Thesis projects

BSc and MSc

Food Quality and Design

2025 – 2026, 1st round

WAGENINGEN
UNIVERSITY & RESEARCH

Introduction to Food Quality and Design

Welcome to our thesis booklet and thank you for your interest in doing a thesis at our chair group! At Food Quality and Design, our work is focused on both food quality as well as food design. This hopefully makes sense when looking at the name of our chair group, but what does this mean for our research and, more importantly, your thesis?

As a student with an interest in food technology, you have already learned a lot about the chemical, physical, microbial, and technological properties of foods. This knowledge is essential to go into the design of new foods and ingredients, and to determine or even predict the quality of foods. Therefore, when doing a thesis at our group, you will be able to integrate and connect your knowledge from various disciplines in one project. If you are interested in a complete food science immersion, FQD is the right place for you!

At Food Quality and Design, the work that we do can be placed in five themes:

- Food Design
- Food Digestion and Health
- Quality in the Chain
- Consumer Science
- Dairy Science and Technology

Further on in this booklet, you will find all the available topics in each research theme. Within all these topics there is room to discuss your personal preference and design a tailored thesis assignment, often together with the staff member(s) or PhD student(s) working on these topics.

Our multidisciplinary studies help WUR to succeed in its grand mission: To explore the potential of nature to improve the quality of life. Will you join us on this journey?

We hope to see you soon at Food Quality and Design.

Sincerely,

Vincenzo Fogliano & Kasper Hettinga

Contents

REQUIREMENTS FOR YOU AS A STUDENT 4

THEME 1: FOOD DESIGN 5

THEME 2: FOOD DIGESTION & HEALTH 26

THEME 3: QUALITY ALONG THE CHAIN 42

THEME 4: CONSUMER SCIENCE 56

THEME 5: DAIRY SCIENCE & TECHNOLOGY 63

Requirements for you as a student

Please read this section carefully, as it explains the requirements (including study programs, courses, and credits) for doing a thesis at Food Quality and Design.

General information

Each topic's page mentions the topic title, supervisor(s), whether it's a topic suitable for BSc and/or MSc students, and if there are any specific prerequisites. Most thesis topics are part of ongoing research projects, so they will be adapted and defined in detail when you start writing your research proposal.

Most topics are only available to one student, but some may accept two or more students. Generally, the number of student places per thesis topic is flexible and depends on the number of student applications and supervisor availability.

The type of supervision differs between supervisors. However, there is one general rule: a topic supervised by a PhD candidate will have closer daily supervision than a topic that is 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 a member of staff.

BSc: Specific requirements that apply to any topic

To start with a BSc thesis at Food Quality and Design, you should meet these requirements:

- You should have passed all 1st year courses.
- You should have passed at least 102 credits of the BFT program.

In addition, it is highly recommended that you have passed FQD21306 – Food Packaging and Design.

MSc: Specific requirements that apply to any topic

To start with an MSc thesis at FQD, you must have a study progress of at least 30 credits of your individual study program. In addition, you must meet the minimum mandatory knowledge:

- For students of MFT and MFQ, completion of 12 credits is compulsory to start an MSc thesis project at FQD. The 12 credits should be from advanced courses (advanced meaning a course code starting with the digit 3). Within those 12 credits, at least 6 credits should be from one of the following courses: Predicting Food Quality (FQD31306), Product Properties and Consumer Wishes (FQD31806), Dairy Chemistry and Physics (FQD33306), Food Quality Management Research Principles II (FQD35906), Qualitative Consumer Research in Food Design (FQD24806), or Food Flavour Design (FQD37806).

For students in other study programs (e.g. MDS and MNH), other requirements may apply. Please contact the thesis coordinator (Nora van Os, nora.vanos@wur.nl) for more information.

Topic-specific requirements

Some topics may also have specific course requirements. If this is the case, this mandatory knowledge will be listed on the topic information page.

Theme 1: Food Design

At Food Quality and Design, food and ingredient design are approached holistically, integrating nutritional, technological, and consumer perspectives. This theme explores a wide range of topics centered on developing innovative food products and ingredients.

The ingredients and foods investigated in this research theme are designed to improve sustainability, biodiversity, and public health. Some topics even target specific categories, such as people affected by celiac disease, diabetes, or obesity.

Addressing malnutrition is another key aspect. Many people in developing and transitioning countries have limited access to high quality foods. This prevents them from meeting their daily requirements of macro-and micronutrients, such as vitamins, minerals, and essential amino acids. As a solution, we work on alternative, non-conventional protein sources that can improve food quality and accessibility. Local sourcing should also be prioritized, particularly in transition countries, to enhance sustainability.

Plants, insects, and microbial biomass can be good alternatives to traditional animal-based proteins like meat and dairy. Beyond diversifying protein sources, the entire food system (from raw materials and production to storage and transportation) must be optimized. For this, these novel food sources are investigated by checking their structuring properties (such as gelling or fiber formation) or specific quality parameters (such as micro- and macronutrient concentrations and accessibility) after the processing or changing of ingredients.

Together, this research theme drives innovation toward a more sustainable and nutritious food system. By exploring novel ingredients, improving food production, and addressing global dietary challenges, it paves the way for healthier populations and a more resilient planet.

1.1 Healthy plant food design and potential health effects

FOOD DESIGN | BFT, MFT

Supervisors
Teresa Oliviero

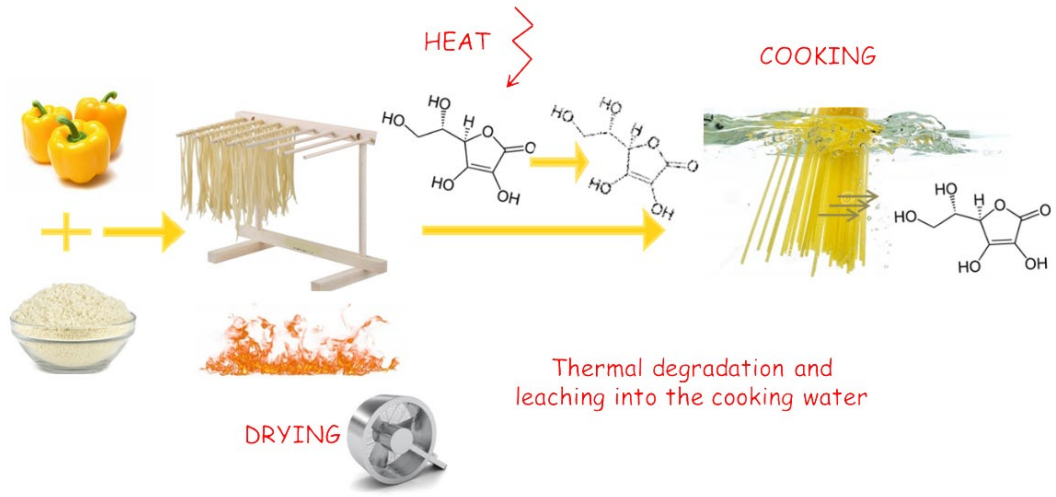
MSc: Specific prerequisite course
-

Topic overview
Raising consumer awareness that a diet rich in plant-based food is health-beneficial, urges companies to develop plant-based foods (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 & approach
The aim of this topic is to study the changing 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 to design healthier food products. In some cases, the effect on the bioactivity of those compounds will be part of the aim.

First, you will select a vegetable, fruit or legume, target bioactive compounds, and a product to be investigated. Then, you will investigate which steps of the production process can affect the concentration of these 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). You will make the product, and depending on the target compounds, different analytical and instrumental technics can be used to analyze or to test the bioactivity of such compounds.



1.2 Designing functional ingredients by upcycling tomato industry by-products

FOOD DESIGN | MFT

Supervisors
Vincenzo Fogliano, Nicoletta Pellegrini, Trang Anh Nguyen

MSc: Specific prerequisite course
-

Topic overview
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 still contain 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) will be used.

1.3 Upcycling of food by-products and production of vitamin K2 by fermentation approaches

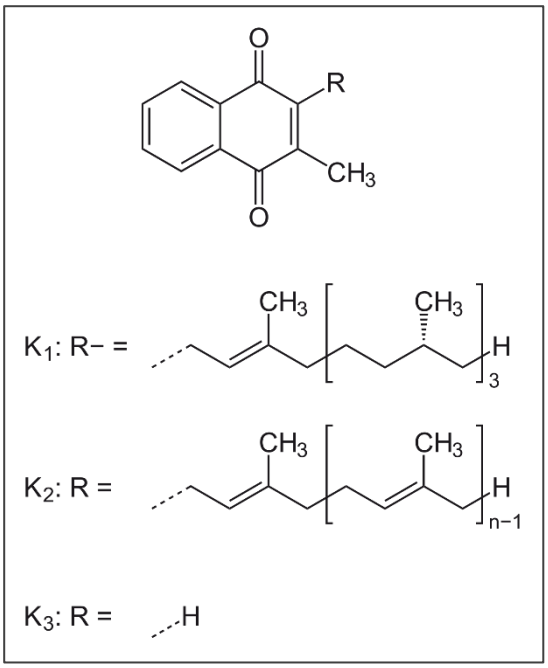
FOOD DESIGN | MFT

Supervisors
Xin Wei (PhD), Melania Casertano,
Oscar van Mastrigt, Vincenzo Fogliano

MSc: Specific prerequisite course
-

Topic overview

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 cremoris,* known for producing vitamin K, mainly MK-8, MK-9, and MK-10, fermentation shows a dual advantage for sustainability and nutrition.

Objectives

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

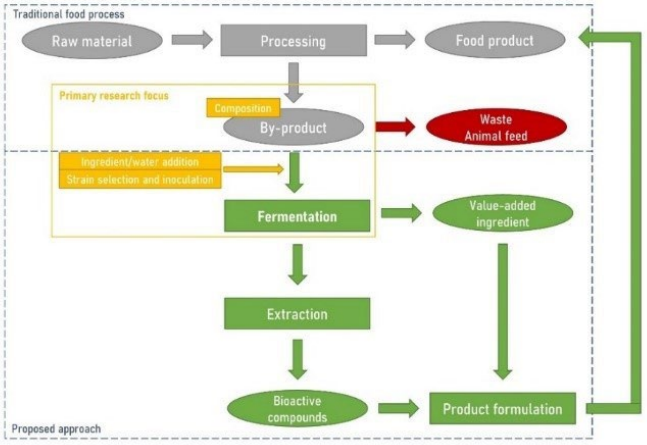
1.4 Sustainable approaches to upcycle food waste streams

FOOD DESIGN | MFT

Supervisors
Melania Casertano, Ruth Ngadze, Vincenzo Fogliano

MSc: Specific prerequisite course
-

Topic overview
Global food production generates by-products that are often discarded due to their undesirable traits, wasting valuable resources like dietary fiber and bioactive compounds. To address this issue, there's growing interest in upcycling by-products. Green technologies, such as fermentation and enzymatic treatment emerge as key solutions, offering enhanced nutritional profiles and sustainability benefits. One of these ways is achieving a good production of bioactive compounds by a microorganism, or by transforming the product into a functional ingredient.



Additional processes could be applied before fermentation to improve this process. Ongoing research is being done in the fermentation of fruit peels as a by-product from juice production, or in spent coffee and tea.

Aim
Investigate the applicability of fermentation strategies to by-products of food production to create value-added products with enhanced nutritional profiles and sustainability benefits.

Approach
1. Literature research to understand how physical treatments, enzymatic treatments, fermentation, etc. influence the properties of the obtained ingredients
2. Identification of possible side-streams from food production with high processing volumes.
3. Come up with realistic ideas on food fermentation. Our approach encompasses:
    - Microorganism Diversity: 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.
    - Bioactive Compound Production: 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.
    - Integration with Process Technologies: We synergize fermentation with other process technologies to optimize the overall production process.

1.5 Unlocking cocoa flavor: Navigating the Maillard reaction pathways for sustainable alternatives

FOOD DESIGN | BFT, MFT

Supervisors
Riccardo Bottiroli, Vincenzo Fogliano

MSc: Specific prerequisite course
-

Topic overview

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
- 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.

1.6 The Maillard reaction in food: Balancing flavor and safety in alternative food production

FOOD DESIGN | BFT, MFT

Supervisors
Vincenzo Fogliano, Burçe Ataç Mogol (Hacettepe University Ankara)

MSc: Specific prerequisite course
FQD37806 Food Flavor Design

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

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 color, 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 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?

