be a promising method to obtain bioactive substances like phenols, oligosaccharides, amino acids, etc. and increase the economic value of food waste.

Melanoidins in DSG generated from the Maillard reaction are brown high molecular weight compounds, showing the potential to serve as functional food ingredient due to their various health-promoting properties. Existing methods for extracting melanoidins via aqueous or organic reagents are often inadequate due to the presence of trapped melanoidins in the complex matrix. The microorganisms themselves or through enzyme production could influence melanoidins during the fermentation process, but this effect remains unclear now.

Aim

Investigate the effect of fermentation of Chinese distilled spent grain on melanoidins.

Approach

For this project, we first will apply liquid extraction as a conventional method and compare it to fermentation approach, to understand the applicability of both techniques on the extraction of DSG melanoidins. Subsequently, a comparative study will be conducted on the effect of the DSG melanoidins obtained with or without fermentation, investigating extraction yield, structure, and function. *In vitro* digestive properties and gut fermentation might be included in these comparisons.



FQD-0209 M *In vitro* fermentation of encapsulated hesperetin and quercetin

Title	<i>In vitro</i> fermentation of encapsulated hesperetin and quercetin
Thesis	MSc
Specialisation(s)	MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Xiangnan Meng (PhD)
Co-supervisor	Tamara Hoppenbrouwers, Vincenzo Fogliano

Description

Poor bioavailability of bioactive compounds (e.g., bioactive peptides, polyphenols) in food hinders their application in functional foods. Nanoliposomes (NL) are one of the most applied encapsulation and drug delivery systems. A carrageenan and chitosan coated nanoliposome delivery system (CGN-CH-NL-HST) can protect NL during digestion and improve the bioavailability of hesperetin, but there is still a lot of hesperetin that isn't absorbed, that could potentially be utilized by the microbiome in the colon. However, we do not know how the delivery systems behave when fermented with microbiota, or how microbiota can be influenced by polyphenol delivery systems.

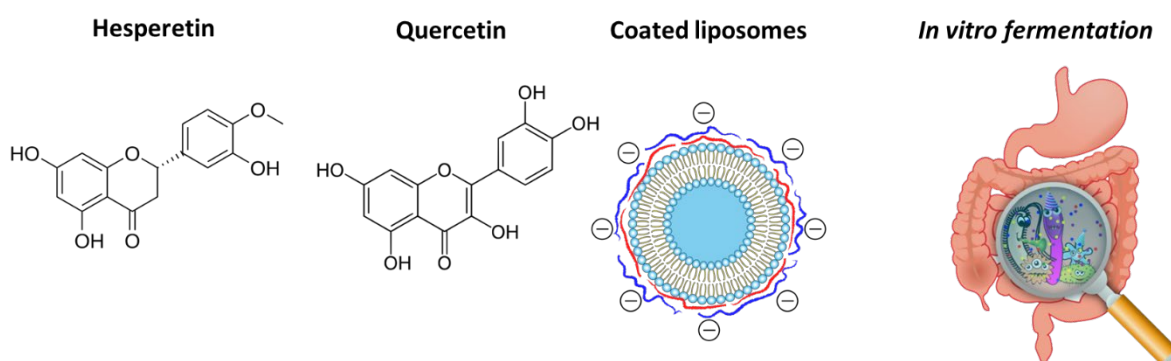
Aim

To study the interaction between delivery systems and microbiota.

Student's activities

- Encapsulation of hesperetin and quercetin into CGN-CH-NL-HST
- *In vitro* digestion
- Perform *in vitro* fermentation (static and dynamic)

In this project, you are going to learn how to use the rotary evaporator, LCMS, and HPLC. You will also have a deeper understanding in simulated digestion and fermentation *in vitro*.

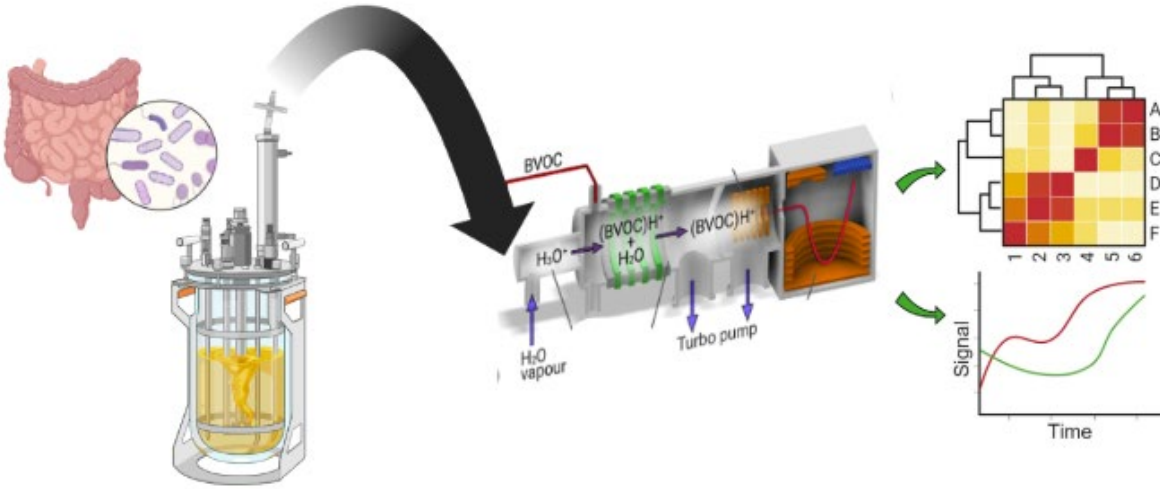


FQD-0210 M Understanding the interaction between fermented foods and the gut microbiota during gut *in-vitro* batch fermentation using non-invasive VOCs monitoring

Title	Understanding the interaction between fermented foods and the gut microbiota during gut <i>in-vitro</i> batch fermentation using non-invasive VOCs monitoring
Thesis	MSc
Specialisation(s)	MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Andrea Dell'Olio (PhD)
Co-supervisor	Vincenzo Fogliano

Description:

The diet shapes the gut microbiota composition and function. Which microorganisms colonize the colon is determined by the composition and diversity of food consumed. Therefore, there is a large interest in adopting dietary measures to improve gut health. The goal is to selectively stimulate the growth and (or) activity of one or a limited number of beneficial bacterial species already resident in the gastrointestinal tract. There is current evidence that frequent consumption of certain fermentable fermented foods results in beneficial effect on gut health due to the production of gut microbiota metabolites (GMMs), such as short-chain fatty acids (SCFAs). In this project an *in-vitro* digestion protocol, followed by *in-vitro* batch fermentations will be used to simulate the colonic fermentation. The study aims to understand how fermented foods exert an effect on the gut microbial metabolic output. The metabolites produced during the *in-vitro* fermentation will be analysed using a noninvasive analytical technique (HS-GC-MS-SPME) to understand which organic volatiles compounds (VOCs) are produced by the gut bacteria upon exposure to the *in-vitro* digested substrate. Are you ready to shape the next generation of functional foods targeting gut homeostasis as the golden standard?



Shanahan, F., van Sinderen, D., O'Toole, P. W., & Stanton, C. (2017). Feeding the microbiota: transducer of nutrient signals for the host. *Gut*, 66(9), 1709-1717.

FQD-0211 M Unlocking the potential prebiotic activity of upcycled Coconut By-Product: An *in vitro* study on infant gut microbiota

Title	Unlocking the potential prebiotic activity of upcycled Coconut By-Product: An <i>in vitro</i> study on infant gut microbiota
Thesis	MSc
Specialisation(s)	MFT: A or E
Prerequisite courses	-
Chair group	FQD
Supervisor	Thisun Ranpatabendi (PhD), Melania Casertano
Co-supervisor	Vincenzo Fogliano

Background

While the demand for coconut-based products continues to rise, coconut processing generates a significant amount of waste in the form of, and defatted coconut flour, coconut testa, and coconut water. The coconut residues after extraction pose environmental challenges and economic inefficiencies, as it is often discarded or underutilized. However, it may be a potential alternative plant protein source to use as a food ingredient to enhance food nutrition and quality.

Many studies have recently focused on plant materials that could potentially be developed into prebiotics for human consumption. The prebiotic potential of upcycled coconut by-products is promising and specifically in the context of infant gut microbiota it can be explored as an alternative to infant formula. The first few years of life play a crucial role in the development of the gut microbiota, which has profound implications for long-term health outcomes. Understanding the effects of coconut by-products on the infant's gut microbiota can provide valuable insights into their potential as a functional food ingredient for early-life nutrition.

Aim

This research attempts to bridge the gap between sustainable food production, gut health promotion, and early-life nutrition. The goal is to develop a functional food for infants by upcycling coconut by product and unveil the optimal trade-off between the functional diversity of the developed functional food, breast milk, and infant formula on the gut microbiota of infants

Approach

In this thesis, the student will mainly work in the laboratory. We might explore some determinants:

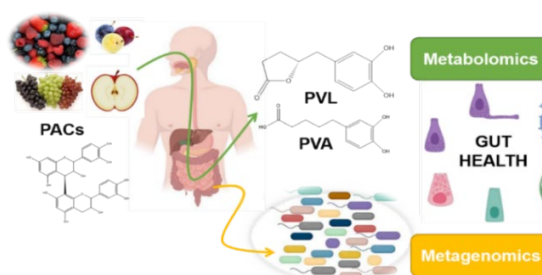
- I. Characterization of the by-product;
- II. Formulation and characterization of the potential functional food;
- III. *In vitro* simulation of the infant colonic fermentation to investigate the potential benefit of the final product on the microbiota

FQD-0212 B/M Understanding of how gut microbial metabolites promote gut health

Title	Understanding of how gut microbial metabolites promote gut health
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Josep Rubert

Description

Dietary patterns, or the food we eat, are the sum of many small molecules foreign to the body. After being ingested and digested, nutrients are altered by the trillions of microorganisms that inhabit our gastrointestinal (GI) tract, shaping the chemical structures of such gut microbial metabolites (GMMs), and thus modifying the lifespan, bioavailability, and biological effects. Indeed, the diet–gut microbiota–host triangle evolves as a promising avenue in preventing GI diseases. If we eat vegetables and fruits rich in PACs, such as apples, pears, stone fruits, cranberries, blueberries, plums, among others, we may have a reduced risk of gastrointestinal diseases. Dietary fiber and PACs reach the colonic region almost intact, undergoing extensive microbial bioconversion, and producing phenyl- γ -valerolactones (PVLs), their derived hydroxy-phenylvaleric acids (PVAs), small phenolic acids, and short-chain fatty acids (SCFAs). These GMMs may play a pivotal role in promoting gut health. However, the type, quantity, and biological activity of GMMs in humans depend on the composition of gut microbiota. For this reason, it is becoming more and more essential to study the gut microbiota function



Aim

This topic aims at studying GMMs, such as PVLs, PVAs, and phenolic acids, and the gut microbiota composition. The interaction between gut microbiota and diet-related compounds (PACs and fiber) will be investigated by combining omics approaches. First, metabolomics will reveal the differences at the GMM level, and sequencing techniques will explore taxonomy and microbial function. This concept will generate and validate microbiome metabolic networks linking GMMs and microorganisms.

