Flash Presentations

Session 1

Food waste management with an automated, modular system based on Hermetia illucens larvae and heterotrophic alga *Galdieria sulphuraria*

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Food waste at the end of the value chains is a challenging problem currently solved with incineration, composting (or landfilling) and anaerobic digestion technologies. They are associated with high environmental impacts and low recycling of valuable nutrients, which can be achieved in a cascading upcycling of nutrients with live organisms (Pleissner & Smetana, 2020). Methods to process such wastes into biomass of defined composition automatically and in decentralized locations are lacking.

The study presents modular designs of food waste treatment relying on insect larvae of *Hermetia illucens* (Pahmeyer et al., 2022a) and continuous production of the heterotrophic alga *Galdieria sulphuraria* (Pahmeyer et al., 2022b). Modular design was dictated by the need to have a mobile system of decentralized food waste treatment close to the point of origin, abilities of species to process the biomass and potential for maximal automation.

A life cycle and economic assessments were carried out on the hypothetical design to define whether the proposed systems would be viable. The designs resulted in continuous and semi-continuous designs able to produce dry biomass of 3.55 € per kg (*H. illucens*) and of 4.38 € per kg (*G. sulphuraria*), which would make them profitable in 5 years. Production of 1 kg of dry biomass of insects and microalgae was associated with impacts in global warming potential: 2.77 and 3.8 kg CO_2 eq; in non-renewable energy use: 55.24 and 69.9 MJ; in arable land occupation: 0.68 and 0.09 m^2 annually. Relying on 1 kg of proteins as functional unit it was possible to demonstrate that even small-scale insect and microalgae production processes have sustainability benefits when relying on food waste as feeding media.

Moreover, present automated, modular technology waste treatment is demonstrated to be more environmentally friendly than most waste treatment technologies applied to the end of the chain wastes.

References

1. Pleissner, D., & Smetana, S. (2020). Estimation of the economy of heterotrophic microalgae-and insect-based food waste utilization processes. Waste Management, 102, 198-203.

2. Pahmeyer, M. J., Siddiqui, S. A., Pleissner, D., Gołaszewski, J., Heinz, V., & Smetana, S. (2022a). An automated, modular system for organic waste utilization using Hermetia illucens larvae: Design, sustainability, and economics. Journal of Cleaner Production, 379, 134727.

Effect of short ultrasound treatment as a chitin pre-treatment: a strategical step to transform shell wastes in chitooligosaccharides

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Chitooligosaccharides (COS) are innovative bioactive oligosaccharides obtained from chitin with applications in many areas such as in food and health as a bioactive ingredient. Québec has a huge potential in the production of these molecules because of its relevant role in the processing of marine products such as snow crab and American lobster, which generates huge amounts of shell wastes, rich in chitin. Although chitin from marine shells constitutes an interesting source of COS, the latter high crystallinity hinders the transformation of chitin into COS without the use of toxic and pollutant chemicals.

The objective of this work is to assess the effectiveness of ultrasound (US) treatment on the diminution of chitin crystallinity and relaxation of the hydrogen bonds in it. Particle's size distribution was standardized and then 1% (m/v) chitin suspensions were US-treated at 40 W for 15 min (30s cycle, ON/OFF), in an ice-bath, in a high-intensity ultrasonic processor (model Vibracell VCX 750 Sonics, Sonics and Materials Inc, Newtown, United States), with a 13 mm tip and an amplitude of 40%.

Two commercial chitins: from crab (naturally more crystalline) and from squid (less crystalline structure) were compared to extracted chitins from shell wastes of crab and lobster. Differences in water solubility, crystallinity (X-ray diffraction, XRD), deacetylation degree and chain bonds relaxation (FT-IR) were monitored in treated and non-treated samples. The US treatment was able to promote a higher increase in solubility in squid chitin, followed by the commercial crab chitin, crab and lobster. Characteristic chitin peaks (2θ) at nearly 10° and 20° in the XRD analyses indicated a decrease in crystallinity in US-treated samples in different extents for each chitin source.

These results encourage the investigation of emergent and green technologies such as US in the transformation of food wastes into high added-value ingredients.

References

W. G. Birolli et al Applied Acoustics, 103 (2016) 239-242.
G. L. Dotto et al. E-Polymers (2016)
F. Hou et al Carbohydrate Polymers, 2310 (2020) 115669.

Optimization of wiped-film short path molecular distillation for recovery of cannabinoids from cannabis oil using response surface methodology

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Only a few studies have explored molecular distillation techniques that improve the recovery of cannabinoids from crude cannabis oil with scale-up potential. Wiped-film short path (WFSP) molecular distillation is commonly employed in the cannabis industry for separating cannabinoids from terpenes and heavy compounds. It is a two-cut process, where the distillation of terpenes and cannabinoids occurs at the first and second cut, respectively. In the second cut, the effects of the distillation parameters, including feed flow rate (FFR) (35 to 55 Hz) (41.6 to 71.3 mL min^{-1}) and internal condensation temperature (ICT) (60 to 90°C), were examined, and optimized using a central composite rotatable design (CCRD) towards maximizing the mass (g) and recovery efficiency (%) of cannabinoids in the distillate and minimizing the mass of cannabinoids (g) in the residue. Results show that irrespective of the internal condensation temperature, reducing the feed flow rate increased the cannabinoid's yield and recovery. Although high distillation time was observed at low feed flow rates, the quality of cannabinoids remained unaffected. Response surface methodology (RSM) was used to optimize the wiped-film short path molecular distillation of cannabis oil. The predicted optimal conditions were a feed flow rate of 35 Hz (41.6 mL min^{-1}) and an internal condensation temperature of 75°C. At these optimized conditions, the masses of tetrahydrocannabinol (THC) in distillate and residue were 174.4 g and 38.8 g, respectively, with a recovery efficiency of 93.4% in the distillate. The study provides the distillation conditions to be considered for the cannabis industry to obtain a cannabinoid rich-distillate, with potential as a food ingredient, from the molecular distillation process without affecting the cannabinoid quality.