1.7 Maillard reaction for enhancing flavor in future foods

FOOD DESIGN | MFT

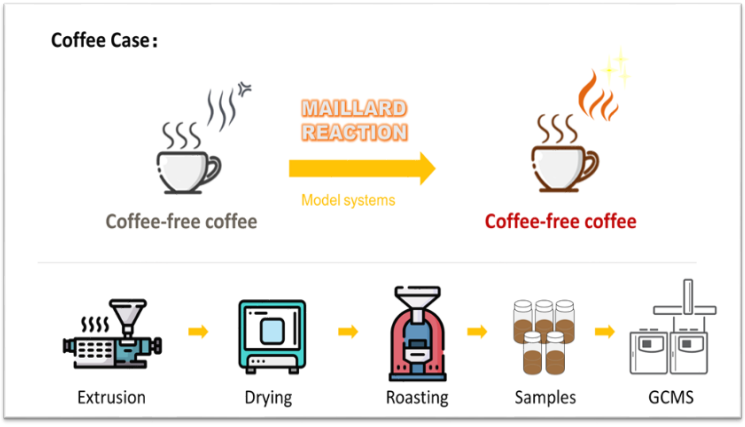
Supervisors
Bei Wang (PhD), Teresa Oliviero

MSc: Specific prerequisite course
FQD37806 Food Flavor Design

Topic overview
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 flavors 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 flavors of specific products in replacers e.g., coffee flavor in beverage with no coffee bean and no coffee extracts. Therefore, the first aim is to create the flavor in a model system and then to investigate if this flavor 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.



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

1.8 Your own barista: Optimizing home brew coffee by investigating coffee properties

FOOD DESIGN | BFT, MFT

Supervisors
Vincenzo Fogliano, Nora van Os,
Anke Sinnema (Versuni)

MSc: Specific prerequisite course
-

Topic overview
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 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 quality foam.

Proposed approach
For this project you will investigate 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 characteristics 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.

1.9 Legumes, the sustainable way towards protein rich pasta

FOOD DESIGN | MFT

Supervisors
Vincenzo Fogliano, Nicoletta Pellegrini, Trang Anh Nguyen

MSc: Specific prerequisite course
-

Topic overview
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 conduct 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.

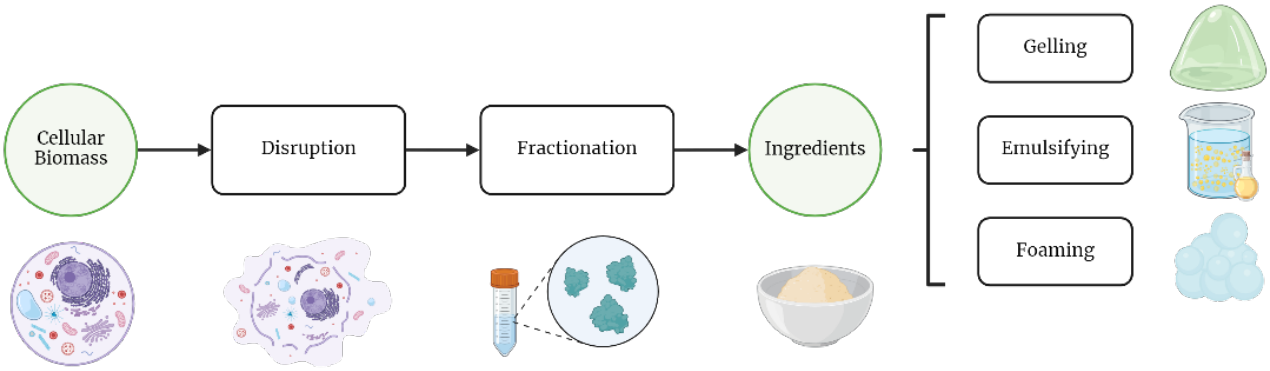
1.10 Techno-functional properties of microbial ingredients

FOOD DESIGN | MFT

Supervisors
Lucas Bozzo (PhD), Maryia Mishyna

MSc: Specific prerequisite course
FPH30306 Advanced Food Physics or
FPH31306 Advanced Molecular Gastronomy

Topic overview
Sustainable diets are a crucial element in addressing ongoing climate change and achieving global health and sustainability. Growing 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 of ingredients economically feasible, a biorefinery approach where all the fractions of the microorganisms are valorized is required. Also, knowledge on the application of the complete microbial biomass or ingredients thereof is fundamental for efficient implementation. This project aims towards developing a generic approach to convert cellular biomass into techno-functional food ingredients.



Objectives
The thesis project will focus on studying the obtention and 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).

1.11 Edible insects: Creating food of the future

FOOD DESIGN | MFT

Supervisors
Maryia Mishyna, Catriona Lakemond, Vincenzo Fogliano

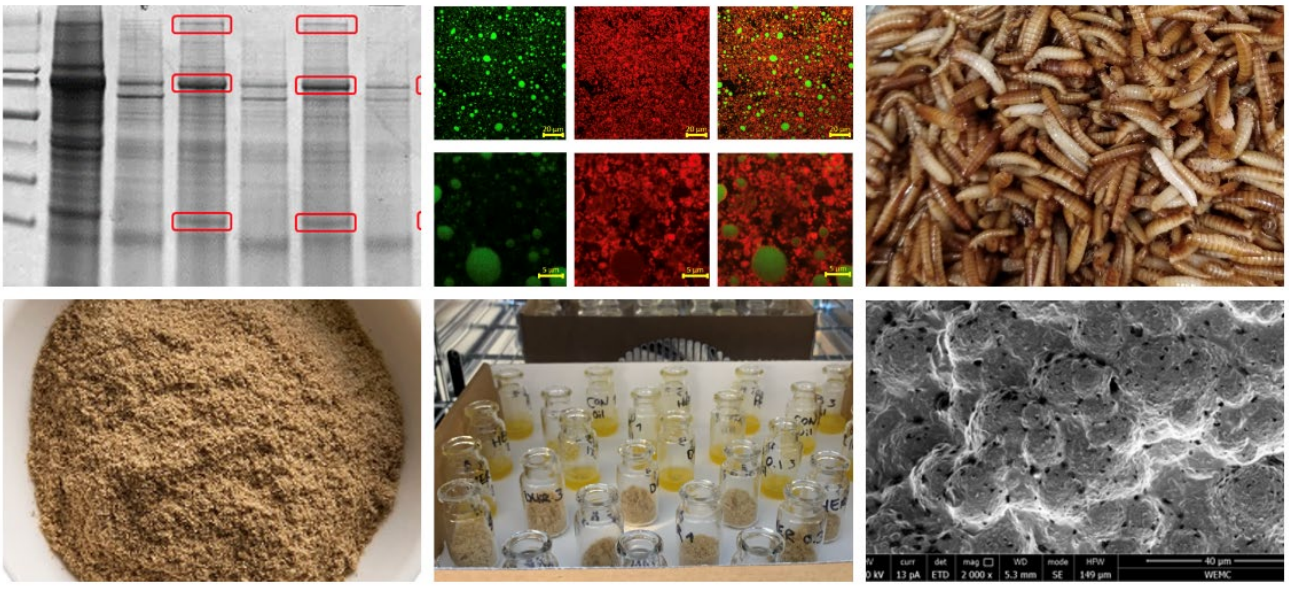
MSc: Specific prerequisite course
-

Topic overview
Edible insects represent a novel food source in Western countries. High protein content, well-balanced amino acid composition, and enough 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. 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



1.12 Next generation methods in food ingredient functionality

FOOD DESIGN | BFT, MFT

Supervisors
Maryia Mishyna, Jack Yang (FPH), Julia Keppler (FPE)

MSc: Specific prerequisite course
-

Topic overview
Nowadays there is an extensive search for plant-based food ingredients with techno-functional properties, such as foaming, emulsifying, and gelation. However, an important challenge which slows down this development is the inconsistency in existing methodology. There are many already existing methods for measuring the same property, but different approaches (sample preparation, test conditions etc.) are used. Thus, the results are often difficult to compare and draw a comprehensive understanding of the functional potential of different food ingredients. This project will contribute to solving this problem.

The project aims to evaluate different methodologies used to study foaming, gelling, and emulsifying properties and determine the advantages and limitations of each method. By applying a well-thought-out and stepwise approach, the project aims to find the most optimal methodology and thus develop the next generation of analysis methods.

The developed methods can be used to write standardized guidelines that will be used worldwide in food academia and industry.

1.13 Is this palm oil alternative the future for food?

FOOD DESIGN | MFT

Supervisors
Xuan Yang (PhD), Maryia Mishyna, Annelie Verbon (NoPalm Ingredients)

MSc: Specific prerequisite course
-

Topic overview
NoPalm Ingredients is a start-up company that makes an alternative for palm oil through fermentation of food waste streams. The carbon footprint of this oil is significantly lower than that of conventional palm oil. Moreover, the oil can be produced locally, that is, also in non-palm oil producing countries.

Oils of varying composition can be made, though the aim is to produce an oil that serves as a drop-in replacement for palm oil. That is, you can simply take out the palm oil, put in the replacement, and it should still work the same.

Your goal is to analyze and determine if the NoPalm oil(s) are indeed a drop-in replacement or if they differ from the current palm oil (and how). You will investigate various relevant applications and a wide variety of analytical methods. Ultimately, you need to create an understanding of why the ingredients behave similar to or different than palm oil, based on your analytical and application data.

1.14 From side-stream to novel food: Composition and variability of spent biomass

FOOD DESIGN | BFT, MFT

Supervisors
Maryia Mishyna, Coen d'Ancona (NoPalm Ingredients)

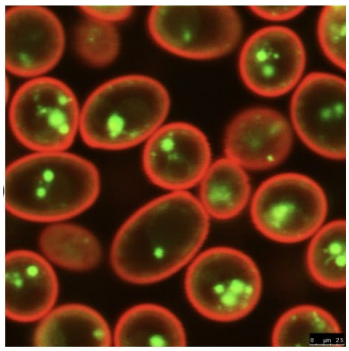
MSc: Specific prerequisite course
-

Topic overview
NoPalm Ingredients is a start-up company which produces an alternative to palm oil through fermentation technology. After extraction of the oil, a side-stream of defatted yeast remains (spent biomass). To make an impact, this side stream needs to be understood and valorized, which is important both for sustainable and economic feasibility.

Yeasts contain a wide variety of compounds, many of which have some market value in nutrition, health and/or functionality. To go to market, it is important to find out what is in NoPalm Ingredient's spent biomass, and what the batch-to-batch variations are.

Besides the positive aspects of the ingredients, the safety of the ingredient needs to be ensured before the product is accepted in the EU market. For example, the presence or absence of allergens and potential toxic compounds needs to be presented with strong scientific evidence.

The goal of this topic is to identify compounds which are likely present in the spent biomass (literature), to measure these compounds in different batches (analytics) and to discuss the opportunities for bringing this to market, threats for EU-approval and processing steps that are required to obtain (a) marketable ingredient(s).




1.15 Design of food matrix with oleaginous microorganisms

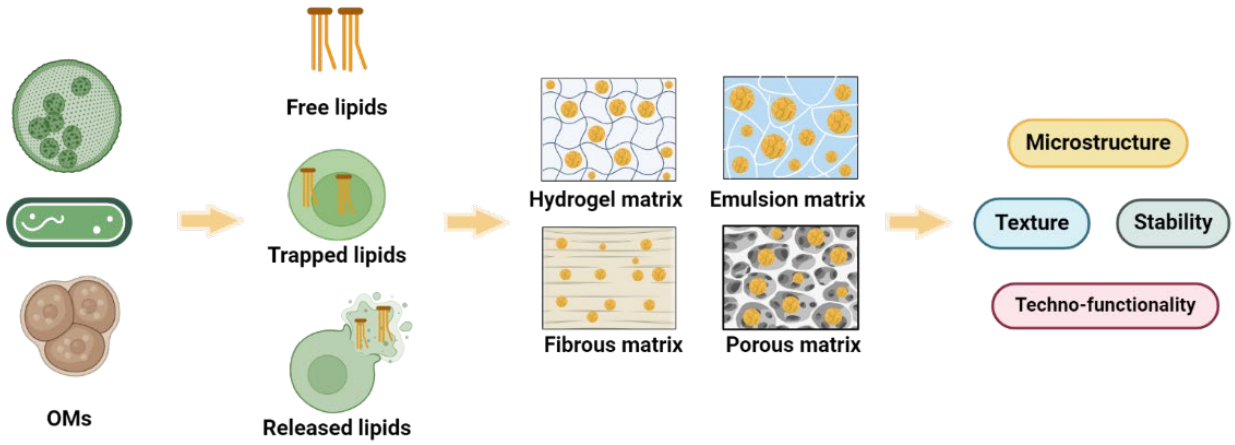
FOOD DESIGN | MFT

Supervisors
Xuan Yang, Maryia Mishyna, Vincenzo Fogliano

MSc: Specific prerequisite course
-

Topic overview
Numerous studies currently focus on alternatives to traditional food sources to achieve more sustainable diets. Oleaginous microorganisms (OMs) as a kind of novel food source are highly nutritious, easy to cultivate, and produced with limited land. Their applications focus on lipids extraction. However, the application of whole biomass is promising, which will not only simplify the processing but also introduce various intracellular nutrients. However, there is still limited knowledge on how to incorporate OMs into different food matrices. Therefore, the aim of this project is to develop a generalized methodology for the conversion of OMs into food ingredients with various techno-functionalities.