Approach

In this research, we will investigate the triangle diet–gut microbiota–host in vitro. Faecal fermentations will be carried out using faecal inoculums. Faecal Batch cultures or SHIME® (Simulator of Human Intestinal Microbial Ecosystem) will be used to mirror the colonic region and investigate biotransformation processes in homeostasis and GI disease. In the slurries, GMMs will be characterized by MS-based methods, and the composition of the gut microbiota will be revealed by metagenomics.

References: Rubert, J. et al. (2020) Intestinal Organoids: A Tool for Modelling Diet–Microbiome–Host Interactions. Trends Endocrinol. Metab. xx, 1–11 DOI:<https://doi.org/10.1016/j.tem.2020.02.004>

FQD-0213 M Are plant-based meat analogues good for your gut microbiota?

Title	Are plant-based meat analogues good for your gut microbiota?
Thesis	MSc
Specialisation(s)	MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Jolien de Boer (PhD)
Co-supervisor	Edoardo Capuano, Atze Jan van der Goot

Description

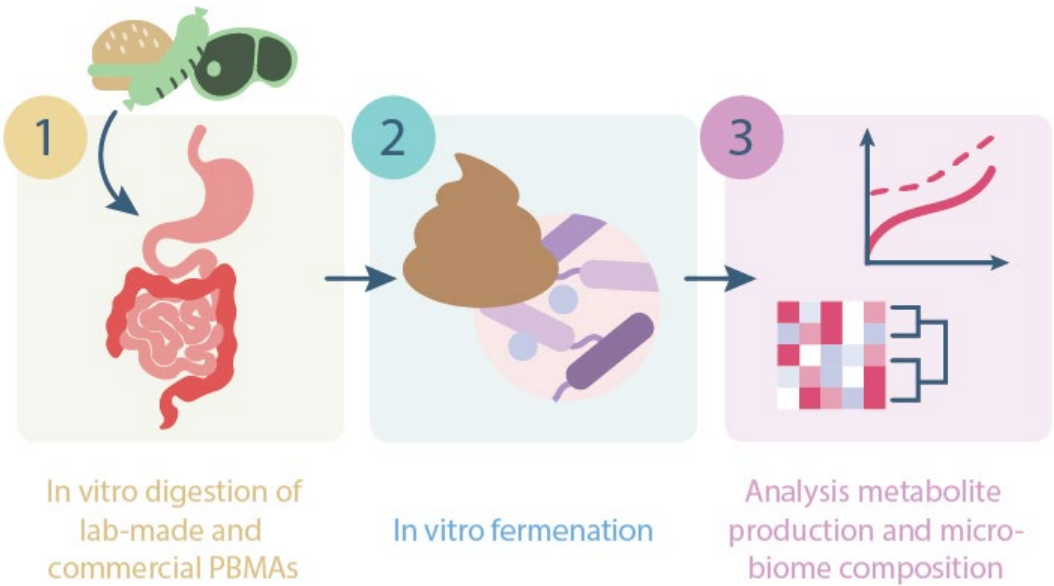
Plant-based meat analogues (PBMA) have found their way into human diets as a result of sustainability and health awareness. However, the impact of PBMA on human health remains relatively unknown, hindering the provision of dietary recommendations. Health- and environmental- related benefits can be gained by evaluating the PBMA processing conditions and their effect on nutritional parameters.

Objective/aim

This research aims to enhance understanding of the health benefits associated with commercial PBMA by investigating their effects on the gut metabolite production and microbial community change. Additionally, we will evaluate the influence of ingredient formulation of lab-made PBMA on these health aspects.

Approach

In this research we will investigate the metabolite (e.g., SCFAs, ammonia, H₂S, TMA) production and microbiome composition during *in vitro* fermentation of commercial and lab-made PBMA. Through comparative analysis with red meat, we aim to contextualize the role of PBMA within a balanced, healthy, and sustainable diet.



FQD-0214 M Influences of Oral Processing behaviour on gut microbiome and metabolites

Title	Influences of Oral Processing behaviour on gut microbiome and metabolites
Thesis	MSC
Specialisation(s)	MFT: A, E, G
Prerequisite courses	-
Chair group	FQD
Supervisor	Zhen Liu (PhD)
Co-supervisor	Josep Rubert, Markus Stieger

Description

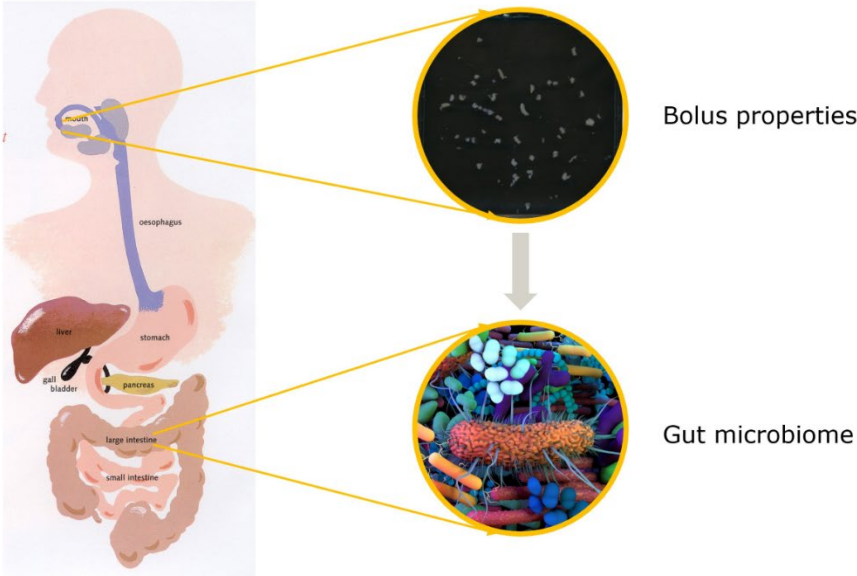
Food oral processing is the initial stage of the digestion process, during which food structures are broken down and lubricated with saliva to form a bolus that is subsequently swallowed and then digested in the gastrointestinal tract. An expanding body of literature indicated that oral processing significantly influences the digestion of food products and therefore plays an important role in determining the nutritional benefits of food. However, the influence of oral chewing behaviour on colonic metabolites and microbiome structure has not been studied, despite its notable effect on dietary intake and food digestion.

Aim

This topic aims to investigate the possible effects of oral processing behavior and the degree of particle size breakdown during mastication on gut microbiome and metabolites.

Activities

Oral processing behaviour, bolus properties analysis, in vitro digestion, in vitro batch fermentation, metabolites analysis, microbiome analysis.



FQD-0215 M Effect of processing on peanuts allergenicity

Title	Effect of processing on peanuts allergenicity
Thesis	MSc
Specialisation(s)	MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Edoardo Capuano
Other supervisors	Stef Koppelman (on behalf of the University of Nebraska, Lincoln, NE, USA)

Background

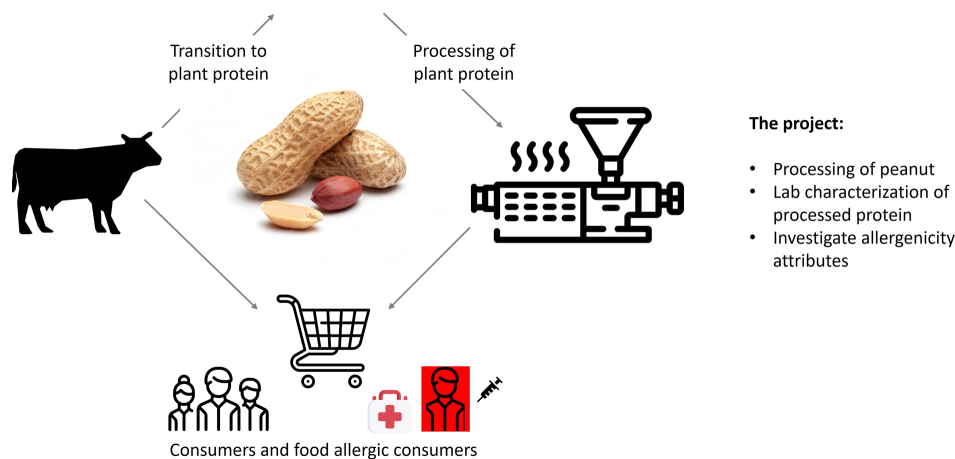
Peanut allergy is a common food allergy, with a prevalence of 1–2% in Western countries and has a major impact on the quality of life of patients. Compared to other legumes, peanut is notorious for its allergenic potency, and it is not completely understood what makes peanut so much different from other legumes, although it is suggested that differences in food processing for different legumes play a role. Indeed, foods undergo various processing steps before consumption that could affect conformation of food proteins, their digestion and thereby allergenicity. With the increasing demand of vegetable alternatives for animal protein, there is a renewed interest in using legume proteins for human nutrition. However, until now, it is risky to utilize peanut as a food ingredient, due to the peanut's extraordinarily allergenicity compared to other plant proteins.

Aim

The aim of the project is to investigate the effect of processing on *in vitro* digestibility and allergenicity of different peanuts allergens.

Student's activities

You will process peanut materials using thermal treatments, extrusion, and shear cell technology. Conditions will be varied to investigate the change in the protein structure induced by processing. You will investigate the protein digestibility of the products using the standardized INFOGEST *in vitro* digestion model mimicking adult gastrointestinal conditions. From different time points of the gastric and intestinal phases of digestion, you will determine the degree of hydrolysis, protein profile (SDS-PAGE), particle size analysis, etc. The University of Nebraska, Food Science Dept and Food Allergy Research and Resources Program (UNL-FARRP) will contribute well characterized peanut allergens as reference materials. UNL-FARRP will also contribute expertise on allergen characterization to demonstrate relevance for peanut-allergic consumers.



FQD-0216 B/M Unravelling the interaction between dietary Advanced Glycation End Products and Intestinal Epithelium and Immune System

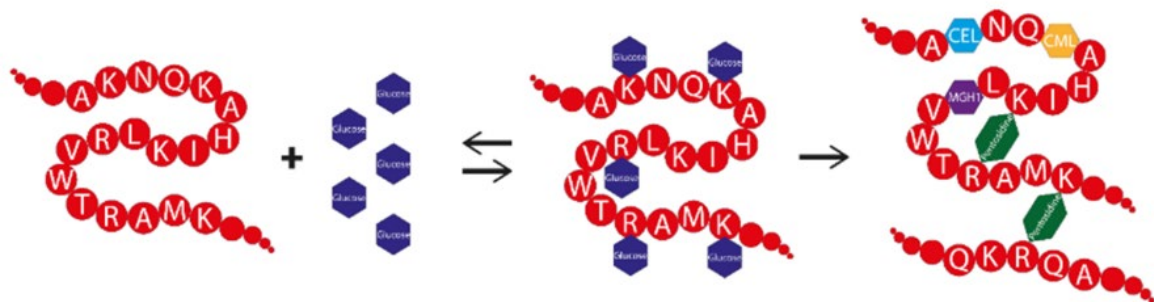
Title	Unravelling the interaction between dietary Advanced Glycation End Products and Intestinal Epithelium and Immune System
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Fleur Jansen (PhD)
Co-supervisor	Josep Rubert / Tamara Hoppenbrouwers

Description:

The Maillard Reaction is a non-enzymatic reaction between proteins and simple sugars, under the presence of heat. This is a widespread reaction in nature and reaction products are formed in our body (endogenously) as well as during food processing (exogenously). These reaction products are called Advanced Glycation End products and research has indicated that, when they are formed endogenously, they are related to age-related diseases (like cataract, neurodegeneration, cardiovascular diseases), hence their abbreviation AGEs. Currently, it is unknown whether the consumption of dietary AGEs affects health as well. Therefore, this project aims to unravel the interaction between these exogenously-formed AGEs and the organ(system) they are in direct contact to: the intestinal epithelium and intestinal immune system. To study this, we use *in vitro* cell culture models.