Effects of pulsed electric fields and polarity reversal on the selectivity of peptides migration from porcine cruor hydrolysate, with electrodialysis with ultrafiltration membrane

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Porcine blood is a major coproduct from slaughterhouses. Its precipitated part after centrifugation, cruor, is mainly composed of hemoglobin. After its enzymatic hydrolysis, a wide variety of peptides is obtained, especially antimicrobials.

To produce fractions of peptides with increased bioactivities and higher purity, electrodialysis with ultrafiltration membrane (EDUF) was proposed[1]. Indeed, this technology is a promising ecoefficient strategy to recover bioactive peptides[2]. EDUF is hybrid with a selectivity based on the charge and the molecular mass, thanks to the UF membrane. Moreover, the aim was to evaluate the impacts of different current conditions (pulsed electric field (PEF) and polarity reversal (PR)) on peptide migration selectivity[3]. Hence, the direct current (DC) was compared with combination of pulse/pause duration corresponding to ratios of 1 and 10 for PEF and PR.

The peptide populations in the recovery compartments were analyzed using UPLC-MS/MS. Principal component analyzes, on peptides and conditions, highlighted that PR ratio 1 generated the most significant differences concerning the migrated peptides. PEF ratio 1 was the second most different. PEF and PR ratio 10, and DC had similar migrated peptide populations.

A linear discriminant analysis based on peptides groups and their physicochemical characteristics, demonstrated that main differences were explained by the charge at pH 9, the molecular mass, and the mass/charge ratio. Indeed, DC, PEF, and PR at ratio 10 allowed the migration of mainly cationic peptides, while PR ratio 1 allowed the migration of some anionic peptides with lower molecular masses, due to the short polarity reversal. PEF ratio 1 peptides population was less explained by their physicochemical characteristics.

It appeared from these results that the current condition and the pulse/pause combination strongly affected the selectivity of migration during EDUF and consequently may impact the final bioactivity. The next step is to evaluate the antimicrobial activities of the fractions produced.

1. Przybylski, Rémi, Laurent Bazinet, Loubna Firdaous, Mostafa Kouach, Jean-François Goossens, Pascal Dhulster, and others, 'Harnessing Slaughterhouse By-Products: From Wastes to High-Added Value Natural Food Preservative', Food Chemistry, 304 (2020), 125448.

3. Pahmeyer, M. J., Siddiqui, S. A., Pleissner, D., Gołaszewski, J., Heinz, V., & Smetana, S. (2022b). An automated, modular system for organic waste utilization using heterotrophic alga Galdieria sulphuraria: Design considerations and sustainability. Bioresource Technology, 348, 126800.

Evaluating price sensitivity for plant and animal protein foods by socioeconomic status: A study of grocer loyalty program data from Quebec and Finland

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Many green food innovations have been launched on the market in recent years. Yet, actual consumer demand for green products has been slow to grow. In this article, we study food prices as an entry point for the transition of consumer diets away from animal protein consumption toward new plant-based alternatives.

Using loyalty program data from two large grocery retailers in Quebec and Finland, we investigated how socioeconomic status (SES) impacts consumer price sensitivity for 21 plant and animal proteins categories. Longitudinal data containing consumer purchasing behaviors for 58,267 loyalty program cardholders in Quebec and 29,131 in Finland were included in the analyses. Separate multilevel mixed effects Tobit regression models were used for each category. Random-effect models were used in a meta-analysis to summarize key results.

The average daily consumption of plant proteins was less than one-tenth that of animal proteins in both countries. Overall, results show that low SES consumers are more price sensitive than high SES for animal proteins ($p<0.001$), but not plant proteins ($p=0.28$). Consumers are overall more sensitive to plant protein prices ($\beta= -22.97$, $p<0.0001$) than animal protein ($\beta= -13.83$, $p<0.0001$). Within plant proteins, some categories, such as plant-based cheeses, yogurts, and simulated meats, did not have significant interactions between SES and price. In ancillary analyses, we observe that the number of brands, but not the number of products, is one mechanism contributing to the differential in price sensitivities across SES groups.

This research makes contributions to marketing theory by showing how the impact of SES on price sensitivity is category-dependent and moderated by brand variety. Insights for food policy and retail strategies will also be discussed.

Flash Presentations

Session 2

Effect of ultrasound to assist the synthesis of galacto-oligosaccharides with native whey

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Concentrated native whey obtained during casein micelles microfiltration was used as a novel source to produce galacto-oligosaccharides (GOS). Since the presence of macromolecules such soluble proteins and other interferers reduce biocatalyst performance (1), this work evaluated the effect of ultrasound processing to assist the GOS synthesis in terms enzyme stability, reaction yield, and specific enzyme productivity. For such purpose, a combination of different conditions of percentage of wave amplitude (10 – 70%), temperature (30 – 60°C), and duty cycle duration (0.2 s/s to 1 s/s) were evaluated, respect to the ultrasound intensity (UI) achieved on wide range of substrate concentrations (50 - 470 g/L).

The UI decreased with the increase of the solute concentration, showing remarkable effect at concentrations above 100 g/L. Results also showed the ultrasound attenuation due to the presence of solutes was significantly reduced with the increase of the wave amplitude. Respect to the biocatalysts stability under non reactive conditions, at 40°C, and UI below 11 W/cm^2, the enzyme from *Aspergillus oryzae* increased its activity for several minutes, while for the enzyme from *Kluyveromyces lactis* the effect of ultrasound accelerated its inactivation regardless the temperature or the level of sonication. Hence, the later resulted not suitable the pursued objectives.

Under reactive conditions (native whey at 470 g/L and 40°C), 70% wave amplitude, and 0.6 s/s of duty, an UI of 30 W/cm^2 was achieved. At these conditions, reaction yield did not improve respect to the control. However, the specific enzyme productivity increased significantly, and was similar to that obtained with pure lactose (~ 0.136 g GOS/h/mg$_E$).

This strategy allows obtaining a product simultaneously containing prebiotics with the healthy and functionally properties of the whey proteins, avoiding the required purification steps currently used in the production of food grade lactose (2).