Objectives and activities
The thesis project will focus on investigating physical-chemical and techno-functional properties of OMs-based food matrix, establishing links between OMs and functionality, and designing food matrix with OMs.



1.16 Application of flavor compounds in meat and plant-based food

FOOD DESIGN | MFT

Supervisors
Haonan Shi (PhD), Markus Stieger, Teresa Oliviero

MSc: Specific prerequisite course
FQD37806 Food Flavor Design or
HNH30506 Principles of Sensory Science

Topic overview
Flavor plays a critical role in consumer acceptance of meat and plant-based foods. However, during thermal processing, key flavor compounds may be lost or altered, thus affecting the overall sensory experience. Replicating the complex flavors of meat in plant-based protein products remains a challenge. This study examines the formation and application of flavor compounds in meat and plant-based foods to form flavor enhancers to enhance their sensory appeal and consumer acceptance.

The aim of this study is to investigate the formation and application of key flavor compounds in the reducing sugar-plant protein isolates-amino acids model system and to explore the possibility of developing flavor enhancers. The study will analyze the effect of flavor enhancers on the sensory properties of meat and plant-based foods.

Activities to be performed by the Student:

- Develop and analyze model systems mimicking flavor formation during food processing.
- Identify and quantify key aroma compounds using analytical techniques (e.g., GC-MS).
- Conduct sensory evaluations to assess consumer perception and acceptance.
- Interpret data and provide insights into optimizing flavor retention and enhancement.

1.17 Innovations for product diversity and diets using non-traditional crops and ingredients

FOOD DESIGN | BFT, MFT

Supervisors
Zhuojia Xu (PhD), Ruth Ngadze

MSc: Specific prerequisite course
-

Topic overview
Non-traditional crops, such as amaranth and pearl millet, are rich in bioactive compounds that contribute to human health. However, their bioavailability and functionality can be influenced by bioprocessing techniques such as germination, fermentation, and enzymatic modification. These processes can change the composition of bioactivity components or generate new bioactive molecules, potentially enhancing or reducing their effects on immunity and overall health. Traditionally, such bioprocessing methods have been widely used at the household level, demonstrating their potential in enhancing nutritional qualities and functional properties. Understanding how these processes impact bioactive compounds after digestion and batch fermentation will provide valuable insights for developing functional foods to support immune health.

Aim
To analyze the bioactive compounds in different bioprocessed crops and assess their potential to enhance immunity or exhibit anti-inflammatory properties in vitro.

Approach
The student will select one crop and apply a specific bioprocessing method. The processed product will be prepared as porridge for digestion experiments. The study will identify changes in bioactive properties, such as increased polyphenol availability or bioactive peptides with immune-modulating effects, following digestion and batch fermentation. Additionally, the production of short-chain fatty acids (SCFAs) and other potential bioactive components will be monitored.

1.18 Exploring new meat analogues: Extrusion with edible insect protein

FOOD DESIGN | BFT, MFT

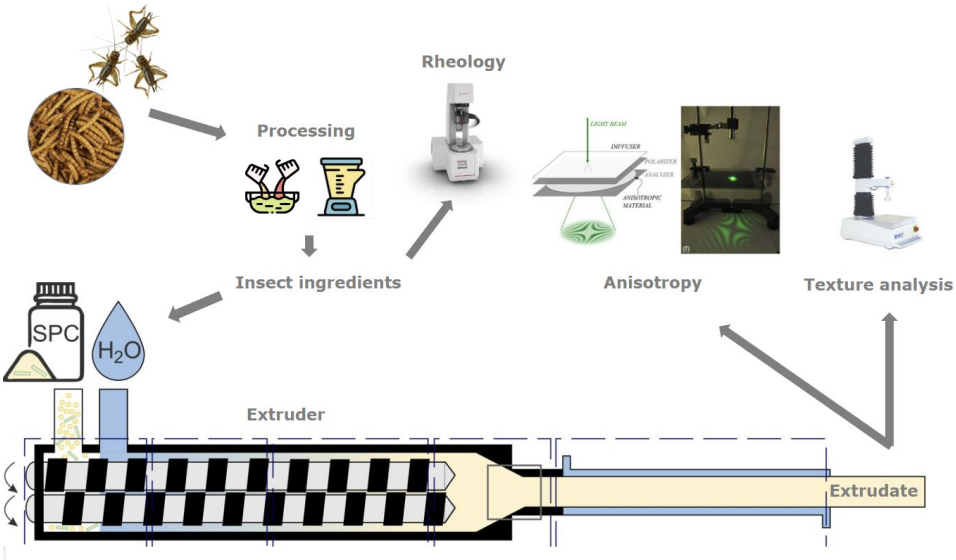
Supervisors
Andrés Mateo (PhD), Maryia Mishyna, Vincenzo Fogliano

MSc: Specific prerequisite course
-

Topic overview
The increasing world population and climate change create the necessity for new and sustainable food solutions. In the case of meat analogues, soy protein-based extrusion has been widely studied in the last years and has proven to be suitable for extrusion with good fiber formation and alignment, resembling meat structure. In the last years, new protein sources for food have been explored, with potential as meat replacers. Due to the complexity of the extrusion process, the use of new materials as ingredients is not fully comprehended and more research is still needed. In this scenario, the addition of these new materials to soy proteins would make it the perfect system to study the functionality of the new protein sources.

Novel protein sources, like insects, are explored less and limited knowledge is available about extrusion of insect materials. Insects are considered a promising protein source for the future due to their high protein content, well-balanced amino acid composition, and sustainability of insect farming with low environmental impact in comparison to conventional livestock. After harvesting, insects are often processed into food ingredients using different processing methods, such as milling, defatting, drying, and fractionation, that affects their techno-functional properties. However, there is still little knowledge on the effect of different processing methods of edible insects on extractability of insect materials and ability to form fiber.

The project aims to understand how inclusion of insect ingredients of different qualities into soy protein concentrate blends affects formation fiber structures and textural properties.



1.19 How does processing affect microplastics in insects reared for food and feed?

FOOD DESIGN | BFT, MFT

Supervisors
Catriona Lakemond, Maryia Mishyna, Nathan Meijer (WFSR)

MSc: Specific prerequisite course
-

Topic overview
Insect species like black soldier fly larvae and yellow mealworm are increasingly seen as a very suitable alternative source of protein for food and feed. However, alternative feed materials than those already being used for pigs and poultry should be sought out to realize this new type of mini-livestock's full potential. One such alternative could consist of former foodstuffs with elevated levels of packaging materials (plastics): such particles are currently completely prohibited from being in any feed, including insects. Concerns over suffocation or accumulation of particles may not apply to farmed insects, due to their much smaller size. However, little is known on potential transfer of microplastics that originated from packaging materials, or other sources – since microplastics can now be found in almost all biomes. Some studies have investigated the effects and potential transfer of microplastic exposure for farmed insects, but many data gaps remain. In particular, the effects on microplastics of processing raw (insect-based) materials into food or feed products are largely unknown.

The assignment will consist of processing insects that have been in vivo exposed to dietary microplastics (provided) into food or feed products and analyzing samples before and after processing for microplastic particles. The envisioned method for analysis is Confocal Laser Scanning Microscopy (CLSM). However, other and/or additional methodologies can be considered depending on student's reasoned justification and technical background.

Depending on the start-date of the thesis, gaining experience with designing and/or conducting in vivo experiments with live insects will be possible. Results should be written up in a thesis report; the work will contribute to a scientific paper.

The thesis project will be conducted at FQD group in close collaboration with WFSR (Wageningen Food Safety Research).

1.20 The strength of the tiniest: Using fermentation for novel food sources

FOOD DESIGN | MFT

Supervisors
Maryia Mishyna, Arnau Vilas Franquesa (Universitat Autònoma de Barcelona, Spain), Sultan Arslan Tontul (Selcuk University, Türkiye)

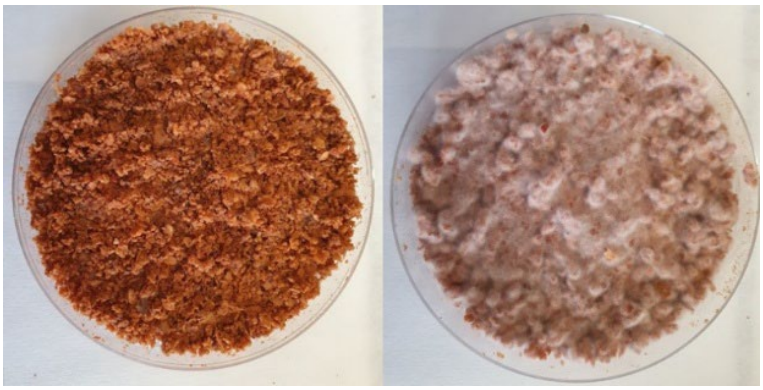
MSc: Specific prerequisite course
-

Topic overview
Fermentation is a versatile and complex process driven by the enzymatic activity of bacteria, yeast, or molds, triggering various biochemical reactions. It can be applied to a diverse range of products to enhance both shelf life and nutritional value. The latter makes fermentation a valuable strategy for improving food security and combating malnutrition.

Several fermentation processes, such as those used in beer and yogurt production, are well known, but our understanding remains limited. There is still much to explore regarding different microorganisms and substrates. Among the most interesting applications are novel foods, including edible insects and microalgae, which hold great potential as they are expected to play a key role in the future of food.

Fermentation is still little studied for novel food sources. The existing studies demonstrated the potential, for example, in solubilization of proteins from insect fractions which have low solubility. Along with an effect on techno-functional properties, fermentation can be used as an approach to tailor sensory properties, for instance, by modifying specific volatile compounds or umami flavor. Also, fermentation could release and generate prebiotics and bioactive compounds which can be used for the fortification of traditional food products.

This project aims to understand how integrated quality characteristics of novel food sources can be enhanced (e.g. volatiles, nutritional quality, techno-functional properties) by fermentation processes (using e.g. bacteria, filamentous fungi, yeast). The goal will be to create food ingredients (or products) to incorporate in food formulations.



The project will be done in collaboration with Universitat Autònoma de Barcelona (Spain) and Selcuk University (Türkiye).

Theme 2: Food Digestion & 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 nutrients bioavailability, gastrointestinal health and sensory perception. This theme has two sub-themes.

Nutrient digestibility and bioavailability

The first sub-theme typically investigates food-related factors affecting nutrient digestibility and 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.

This sub-theme typically involves the following research questions:

- What is the effect of food formulation and processing on nutrients/bioactive compounds bioaccessibility and bioavailability?
- What is the effect of food formulation and processing on gut microbiota composition and functionality?
- What is the effect of specific food components on gut permeability, inflammation, and immunomodulation?

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 can design food with optimized digestibility/bioavailability of nutrients, optimized effect on gut microbiota as well as an optimized biological effect on gut health.

Oral processing

The second 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).

2.1 Effect of plant cell wall integrity and permeability on nutrient bioaccessibility and digestibility

FOOD DIGESTION & HEALTH | BFT, MFT

Supervisors
Edoardo Capuano

MSc: Specific prerequisite course
-

Topic overview
In plant tissues, cells are surrounded by a cell wall that is made up of fiber, 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 fiber-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.

2.2 Resistant starch type IV. Is it really resistant?

FOOD DIGESTION & HEALTH | BFT, MFT

Supervisors
Edoardo Capuano

MSc: Specific prerequisite course
-

Topic overview
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 suggests that it may not be fully resistant and part of it can be 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 shoer 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 give an overview of commercially available resistant starch type IV in the market. After this you will study the digestibility of 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 behavior) and its digestibility. This 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 fecal inoculums.