Aim of the thesis:

The thesis entails unravelling the cellular responses to these compounds in different *in vitro* models (e.g. epithelial cells/immune cells).



FQD-0217 M The effect of omega-3-rich algae oil on the immune system

Title	The effect of omega-3-rich algae oil on the immune system
Thesis	MSc
Specialisation(s)	MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Daniëlle Wessels (PhD)
Co-supervisor	Tamara Hoppenbrouwers, Harry Wichers

Description

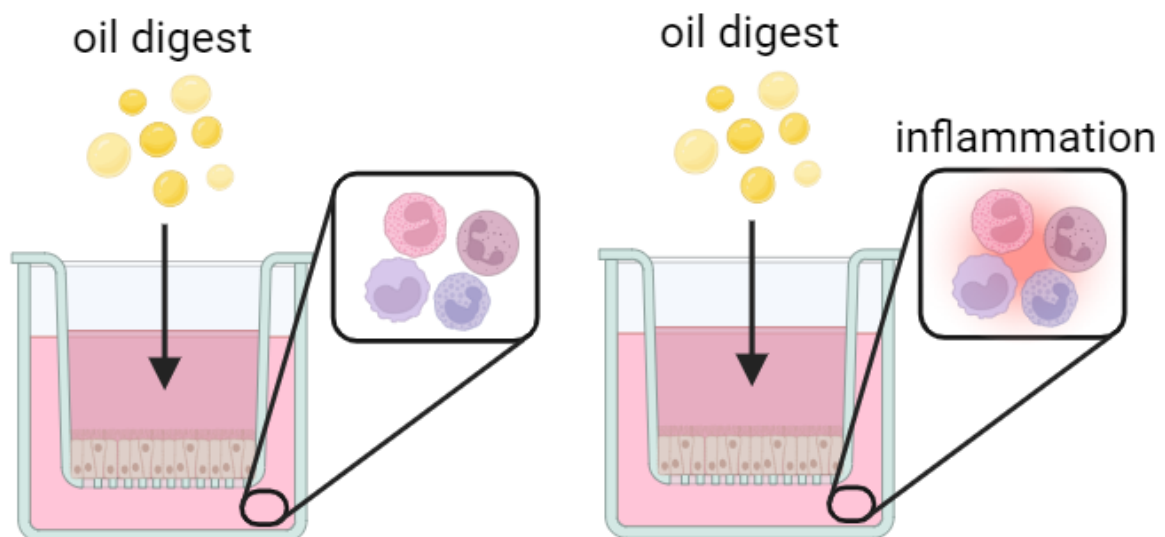
Omega-3 polyunsaturated fatty acids (PUFAs), in particular, eicosapentaenoic acid (EPA; 20:5 ω 3) and docosahexaenoic acid (DHA; 22:6 ω 3), are gaining more and more attention for their potential health benefits. However, the dietary intake of omega-3 PUFAs is low in the general population even more in vegetarians and the intake is typically absent in vegans. The availability of food items fortified with these nutrients would be an excellent opportunity to improve the nutritional quality of vegetarian and vegan diets. Fish oil is the most common natural source of omega-3 PUFAs incorporated into food products. Due to safety and environmental reasons, the use of fish as a source of PUFAs is sometimes questioned and marine microalgae have been proposed as alternative sources of these compounds. However, PUFA, mainly DHA, could be differently incorporated in algae lipids than in fish oils. Little is known so far about the digestibility of oils rich in DHA from different sources. Differently digested lipids could have different effects on health. The health effect that we will look into is the immune response. DHA and EPA are known to have an anti-inflammatory effect.

Aim

The project aims to evaluate the effect of algae and fish oil on the immune response.

Student's activities

The student will get different omega-3-rich algae and fish oils. These can be digested using a standardized INFOGEST protocol and absorbed using a caco-2 cell culture model. Below this Transwell model, immune cells will be cultured, and their response will be measured using ELISA, PCR, flow cytometry, and more.



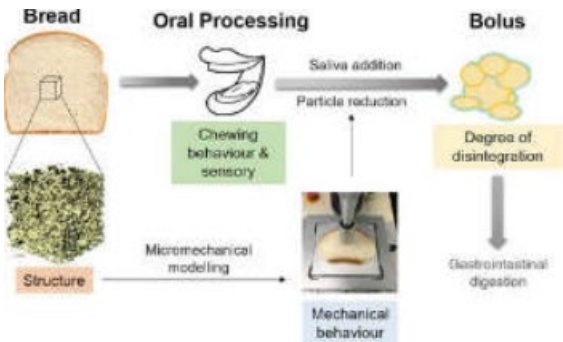
FQD-0218 M Consuming Gluten-Free Breads with Toppings: The role of single food properties in oral processing behavior, bolus properties and sensory perception of composite foods

Title	Consuming Gluten-Free Breads with Toppings: The role of single food properties in oral processing behavior, bolus properties and sensory perception of composite foods
Thesis	MSc
Specialisation(s)	MFT: A, E, G
Prerequisite courses	-
Chair group	FQD
Supervisor	Nicoletta Pellegrini
Co-supervisor	Markus Stieger, Stefano Renzetti

Students must start their thesis at the start of period 1

Description

Gluten-free (GF) breads became more and more popular in the last years. GF-breads are specifically formulated for consumers with gluten-related disorders such as celiac disease. Since GF-breads are perceived as healthier compared to common breads, also part of the general population consumes GF-breads.



GF-breads are formulated with several ingredients that affect their nutritional composition, texture and sensory properties. GF-breads have different visual appearance, texture, flavor, and mouthfeel properties than its gluten-containing counterparts. The sensory properties of GF breads have been studied extensively in comparison to gluten-containing breads and have been related to its nutritional quality, physical-chemical properties and structural breakdown properties during mastication.

GF-breads are typically consumed with toppings such as butter, cheeses or meats. Addition of toppings to breads strongly changes eating behavior of breads, bolus properties and sensory perception. Breads that are perceived differently when consumed by themselves might not be discriminated when toppings are added as toppings can mask flavor and texture defects. Generating knowledge about the eating behavior, bolus and sensory properties of GF-breads with toppings creates opportunities for product optimization and reformulation.

Aim: The aim of the project is to quantify the effect of addition of toppings to GF-breads on oral processing behaviors, bolus properties and sensory perception.

Student's activities: You will work on different formulations of GF-breads in combination with different toppings. You will determine oral processing behaviors of consumers masticating breads using video recordings. You will analyze the physical-chemical properties, particle size, rheological and tribological properties of boli. You will determine the sensory properties of GF-breads in combination with different toppings. You will combine the data sets and reveal whether addition of toppings to GF-breads allows to mask flavor and texture defects. This information is pivotal in reformulating GF-breads with higher consumer acceptance.

FQD-0219 M Exploring the Metabolic Impact of Future Food Processing

Title	Exploring the Metabolic Impact of Future Food Processing
Thesis	MSc
Specialisation(s)	MFT: A, E
Prerequisite courses	-
Chair group	FQD
Supervisor	Hanhong Lu (PhD)
Co-supervisor	Markus Stieger

Description

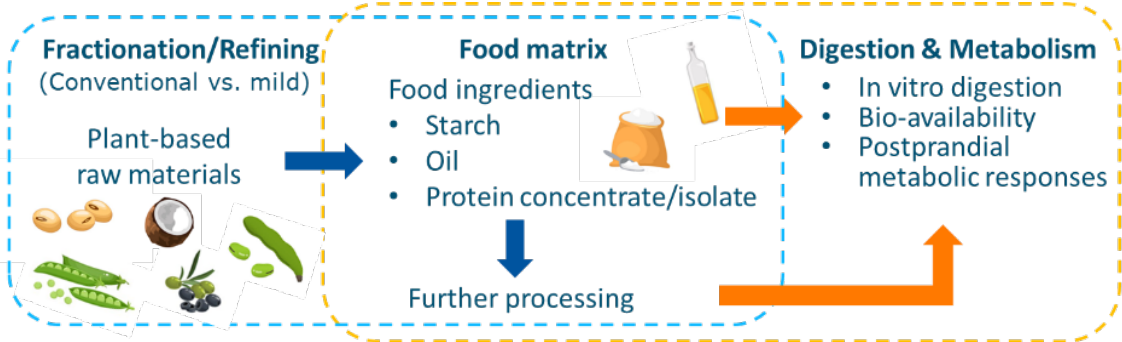
The development of the modern food industry has made safe and affordable food accessible to millions of people, but concerns have been raised about the negative impacts of intensive food processing on human health and the environment. Therefore, mild food processing technologies have been developed as alternatives or complementary methods to conventional processing. Research has shown the benefits of mild processing in both environment and functionality, but knowledge of the effects of different food processing on sensory, digestion, and metabolism is still limited.

Aim:

This project aims to investigate the relationship between degree of food processing, matrices integrity, and the human sensory, digestion and metabolic responses.

Approach:

In this study, the matrix properties of lipids, proteins, and carbohydrates resulting from conventional and mild food processing methods will be characterized and related to human digestion and metabolic responses, which might involve in vitro digestion models.



FQD-0220 M Texture properties, aroma components and sensory perception of snack products

Title	Texture properties, aroma components and sensory perception of snack products
Thesis	MSc
Specialisation(s)	MFT: A, F, G
Prerequisite courses	-
Chair group	FQD
Supervisor	Arianne van Eck
Co-supervisor	Markus Stieger

Description

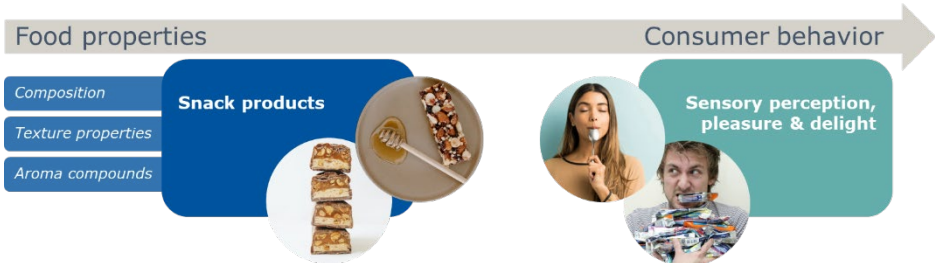
Snack consumption has increased over the years. Snack products are easy to consume and energy-dense; and they thereby contribute substantially to consumers’ daily energy intake. Consumers are nowadays demanding healthier and more sustainable snack products while maintaining sensory pleasure; and the food industry has been launching new snack options by changing the composition and/or other food properties.

This project aims to study product properties (composition, texture, volatiles in headspace) of a broad range of snack products to obtain more insights into which properties drive sensory perception and liking of snacks.

Sensory science is a multidisciplinary research field, and it functions as a bridge between food properties (instrumental analyses) and sensory perception/consumer behavior (sensory analyses). In this project, the instrumental analyses will capture the main composition/texture/aroma differences within the snack category. The sensory analyses will capture the main differences in taste/texture perception within the snack category.