References

1. F. Rico-Rodriguez et al. Ultrasonics -Sonochemistry, 67 (2020) 104945
2. A. Paterson. International Dairy Journal, 67 (2017) 80-90

Food's Carbon Footprint Surveillance Dashboard for the City of Montreal

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While food consumption policies mainly focus on food security and nutritional value, the environmental dimension of this sector is often ignored and is theoretically and practically nonexistent in policymaking. Nevertheless, its relevance for climate mitigation policies is urgent and time-sensitive, specifically in the context of sustainable systems transition globally and locally (Galli et al., 2020). While data regarding the environmental impact of food choices exist, its dissemination in silo and disconnect from other disciplines make it difficult for policymakers to make sense of the food consumption landscape from an environmental perspective and even more difficult to design adequate food consumption and waste management policies that are informed by real-world data.

Acknowledging the environmental dimension of citizens' food choices can promulgate alternative food diets that are both nutritious and sustainable (Willett et al., 2019), and would ultimately bring governments, businesses, and citizens closer to the realization of the SDGs of the UN.

The current project addresses this pressing matter and builds on convergence science to design an informative support tool that monitors the environmental impact of food consumption and guides policymakers in building sustainable local food policies.

This project integrates retail data (consumer purchases in the City of Montreal) and census data (average household spending) with product life-cycle assessment inventory data (carbon footprint) to create an interactive dashboard portraying Montrealers' food consumption carbon footprint. This Dashboard's raison d'être is to inform policymakers in assessing carbon emission magnitude based on citizens' geographic location and food choices accessibility (postal code precision). Specifically, we partner with several governmental agencies and integrate them as end-users to create a decision tool supporting them in designing food security and nutrition-related policies that include the long sought-for environmental dimension, ultimately culminating as a fundamental part of climate mitigation practices on the local, national and international levels.

References

1. Galli, A., Pires, S. M., Iha, K., Alves, A. A., Lin, D., Mancini, M. S., & Teles, F. (2020). Sustainable food transition in Portugal: Assessing the Footprint of dietary choices and gaps in national and local food policies. Science of the Total Environment, 749, 141307.

2. Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., . . . Wood, A. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. The Lancet, 393(10170), 447-492.

Biocontrol of *Listeria monocytogenes* on ready-to-eat pork-cooked ham by treatment with porcine hemoglobin hydrolysates: A circular economy approach for the slaughterhouse blood valorization

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Listeria monocytogenes is one of the most problematic foodborne pathogens representing a serious concern for ready-to-eat (RTE) meat products due to its persistence in production facilities.[1,2] Among the different strategies for the control of this pathogen, the use of antimicrobial peptides, in the context of circular economy, has emerged as a biocontrol strategy with great potential, especially when the peptides are derived from food by-products such as slaughterhouse blood proteins.[3] This study evaluated for the first time the use of porcine hemoglobin peptide hydrolysates as a biocontrol strategy of *L. monocytogenes* on ready-to-eat cooked pork ham.

Pure porcine hemoglobin (Hb-P) and porcine cruor (P-Cru) were hydrolyzed with pepsin for 3 h at different temperatures (37 °C for Hb-P and 23 °C for P-Cru). Afterwards, the hydrolysates were characterized in terms of their degree of hydrolysis (DH), peptide population, color, and antimicrobial activity (*in vitro* and *in situ*) against three different serotypes of *L. monocytogenes*. The reduction in the hydrolysis temperature for P-Cru affected the enzyme performance, resulting in 2 percentage units less DH compared to Hb-P hydrolysate, as well as some differences in the peptide population. However, the antimicrobial activity (*in situ*) was not significantly affected, decreasing the viable count of *L. monocytogenes* by ~1-log and retarding its growth for 21 days at 4 °C. The color of the product was visibly altered by product application towards more saturated reddish and yellowish colors and lower brightness. Nevertheless, discoloration of the hydrolysates can be considered to overcome this concern.

This biopreservation approach could also be applied to other meat products and represents a good alternative for the valorization of slaughterhouse blood, the production of new anti-listerial compounds, and the reduction of the risk of listeriosis infection under a circular economy concept.

References

1. Figueiredo, A. C., & Almeida, R. C. (2017). Antibacterial efficacy of nisin, bacteriophage P100 and sodium lactate against Listeria monocytogenes in ready-to-eat sliced pork ham. Brazilian Journal of Microbiology, 48(4), 724-729
2. Zhou, H., Xie, Y., Liu, H., Jin, J., Duan, H., & Zhang, H. (2015). Effects of Two Application Methods of Plantaricin BM-1 on Control of Listeria monocytogenes and Background Spoilage Bacteria in Sliced Vacuum-Packaged Cooked Ham Stored at 4°C. Journal of Food Protection, 78(10), 1835-1841
3. Przybylski, R., Firdaous, L., Châtaigné, G., Dhulster, P., & Nedjar, N. (2016). Production of an antimicrobial peptide derived from slaughterhouse by-product and its potential application on meat as preservative. Food Chemistry, 211, 306-313.

A high throughput approach to identify the role of microbial interactions in dairy spoilage

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In almost all environments, microorganisms cohabit with other microorganisms. This coexistence gives rise to interactions that can play a crucial role in food alteration [1]. However, these microbial interactions and their roles in food spoilage are not well known. In addition, the lack of high-throughput experimental methods limits our potential to explore microbial interactions.

The aim of our study was to characterize on a large scale the social relationships between microorganisms of the dairy processing environment. To this end, an automated method was developed to measure microbial interactions between 18 reference strains of lactic acid bacteria including *Lactococcus lactis*, *Streptococcus thermophilus*, *Lactobacillus delbrueckii* and 73 dairy products isolates. In total, 1620 binary combinations were tested and tracked on a time series of images for seven days and quantified with an image analysis software (ColTapp) [2]. A three-parameter Gompertz model was used to model growth curves.

We were able to identify different social personalities in lactic acid bacteria with divergent affinities towards endogenous isolates. For example, some lactic acid bacteria such as *Lactobacillus pentosus* are good competitors against endogenous isolates while other strains such as *Lactococcus lactis Subsp. cremoris* have a more neutral behavior. Another strain of *Lactococcus lactis Subsp. cremoris* seems to favor the growth of some endogenous isolates.

However, this result requires further investigations. Optimization of the approach should provide quantitative measurements of other phenotypes such as color, pH, morphological changes, or antimicrobial activity. Ultimately, the method developed will allow us to identify combinations of strains with desirable behavior for various applications and to avoid combinations that may lead to quality problems. For example, consortia of bio-protective cultures capable of naturally extending the shelf life of dairy products could be developed.