2.3 Tweaking bean macronutrient digestibility through modification of the cell wall integrity

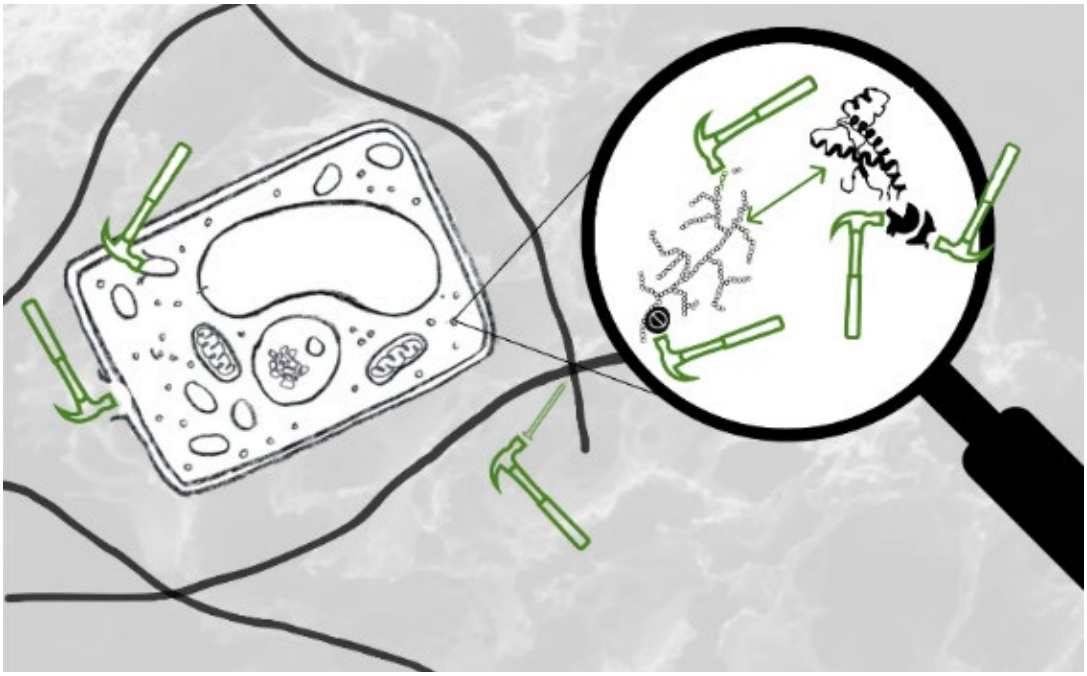
FOOD DIGESTION & HEALTH | BFT, MFT

Supervisors
Edoardo Capuano, Gaëlle Boisset (PhD)

MSc: Specific prerequisite course
-

Topic overview
The nutritional quality of a food product is determined by much more than only its nutritional composition. A plethora of studies have demonstrated the impact of the so-called food matrix on nutrient accessibility, digestibility and bioavailability through various mechanisms (see figure). This thesis focusses on the effect of cell wall preservation on legume macronutrient digestion. Several studies have researched the impact of cell wall integrity on macronutrient digestion of purely legumes. In addition, research is conducted to show if this effect persists when present inside a complex food matrix.

Objective
Study the role of legume cell wall integrity on macronutrient digestion and its effect when incorporated into a food product.



Activities
Relevant production methods to produce flour containing intact cell walls and post processing methods will be selected. Flour and food products will be produced. The microstructure will be investigated and visualized by microscopy. Its effect will be studied by mechanistical research or by mimicking human starch or protein digestion in vitro using the Infogest 2.0 protocol or the Englyst method respectively.

2.4 The digestive fate of plant pomaces

FOOD DIGESTION & HEALTH | MFT

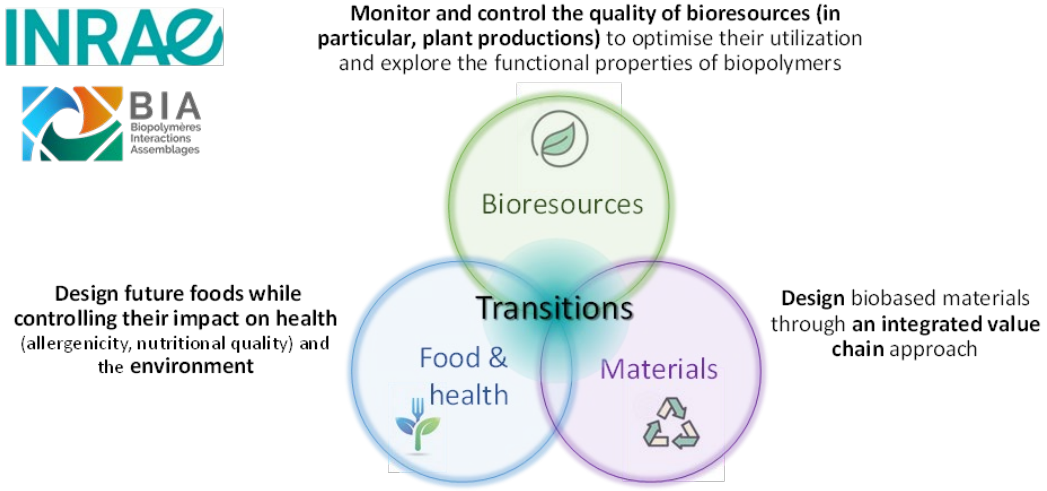
Supervisors
Claire Berton-Carabin, Edoardo Capuano

MSc: Specific prerequisite course
-

Topic overview
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.



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.

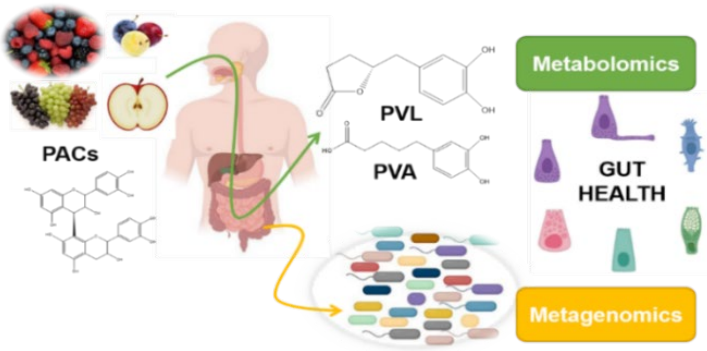
2.5 How do gut microbial metabolites promote gut health?

FOOD DIGESTION & HEALTH | BFT, MFT

Supervisors
Josep Rubert

MSc: Specific prerequisite course
-

Topic overview
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.

2.6 Influences of oral processing behavior on human metabolism and health

FOOD DIGESTION & HEALTH | MFT

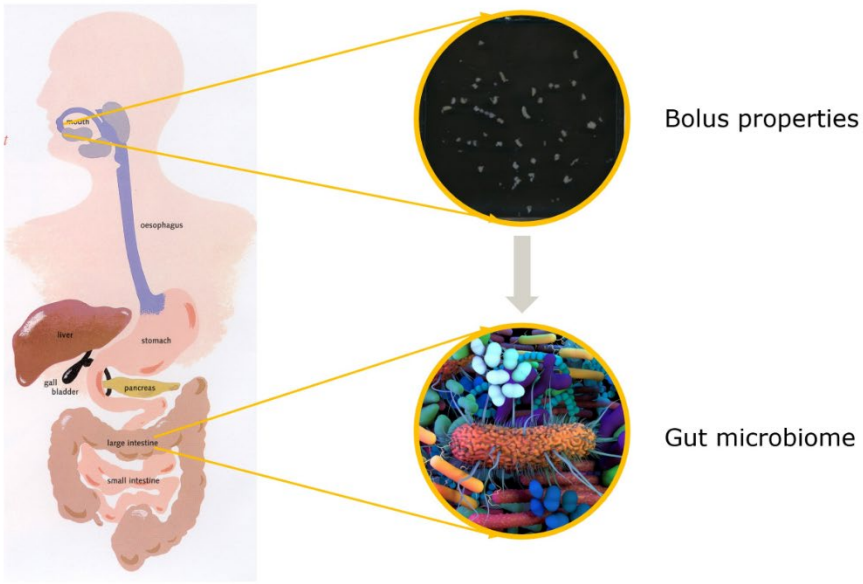
Supervisors
Zhen Liu (PhD), Josep Rubert, Markus Stieger

MSc: Specific prerequisite course
-

Topic overview
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 behavior 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 human metabolic and health.

Activities
Oral processing behavior analysis, metabolites analysis, data analysis.



2.7 Effect of processing on peanut allergenicity

FOOD DIGESTION & HEALTH | MFT

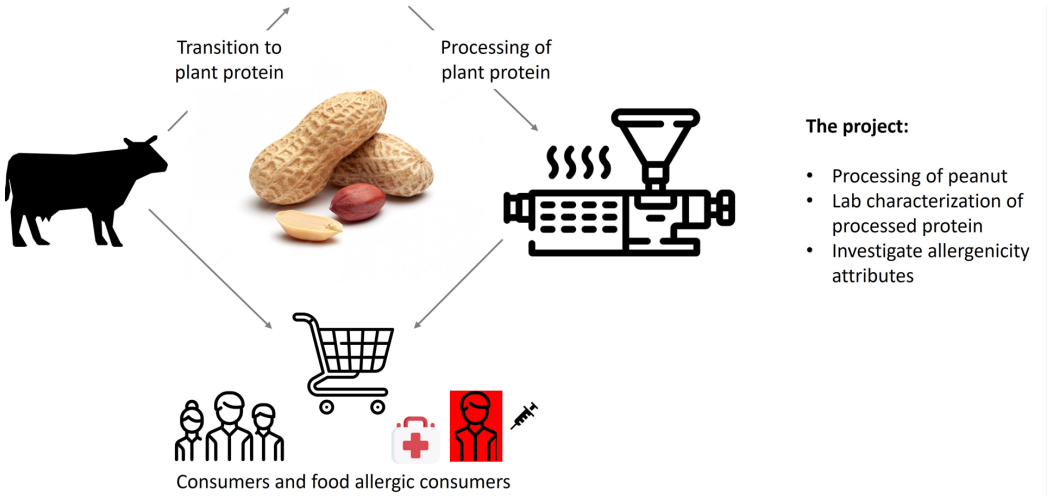
Supervisors
Edoardo Capuano, Stef Koppelman

MSc: Specific prerequisite course
-

Topic overview
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, peanuts are notorious for their allergenic potency, and it is not completely understood what makes peanuts 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 for 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 peanuts 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.

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.



2.8 Exploring the metabolic impact of future food processing

FOOD DIGESTION & HEALTH | MFT

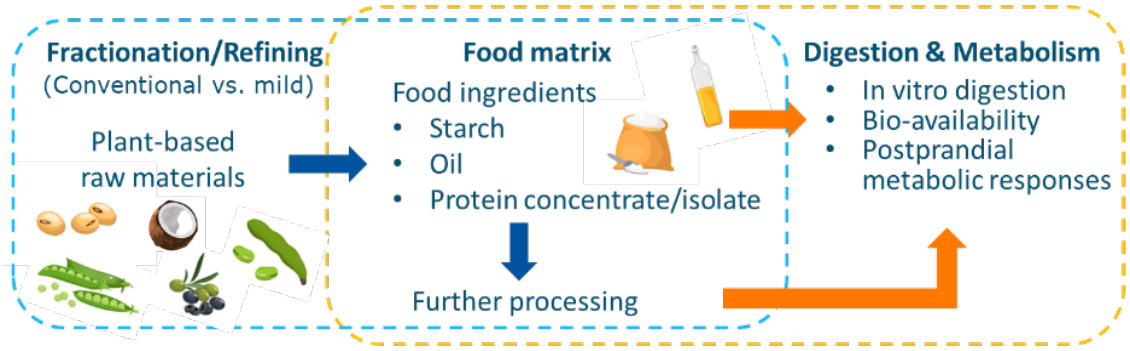
Supervisors
Hanhong Lu (PhD), Markus Stieger

MSc: Specific prerequisite course
-

Topic overview
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 the 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.