Methodologies:

- Sample composition analyses (water content, fat content, etc.)
- Texture analysis (Texture analyzer)
- Volatiles in headspace (GC-MS)
- Sensory evaluation



FQD-0221 M Understanding juiciness and texture perception in plant-based meat analogues

Title	Understanding juiciness and texture perception in plant-based meat analogues
Thesis	MSc
Specialisation(s)	MFT: A, G
Prerequisite courses	-
Chair group	FQD
Supervisor	Yifan Zhang (PhD)
Co-supervisor	Markus Stieger

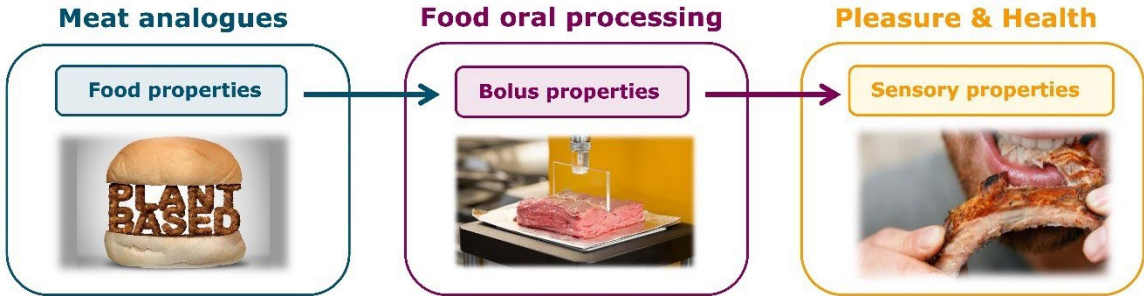
Description

Plant-based meat analogues (PBMA) are food products that are designed to have meat-like characteristics, but no animal-derived ingredients. With the increasing trend of PBMA consumption, consumers complain more and more about unsatisfactory sensory properties of PBMA. A major consumer complaint is the lack of juiciness as one of the main texture drivers for liking of PBMA. There is a lack of knowledge on how to quantify juiciness instrumentally and which food and bolus properties affect juiciness perception. Food oral processing is a research approach that integrates a series of sensorial, physical, physicochemical and oral physiological methods to better understand the food and bolus properties which determine juiciness and texture perception and impact product acceptance.

This project aims to apply food oral processing research methodologies to gain more insights into the mechanism that drive the perception of juiciness and texture in PBMA.

Methodologies:

- Sensory evaluation
- Texture analysis (Texture Analyzer)
- Particle size measurement (Master sizer)
- Bolus properties
- Rheology
- Sample composition determination (water content, fat content)



FQD-0222 B/M The influence of juiciness on flavour release and perception in plant-based meat analogues

Title	The influence of juiciness on flavour release and perception in plant-based meat analogues
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, G
Prerequisite courses	-
Chair group	FQD
Supervisor	Rutger Brouwer (PhD)
Co-supervisor	Markus Stieger

Only choose this topic if you can start with your thesis in July '24 or, at latest, at the beginning of August '24.

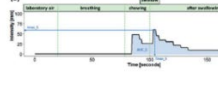
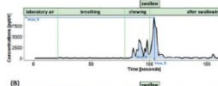
Description:

Plant-based meat analogues (PBMA) are a promising innovation in the food industry. PBMA could help humanity to shift their diets from mostly animal-based towards more plant-based. Such a change would support our climate change goals.

The aim of PBMA is to mimic meat palatability and sensory characteristics, which are some of the most important drivers of meat consumption. However, the meat analogues on the market often fall short when it comes to texture (e.g. juiciness, tenderness, and fibrousness) and flavour (e.g. meat and off-flavours). The fundamental mechanisms behind texture and flavour perception in PBMA are yet to be discovered. Obtaining this knowledge is crucial to improve the sensory quality of PBMA.

This study aims to determine how changes in texture and juiciness of PBMA affect flavour release and perception. In our first study we hypothesize that a higher level of juiciness leads to higher flavour release and more intensive flavour perception. A selection of the following methodologies will be used to conduct this study:

- Instrumental analyses (e.g. Texture, Rheology)
- Static sensory methods (e.g. RATA, QDA)
- Temporal sensory methods (e.g. TI, TDS, TCATA)
- Static head space analyses with GC-MS
- In-vivo dynamic flavour release with PTR-QiToF-MS
- Multivariate data analysis (e.g. PCA)

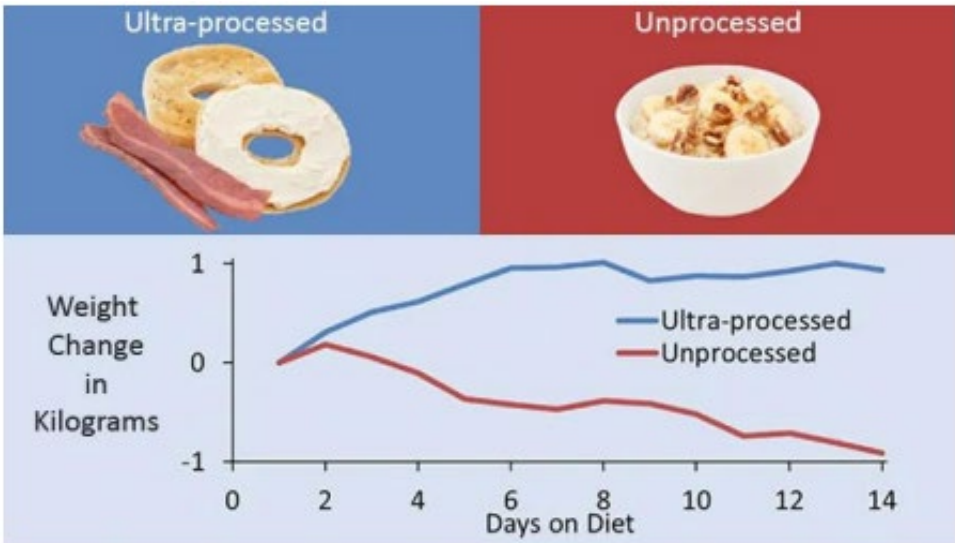


FQD-0223 M Exploring the impact of eating rate on food and energy intake of ultra-processed diets

Title	Exploring the impact of eating rate on food and energy intake of ultra-processed diets
Thesis	MSc
Specialisation(s)	MFT: A, E, G
Prerequisite courses	-
Chair group	FQD
Supervisor	Zhen Liu (PhD)
Co-supervisor	Markus Stieger, Marlou Lasschuijt

Description

Consumption of industrially processed foods has been associated with obesity and related adverse health outcomes. Yet it is unknown what properties of industrially processed foods drive this association. It is hypothesized that the high energy intake of industrially processed foods is caused by their high palatability, energy density, and eating rate rather than by the ultra-processing itself. Extensive research has shown that foods that can be consumed more quickly, lead to higher food intakes and this has been suggested as one of the ways in which processed foods promote excess in calorie intakes.



Aim

The effect of food processing and texture modifications on eating rate, energy intake, body composition, and physiology will be investigated in a cross-over human trial with an ultra-processed slow, ultra-processed fast diet lasting for two weeks.

Student activities

- Performing practical work in an ongoing human intervention trial (this mostly involves providing diets to participants)
- Annotating videos on eating behavior outcomes
- Write a thesis report

Research theme 3 - Quality along the chain

In this research theme, you can find topics that investigate food quality along the supply chain. We investigate various food quality aspects from farm to fork, such as how farming/production practices can influence food quality, how to measure and/or predict and/or monitor these changes using statistical (e.g., advanced modelling and intelligence) and/or analytical tools (e.g., non-destructive sensors, handheld devices, advanced analyses, etc.).

There is increasing pressure on the food industry to become more environmentally friendly and sustainable. This means that changes need to occur at various levels in the supply chain. For example, farming practices can be changed/modified; changes can be made towards more efficient production/processing/storage/transport systems. Packaging design is a crucial component, aiming to create safe and environmentally friendly packaging that extends shelf life and reduces food waste. The goal is to strike a balance between high-quality food preservation and minimal environmental impact. However, there are various challenges that need to be addressed to be able to make these changes. Furthermore, it is of scientific value that we also seek to gain a deeper understanding of how the food product is being influenced. In the bigger picture, the data generated along the chain can also be effectively used to help us address these challenges.

This research theme includes topics that are focused on food and (specifically meat and postharvest) quality and supply chain integrity. We explore how intrinsic quality is influenced by various extrinsic factors such as farming practices, processing, storage, etc. This requires that we characterize the product's quality traits. These quality traits can then also act as a way of ensuring the authenticity and traceability of a product, especially in cases where the final product has an added value, i.e., organic, free-range, etc. In the past, a series of food fraud incidents have occurred (i.e., melamine, horse meat, organic eggs, cardboard stuffed dumplings) that demonstrate the vulnerability of the food systems. Hence, together with understanding the quality traits, we investigate ways to develop and validate methodologies to

ascertain food authenticity. Mathematical modelling plays a significant role in this research theme, aiming to describe and predict the physical and chemical processes occurring throughout the food production and consumption chain. This provides valuable insights into the underlying mechanisms governing these processes, from production to home processing and consumption.

Research Theme 3 is a comprehensive exploration of food quality and supply chain integrity, addressing the complexities of sustainability, packaging, authenticity, and the physical and chemical phenomena driving food processes. It aims to contribute to a more sustainable and transparent food supply chain while enhancing food quality and safety.

FQD-0300 B/M Exploring Maillard reaction in Fully Aqueous Emulsions

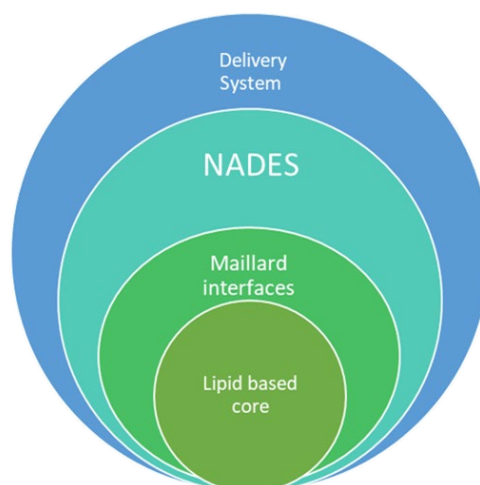
Title	Exploring Maillard reaction in Fully Aqueous Emulsions
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Kangni Chen (PhD) (kangni.chen@wur.nl)
Co-supervisor	Antonio Dario Troise & Ashkan Madadlou

Description:

Liquid-liquid (L-L) droplet reactors conventionally comprise aqueous-organic solvent pairs. This enables reacting immiscible partners of a reaction at the aqueous-organic interface. However, environmental and consumer concerns associated with the use of organic solvents and synthetic low-molecular weight surfactants in the conventional L-L droplet reactors encourage scientists/industry to develop alternative tiny reactors.