In the long term, the results of this study could contribute to the reduction of food waste.

References

[1]. Galie et al. (2018).Front. Microbiol ., 9:
[2]. Bär et al. (2020). Nature.,10:16084

Effect the maturity stage on the physico-chemical composition of pulses

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Pulses and legumes are highly prized for their rich nutritional profile (high protein, carbohydrates, and fiber). However, their consumption is hindered by the presence of anti-nutrients. Furthermore, the chemical composition of these crops may vary based on the cultivar and soil, but there is limited research on how maturity stage impacts this constitution.

The aim of this study was to investigate the effect of maturity stage (fresh (FMS) ≈45% dry matter (DM) and dry stage (DMS) ≈90% DM) on the chemical composition (total solid, protein, lipid, and ash content) and amino acid (AA) composition of four legumes: red, black and borlotti beans and chickpea. The protein profiles of the protein concentrates (obtained after flour alkaline solubilization) were evaluated by gel electrophoresis.

Results revealed that black beans at FMS had the highest protein content (25% DM), with no significant difference in ash and lipid content, or essential AA. The protein profile also varied, displaying an increase in vicilin and α-amylase inhibitors in the DMS. The FMS had the highest protein content (29 % of DM) and the lowest lipid content (1.4% of DM) in red kidney beans. Nevertheless, no significant differences were found in the protein profile.

The content of several essential AA (phenylalanine, leucine, isoleucine and histidine) was improved. In contrast, for chickpeas, FMS had the highest lipid content (6 % DM) and the lowest protein content (15% DM), while similar essential AA was observed. There was, however, a drastic reduction of the albumin band in the DMS. For borlotti beans, no significant effect of maturity stage was observed on its composition. A slight reduction was only observed in vicilin and phytohemagglutinin with DMS.

These findings indicate that the chemical composition of beans and chickpeas can be modulated, potentially leading to the generation of products with improved nutritional properties.

References

Boye, J., et al. (2010). "Pulse proteins: Processing, characterization, functional properties and applications in food and feed." Food Research International 43(2): 414-431.

Kmiecik, W., et al. (1999). "Content of amino acids in fresh and frozen and cooked broad bean seeds (Vicia faba var major) depending on cultivar and degree of maturity." Journal of the Science of Food and Agriculture 79(4): 555-560.

Flash Presentations

Session 3 - GastronomiQc Lab Session

Emulsion properties of novel ingredients: yellow pea and black Beluga lentil purees

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There is an increasing demand for healthy, locally produced simple ingredients in food formulations. Hence, this study uses two Quebec pulses, yellow peas and black Beluga lentils, to produce new ingredients. Pulses were separately cooked and ground in their cooking water to produce purees. To determine the potential of these purees to form an emulsion, emulsions containing from 10 to 30% of oil and 5 to 25% of pea or lentil puree were made.

The emulsion activity index (EAI) was determined by a turbidimetric method according to Pearce and Kinsella (1978). To visualize the stability of the emulsions, oil was coloured in red and the creaming index was calculated (height of the cream layer after one day storage expressed as a percentage of the total emulsion height). For a specific oil content, as the amount of puree increases, the stability of the emulsions increases. The emulsions containing 30% of oil and 25% of puree were the most stables. The cream layer was smaller for the emulsions made of lentil purees compared to the ones made of pea puree. However, emulsions showed different destabilization process with less coalescence in the pea puree emulsions. The EAI of the emulsions made with pea purees are higher than the ones made of black Beluga lentil puree.

These results suggest that some compositional variations of the yellow peas and black Beluga lentils may impact the formation and stability of the emulsified system differently. Depending on the formulation and the ingredients to substitute, pulses purees could be considered as a novel ingredient to be used in emulsified systems.

Effects of Xanthan, Agar, Gelatin, and Pectin on physicochemical and rheological properties of canola protein microgel stabilized Pickering emulsions as a Potential Animal Fat Replacer

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Due to the negative effects of saturated fat on human health such as elevated plasma cholesterol and cardiovascular diseases, elimination or significant decrease in animal fat content in foods has gained more attention over recent years. To achieve this objective, the use of structured vegetable oils in form of Pickering emulsion as an animal fat replacer is one of the privileged and promising methods[1]. In this context, this study aimed to investigate the influence of the type and ratio of four hydrocolloids, namely xanthan, agar, gelatin, and pectin, on the stability, physicochemical, and rheological properties of the Pickering emulsions stabilized by canola protein microgel as a potential fat replacer. Microscopic and FTIR analyses were also carried out to explore the structure and possible interactions. Hydrocolloid addition was done in two ratios of 1:1 and 2:1(Pickering emulsion: hydrocolloids). In both ratios, adding xanthan, gelatin, and agar increased G'' and G' values. However, the sample with pectin did not show the same behavior and it was far from a gel-like structure. Individual Pickering emulsion fabricated without any hydrocolloids was unstable after one day, while no phase separation was observed after adding xanthan, agar, and gelatin over 40 days of storage. Microscopic images and particle size analysis showed that the Pickering emulsion with xanthan had the smallest particle size. Moreover, adding hydrocolloids in the same proportion as Pickering emulsion leads to a significant decrease in span and less polydispersity. Based on the rheological measurements, adding xanthan, agar, and gelatin increased elasticity, solid-like, and viscose behavior of the Pickering emulsions. The samples with agar represented the most elastic solid-like and viscose character. We believe that such stable viscoelastic gel-like systems could find potential applications as animal fat replacers in developing novel low/non-fat food products, consequently reducing the health risks caused by animal fat consumption.