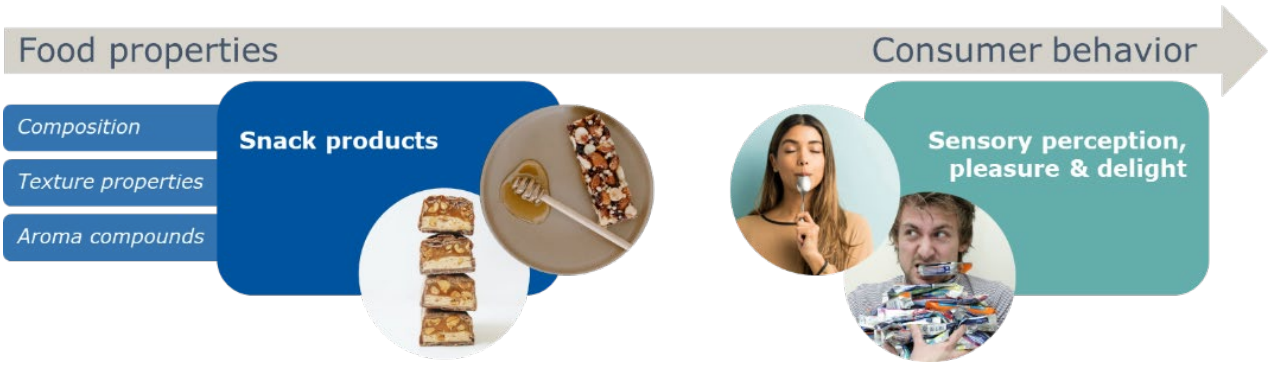
2.9 Texture properties, aroma components and sensory perception of snack products

FOOD DIGESTION & HEALTH | MFT

Supervisors
Nienke van Iterson (PhD), Arianne van Eck, Markus Stieger

MSc: Specific prerequisite course
FQD37806 – Food Flavor Design or
HNH30506 - Principles of Sensory Science

Topic overview
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 nowadays demand 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 insight 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/flavor/texture perception within the snack category.

Methodologies:

- Sample composition analyses (water content, fat content, etc.)
- Texture analysis (Texture analyzer)
- Volatiles in headspace (GC-MS)
- Oral processing behavior (video recordings, bolus analysis)
- Sensory evaluation

2.10 Digestive behavior of fiber-based aerogels in the gastrointestinal tract

FOOD DIGESTION & HEALTH | BFT, MFT

Supervisors
Ziqi Zhuang (PhD), Edoardo Capuano

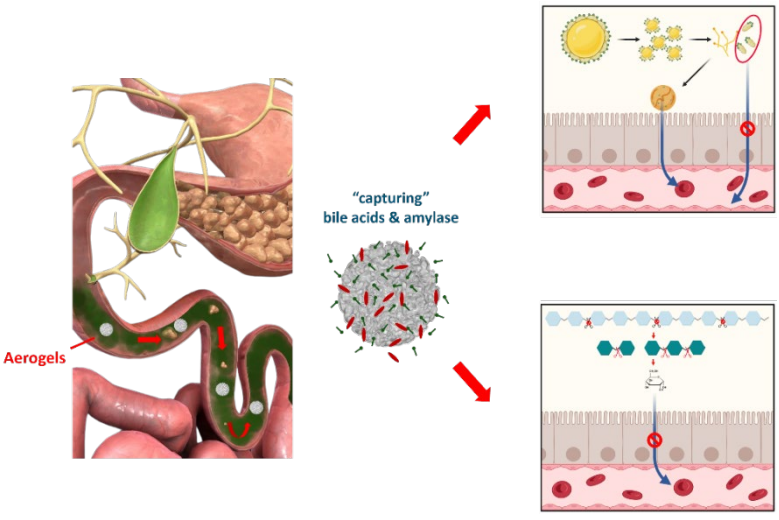
MSc: Specific prerequisite course
HNH30706 Nutrient Breakdown and Absorption
or FCH32306 Fermentation and Gut Health

Topic overview
Aerogel is a novel material with broad applications. Aerogels have several interesting properties for example, low density, high surface area, high porosity, and excellent mechanical properties. They have been extensively used in biological engineering, food science, pharmacies, medicine, aerospace engineering, and textile, etc. In the meantime, different preparation methods have been developed with compatible technological breakthroughs. For example, freeze-drying, supercritical CO_2 drying, micro-emulsification method, spray freeze-drying, droplets jetting, and micro-fluidic method, etc.

In recent years, aerogels have been increasingly utilized in human-related applications, including wound healing, bone regeneration, and the encapsulation of bioactive compounds or pharmaceuticals. Their potential use in specific food applications, such as texture modulation, represents an emerging and innovative avenue. Furthermore, given their unique microstructural properties such as high porosity and surface area. It can be hypothesized that aerogels may interact with digestive fluids, thereby influencing digestion physiology. However, research on the behavior of aerogels within the human gastrointestinal tract remains highly limited.

Aim
The goal of this project is to characterize the behavior of aerogels in the human gastrointestinal tract and investigate how they can modulate digestive physiology, e.g., slowing down starch or lipid digestion and how this modulation is related to aerogels properties.

Approach
In this project you will produce fiber-based aerogels and characterize them in terms of microstructural and mechanical properties. After that you will characterize their digestive behavior during digestion using in-vitro models of digestion. This will include the stability of aerogels, the change in their structural and mechanical properties and the ability of aerogels to bind/entrap digestive enzymes (e.g., amylase) and bile salts during digestion. This may modulate starch and lipids digestion in a beneficial way for health.



2.11 Exploring the role of the gut microbiome as an auxiliary liver to deal with food contaminants

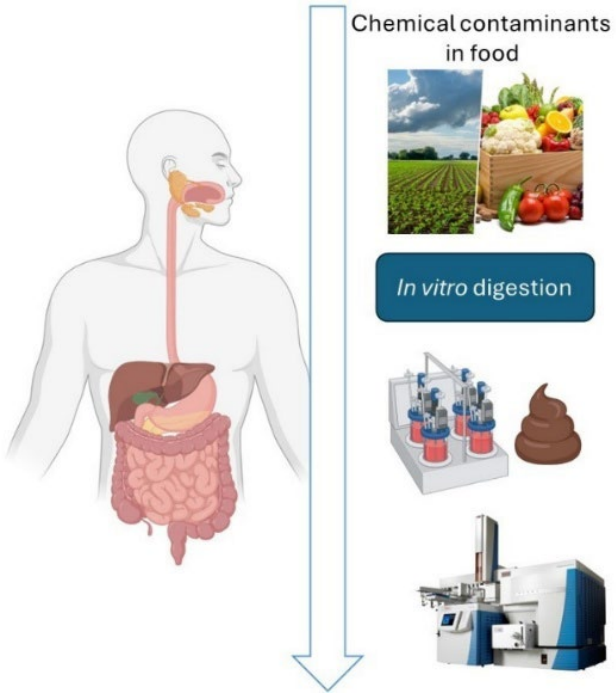
FOOD DIGESTION & HEALTH | BFT, MFT

Supervisors
Josep Rubert, Laura Righetti

MSc: Specific prerequisite course
HNH30706 Nutrient Breakdown and Absorption
or FCH32306 Fermentation and Gut Health

Topic overview
Emerging experimental evidence indicates that toxicant-induced alterations in gut microbiota composition and activity may affect host homeostasis. However, data from human studies are scarce, and we do not know whether these compounds affect the gut microbiome or whether the microbiome has the capacity to detoxify. The relationship between food contaminants and the gut microbiome is an area of increasing scientific interest, as it highlights the complex interactions that impact human health. Contaminants, such as mycotoxins, may affect the composition and function of the gut microbiome, leading to a variety of health implications.

To tackle this challenge, we will first explore the digestion of these compounds using different food matrices. As soon as we understand the biological fate of these residues and contaminants in the gastrointestinal tract, we will then expose the gut microbiome to them. We will study the capacity of these microbial communities to detoxify these compounds by exploring the metabolites released and markers of microbial stress. The activities to be performed range from *in vitro* digestion to the use of bioreactors and quantification of microbial-related metabolites.



2.12 Does food particle size affect the production of microbial metabolites?

FOOD DIGESTION & HEALTH | BFT, MFT

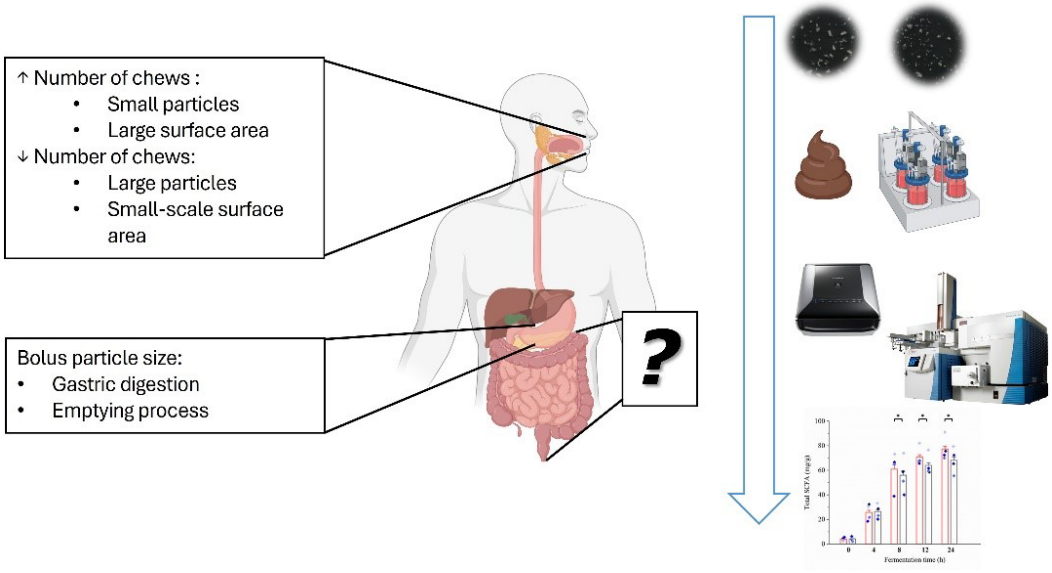
Supervisors
Josep Rubert, Zhen Liu (PhD), Jack Yang

MSc: Specific prerequisite course
HNH30706 Nutrient Breakdown and Absorption or FCH32306 Fermentation and Gut Health

Topic overview
Food oral processing, as the initial stage of digestion, exerts a significant influence on food particles. During oral processing, food matrices are disintegrated and minced into smaller ones. Research has demonstrated that the final particle size of the ingested food bolus after oral processing can be considered a critical factor in gastric digestion by impacting the duration of gastric digestion and the kinetics of the gastric emptying process. However, it remains elusive how microorganisms inhabiting the upper and lower intestines are affected by the particle size.

Aim
The objective of this research topic is to investigate how food particle properties affect the production of microbial metabolites.

Approach
To tackle this challenge, we will first generate food particles of different sizes containing a single or combination of macronutrients. Methodologies to control particle size will be explored; examples of methods are controlled particle formation or disruption of large gels into microgel particles. These particles will be the starting material needed to perform fecal batch cultures and explore how food particles may lead to the production of different metabolite concentration levels and, potentially, a different metabolite pattern. The activities to be performed range from the generation of food particles to the use of bioreactors and quantification of microbial-related metabolites.



2.13 Non-thermal processing and fermentation for the development of whole plant-based snacks with improved nutritional properties and digestibility

FOOD DIGESTION & HEALTH | MFT

Supervisors
Stefano Renzetti (WFBR), Nicoletta Pellegrini

MSc: Specific prerequisite course
-

Topic overview
Up to now, the food industry has developed scalable fractionation and refinery processes that focus on removing key nutrients (e.g., dietary fiber (DF), minerals, vitamins, and unsaturated fats) to improve the palatability of processed food. However, ingredients from whole plant raw materials contain fibers and co-passengers (micronutrients, antioxidants) that are beneficial to human health. These ingredients are also more sustainable.

This project aims to use non-thermal technologies (like High Pressure Processing (HPP) and natural bioprocessing technologies such as fermentation to produce nutrient-rich, wholesome plant-based ingredients focusing on three pillars of functionality: nutritional, technological, and sensorial. These whole plant ingredients will be used to develop food prototypes like baked snacks with improved nutritional profile compared to commercial benchmarks that are high in added sugar, salt or saturated fat. The aim is to look beyond the "protein transition" and utilize the entire plant matrix to provide not only protein with increased digestibility but also dietary fibers, starch with reduced rate of digestibility, as well as antioxidants and essential minerals and vitamins with enhanced bioavailability. This approach maximizes nutritional quality and offers associated health benefits as it gives a wider range of tools to modulate the structure and texture of baked snacks.

The project can include:

- Non-thermal processing and fermentation of cereals, legumes and pomaces from fruit and vegetables
- Chemical, physical and rheological characterization of the obtained ingredients
- Relating ingredient properties to the structure and texture of prototype baked snacks
- Nutritional analysis of ingredients and prototype baked snacks
- Studies on protein and starch digestion in the prototype food

2.14 Micronutrients and immune functioning

FOOD DIGESTION & HEALTH | MFT

Supervisors
Karen Fransen (PhD), Tamara Hoppenbrouwers

MSc: Specific prerequisite course
-

Topic overview
In this thesis you will focus on the immune system, and work (in vitro) with primary innate immune cells such as monocytes/macrophages or natural killer cells and investigate the influence of micronutrients (e.g. vit B12, folic acid, zinc, your own interest) on these cells. Furthermore, you will investigate the absorption, bioaccessibility, and bioavailability of these micronutrients from different food sources (e.g. vegetables vs supplements). The project will align with the initiation of a birth cohort study by your supervisor (and others).