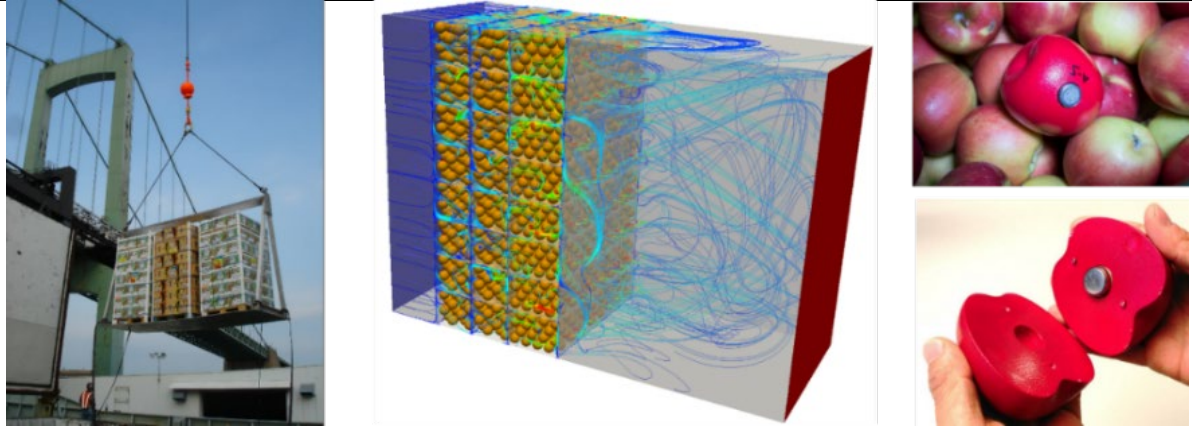
Fully aqueous droplet reactors (FADR) fabricated through miniaturizing aqueous two-phase systems (ATPS) to all-aqueous (water-in-water) emulsions in either microfluidics or bulk scales are considered green, inexpensive, and rather sustainable options for accomplishing a diversity of reactions between water-soluble substances. Comparable to aqueous-organic droplet reactors, FADR compartmentalize reactants in discrete phases. The spatial distribution of reactants can be crucial when dealing with yield and the concentration of the end-products of the Maillard reaction.

In the current project, W/W emulsion and natural deep eutectic solvents (NADES) will be used to develop miniaturized reactors to run and investigate the early stage of the MR, with the formation of Amadori compounds and the advanced stages. To find suitable NADES, various types of NADESs (e.g., betaine: sucrose and betaine: glycerol) and PEG will be used to prepare ATPS. The preparation method of NADES-based ATPS will be developed. The partition coefficient of NADES components, amino acids, and reducing sugars will be measured and putative interaction between NADES and Maillard precursors will be outlined as well. Cloud point method will be chosen to determine the phase diagram and binodal line.



FQD-0301 M Digital, physical, and emulated-twin modeling tools to optimize fresh fruit cold chains from tree to table

Title	Digital, physical, and emulated-twin modeling tools to optimize fresh fruit cold chains from tree to table
Thesis	MSc
Specialisation(s)	MFT: A, MFQ: A, B
Prerequisite courses	- Recommended courses: Predicting Food Quality (FQD31306)
Chair group	FQD
Supervisor	Thijs Defraeye
Co-Supervisor	Taylor Person, Elisabeth Tobler
<p>Description Optimizing cold chains of fruits across all unit operations is of crucial importance to maintain fresh food quality and reduce food losses. Temperature and the gas composition in the air affect decay and fruit quality, so they need to be controlled during precooling, refrigerated transport, and cold storage. By optimizing these environmental parameters, shelf life can be maximized. Currently, extensive monitoring of the environmental conditions in food supply chains (air temperature and humidity) is performed. However, this information is not yet optimally used to quantify how the fruit feels and how its quality evolves throughout the cold chain.</p> <p>Aim In this project, we look to use a sensor data to better predict how the life of each fruit and vegetable in a refrigerated container, truck or cold storage room. For that purpose, we develop different types of twins of the cargo:</p> <p>Digital twins (Figure – middle) that rely on measured air temperature and humidity data in fruit cold chains by commercial sensors. These data are fed into physics-based models to provide theoretical estimates of key performance indicators such as average cargo temperature, mass loss, and remaining fruit quality at the end of the chain. We upcycle the temperature-time data to obtain quality decay data as a function of temperature. These digital twin models entail computational fluid dynamics (CFD) simulations of airflow and heat transport in these cooling units.</p> <p>Physical twin sensor systems (Figure - right) that measure all relevant metrics that affect fruit quality evolution, such as pulp temperature, surface temperature, surface condensation and humidity, and acceleration. These sensor systems are integrated into a biomimetically engineered artificial fruit to have the same response as a real fruit.</p> <p>Emulated twin setup in the lab, where the measured physical twin environmental conditions in a real supply chain are mimicked in a lab environment, enabling experiments evaluating fruit quality over time in a controlled environment.</p> <p>The choice between the type of twin that is focussed on depends on the available supply chain contacts at hand.</p>	



Approach:

The approach in this project is to develop and test one of these twin concepts further for use in commercial cold chains and analyze data. Afterward, you use the twin to optimize fresh fruit supply chains.

With this thesis, you will learn a variety of modeling or sensing tools largely used in the twin domain.

Further background information on the research at the partner institute (Empa) for this project can be found on our website (<https://www.empa.ch/web/simbiosys>).

FQD-0302 B/M Changes of nutrients and phytochemicals during processing of fruit and vegetables

Title	Changes of nutrients and phytochemicals during processing of fruit and vegetables
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Matthijs Dekker

Description

Fruit and vegetables are an important part of a healthy diet. During processing and preparation of these foods changes in the nutrient and phytochemical composition occurs that are related to the health benefits and also other quality attributes like sensory quality.

Previous research has shown that the retention of compounds in plant tissues depends on reaction rates of formation or degradation of certain compounds and on the cell lysis and leaching. Different plant structures and different processing methods will have an effect on these mechanisms and thus on the retention of the compounds. In this topic you will study the changes in the content of certain nutrients (e.g. vitamins) or phytochemicals (e.g. carotenoids, flavonoids) This research is partly experimental and can be extended with applying kinetic modelling of the analytical data to get more insight and to quantify the effects.



FQD-0303 B/M Food packaging – Sustainable package design

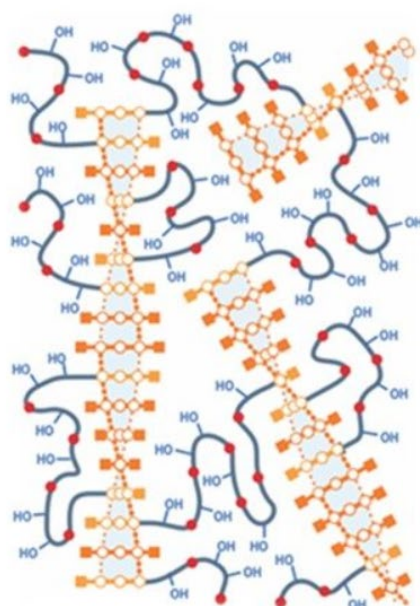
Title	Food packaging – Sustainable package design
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, B
Prerequisite courses	-
Chair group	FQD, ORC
Supervisor	Deniz Turan-Kunter, Maarten Smulders

Description

Packaging is essential to preserve the food quality and safety during storage, improve shelf-life and decrease food waste. However, because optimal protection is still attained using plastic materials, food packaging contributes in a significant way to environmentally persistent plastic waste and microplastic pollution. Sustainable, recyclable biodegradable packaging materials are seen as the solution in agendas such as the EU Circular Economy strategy. However, these materials do not provide sufficient barrier properties against gases such as water vapor and oxygen, which prevents their broad application in food packaging.

Tailoring chemical structure of biopolymers aiming to achieve oxygen/water vapor barrier-mechanical balance without sacrificing the biodegradability is very challenging. Therefore, this thesis study aims towards a new class of recyclable and/or biodegradable barrier material and testing the package performance for preserving the food quality. This research will produce a new generation of barrier coatings, presenting a solution to the problem of sustainable food packaging, and generate new designs for further research in the field of bio-polymer synthesis.

High-Barrier Material



Design Criteria:

- soft,
- bio-sourced, biodegradability,
- barrier properties,
- thermomechanical properties, self-healing



Figure 1. The structure and design criteria of the polymer to be used as novel food packaging

Activities

You will perform a combination of literature research, laboratory research (including polymer synthesis) and data analysis.

FQD-0304 B/M Food packaging – Enhancing shelf life

Title	Food packaging – Enhancing shelf life
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, B
Prerequisite courses	-
Chair group	FQD
Supervisor	Deniz Turan-Kunter

Description

Food loss and waste is a big problem for environmental, economic, and food security reasons. Annually, one third of the globally produced food for human consumption (1.6 billion tonnes) gets lost or is wasted although 81% of the amount is still in an acceptable conditions for human. Enhancing the shelf life is one way of preventing food to expire before consumption. Poor packaging materials or inadequate packaging can lead to product spoilage, reduced shelf life, or product recalls. Therefore, understanding the complex interactions between physiological response of individual food produce and optimum packaging/storage system design is one of the keys to achieving the sustainable food supply. Every supply chain comprises a different combination of unit operations, and unique logistic and environmental boundary conditions. In this sense, every supply chain has different packaging requirements. Better knowledge of the effects of different and dynamic conditions in the chain can help to better define the shelf life of products compared to a worst case scenario.

Activities

You will perform a combination of literature research and laboratory research, data analysis and possibly mathematical modelling.



FQD-0305 B/M Food packaging – Optimising logistics

Title	Food packaging – Optimising logistics
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, B, MFQ: B
Prerequisite courses	-
Chair group	FQD
Supervisor	Deniz Turan-Kunter

Description

One third of the food that is produced worldwide is lost or wasted (FAO 2013). The causes of food losses and waste in medium and high-income countries mainly relate to consumer behaviour as well as to a lack of coordination between different actors in the supply chain. In this thesis you study how real-time information on actual product quality can be combined with logistics decision-support models to improve the performance of food supply chain logistics. The information about food quality gained from sensors from intelligent packaging or packaging real-life data-driven approach can be incorporated in quality change models during the complete distribution process leading to knowledge on the product quality status at its finally destination. This information from intelligent packaging or data-driven modelling might help to optimize supply chain management in order to reduce waste or increase sales. Factors to study in the models are food waste, costs, shelf life, end quality, packaging type, product prize, logistic actions and perhaps sales strategy (e.g. FEFO).

Activities

You will perform a combination of literature research, data analysis, machine learning and mathematical logistics modelling.



FQD-0306 B/M Dynamics and diversity of microbial contaminants on pig carcasses

Title	Dynamics and diversity of microbial contaminants on pig carcasses
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Sara Erasmus (sara.erasmus@wur.nl) Ireoluwa Isaac-Bamgboye (PhD) (ireoluwa.isaac-bamgboye@wur.nl)

Introduction

One of the meats that is most commonly consumed worldwide is pork, which is produced from domestic pigs. It's well-known for its rich flavor profile and versatility in the cooking process, working well with both fatty and lean dishes like bacon and tenderloin. Pork is a good source of iron, zinc, and thiamine, among other important vitamins and minerals, as well as protein. A major threat to safety and quality during the processing of pork meat is microbial contamination of pig carcasses. It is essential to understand the dynamics and diversity of these contaminants, to put control measures in place that effectively reduce the risks associated with foodborne illnesses. Your task will be to investigate the distribution, frequency, and levels of contamination of pig carcasses, compare them across different processing stages, and understand their origin, and mode of transference across each processing stage.