References

M. Rezaee et al . ACS Food Sci. Technol. 2 (2022), 751−762.

Promoting the use of Quebec Forest mushrooms in cooking through a better description of their sensory characteristics

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Although local edible forest mushrooms were once considered as niche products not very accessible for the vast majority of Quebecers, the enthusiasm for these products has increased among consumers in recent years[1]. Professional chefs and cooks are one step ahead of this craze. Sensory description is identified as a judicious tool to support the promotion of a wider variety of products, which is in line with a perspective of sustainable development[2]. The main purpose of our initiative is to document some sensory characteristics (aromas, texture) and some related physicochemical properties specific to each species of a selection of edible forest mushrooms from Quebec. This first study focuses on texture properties. Ten (10) species harvested by professional pickers in Mauricie (Quebec) during summer and fall 2022 were selected aiming for a wide diversity of textures and a good representation of various forest mushrooms available. Upon receipt, the fresh mushrooms were cleaned and sliced into 5 mm thick slices. Mushrooms' texture was measured for each species at fresh and cooked/stir-fried states with a texturometer (TA.XTplus, Stable Micro Systems) by uniaxial compression using a knife probe, which allowed to obtain various texture parameters including firmness, hardness, resilience, and elasticity (Young's modulus).

According to the results, three texture groups can be identified among the selected mushrooms: firm and tough mushrooms (*Hypomyces lactifluorum*, *Laetiporus sulfureus*, and *Tricholoma magnivelare*), medium firm mushrooms (*Boletus chippewaensis*, *Cantharellus cibarius*, and *Chlorophyllum rhacodes*), and less firm- crumbly mushrooms (*Lactarius lignyotus*, *Pleurotus ostreatus*, *Sarcomyxa serotina*, and *Suillus cavipes*).

These first results will feed an upcoming sensory study involving chefs, professional cooks and mycology experts to generate sensory descriptors for the different mushrooms species. All this, hoping to support the sector in promoting a diversity of species and to better guide consumers and chefs in their selection for culinary uses and innovation.

References

1. Biopterre, 2009. Analyse de commercialisation des champignons forestiers sauvages à potentiel commercial du Québec- Projet AF-08-021.
2. Chun, S., Chambers, E., & Han, I. (2020). Development of a Sensory Flavor Lexicon for Mushrooms and Subsequent Characterization of Fresh and Dried Mushrooms. Foods, 9(8), 980. https://doi.org/10.3390/foods9080980

Guide of eco-efficient practices in the food service sector

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Climate emergency and population health are major challenges of the 21st century. Among the actions that can be taken in response to them, food is a powerful lever to work simultaneously on both issues. Besides, by their scope, both in terms of societal purchasing power and as a living environment, institutions constitute a favorable sector for the deployment of health promoting and environmental actions. Thus, the aim of this work was to propose an approach, developed in the form of an implementation guide for institutional food service managers, to produce eco-efficient meals, which have high nutritional quality and low environmental impacts.

To evaluate meal eco-efficiency, the Nutrient-Rich Food Index 9.3 is used to calculate the nutritional quality, whereas the environmental impact is represented by greenhouse gas emissions in kg of CO_2 equivalents. Therefore, the step-by-step approach of the guide increases eco-efficiency, whether by modifying the existing meal recipes or by introducing new meals. To do so, six recommendations can be followed: five are related to the ingredients used in the meal recipes (e.g.: favor the use of plant-based foods, ensure a proportion of 50 % of fruits and vegetables per meal, etc.) and the sixth reaches to limit food waste. The guide includes two levels of involvement from the food services and its approach is based on 4 steps: 1) diagnosis realization, 2) development of objectives, 3) implementation of recommendation and 4) deployment of a communication strategy. These steps are carried out differently according to the level of involvement chosen, but in either case, each step is clearly expanded in the guide.

This guide and its approach can be used by any institutional food services but is currently deployed at Université Laval in a project granted by Recyc-Québec.

Revealing the potential of Brewer's Spent Grains In Human Nutrition: Exploration of Protein Extraction Performance and Functional Properties

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To reduce the environmental and waste management costs of the brewing industry it is necessary to find new ways to increase the value of brewer's spent grain (BSG), the main organic waste associated with beer production. Currently, most of this by-product is relegated to animal feed or landfills but it could have other potential uses with higher economical value such as human consumption. BSG's protein content is of particular interest for human consumption (1). To investigate BSG proteins and identify potential food applications, native BSG, alkaline extract and alkaline extract with reducing agent (L-cysteine) were compared for a wide range of functional properties at pH 2, 4, 6 and 8.

Both methods of protein extraction yielded extracts with higher protein content than native BSG. Extractions with reducing agent (L-Cysteine) doubled protein content (from 20 to 40 %) while extractions with solely NaOH yielded smaller increases (from 20 to 30 %).

Native BSG showed no emulsifying and foaming properties while both types of protein extracts demonstrated significant improvements of these functional properties, which were comparable with casein and pea proteins (2). In all cases, functional properties were improved in higher pH conditions (pH 6 and 8) and were the lowest at pH 4 where isoelectric precipitation was observed. Overall, low BSG proteins solubility in acid conditions is the main obstacle to food applications but extractions using a reducing agent showed increased protein solubility in almost all tested pH ranges.

Extraction methods used were simple enough to be easily implanted in breweries, eliminating the need for transportation to another processing factory. BSG protein extracts have interesting potential applications in human consumption especially regarding their emulsifying and foaming properties. However, future food applications should focus on low acid foods to maximise BSG protein extracts' application potential.

References

1. Deschênes Gagnon, R., et al. (2022). "Functional Properties of Casein and Caseinate Produced by Electrodialysis with Bipolar Membrane Coupled to an Ultrafiltration Module." Membranes 12(3): 270.

Flash Presentations

Session 4

Environmental impact associated with the cultivation of underutilized crops versus well-established counterparts – A case study of black (Desi) and white (Kabuli) chickpeas cultivation

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The current food system is at an impasse: it needs to keep growing to be able to feed the growing population but it needs to decrease its environmental impact. Besides the high environmental impact, the current diets are getting similar due to globalization. The same raw materials are required in different parts of the globe, creating a global co-dependent network, with a high risk of disruption. The use of underutilized crops can be beneficial as they can adapt to different climate challenges (e.g.: drought, low availability of soil nutrients) and improve the stability of the chain in the short and long term. This study was conducted to assess the impact of the cultivation of an underutilised chickpea crop (desi chickpea, bioproduction-DC) versus the cultivation of the commercially available counterpart (kabuli chickpea, conventional or organic production-KC). The data relating to desi farming stage was collected and provided by the farmers on-site, while data relating to kabuli farming stage were collected from farmers and different available databases. Data was analysed with the SimaPro software with ReCiPe Midpoint(H) methodology. The results show that the production of organic KC carries an overall lower environmental burden than the production of DC. Data for conventional production of KC shows that in most categories (e.g.: Climate change 1.53kg CO2 eq., Marine eutrophication 1.71E-2kg N eq.), it carries a higher environmental impact than DC bioproduction (1.07kg CO2 eq. and 1E-3kg N eq., respectively). One reason for this is that the production of DC is being produced at a small scale and is not optimised, with a big input of human labour. Whereas the production of KC has been optimised over the years and that's why it is currently more widely available. Further processing of these crops for novel product development will deliver different environmental burdens and nutritional profiles.