2.15 Food flavor dynamics: Flavor release & sensory perception of foods

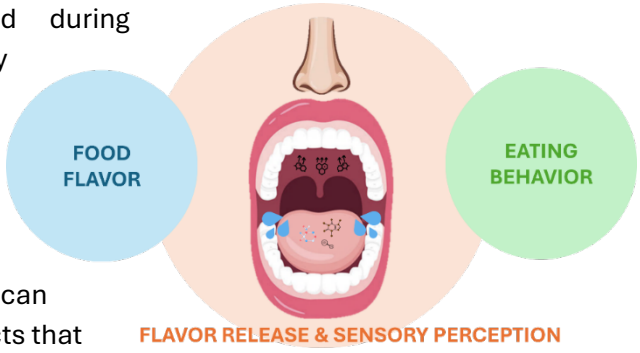
FOOD DIGESTION & HEALTH | MFT

Supervisors
Arianne van Eck

MSc: Specific prerequisite course
FQD37806 Food Flavor Design or
HNH30506 Principles of Sensory Science

Topic overview
Have you ever wondered why your wine smells floral but tastes fruity? Or why products with reduced fat or sugar are generally less liked by consumers? These everyday food experiences are rooted in the science of flavor, a scientific field that explores how we perceive food and enjoy what we eat. In this thesis, we hope to further unravel some of those (delicious) flavor mysteries.

Flavor perception is the sensation perceived during eating/drinking, and it's composed of several sensory modalities: olfactory (smell), gustatory (taste) and trigeminal sensations. Flavor perception is a multisensory and dynamic experience and can change while eating due to food breakdown in mouth and saliva incorporation. By understanding how we perceive flavors during consumption, we can create better/healthier/more sustainable food products that are well accepted by consumers worldwide.



Flavor research is a multidisciplinary field that combines elements of chemistry, physics, biology, psychology, food science and/or sensory science. Recent research initiatives focus on the use of interdisciplinary and state-of-the-art methods to better understand and manipulate the complex interactions between food matrixes, chemical compounds and human flavor perception.

Although many studies attempted to understand the complex phenomenon of flavor perception, it is not fully understood yet. Most studies focused on flavor release and/or perception of model foods (emulsions, gels) spiked with one or few flavor compounds. However, consumers generally consume more complex foods or meals providing a composite blend of physicochemical and sensory properties.

This thesis focuses therefore on understanding how food matrix properties and flavor properties drive flavor release and perception, and this is key to being able to develop foods that meet the sensory expectations of consumers.

Methodologies:

- Flavor: headspace or in vivo aroma release
- Sensory: dynamic sensory methods such as Time-Intensity, TDS or T-CATA
- Eating behavior: food choice, bite size, chewing time, satiation

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.

Quality Along the Chain 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.

3.1 Digital, physical, and emulated-twin modelling tools to optimize fresh fruit cold chains from tree to table

QUALITY ALONG THE CHAIN | MFT

Supervisors
Thijs Defraeye, Taylor Person, Elisabeth Tobler

MSc: Specific prerequisite course
FQD31306 Predicting Food Quality

Topic overview
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.

Aim
In this project, we look to use 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 cargo twins:

- 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.
- 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.
- 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.

The choice between the type of twin that is focused on depends on the available supply chain contacts at hand.

3.2 Food packaging – Sustainable package design

QUALITY ALONG THE CHAIN | MFT

Supervisors
Deniz Turan-Kunter, Maarten Smulders

MSc: Specific prerequisite course
FQD31306 Predicting Food Quality

Topic overview
Packaging is essential to preserve 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 the 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.

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

3.3 Food packaging – Optimizing logistics

QUALITY ALONG THE CHAIN | BFT, MFT

Supervisors
Deniz Turan-Kunter

MSc: Specific prerequisite course
FQD31306 Predicting Food Quality or
FHM36306 Food Data Science or
YSS36306 Data Science for Food and Consumer Behaviour Research

Topic overview
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 behavior 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 into 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 to reduce waste or increase sales. Features to study in the models are shelf life, end quality, sensor data, transportation metadata, 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.

3.4 Dynamics and diversity of microbial contaminants on pig carcasses

QUALITY ALONG THE CHAIN | BFT, MFT

Supervisors
Sara Erasmus, Ireoluwa Isaac-Bamgboye (PhD)

MSc: Specific prerequisite course
-

Topic overview
One of the meats that is most 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.

3.5 Does a happy animal equal quality meat?

QUALITY ALONG THE CHAIN | BFT, MFT

Supervisors
Sara Erasmus, Seren Yigitturk (PhD)

MSc: Specific prerequisite course
-

Topic overview
Meat is one of the food sources with a high nutritional value. As for any food product, high quality is important for consumers. The major components determining meat quality are yield and composition, appearance, technological characteristics, palatability, wholesomeness and ethical quality.

These properties are referred to as 'intrinsic quality', associated with extrinsic factors that define the way 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. The main task will be to assess the intrinsic quality of meat 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.

3.6 Ensuring the integrity of the food supply chain: Authenticity and traceability challenges

QUALITY ALONG THE CHAIN | BFT, MFT

Supervisors
Sara Erasmus

MSc: Specific prerequisite course
-

Topic overview

In the efforts to make food systems fair, healthy and environmentally friendly, it is vital that the food supply chain is free of food fraud. This means that every supply chain actor should be able to demonstrate the quality aspects of food, but also the traceability of their products.

Food fraud is a global issue that disrupts the normal market environment. It is a major concern for various supply chain actors and stakeholders. Food fraud incidents have a significant impact, generating considerable global monetary losses, eroding consumer confidence and trust in food products. Due to globalisation, food ingredients are sourced globally, while food supply chain networks have become more complex and adaptive in response to current world-wide incidents. There is also extra pressure to ensure that products from nature-positive food systems that enhance biodiversity and have lower environmental impacts do not fall victim to food fraud. The opportunities and motivations to commit food fraud prevail, while the adequacy of technical and managerial controls is not always sufficient to deter fraud. Although authentication techniques perform well in detecting fraudulent vulnerable food quality traits, the defence is passive, while an approach to actively prevent the fraud crimes happening in the early stage needs to be investigated. To improve food supply chain integrity, it is required to elucidate risk factors contributing to food fraud vulnerability and study advances that can help in the fight against food fraud.

Objectives

The main objectives are to elucidate economic/criminological risk factors contributing to food fraud vulnerability, discern markers which substantiate the identity of food products and to study advances that can help in the fight against food fraud. Such information on vulnerability and detection options and/or advances will help to set up food fraud management systems.

In this thesis, your tasks are:

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

3.7 Exploring the potential of spectral imaging to address food quality and or authenticity challenges

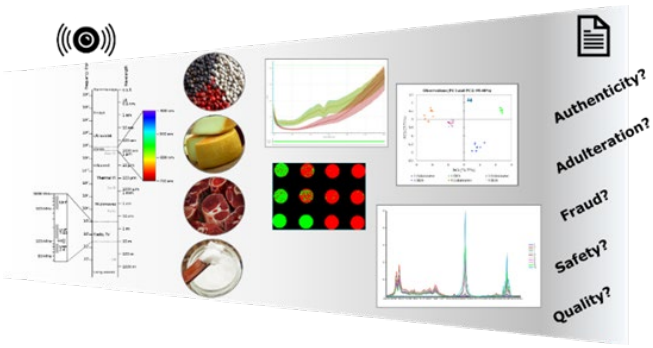
QUALITY ALONG THE CHAIN | BFT, MFT

Supervisors
Sara Erasmus, Joseph Peller (WPR)

MSc: Specific prerequisite course
-

Topic overview
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 into 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.

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

3.8 Development of sustainable smart packaging solutions for fresh fruits and vegetables using nanocellulose-based materials

QUALITY ALONG THE CHAIN | MFT

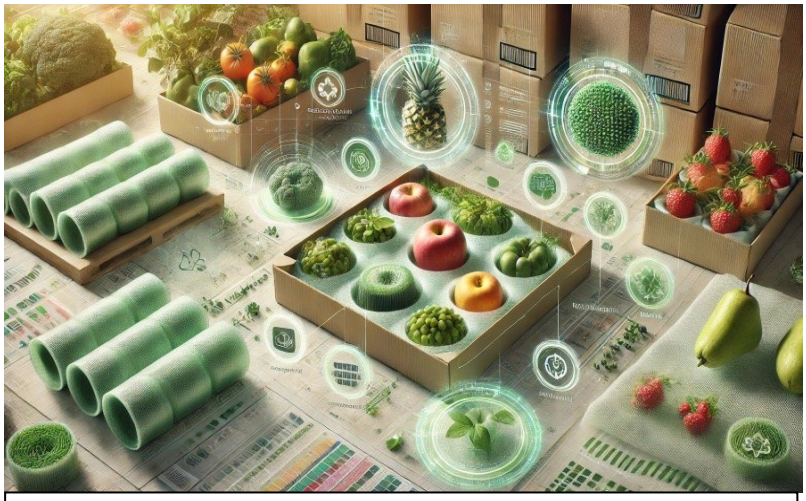
Supervisors
Deniz Turan-Kunter, Joice Kaschuk

MSc: Specific prerequisite course
-

Topic overview
Transportation-induced damage and moisture-related deterioration are major issues in the logistics of fresh produce, leading to significant postharvest losses. Traditional packaging materials, such as expanded polyethylene and polystyrene, are effective but pose environmental challenges due to their non-biodegradable nature. This project proposes to address these challenges by developing bio-based, biodegradable smart packaging solutions that combine mechanical durability with advanced sensing capabilities.

This thesis will explore the development of sustainable smart packaging solutions for fresh fruits and vegetables, focusing on optimizing packaging performance, reducing postharvest losses, and promoting environmental sustainability.

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



Conceptual representation of innovative sustainable food packaging for fresh fruits and vegetables, highlighting bio-based materials with smart sensor integration.

The design emphasizes eco-friendly materials, recyclable packaging, and the monitoring of transportation conditions to reduce food waste.

3.9 Predicting food quality changes based on neural networks

QUALITY ALONG THE CHAIN | BFT, MFT

Supervisors
Yizhou Ma

MSc: Specific prerequisite course
-

Topic overview
Food product quality evolves based on kinetic changes during processing (e.g., baking, frying, drying) and storage (e.g., color change, lipid oxidation, creaming, softening). Understanding these transformations is crucial for optimizing processing parameters and product quality.

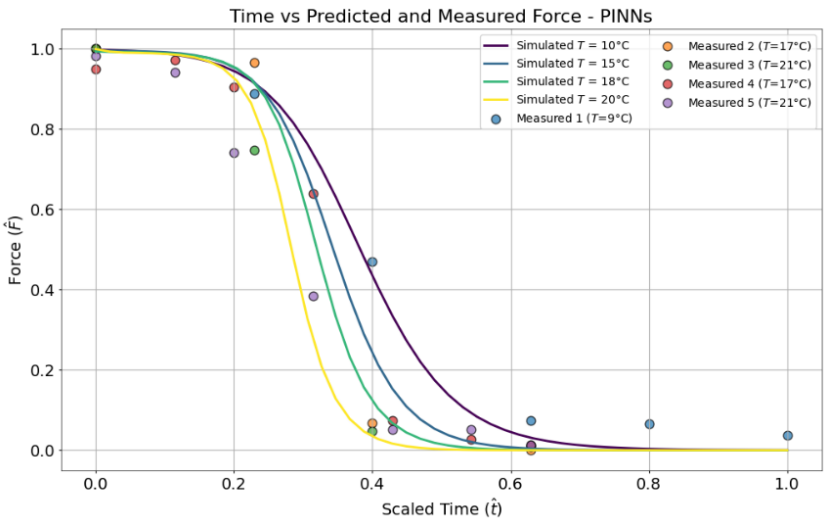
Traditional kinetic models rely on reaction kinetics and transport phenomena, which describe fundamental physical and chemical changes in food. However, these models often require extensive parameter estimations and experimental data. Neural networks offer a more flexible, data-driven approach to predicting quality changes. Long Short-Term Memory (LSTM) networks effectively model time-series data, capturing complex dependencies in food kinetics. Additionally, Physics-Informed Neural Networks (PINNs) incorporate scientific principles into neural architectures, enabling accurate predictions with limited data.