Aim

This topic aims to determine various types, distribution, and levels of microbial contaminants in pig carcasses at each processing stage, and identify the high-risk (critical control) points, where microbial contamination is most likely to occur during processing.

Research activities

Collection of samples from pig carcasses during various stages of processing, such as pre-slaughter, slaughter, evisceration, and chilling in a slaughtering plant.

Using microbiological, molecular, and culture-based methods to identify and quantify microbial contaminants.

Analyzing how the processing environmental variables (temperature, humidity, and hygiene standards) affect the dynamics of microbial contamination.

Use statistical analysis to determine whether environmental factors, microbial loads, and processing stages are correlated.

Approach

The work will focus on investigating a complete slaughtering process which will be carried out in a pig processing plant. The focal point is to identify the critical control points associated with microbial contamination and understand its origin and transference across the slaughtering line.

The experiments will be carried out at Marel and/or Wageningen University. The topic is for students who would like to expand their understanding of laboratory techniques, meat quality, and industry interaction.

FQD-0307 B/M Does a happy animal equal quality meat?

Title	Does a happy animal equal quality meat?
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Sara Erasmus (sara.erasmus@wur.nl) Seren Yigitturk (PhD) (seren.yigitturk@wur.nl)

Introduction

Meat is one of the food sources with a high nutritional value. As for any food product, a high quality is important for consumers. The **major components determining high quality meat are: yield and gross composition** (i.e., quantity of saleable product, ratio of fat to lean, muscle size and shape); **appearance and technological characteristics** (i.e., fat texture and colour, amount of marbling, chemical composition, colour and water holding capacity); **palatability** ('organoleptic quality and/or 'sensorial features') (i.e., texture and tenderness, juiciness, aroma and flavour); **wholesomeness** (i.e., nutritional quality, chemical safety, microbiological safety); **ethical quality** (i.e., acceptable husbandry of animals, welfare).

The abovementioned properties are referred to as 'intrinsic quality', associated with extrinsic factors that define the way the meat is produced. Some of these factors, like animal husbandry (e.g., breeding, feeding, management), are well-known to affect the intrinsic quality of meat, whereas the influence of others like ecological sustainability of production systems are less known. This is largely since the latter has only recently started to gain more momentum with the need to switch to more sustainable systems. Although the intrinsic quality of meat is important, there is increasingly more attention being placed on the extrinsic factors and how they link to the demands of society, and how they offer the prospect to develop consumer-led meat products and more market segmentation. With the **demand for more sustainable animal husbandry practices**, there is great pressure to produce meat that is still of high quality. Extensification is seen as a more 'sustainable' system with increased animal welfare. Hence, it is vital to explore the effect of 'extensification' on meat quality.

Your task, in line with the H2020-FNR-05 European mEATquality project, would be to distinguish the importance of factors determining fresh **pork and poultry** meat quality.



Aim

The aim of the topic is to assess the intrinsic quality of meat obtained from **pigs and broilers** produced under varying husbandry conditions. A main task will be to assess the **intrinsic meat quality in relation to extensive husbandry factors**.

Approach

Perform a literature review and patent search to gather state-of-the-art information on the relationships between husbandry practices (i.e., extrinsic factors), intrinsic product quality (i.e., nutritional value, organoleptic quality, fat/lean ratios and sensorial features) and/or meat authenticity for pork and broiler meat. At the start of the thesis, together with the supervisor, a decision will be made about the approach (intrinsic quality) and type of analyses to focus on. Based on literature and standard practice, a standardised protocol to assess the intrinsic quality of the meat samples will be developed and used for the intrinsic quality testing.

Intrinsic quality testing: Perform basic (pH, temperature, drip loss, cooking loss, texture, colour, moisture, protein and fat measurement) and advanced analyses (i.e., fatty acids, volatiles, muscle fibre, etc.) on meat samples from different production systems to determine the effect of production on meat quality.

Important questions to consider:

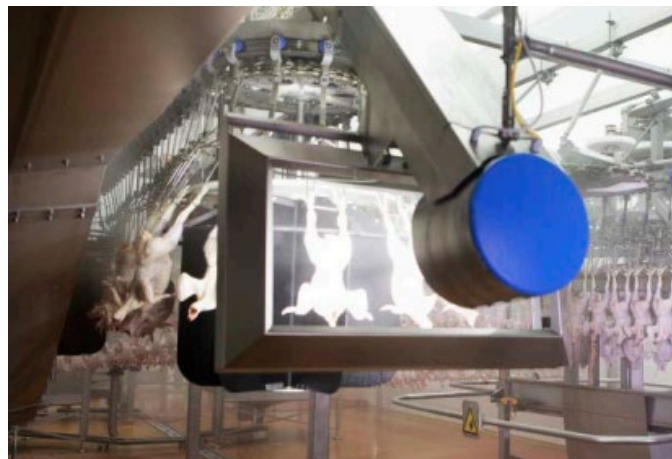
- What is the effect of “extensification” on meat quality?
- Are these effects positive or negative?
- Can these effects be used to differentiate the products originating from different systems?
- Can we identify reliable indicators for evaluating meat quality?

FQD-0308 B/M Sensing meat quality towards consumer appreciation

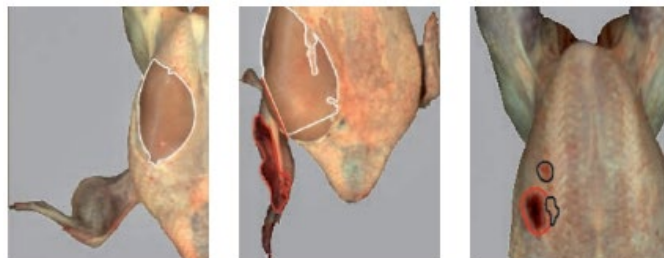
Title	Sensing meat quality towards consumer appreciation
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Sara Erasmus (sara.erasmus@wur.nl)
Co-supervisor	Patricia Hoekstra (Marel/ADP, Patricia.Hoekstra@marel.com)

Introduction

The advancement of sensor technology has provided the opportunity for rapid and non-destructive measurements of food products inline, especially within the meat industry where, for example, spectral imaging of animal carcasses has allowed its accurate, objective, and rapid classification. Additionally, it also permits processors to decide how meat from the carcass should be further processed. A next step is to implement sensors that can measure meat quality parameters that are relevant to and appreciated by consumers, and valuable to retailers. However, this is not a simple process as one needs to establish which quality parameter(s) are of importance (influenced by husbandry factors, appreciated by consumers and valuable to retailer) and if the parameter(s) can be measured with a sensor.



The IRIS system in the defeathering line (picture: copyright belongs to Marel)



An example of how the IRIS system operates in the distribution line (picture: copyright belongs to Marel)

As part of the H2020-FNR-05 European mEATquality project, Marel will explore the feasibility of integrating sensors for inline measurements of broiler/pork meat quality parameters relevant to consumers, and valuable to retailers. The project consists of five activities: 1. sensor selection; 2. sensor feasibility; 3. offline feasibility tests; 4. inline data collection; 5. data analysis.

Note: the specific thesis approach will depend on the project stage.

Activity 1: Relevant extrinsic factors (diet, breed, etc.) and the analytical/sensor techniques used to detect effects on meat quality have been established. The next task is to validate the primary functions of the sensors and the suitability of the sensor(s) for the measurement of the intrinsic meat quality parameter(s). Standard operating protocols will be developed regarding, for example, carcass weights and images as well as utilization of currently existing technologies. These are likely to include the Intelligent Reporting, Inspection and Selection (IRIS) system and the unique inventory control software system (INNOVA) of Marel.

Activity 2: The feasibility of conducting the measurements with variable conditions in the plant (temperature, humidity, vibration, etc.) and inline (carcass speeds, sample sizes, data handling, etc.) will be determined. An important aspect is to concretize the exact measuring locations. Therefore, sensor validation will be performed on the technical capabilities/specifications, as well as on data accuracy and/or reliability to ensure that the sensors are capable before going inline. Ultimately, the data quality will be validated.

Activity 3: The functionality of the new sensor technologies in offline situations will be established. The main relevance for this step is to establish a complete data package, generated to be sufficient for actual data analysis, prior to generating inline data sets. Fieldwork will be conducted at a Marel customer who already has IRIS and INNOVA. Initial tests will be done on two broiler flocks ($n \geq 100$ birds/flock) produced under two different husbandry conditions, ages, or DNA-type (i.e., breed, organic vs. conventional, etc.). This will be followed with a final evaluation of sensor feasibility for inline circumstances.

Activity 4: Continuous inline data collection and feasibility tests (field work) for two scenarios: poultry processing with low-medium volume (field work: round one of poultry processing line tests) and poultry processing with high volume (field work: round two of poultry processing line tests) will be conducted. Marel customer's processing facilities are envisioned to be the location for these tests for both rounds.

Activity 5: The data will be anonymised and prepared for analyses.

Aim

The aim of this topic is to explore the feasibility of integrating sensors for inline measurements of broiler/pork meat quality parameters relevant to consumers, and valuable to retailers.

Approach

The work will focus on sensor testing offline (can be done at Marel) and establishing the best configuration of the sensor test setup.

- The focus is on creating the best possible test setup for measurements.
- Aspects such as distance to the product, incidence of light, selection of the right nozzle, type of background, etc. will be tested (sensor dependant).
- Calibration of the sensor vs. the meat quality parameter(s) being measured (e.g., colour and/or texture measurement).
- Gathering actual measurement data, analysing the data, and writing the report.

The next step of the work (thesis that follows on the previous) will focus on inline measurements at a poultry/pig processing plant.

The experiments will be executed at Wageningen University and/or Marel lab in Boxmeer. The assignment is for students interested in implementing and broadening their knowledge of food/meat quality, laboratory techniques, and interaction with the industry.

FQD-0309 B/M Exploring the potential of spectral imaging to address food quality and/or authenticity challenges

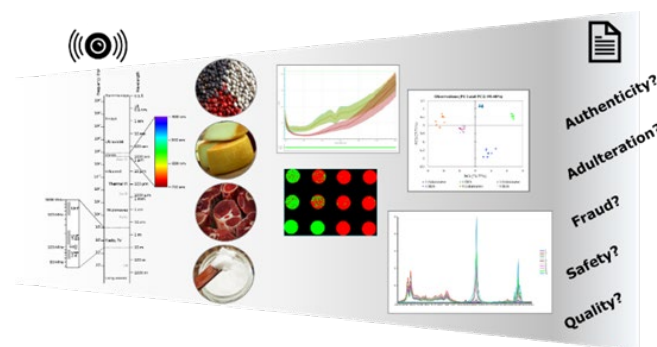
Title	Exploring the potential of spectral imaging to address food quality and/or authenticity challenges
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	-
Chair group	FQD
Supervisor	Sara Erasmus (sara.erasmus@wur.nl)
Other supervisor(s)	Joseph Peller (Plant Science Research, joseph.peller@wur.nl)

Introduction

The advancement of technology enables scientists to actively address food quality and authenticity challenges through the development of innovative analytical techniques. The food industry is implementing these advances and techniques into their production systems to stay up to date and improve product quality, authenticity, safety and nutrition. In addition, if a technique could replace or reduce the usage of traditional methods it is always advantageous to explore. Spectral devices (spectral imaging) are increasingly used as rapid, objective and non-destructive analytical tools instead of expensive, invasive, time-consuming and destructive traditional laboratory techniques. Various applications still require research for these techniques to be used successfully in the industry. Hence, it is important to explore the use of spectral imaging in the food industry to address food quality and authenticity challenges.