Optimization of protein extraction from water lentils followed by a qualitative study of the extracted proteins and some of their functional properties.

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Water lentils are free-floating aquatic plants which can grow almost anywhere on Earth. They have a great agronomic potential since they can double their biomass in less than 24h[1] and are very rich in RubisCO[2], a protein that can be quite easily purified on laboratory-scale, though the extraction yields are very low when high protein purity are achieved[3]. RubisCO showed promising properties for human consumption since it is tasteless, odourless, and white coloured as well as having a high nutritive value and excellent functional properties[3]. However, their use for human food is limited because of the protein extraction step[1]. Therefore, in this work, an optimized protocol was developed to extract water lentils proteins. The proteins were first solubilized using heat and pH shifts followed by an isoelectric point precipitation. For each step, the protein concentration, temperature and/or pH values were optimized to maximise protein yield and purity.

Protein samples were analysed using LC/MS/MS to qualify the extracted proteins in terms of mass for each condition. Following the optimized procedure, combining the best conditions of pH, temperature and protein concentration, a protein concentrate containing 55% protein with a protein yield of 60% was produced. These combined yield and purity were the highest reported in the literature for leaf protein concentrates extracted by isoelectric point precipitation. Furthermore, the secondary and tertiary structure of the protein extracts were studied and compared to the initial raw material using FTIR and DSC analyses. This concentrate also showed excellent foaming properties since it had a better foaming capacity and the same foaming stability as egg white, while the egg white solution contained 7.3 times more proteins. Its digestibility by pepsin at pH2 was also assessed and showed that the proteins were more digestible in the initial raw material compared to the end-product.

References

1.Fourounjian et al. Springer, Champ, The Duckweed Genomes. Compendium of Plant Genomes (2020) 1-17.

2. Nieuwland et al. ACS Food Science Technology, 1, 5 (2021) 908–916.

3. Barbeau et al. Food Reviews International, 4 (1988) 93-127.

Effect of bacterial-derived antimicrobial solutions on the preservation of raw chicken legs under refrigerated condition

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In the present study, bacterial-derived antimicrobial agents included 5 mM reuterin combined with either 0.78% lactic acid (RL) or 0.08 µM microcin J25 (RJ) were evaluated for their effects on the microbiota and sensory attributes of raw chicken legs.Peracetic acid (0.1%), a conventional chemical commonly used in the poultry industry, was used as a positive control to compare efficacy. The chicken legs were sprayed with antimicrobial solutions and aerobically stored at 4^{o}C for 10 days. The RL treatment maintained the total viable count below the limit of 7 log CFU/g until the 8th day. Therefore, compared to the nontreated group, shelf-life was extended by 3 days in the RL treated group. The RJ treatment extended the shelf-life to 7 days, which is similar to what was achieved with the use of peracetic acid. Based on culture-independent amplicon sequencing, the RL and RJ treatments affected the microbial community on the chicken legs, inducing a delay in the increase of *Pseudomonas, Psychrobacter* and *Carnobacterium* while decreasing of *Shigella*. Significant decreases in sensory scores occurred in the nontreated group, while slight changes occurred in the combinations treated groups over the same period.Overall, sensory property scores for chicken legs treated with RL and RJ remained higher ($P < 0.05$) than those treated with peracetic acid or without antimicrobial agents. The antimicrobial combinations delayed the deterioration of sensory attributes throughout the storage period. These results suggest that RL and RJ provide a promising natural-sourced antimicrobial approach to control the growth of spoilage microorganisms on chicken legs.

References

L. Zhang et al. International journal of food microbiology, vol. 383 (2022): 109958.

Development of ethyl cellulose shell-coated alginate droplets in w/o emulsions by electrospraying

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This research investigated the use of ethyl cellulose (EC) in w/o emulsions to stabilize dispersed aqueous alginate droplets in 0:100 or 90:10 (w/w) medium chain triglyceride (MCT): canola oil continuous phases. When the aqueous alginate solution (2 % w/w) was electrosprayed in the oil phases containing dissolved EC, a thin layer of EC shell was formed rapidly around hydrophilic alginate droplets, thereby stabilizing the dispersed phase [1,2]. As EC concentration in the oil phases increased from 0.2 to 1.0 % (w/w), the interfacial tension value (determined from pendant drop tensiometry) increased from 7 to 11 mN/m for canola oil but decreased from 3.87 to 0.21 mN/m for MCT/canola oil blend. At 2 kV applied voltage, as EC increased from 0.2 to 1.0 % (w/w) the electrosprayed alginate droplet diameter decreased from 1600 to 2000 µm and from 1600 to 800 µm for canola and MCT/canola blend, respectively. At 7 kV, the droplet diameter decreased from 220 to 110 µm and from 160 to 70 µm for canola and MCT/canola blend, respectively. The changes in alginate particle size can be attributed to the process-dependent EC depletion rate in the continuous phases that altered the surface activity at the w/o interfaces. The emulsions prepared in MCT/canola blend were more stable than those prepared in canola oil. For example, at 1 % (w/w) EC and 7 kV, the w/o emulsion stored at 22 ^{o}C for 14 days resulted in 91 and 38 % (initial emulsion volume) settlement, for canola and MCT/canola, respectively. Overall, this study showed that EC is promising for forming an elastic shell on electrosprayed alginate droplets in w/o emulsion systems.

References

1. K. Lamont et al, J Colloid Interface Sci, 562 (2020), pp. 470–482.
2. Z. Wang et al, J Dispers Sci Technol, 40 (2019), 612–626.