This thesis project explores LSTMs and PINNs for modeling food quality changes, aiming to unify data-driven and physics-based approaches. By reviewing existing methods and datasets, we seek to outline a computational framework that enhances predictive accuracy while improving data efficiency.

Join this thesis if you want to:

- Model complex food systems with data-driven approaches.
- Write modelling scripts in Python with the help of artificial intelligence.
- Making meaningful prediction models that the food industry can benefit from.

This is a desk research topic, but students must be comfortable with using programming languages (with the help of AI, of course).



3.10 Food packaging – Active edible coatings from food by-products for confectionery

QUALITY ALONG THE CHAIN | MFT

Supervisors
Niloufar Sharif, Deniz Turan-Kunter

MSc: Specific prerequisite course
FQD31306 Predicting Food Quality

Topic overview
As natural resources diminish and global environmental waste increases due to the extensive use of petroleum-based plastic packaging, there is an urgent need to explore eco-friendly alternatives for traditional food packaging. In this regard, food by-products and waste are potential sources that can be transformed into biodegradable and functional coatings.

This research focuses on developing edible coatings with enhanced heat resistance, anti-melting, anti-clustering, and anti-blooming properties to improve the stability and quality of confectionery products. Additionally, these coatings will be designed as functional membranes to preserve fillings by acting as effective barriers to water, oxygen, and fat migration. By improving mechanical strength and thermal resistance, these coatings will help maintain product integrity throughout the supply chain.

This research focuses on extracting functional compounds from food industry by-products and waste, formulating edible coatings with desired functional properties, and evaluating their potential to confectionery products in terms of barrier properties as well as mechanical, safety, and sensory characteristics. The findings aim to contribute to the development of sustainable food packaging solutions that meet both environmental goals and consumer demands for safe, and high-quality confectionery products.

3.11 Developing a database to unlock food packaging-quality interactions in foods

QUALITY ALONG THE CHAIN | BFT, MFT

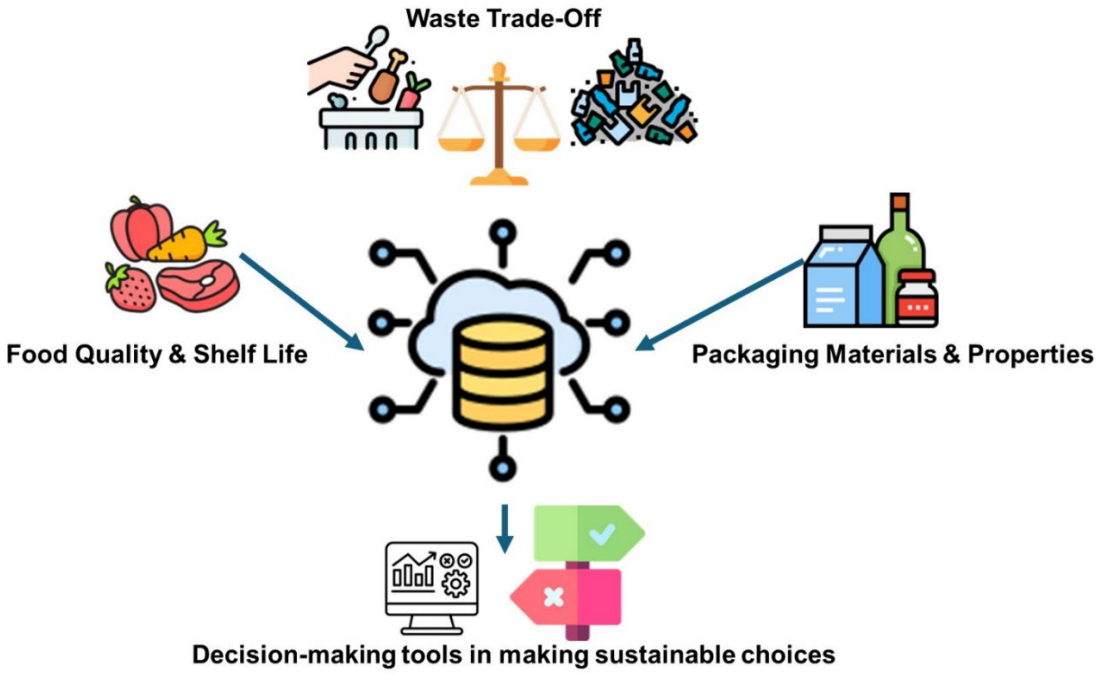
Supervisors
Deniz Turan-Kunter

MSc: Specific prerequisite course
-

Topic overview
Food packaging plays a critical role in preserving food quality and extending shelf life. However, there is an ongoing trade-off between reducing plastic waste and preventing food spoilage. While sustainable packaging alternatives are being explored, their impact on food quality and shelf life is not always well understood. A structured database linking food packaging materials with quality indicators can support data-driven decision-making to optimize both sustainability and food preservation.

The aim of this thesis is to develop a comprehensive database that consolidates information on food packaging materials, their barrier properties, and their impact on food quality attributes. The database will serve as a tool to support sustainable packaging decisions while minimizing food waste.

You will conduct a systematic literature review, collect and organize existing experimental data on packaging-performance relationships, develop a structured database framework to categorize food types, packaging properties, and quality outcomes, analyze trends to identify optimal packaging solutions for different food products and validate the database through case studies.



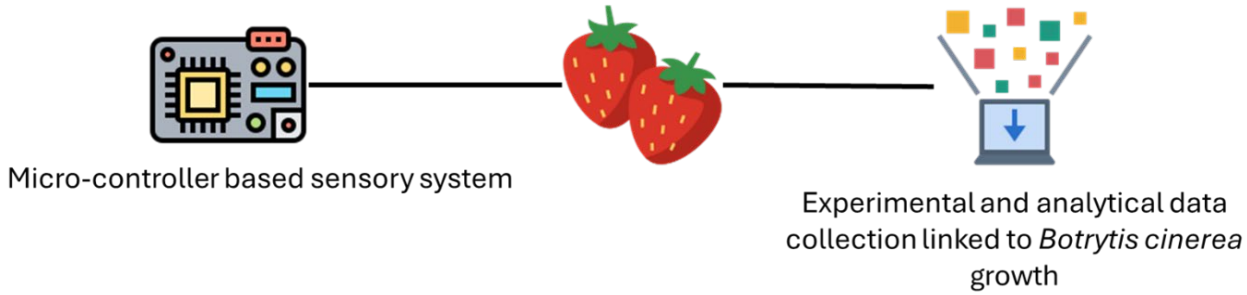
3.12 Sensor-based monitoring for early detection of Botrytis cinerea in strawberries

QUALITY ALONG THE CHAIN | MFT

Supervisors
Eda Coşkun, Deniz Turan-Kunter

MSc: Specific prerequisite course
FQD31306 Predicting Food Quality

Topic overview
Strawberries are among the most perishable fruits due to their high transpiration rates and delicate tissue, making them highly susceptible to post-harvest decay. One of the greatest threats to strawberry quality is Botrytis cinerea (gray mold), a fungal pathogen that significantly reduces shelf life. Intelligent packaging equipped with sensors offers a promising solution for real-time monitoring of environmental and biochemical changes associated with fungal growth.



This study aims to correlate sensor responses with strawberry quality deterioration to enable early detection of Botrytis cinerea before visible spoilage occurs. Various sensors, including gas sensors (for detecting VOCs released during fungal metabolism), and pH sensors (for acidity shifts caused by microbial activity) will be evaluated for their sensitivity and accuracy in predicting mold development.

Strawberry samples will be stored under controlled conditions, with mold development continuously tracked. Changes in pH, VOC profiles, and other key indicators will be analyzed using instrumental techniques. The data will be used to define sensor detection limits for Botrytis cinerea and assess the effectiveness of different sensors in providing early-warning signals for fungal spoilage. Ultimately, the findings will support the development of smart packaging solutions that help reduce food waste and improve supply chain management.

3.13 Integrating safety and quality in alternative protein sources evaluation

QUALITY ALONG THE CHAIN | MFT

Supervisors
Matilde Milana (WFSR), Esther van Asselt (WFSR), Vincenzo Fogliano

MSc: Specific prerequisite course
-

Topic overview
Are you curious about which protein source could be the best alternative to animal-based products? The transition to more sustainable diets is a hot topic, but choosing the right alternative isn't as simple as it seems. Many factors play a role in this decision, from environmental impact and nutritional value to food quality, safety, and consumer acceptance. This research focuses on food quality, which goes beyond just taste and texture—it includes how ingredients are designed, how they impact digestion and health, and how they are processed, packaged, and kept safe along the food chain.

A key question is how food safety and quality are connected and how improvements in formulation and processing can enhance both. To bring all these factors together, we will use Multi-Criteria Decision Analysis (MCDA), a decision-making methodology that helps compare different protein sources by weighing their pros and cons in a structured way. The goal of this thesis is to develop a framework to simultaneously consider - and balance - all these aspects, providing insights into how to create high-quality, safe, and consumer-friendly meat and dairy alternatives. If you're interested in the science behind sustainable food choices, this project will give you hands-on experience in evaluating future protein sources.

The thesis will not include any laboratory activities; instead, the student will be responsible for the design and implementation of a MCDA framework using secondary data from relevant literature.

Theme 4: Consumer Science

The consumer science team of the chair group Food Quality and Design (FQD) aims to generate consumer insights that can be used to optimize product development, use and quality. Therefore, FQD focuses on the interaction between consumers and products with which the consumer gets in touch in a certain context. Interviews, focus groups, or observations are often used methods to study consumers, sometimes supplemented by questionnaires.

The consumer science team of FQD is engaged in:

- Studying consumer needs and wishes
- Understanding the daily life context of the consumer to solve complex consumer issues
- Analysing the interrelationship between consumers and products/services to gain insight into consumption patterns and behaviours
- Translating consumer insights into guidelines for other stakeholders to enable optimisation of the consumer context and experience

4.1 Children's perception of plant-based food alternatives

CONSUMER SCIENCE | MFT

Supervisors
Lotte Pater (PhD), Bea Steenbekkers

Specific prerequisite course
FQD24806 Qualitative Consumer Research in Food Design

Topic overview
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 have 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 of 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.

4.2 Acceptance of edible insects by school children: A cross-country study

CONSUMER SCIENCE | MFT

Supervisors
Maryia Mishyna, Lotte Pater (PhD)

Specific prerequisite course
FQD24806 Qualitative Consumer Research in Food Design

Topic overview
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 neophobia regarding insects.

The present project aims to evaluate the effect of information provision on children on their willingness to taste and on their hedonic response to foods containing insects. The study can be done as a comparison between two countries: the Netherlands and Italy.

Information about two types of insects (grasshopper and mealworm) will be gathered and incorporated into the activities, where children will evaluate their hedonic responses to insect-based snacks. Children aged 9 to 11 years old will be recruited from local schools in Turin and if possible/desired from schools in the Netherlands.

Activities to be performed by the student will comprise:

1. Collect and prepare an interactive presentation for children about the benefits of insects and their use as foods information (lecture/workshop).
2. Assistance during the lectures/workshops, and hedonic test which will be provided at the beginning and end of the workshop.
3. Collecting and analyzing 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 can allow a student to apply for Erasmus Grant and stay for some time in Turin, Italy.

4.3 Consumer Perception of Hybrid Meat

CONSUMER SCIENCE | BFT, MFT

Supervisors
Pieter Groen (PhD)

Specific prerequisite course
FQD24806 Qualitative Consumer Research in Food Design

Topic overview
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 in consuming 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 consumer's diet, how it has to be named or categorized, etc. The exact research question can be decided upon in collaboration with your supervisor.

4.4 Consumer perception & co-creation of authentic vegetarian meals

CONSUMER SCIENCE | BFT, MFT

Supervisors
Pieter Groen (PhD)

Specific prerequisite course
FQD24806 Qualitative Consumer Research in Food Design

Topic overview
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. However, the actual consumption of these products remains low, resulting in an actual meat consumption that remains (too) high.

In scientific literature much attention is being paid to the consumer's 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 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. A combination with sensory research is also possible.

4.5 Information on food labels and consumer research

CONSUMER SCIENCE | BFT, MFT

Supervisors
Esther Oldenhuis

Specific prerequisite course
FQD24806 Qualitative Consumer Research in Food Design

Topic overview
Are you interested in exploring how food labels influence consumer perceptions and behavior? When deciding what to eat or drink, consumers often must rely on the product's packaging and label as their first source of information. While part of the information on food labels is legally required, much of what appears on the front of the package is voluntary information, which the company uses to communicate to the consumers.