Aim

The aim of the study is to explore the use of spectral imaging (i.e., near-infrared spectroscopy, (hyper)spectral imaging, Raman spectroscopy, etc.) to study the quality (including safety and nutritional aspects) and/or authenticity of food products.



Approach

Use spectral imaging (or sensor technology) to solve quality-related issues for various food products, for example:

- Meats: to examine different animal muscle cuts and meat products.
- Oils and fats: for detection of virgin coconut oil adulterated with palm oil/lard.
- Dairy products: to examine and monitor quality issues regarding cheese, infant formula or yogurt.
- Spices: detection of the foreign biological material (adulterants) in spices.

Note: the food products can vary and will be decided when the student starts with the topic.

Research theme 4 – Consumer

Consumer research

The way consumers perceive food quality is an essential factor to predict the acceptance and so the success of products. Thus, researching the food quality perception provides useful information both when launching new products (also conventional product added with unconventional ingredients) and when predicting the future purchase of well-established products.

Moreover, in the production and supply chain, the overall quality of food products is controlled to keep them at an optimal level. However, after a product is purchased by consumers, we lose control over how the product is handled (storage, preparation, consumption).

In this research theme, you can find topics in which researchers perform observations and have to ask questions to consumers using interviews and questionnaires to acquire knowledge to be able to anticipate consumers' behaviour and design food accordingly. Therefore, the majority of the following topics request as recommended course Qualitative Consumer Research in Food Design (FQD24806).

FQD-0400 B/M Consumer Behaviour and Food Quality

Title	Consumer Behaviour and Food Quality
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	Qualitative Consumer Research in Food Design (FQD24806)
Chair group	FQD
Supervisor	Bea Steenbekkers, Pieter Groen (PhD)

Description

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. Students BSC AND MSC can also focus on consumer perception, understanding and/or acceptance of new products and/or ingredients and assess best ways to inform consumers about this. 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.

Students are also invited to define a topic of their own interest in which food products/ ingredients and food quality is studied from the consumer perspective.

FQD-0401 M Children's perception of plant-based food alternatives

Title	Children's perception of plant-based food alternatives
Thesis	MSc
Specialisation(s)	MFT: A
Prerequisite courses	Qualitative Consumer Research in Food Design (FQD24806)
Chair group	FQD
Supervisor	Lotte Pater (PhD)
Co-supervisor	Bea Steenbekkers

Description

The shift of consumption from animal- to plant-based food alternatives is one of the major food-related challenges in the coming decades, considering the negative impact of animal-based food production and consumption on the environment, animal welfare and human health. Plant-based alternatives have the potential for mainstream acceptance and consumption but will only become part of consumer's habitual everyday diet when they provide a rewarding product experience and are accepted.

Families could play an important role in the mainstream acceptance and consumption of plant-based alternatives. Food perceptions and preferences of children are of great influence on parents' food choice and children can have a promising influence on the consumption of plant-based alternatives of the whole family. Attempts to understand consumer acceptance and to direct consumers towards plant-based alternatives has limited potential unless children are convinced to eat those alternatives. As children have a pivotal role as actors of environmental change, starting at the dinner table, a deep understanding of children's perception of plant-based alternatives is needed to effectively transit from an animal- to a plant-based diet.

Aim

The aims of this project are:

- to understand children's perception of plant-based food alternatives and the influence of product-related and context-related factors on this perception.
- to understand children's influence on plant-based food perception and choices within the household
- to develop an innovative qualitative mixed method design for investigating children's perception in a more accurate and valid way.

Different traditional and novel qualitative research methods can be used, applied and evaluated to enhance the effectiveness of qualitative research in understanding children as a target group. Creating a deep understanding on children's perception of plant-based food alternatives enables the development of plant-based alternatives that better fit children's needs and wishes, for current and future plant-based food innovations.



FQD-0402 M Acceptance of edible insects by school children: A cross-country study

Title	Acceptance of edible insects by school children: A cross-country study
Thesis	MSc
Specialisation(s)	MFQ: C, MFT: G
Prerequisite courses	Qualitative Consumer Research in Food Design (FQD24806)
Chair group	FQD
Supervisor	Maryia Mishyna; Lotte Pater (PhD)
Co-supervisor	Jatziri Mota Gutierrez (University of Turin) Claudio Forte (University of Turin)

Description

Tactile stimuli with food have been demonstrated to be an alternative strategy to reduce children’s natural neophobic reactions. In light of the growing demand for alternative protein sources, edible insects have been promoted as a nutritious and sustainable source of protein. However, many consumers are still unwilling to eat insects due to the perceived disgust of insects and the neophobia with regard to insects.

The present project aims to evaluate the effect of involving children in cooking activities, including tactile interactions with edible insects, on their willingness to taste and on their hedonic response to foods containing insects. The study will be done as a comparison between two countries: the Netherlands and Italy.

Tactile interactions with two types of insects (grasshopper and mealworm) will be designed and incorporated into the cooking activities, where children will evaluate their hedonic responses to insect-based snacks that will be either self-cooked during cooking activities or commercialized products. Children aged 9 to 11 years old will be recruited from local schools in Turin, Italy and Wageningen, the Netherlands.

Activities to be performed by the student will comprise:

1. Food preparation and cooking activities required for the workshops both in the Netherlands and Italy;
2. Collect and prepare an interactive presentation for children about the benefits of insects and their use as foods information (lecture)
3. Assistance during the cooking activities, hedonic test and lecture which will be provided at the beginning of each workshop;
4. Collecting and analysing data

The project will involve interaction with children in their mother tongues, therefore it is mandatory to have proficiency in Dutch and/or Italian languages. Also, the project will require a student to apply for Erasmus Grant and stay at least two months in Turin, Italy.



FQD-0403 B/M Consumer Perception of Hybrid Meat

Title	Consumer Perception of Hybrid Meat
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A
Prerequisite courses	Qualitative Consumer Research in Food Design (FQD24806)
Chair group (initials)	FQD
Supervisor	Pieter Groen (PhD)

Description

The production of meat is negatively linked to environmental problems like pollution, animal welfare, deforestation, depletion of natural resources, etc., while on the other hand the overconsumption of meat is related to public health issues like cardiovascular diseases, diabetes and colorectal cancer. To move consumers to a more plant-based diet, many meat substitutes are launched on the market, especially meat analogues that mimic the appearance, taste and texture of animal meat. Although consumers show a general interest to consume alternative protein sources, research shows that the actual meat consumption per capita (NL) is still growing. Actual consumption of meat substitutes/analogues remains low, which suggests that the products that enter the market do not (yet) meet consumers' expectations.

A growing trend in both research and society is that of **hybrid meat**: a product consisting of both 'real' meat and more sustainable plant-based ingredients. With hybrid meat products one could aim to decrease consumers' meat consumption without cutting it completely from their meals. Such products might convince regular meat eaters to consume less meat.

Research on consumers' perception of hybrid meat products is still very limited. There are several aspects within this topic that could be interesting to study. For example regarding perceptions of different 'type of consumers' (e.g. omnivores, flexitarians, etc.). Or more related to the composition of the product: what type of meat and plant-based ingredients, and in what ratio? It might also be interesting to study how such products should fit in a consumers' diet, how it has to be named or categorized, etc.

So the exact research question can be decided upon in collaboration with your supervisor.



FQD-0404 B/M Consumer Perception & Co-Creation of ‘Authentic Vegetarian Meals’

Title	Consumer Perception & Co-Creation of ‘Authentic Vegetarian Meals’
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, MFQ: C
Prerequisite courses	Qualitative Consumer Research in Food Design (FQD24806)
Chair group (initials)	FQD
Supervisor	Pieter Groen (PhD)

Description

One of the main societal challenges nowadays is to shift the production and consumption from animal proteins to plant-based proteins, since the production and (over) consumption of meat is negatively linked to environmental problems and public health issues. Various strategies are used to direct consumers towards a more plant-based diet, with a main strategy being the development of substitute products that mimic the appearance, taste and texture of animal meat. The actual consumption of these products however remains low, resulting in an actual meat consumption that remains (too) high.

In scientific literature much attention is being paid to the consumer perception and acceptance towards single meat substitute products, while it is just as important to study the meals in which these substitute products are used. Recent qualitative research amongst flexitarian consumers even suggested that those consumers who successfully lowered their meat consumption in the main meal, mainly did so by reformulating their entire meal composition instead of substituting meat. These consumers talked about ‘authentic vegetarian meals’ without the use of meat substitutes. They expressed a desire for a completely different culinary experience and to explore unique meatless dishes that deviated from traditional meat-centric recipes.

This thesis topic focuses on how these so-called ‘authentic vegetarian meals’ should be constructed according to consumers wishes and perceptions, and if and how these can further foster the shift towards the consumption of more plant-based meals. The exact research question can be decided upon in collaboration with your supervisor, but might go in the direction of:

- What are consumers wishes/perceptions regarding ‘authentic vegetarian meals’?

Possible research methodologies are interviews, focus groups, consumer co-creation. But also a combination with sensory research is possible.

FQD-0405 B/M Snackification: Insights from Nutrition and Consumer Sciences

Title	Snackification: Insights from Nutrition and Consumer Sciences
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT:A
Prerequisite courses	Qualitative Consumer Research in Food Design (FQD24806)
Chair group	FQD
Supervisor	Marielle de Vaal (PhD)
Co-supervisor	Ruud Verkerk, Bea Steenbekkers

Description

Consumers nowadays are increasingly moving towards a more flexible eating pattern, where they rely on the consumption of snacks at any time and any location to fulfil dietary needs, instead of a traditional format of three meals - breakfast, lunch and dinner - interspersed with snacks at predetermined times each day. This trend where snacking is becoming the new way of eating, is known as Snackification, and has a substantial impact on consumers’ lives and the snacking industry: it has not only been leading to an increase in the consumption of snacks, but it has also changed the definition of snacks and snacking, consumers’ snacking needs and desires, and the competitive and nutritional snacking landscape. Accompanying the Snackification trend, consumers have become increasingly concerned about their health and are looking for foods, including snacks, that fit their healthy lifestyle. Snackification and health have become clear consumer trends that drive manufacturers in the industry to reformulate existing, as well as develop new innovative snack products while keeping a good taste as priority.

The Aim

The aim of this topic is to study the current landscape of snacks, snack foods and snacking behaviour in the broadest sense, in order to gain a better understanding of consumers’ snacking wishes and demands. These insights are relevant for the development of innovative snacking products that are in line with the Snackification trend.



Research theme 5 - Dairy Science and Technology

The dairy industry is an important player within the food industry, not only by making dairy products, but also through the production of a broad range of dairy-based ingredients. The dairy science & technology research focuses on understanding the physical & chemical properties of milk components, as well as the impact of dairy processes on these properties. This understanding can contribute to product and process innovations, e.g., infant formula that better resembles the composition of human milk or improved texture and flavour of cheese. This knowledge is not only useful within the dairy industry, but also within the food industry as a whole, because dairy-based ingredients are used in a wide range of food products.

But dairy research is not limited to the traditional dairy chain, we also work on topics related to the protein transition, such as the production of animal-free milk as an alternative for animal-based milk using proteins that have been recombinantly produced by micro-organisms. Also for this, a thorough understanding of the physical-chemical properties of milk components is required.