Effect of pulsed electric field pretreatments on protein extraction from brewery spent grains

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Efforts are underway globally to minimize processing waste and encourage the recycling of generated secondary products to support a sustainable economy over the coming decades[1]. For the beer industry, the recovery and use of brewers' spent grains (BSG) proteins is of great interest to improve its sustainability. The present study proposes to explore the bioactive potential of peptides obtained via enzymatic hydrolysis using trypsin, chymotrypsin and pepsin, from the BSG proteins.

Protein extracts were obtained by alkaline extraction with NaOH alone or by adding 5% w/v L-cysteine reducing agent followed by isoelectric precipitation at pH 3.8. The precipitate obtained via extraction with NaOH and L-cysteine demonstrated the best percentage of proteins compared to the one resulting from NaOH extraction only with contents respectively 68.8 ±0.8% and 56.6 ±1.2%. To obtain the peptides from extracted proteins, several conditions were tested, including the hydrolysis time (3h and 5h) and enzymatic inactivation (HCl/NaOH or heating).

The degree of hydrolysis (DH) obtained after 3 hours and with acid/base enzyme inactivation was the lowest for the 3 enzymes, especially for trypsin which demonstrated a final DH of 1.4% only. Heating, compared to acid/base, as well as increasing the hydrolysis time to 5 hours, increased the DH by 9 times for trypsin hydrolysates and by 2 times for chymotrypsin ones. The hydrolysates from NaOH alone (inactivation at 90°C/10 min) had the best DH compared to those obtained with L-cysteine, with average values between the enzymes of 9.6% and 7.7% respectively.

Further studies will focus on the characterization of the resulting peptides as well as improving protein extraction[2] and enzymatic hydrolysis efficiency using pulsed electric fields as a pre-processing step to improve overall performance of the process and to promote applications of the proposed approach on an industrial scale[3].

References

1-A. Jaeger et al. Barley Protein Properties, Extraction and Applications, with a Focus on Brewers' Spent Grain Protein. Foods, (2021) 10(6), 1389

Antimicrobial and antioxidant activities of protein hydrolysates produced through enzymatic hydrolysis of chicken cruor

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Blood is an inevitable by-product of slaughterhouses. Annually, 77 million kg of blood are produced in Canada following chicken slaughtering. Cruor is the solid part of blood and represents 40% of the whole blood. Chicken cruor is rich in proteins which can be used to generate high-added value products. After blood separation, hemoglobin is obtained. This protein, when hydrolyzed, allows the bioproduction of bioactive peptides. It has been shown that bioactive peptides can provide health benefits such as antimicrobial (antibacterial and antifungal), antioxidant, antihypertensive, and antihyperglycemic properties. Bioactive peptides as bio-preservatives have gotten significant attention in past years in developed countries where people demand more healthy foods without synthetic preservatives. In this project, after collecting the chicken blood from slaughterhouses and separating it, cruor was hydrolysed by pepsin in different pH conditions (2,3,4 and 5) and duration (30 and 180 minutes). Following this, antifungal and antibacterial activites (*Listeria ivanovii* HP B28, *Escherichia coli* MP 4100, *Mucor racemosus* LMA-722) and *Rhodotorula mucilaginosa* 27,173) and antioxidant activity (DPPH radical scavenging activity and Oxygen Radical Absorbance Capacity) of the hydrolysates were evaluated. Also, peptide population, sequences, enzyme mechanism, and DH% were determined to perceive better the hydrolysates generated during process, to relate peptide and bioactivities and to potentially identify new sequences with new bioactivities. The experiments are currently underway, and the results should be available within the next few months. This final aim of this project is to valorize blood waste as a source of peptide fractions to produce protein hydrolysates with good antimicrobial or antioxidant properties. Indeed, besides reducing waste, a natural preservative will be produced.

References

A. Jahan-Mihan et al. Nutrients, 3 (2011) 574–603.
M. Abou-Diab et al. Membranes (Basel), 10 (2020) 1–23.
C. S. Bah et al. Journal of the Science of Food and Agriculture, 96 (2016) 79–89.
2. Ikram, S., et al. (2017). "Composition and Nutrient Value Proposition of Brewers Spent Grain." Journal of Food Science 82(10): 2232-2242.

Flash Presentations

Session 5

Impact of pre-concentration on the extraction of protein from tofu whey by a combination of electrodialytic processes

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Tofu whey is a by-product generated in very large volume during tofu processing. Although rich in nutrients, this by-product is mainly thrown away, after treatment to decrease its environmental impact, since no recovery method has been integrated to industrial production. Treatments that must be applied before its disposal represent important costs for the industries as well as a significant waste of resources. Indeed, tofu whey contains soy proteins, which have a high nutritional value and interesting functional properties. In 1999, Bazinet et al. demonstrated the feasibility of extracting proteins from tofu whey by an innovative process which couples conventional electrodialysis (ED - lowering of ionic strength) with electrodialysis with bipolar membrane (EDBM - acidification). However, the process should be optimized in order to improve the protein recovery. In this context, the aim of this work was to study the impact of a pre-concentration step by Nanofiltration prior to the ED+EDBM treatment on the process performances, particularly on protein recovery. Three conditions were tested : tofu whey without pre-concentration (1X) and concentration factors of 2X and 3X. Results show that protein recovery in the 3X condition allows a recovery 20% higher than the 1X. Protein recovery values, expressed in % w/w, were 16.2% ± 0.7%, 16.9% ± 2.7% and 19.4% ± 1.7% for FCV 1X, 2X and 3X respectively. Also, protein purity of the recovered fraction was similar for these three conditions, with 45.3 %, 44.0 % and 45.2 % on dry powder basis respectively. Although we demonstrated that protein recovery was improved by the pre-concentration step, protein recovery is still pretty low and should be increased by an additional optimization step. Proteins has also been characterized by SDS-Page and proteomic analysis results will be received soon to identify specifically which proteins were precipitated from the tofu whey after acidification.

References

Chua, J.-Y. and S.-Q. Liu (2019). "Soy whey: More than just wastewater from tofu and soy protein isolate industry." Trends in Food Science & Technology 91: 24-32.