What specific information do companies choose to share on the labels, how does this relate to the expected and perceived food quality and how does this shape consumer perceptions and behavior? Is the information clear and transparent to consumers, what type of information does consumers want and need, what claims are being made on the label and how can this influence consumers?

To explore these questions further, consumer research is needed. BSc and MSc students are invited to define a topic of their own interest that examines food labelling from the consumer's perspective. Potential areas of research include, but are not limited to Nutri-Score, nutrition or health claims, sustainability information, logo's, country-of-origin information, allergen information, usage instructions, disposal guidelines, QR codes, accessibility of the information etc. This research will contribute to a better understanding of how label information affects consumers' perceptions and behavior.

4.6 Hybrid dairy: Exploring sensory and consumer insights to bridge the gap between plant-based and animal-based products

CONSUMER SCIENCE | BFT, MFT

Supervisors
Annelies Blok

Specific prerequisite course
-

Topic overview
Despite growing consumer interest in sustainable food choices, current plant-based dairy alternatives struggle to meet expectations, particularly in terms of taste, texture, and nutritional value. As a result, their appeal remains limited to a niche market. Hybrid dairy products, which combine animal-based and plant-based ingredients, offer a promising solution. These products aim to match the sensory and nutritional qualities of traditional dairy while improving sustainability.

This project investigates consumer acceptance of hybrid dairy, focusing on hybrid yoghurt and cheese. It explores key sensory preferences and consumer motivations and barriers to adopting hybrid dairy products. Insights from sensory and consumer research will guide the development of hybrid dairy prototypes, helping to develop appealing, sustainable products that meet both sensory and nutritional expectations. By bridging the gap between plant-based and animal-based dairy, hybrid products could drive a shift towards more sustainable food consumption.

Potential thesis activities:

- Sensory mapping of animal-based and plant-based yoghurts/cheeses
- Preference map: link sensory attributes to consumer liking to reveal sensory properties that drive liking
- Online survey on consumer perception of hybrid dairy products
- Qualitative research (interviews/focus groups) on consumer perception of hybrid dairy products (experience in qualitative consumer research required):
    - Motives and barriers for consuming hybrid cheese
    - Preferred consumption moment
    - Product naming for hybrid yoghurt/cheese
    - Ratio plant-based vs animal-based ingredients
    - Source of plant-based ingredients (soy, coconut, oat, etc)
    - Co-creation: developing hybrid yoghurt prototypes with consumers

Theme 5: Dairy Science & 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, because dairy-based ingredients are used in a wide range of food products.

Dairy research is not limited to the traditional dairy chain. We also perform research 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, e.g. by micro-organisms. As such, a thorough understanding of the physical-chemical properties of milk components is required.

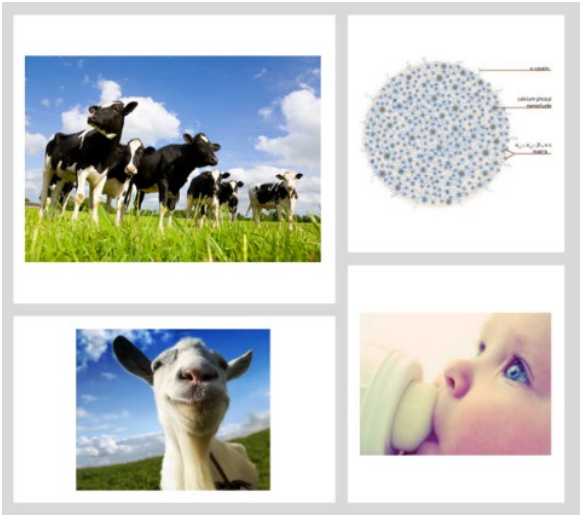
5.1 Exploring variation in milk protein composition within and between species and its potential for dairy product innovation

DAIRY SCIENCE & TECHNOLOGY | BFT, MFT

Supervisors
Etske Bijl

MSc: Specific prerequisite course
FQD33306 Dairy Chemistry and Physics or
FQD32306 Dairy Science and Technology

Topic overview
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; αs1-casein, β-casein, αs2-casein and κ-casein, milk of humans and mares contains no or little αs2-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 understanding how techno-functional properties such as renneting behavior 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 of 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

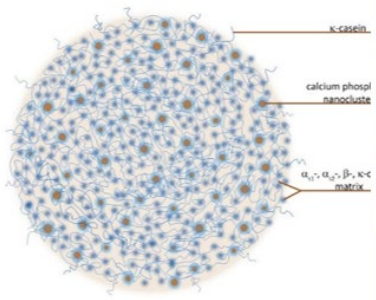
5.2 Towards animal-free dairy products

DAIRY SCIENCE & TECHNOLOGY | BFT, MFT

Supervisors
Etske Bijl, Kasper Hettinga, Zekun Fan (PD), Renske Bouma (PhD), Stefan ten Voorde (PhD)

MSc: Specific prerequisite course
FQD33306 Dairy Chemistry and Physics or FQD32306 Dairy Science and Technology

Topic overview
Milk from cows is an essential source of protein in the Western diet. The major protein fraction in milk are the caseins, which are mostly organized 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 behavior, texture and flavor 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.

5.3 Immune-active proteins and peptides in bovine and human milk

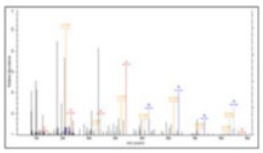
DAIRY SCIENCE & TECHNOLOGY | BFT, MFT

Supervisors
Kasper Hettinga, Siwei Li (PhD)

MSc: Specific prerequisite course
FQD33306 Dairy Chemistry and Physics or
FQD32306 Dairy Science and Technology

Topic overview






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 underline the decrease in native milk proteins are not well understood. Denaturation and aggregation kinetics of single proteins have been studied in model systems. 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. In addition, to better understand the role of immune-active proteins, studying human milk, as the gold standard for infant formula, can lead to novel insights in the role these proteins play in the health of the newborn infant.

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.

5.4 Exploring dairy processing and ingredient changes to determine its effect on a final product's attributes

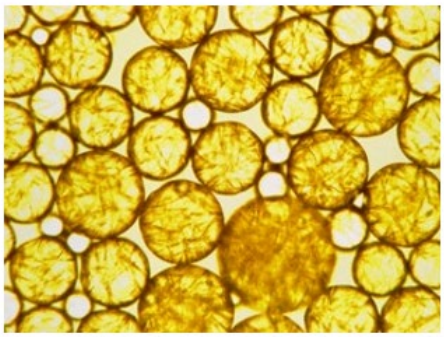
DAIRY SCIENCE & TECHNOLOGY | BFT, MFT

Supervisors
Kasper Hettinga, Etske Bijl, Qing Ren (PhD), Yuqing Zhong (PhD), Ruiwen Sun (PhD)

MSc: Specific prerequisite course
FQD33306 Dairy Chemistry and Physics or
FQD32306 Dairy Science and Technology

Topic overview

Dairy products play a key role in the human diet and nutrition throughout the world. In the coming years, 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, exploring the use of new ingredients or determining the impact of processing on nutrient availability.



Understanding the structure of a dairy product is critical as this dictates the final characteristics such as physical stability, texture, structure, etc. The structure is greatly impacted by two factors: processing and ingredient formulation. In this project, different processing techniques and different dairy components will be tested for their potential use in the dairy industry. This type of research would include using e.g. texture analysis, detailed composition analysis to determine fat, protein, moisture, ash, and lactose content, structural analysis and analysis of product properties like digestion.

Objectives

This thesis topic includes multiple different projects, that can include studying various dairy products such as cheese, infant formula, 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 physical stability, cheese making, digestion).
2. What compositional differences (protein composition, milk fat globule membrane) affect product properties.
3. To study the effect of various ingredient substitutions in dairy product formulations to understand their impact on the final consumer good.

5.5 Effect of processing-induced changes on digestion and functionality of dairy components

Dairy Science & Technology | BFT, MFT

Supervisors
Kasper Hettinga, Qing Ren (PhD), Marit Navis (PhD), Yifan Liang (PhD)

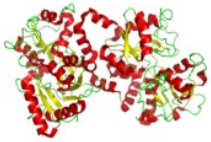
MSc: Specific prerequisite course
FQD33306 Dairy Chemistry and Physics or
FQD32306 Dairy Science and Technology

Topic overview
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. These heat processes may lead to heat-induced denaturation/aggregation of the proteins, as well as glycation, which is the reaction between a reducing sugar and the protein. These changes can affect the digestibility, nutritional value and immunogenicity of 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. However, the link between process-induced protein modifications and digestibility remains largely unknown, especially in infants.
Next to bovine 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 several different PhD and postdoc projects. The aims of these projects are:

1. To investigate the effect of processing on digestibility of dairy components.
2. Difference in processing-induced changes between a dairy matrix and one containing plant-based components
3. Obtain detailed insight in the effect of heat processing on the digestion and immunological consequences, especially in relation to infant nutrition.






Project description
Components used in e.g. infant formula (that can e.g. come from bovine or goat milk, or from plant sources) can be processed at different conditions which will lead to different protein modifications (e.g. denaturation, aggregation). 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.

5.6 Enhancing the stability of dairy alternatives: Synergy between milk and plant proteins for improved texture and functionality

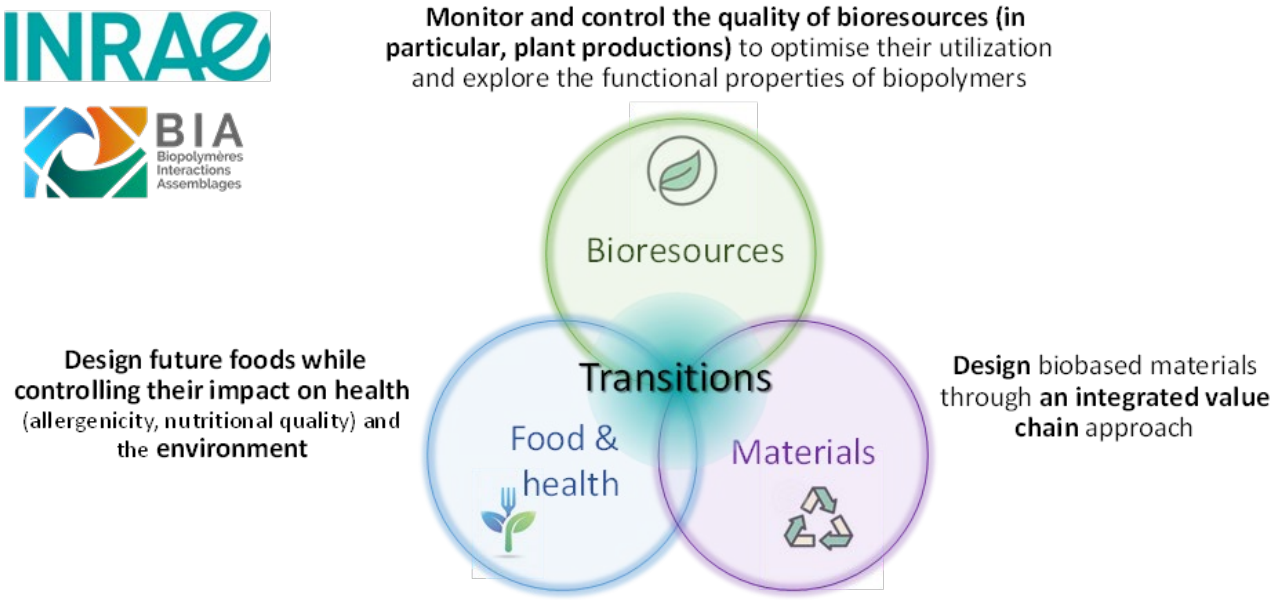
DAIRY SCIENCE & TECHNOLOGY | MFT

Supervisors
Adeline Boire & Fanny Guyomarc'h (INRAe),
Etske Bijl & Kasper Hettinga

MSc: Specific prerequisite course
FQD33306 Dairy Chemistry and Physics or
FQD32306 Dairy Science and Technology

Topic overview
This project explores innovative milk-legume hybrid products to enhance the sensory and functional properties of plant-based dairy alternatives. Specifically, the research will address how casein proteins, key milk components, can stabilize legume protein isolates by preventing heat- and pH-induced precipitation. The project involves formulating casein/legume protein blends, analyzing their stability and microstructure, and characterizing key interactions using biochemical, physico-chemical and optical methods. By testing modified proteins and/or screening different species, the project aims to unravel the key factors for the protective chaperone-like effect of caseins. This project offers hands-on experience in advanced protein analysis and food structuring, contributing to the development of high-quality dairy alternatives.

Practical 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 MFT thesis students to conduct their MSc thesis ***in Nantes***.



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.