There are several main topics in this thesis booklet, and within all these main topics there is room to discuss your personal preference and design a tailored thesis assignment, often together with the PhD students working on these topics.

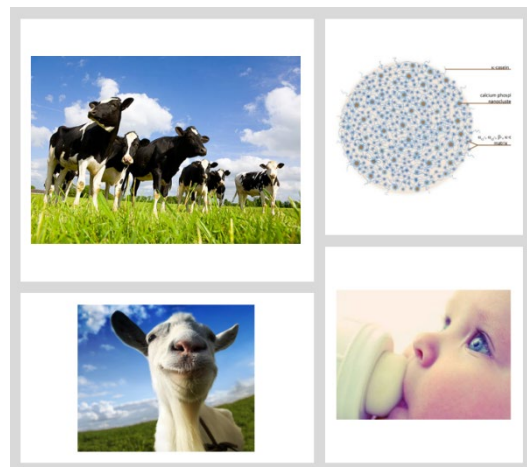
FQD-0500 B/M Exploring variation in milk protein composition within and between species and its potential for dairy product innovation

Title	Exploring variation in milk protein composition within and between species and its potential for dairy product innovation
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: A, D
Prerequisite courses	-
Supervisor	Etske Bijl
Co-Supervisor	Peiheng Wang (PhD)

Description

Large variation exists in milk composition between species such as cows, goats and humans. While the major milk components for all these species are proteins (serum and casein fraction), fats and carbohydrates, the amount of these components in milk varies considerably as well as their chemical composition and structure (e.g. casein micelles and milk fat globules). To illustrate this; if we look at the protein fraction the extent of variation between species is remarkable; fast-growing animals such as rabbits can have milk with 9 % casein, while human milk only contains 0.6 % casein. Also the composition of the casein fraction varies: While the bovine milk protein fraction consists of four caseins; α s1-casein, β -casein, α s2-casein and κ -casein, milk of humans and mares contains no or little α s2-casein, and elephant milk contains only β -casein and κ -casein. Also within species, e.g. different breeds of cows and goats, large variation exists in composition and structures.

Knowledge on variation between species and within species is highly relevant to understand how techno-functional properties such as renneting behaviour or heat stability are affected. Moreover, human breast milk composition is considered the gold standard for providing optimal nutrition for infants. Therefore a clear understanding on differences between and within species is necessary to design products with an optimal nutritional profile.



Aim

In this project we want to further explore natural variation in milk composition, structure, and effect on dairy product properties to create opportunities for future dairy product innovations.

The objective of your thesis project will be defined together with the supervisors based on your interest and ongoing research. Some examples of past and ongoing projects:

- Natural variation in composition and functionality of goat milk caseins
- Spotting new opportunities to determine breast milk composition
- Understanding the structural differences between casein micelles in human milk and bovine milk
- The variation in milk composition between different cattle breeds from the Netherlands, compared to breeds from other countries in Europa and Africa

FQD-0501 B/M Towards animal-free dairy products: composition, structure and functionality of new recombinant protein sources

Title	Towards animal-free dairy products: composition, structure and functionality of new recombinant protein sources
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT-D: Or any other specialisation with the prerequisite that the student participated in at least one of the two MSc dairy courses (dairy chemistry and physics, or dairy technology) and passed that course
Prerequisite courses	(see specialisation(s))
Supervisor	Etske Bijl, Kasper Hettinga
Co-Supervisor	Zekun Fan (PhD), Renske Bouma (PhD), Stefan ten Voorde (PhD)

Description

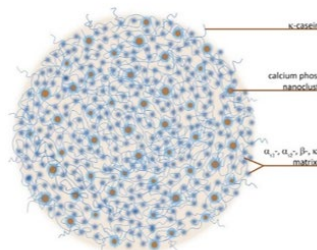
Milk from cows is an essential source of proteins in the Western diet. The major protein fraction in milk are the caseins, which are mostly organised into supramolecular structures called casein micelles. These colloidal structures are essential in obtaining the characteristic structure of dairy products such as cheese and yogurt. Next to that, milk contains whey proteins that are important functional agents in the food industry. Unfortunately, dairy production has a large impact on the environment, and the available alternatives (often plant-based) generally fail to reach nutritional and sensory parity.

Aim

In this project we aim to develop sustainable alternatives for milk proteins by researching a new animal-free source: recombinant proteins produced by microorganisms (e.g. bacteria, yeast or fungi). We compare their composition, structure and functionality to the ones found in cow's milk, and think about how we can produce them into new dairy analogues.

Approach

Many aspects of these new proteins need to be studied and compared to traditional sources and ways of processing (e.g. composition, purity, structure, renneting behaviour, texture and flavour formation, etc). As availability of recombinant proteins is still limited, in some of the projects we will still use caseinate and individual casein/whey fractions from cow's milk as models to study how the new source would behave. The objective of your thesis project will be defined together with the supervisors based on your interest and ongoing research.



FQD-0502 B/M Effect of milk processing on immune-active milk proteins

Title	Effect of milk processing on immune-active milk proteins
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: D
Prerequisite courses	-
Chair group	FQD
Supervisor	Kasper Hettinga
Co-Supervisor	Siwei Li (PhD), Yuqing Zhong (PhD)

Description

Heating of human, bovine and goat milk has all been shown to influence the healthy immune development of newborn infants. Therefore, heat-labile components are expected to cause this difference between breastfeeding and infant formula. Proteins are generally the most heat-labile milk component, so the immune effects of milk may be caused by this class of heat-labile protein components. The mechanisms that underlie the decrease in native milk proteins are not well understood. Denaturation and aggregation kinetics of single proteins has been studied in model system. However, in the case of milk, these processes will be more complex. It has for example been shown that denatured proteins may aggregate with other whey proteins and/or casein micelles. However, the extent of these reactions is often unclear. To solve this, non-thermal processing methods can be used (e.g. UV-C, thermo-ultrasonication, or high-pressure processing), as these may limit the damage to the immune-active milk proteins.

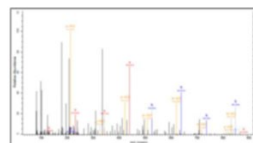
This topic consists of multiple subprojects, of which the overall aim is to study the effect of thermal and non-thermal processing on milk proteins in general and immune-active proteins in particular.

Objectives

1. Characterize the heat damage to immune proteins in milk from different mammals during heat processing.
2. Determine the effect of non-thermal processes on immune-active proteins in comparison to regular thermal processes.
3. Determine functionality of antibacterial milk proteins in bacteriostatic assays after different types of dairy processes.

Methods

1. For the first two research objectives, after processing native proteins will be separated from aggregated proteins, and both classes of proteins will be quantified using proteomics methods.
2. For the third research objective, bacteriostatic assays that have recently been developed will be applied, as an indicator of reduced functionality of immunological active milk proteins.



FQD-0503 B/M Exploring dairy processing and ingredient changes to determine its effect on a final product's attributes

Title	Exploring dairy processing and ingredient changes to determine its effect on a final product's attributes
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT: D
Prerequisite courses	-
Chair group	FQD
Supervisor	Kasper Hettinga
Co-Supervisor	Siwei Li (PhD), Yuqing Zhong (PhD)

Description

Dairy products play a key role in human diet and nutrition throughout the world. In the coming years, the industry will have to find sustainable methods to provide nutritious products to the growing population. This may involve optimizing the way dairy products are processed, the exploring the of use of new ingredients or determining the impact of processing on nutrient availability.

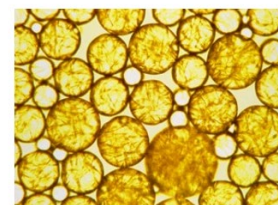
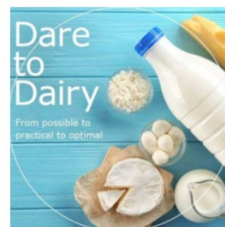
Objectives

This project description can include studying various dairy products such as cheese, cream, etc. with the main objectives being:

1. To elucidate the relationship between different processing techniques on the final quality of the chosen product (such as nutrition, flavor, texture, digestion).
2. To study the effect of various ingredient substitutions in dairy product formulations to understand their impact on the final consumer good.
3. To determine the role of dairy in a sustainable diet .

Project Description:

Understanding the structure of a dairy product is critical as this dictates the final characteristics such as texture, taste, color, and nutrition. The structure is greatly impacted by two factors: processing and ingredient formulation. In this project, novel technologies like high pressure, UV light, and ultrasonic processing can be investigated for their potential use in the dairy industry. It's also possible to test innovative ingredients for their use in various dairy products to understand their viability for the market. This type of experiment would include using texture analysis, GC-MS to track flavor development, and further composition analysis to determine fat, protein, moisture, ash, and lactose content. Another option is to perform desk-studies to identify major nutrients in current food system and the effect of processing on food items.



FQD-0504 B/M Effect of milk processing on digestion of proteins in infant formula

Title	Effect of milk processing on digestion of proteins in infant formula
Thesis	BSc and MSc
Specialisation(s)	BFT, MFT:D
Prerequisite courses	-
Chair group	FQD
Supervisor	Kasper Hettinga
Co-Supervisor	Yifan Liang (PhD)

Description

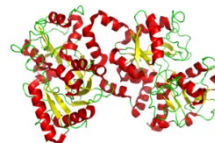
Milk proteins play a major role in nutrition and development of the immune system in infants. During the first months of life, milk proteins are the only source of protein that infants receive. Infants that do not receive breastfeeding rely on infant formula as a replacement. In the industrial processing of this category of products, heat processing plays a central role. This heat processes may lead to heat-induced denaturation/aggregation of the proteins, as well as lactosylation, which is the reaction between the reducing sugar lactose and the milk protein. These changes can affect the digestibility, nutritional value and immunogenicity of milk proteins. For example, reduced access of digestive enzymes to the protein can lower its digestibility, whereas protein modifications may cause an unwanted pro-inflammatory immune response, such as sensitization and allergic responses. Milk proteins can be modified differently depending on the applied processing steps. However, the link between process-induced milk protein modifications and digestibility remains largely unknown, especially in infants.

Next to milk proteins, nowadays plant proteins are also receiving attention as a potential alternative to milk proteins in infant formula. However, compared to milk proteins, even less information is available on the effect of heat processing on the digestibility of these proteins.

Aim

This project description relates to a number of different PhD projects. The aims of these PhD projects are:

1. To investigate the effect of processing on digestibility of milk proteins.
2. To determine the difference in the effect of heating between goat milk and bovine milk proteins.
3. Obtain detailed insight in the effect of heat processing on the digestion and immunological consequences of plant protein to support infant nutrition.



Project Description:

Proteins (either from bovine or goat milk, or from plant protein sources) can be processed at different conditions which will lead to different protein modifications. The effect of these process-induced protein modifications might alter the digestibility of heated proteins. In this project, protein modifications caused by processing and how these modifications affect digestibility will be investigated. Different biochemical techniques (such as SDS-page, HPLC, ANS, OPA, and in vitro digestion models) will be used to characterize the process-induced protein modifications and the digestibility of these proteins. Finally, the immunological impact of the digests resulting from differently heated proteins will be studied. Based on the above studies, the relationships regarding the proteins between heating—protein modification—digestion—immunogenicity will be revealed.