Bazinet, L., D. Ippersiel and F. Lamarche (1999). "Recovery of magnesium and protein from soy tofu whey by electrodialytic configurations." Journal of Chemical Technology & Biotechnology 74(7): 663-668.

Synergic approach of pulsed electric fields and immobilized biocatalysts to obtain biologically active peptides from agro-food proteins

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This research project explores valorization of food by-product proteins, such as α-lactalbumin and pea proteins.

The global market for protein ingredients is growing rapidly, especially for proteins of plant origin. Indeed, the production of animal proteins is resource intensive, with high water and land consumption, and greenhouse gas emissions. Modern food industries are trying to use sustainable and diversified food systems.

That's why this project promotes the use of an animal protein and a plant protein, with the aim of the yield improving of bioactive molecules by enzymatic hydrolysis. It considers the application of pulsed electric fields (PEFs) to affect protein structure and enhance protein cleavage by enzymes thus improving peptide production performance. Indeed, PEFs, partially and reversibly unfolding the protein, improve the availability of cleavage sites to enzymes. Combined with biocatalysis using an immobilized enzyme, the main drawbacks of enzymatic process could be overcome.

The native, PEF-pretreated and preheated (control) α-lactalbumin and pea proteins were hydrolyzed using commercial free α-chymotrypsin (37 °C, Enzyme:Substrate ratio 1:100 w/w). Hydrolysis kinetics were monitored by the o-phthaldialdehyde spectrophotometric method. A degree of hydrolysis of PEF pretreated proteins were improved by more than 90 % compared to the native ones and close to the preheated proteins. Such hydrolysis improvement was due to the modifications of the protein molecular structure confirmed by circular dichroism.

Regarding the chymotrypsin immobilization step, the first results demonstrated a 99.6% immobilization rate on a porous alumina support. The immobilization will then allow to improve the activity of the enzyme thanks to a better structural stability and to reduce the cost of the enzyme by its reuse.

Therefore, the proposed novel synergistic approach can promote the peptide production from proteins, issued from by-products and having biological properties that are of interest to the food, nutraceutical and pharmaceutical industries.

Production of polyphenols-enriched cranberry juice through electrodialysis with filtration membrane: How physicochemical properties of filtration membranes impact anthocyanins migration and selectivity during electrodialysis.

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Health-promoting effects credited to anthocyanins have been extensively studied and recent discoveries have suggested their impacts on the modulation of the gut microbiota[1]. Cranberry juice - a goldmine of anthocyanins - could be enriched to enhance its heath benefit. In previous studies[2],[3], electrodialysis with filtration membrane (EDFM) selectively enriched juice in anthocyanins. The present study focused on this green and promising technology especially on understanding how physicochemical properties of filtration membranes impact global and selective anthocyanin migration during EDFM. Thus, six polyether sulfone (PES) and polyvinylidene fluoride (PVDF) membranes with molecular weight cut-offs (MWCO) of 150kDa, 200kDa, 250kDa, 300kDa and 500kDa were characterized and used during EDFM treatment. Membranes were characterized in terms of thickness, conductivity, contact angle, % of hydrophilic pores, porosity, zeta-potential, roughness. Juices were analysed using UV-visible spectroscopy to assess the global anthocyanins enrichment and HPLC was used to determine the individual anthocyanins, proanthocyanidins and organic acids migration. Results have shown an impact of MWCO and membrane material on anthocyanin's enrichment. Data are currently analysed by redundancy analysis (RDA) and multivariate regression to understand the correlation between membrane physicochemical properties and global and individual anthocyanins migration during EDFM: migration predictive models will be generated.

References

1. R. Mattioli et al. Molecules, 25 (2020) 1420-3049.
2. E. Husson et al. Innovative Food Science & Emerging Technologies, 17 (2013) 153-62.
3. L. Bazinet et al. Separation and Purification Technology, 87 (2012) 31-39.

Effect of hydrolysis duration and pH on peptide populations of peptic hydrolysates derived from turkey cruor: slaughterhouses blood valorisation in a circular economy approach

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Global pressure is growing to minimize the environmental impact of slaughterhouses. One way to answer this issue is to valorize by-products such as blood, by the production of bioactive peptides using enzymatic hydrolysis[1].

To the best of our knowledge, no research has been previously performed regarding the pepsic hydrolysis of turkey cruor which contains, after blood centrifugation, hemoglobin, a protein not yet valorized since the main use of blood is focused on its colorless part (plasma)[2]. This project aims to optimize the enzymatic hydrolysis conditions of turkey cruor and to evaluate the potential antimicrobial and antioxidant activities of peptides produced. Enzymatic hydrolysis of turkey cruor was carried out by pepsin (37°C, E:S ratio of 1:11 and pH 2, 3, 4, and 5).

The kinetics of hydrolysis was evaluated by hydrolysis degree determination employing o-phtalaldéhyde (OPA) spectrophotometric assay and the peptide characterization was performed by reverse-phase high-performance liquid chromatography coupled with mass spectrometry (RP-HPLC-MS). A Gram+ bacterium (*Listeria ivanovi* HP B28) and a Gram- bacterium (*Escherichia coli* MP 4100), a filamentous fungus strain (*Mucor racemosus* LMA-722), and a yeast strain (*Rhodotorula mucilaginosa* 27,173) were tested to evaluate the antimicrobial activities of the time-dependant hydrolysates. Their antioxidant activities were tested by using DPPH free radical scavenging and ORAC tests.

This project is expected to take advantage of slaughterhouse blood by the production of bioactive peptides with the respect of circular economy principles, the adoption of which is currently being encouraged in the food industries.

References

1-Przybylski, R., Bazinet, L., Kouach, M., Goossens, J. F., Dhulster, P., Firdaous, L., & NedjarArroume, N. (2021). Slaughterhouse By-Product Valorization: Hydrolysis Degree Modification for Higher Antimicrobial Recovery by Electroseparation. Waste and Biomass Valorization, 12(4), 1977–1989.
2-Bah, C.S.F., Bekhit, A.E.-D.A., Carne, A., McConnell, M.A.: Slaughterhouse blood: an emerging source of bioactive compounds. Compr. Rev. Food Sci. Food Saf. 12, 314–331 (2013).