Gums & Stabilisers for the Food Industry

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Book of Abstracts

Posters

PO Poster presentations

PO1. Molecular predictors of macroscopic foam functionality of soy proteins

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The poor applicability of plant proteins in food products is mainly due to the many unknowns of the protein ingredients. The unknowns in techno-functionality (e.g. foaming, emulsifying and gelling properties) hamper the decision making in product development, thus slowing down this process. These unknowns can be overcome by experimental testing the plant proteins' techno-functionalities. Unfortunately, this process is both labor-intensive and time-consuming, requiring extensive measurements and analysis, thereby slowing down the development of novel foods. This project aims at finding molecular predictors that could facilitate the predictability of the foaming properties of soy proteins. Such molecular predictors could be hydrophobicity, solubility, degree of denaturation, and aggregate size, which can directly predict the macroscopic properties of proteins, through omitting the mesoscale analysis. To overcome the high workload in understanding the functional properties of proteins, the project aims to identify the minimal information necessary to predict the macroscopic functionality.

We study the molecular parameters that determine the foaming properties of soy proteins. Different extraction methods and conditions used during the extraction have shown that they result in proteins with varying composition, purity, and functional properties[1]. Therefore, we obtain lab-extracted proteins through various extraction methods, such as heating and drying methods. We then evaluate the molecular and foaming properties of these soy ingredients. Using statistical approaches, we find correlations between molecular parameters and foaming properties. The same molecular properties are found in commercial ingredients, which we use to validate these correlations. This project will discuss which molecular predictors should be analysed to accelerate decision-making in product development.

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PO2. Same as Meat? – Rheology as a Tool for Simulating the Digestion of Meat and Meat Substitutes in the Gastrointestinal Tract

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More people are adopting a plant-based diet for health benefits, ethical and environmental considerations, among other reasons. Nowadays, meat substitutes not only convince with their taste but also with their structure, thanks to the latest extrusion technology and structural characterization by means of rheology or tribo-rheology. Although consumer acceptance has increased, it is still unclear how these products compare to real meat in the digestive tract. Rheology offers simpler experimental designs to assess the digestibility of plant-based alternatives than conventional, complex in vivo studies.

To simulate the journey of a bite through the gastrointestinal tract (GIT), a submersion flow cell in combination with a rotational rheometer, equipped with a serrated plate-plate geometry, was designed. This setup can be used to analyze the viscoelastic properties of a semi-solid material under "ambient conditions," i.e., in contact with a temperature-controlled liquid. The measuring cell is equipped with an inlet and outlet so that the liquid can be varied to simulate the gastric or intestinal fluids. This allows pH alterations and enzymatic digestion to be observed in situ while assessing changes in the viscoelastic properties of the samples.

Different meat and meat alternatives were prepared for rheological measurement. Initially, the cooked food was compressed to simulate the chewing process, then the samples were placed in the measuring cell and the cell was flooded with synthetic saliva. The proteins in the meat and meat substitutes remain largely intact. As food enters the stomach through swallowing and the peristaltic movements of the esophagus, it encounters the acidic conditions of the stomach. This is simulated in the measuring cell by changing the rinsing medium to a lower pH value of approximately 2, including digestive enzymes such as pepsin. The stomach acid denatures the proteins in both meat and meat substitutes, causing them to lose their structure. After gastric digestion, the process can continue in the small intestine. During the simulation, the pH value is increased to approx. 7 and further enzymes such as trypsin are added.

Meat and meat alternative extrudates will be digested and measured using the Thermo Scientific HAAKE MARS Rotational Rheometer equipped with a submersion flow cell. The results of these rheological measurements will include texture analysis tests, including normal force and oscillatory tests, as well as tribology measurements. These results show how the rheology can be related to the path of food through the digestive tract.

PO3. via Enzymatic Deamidation with Protein Glutaminase

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This study explores the application of protein glutaminase (PG) for the deamidation of soy protein isolate (SPI) to enhance its functionality in nutritional products. Commercial SPI typically exhibits poor solubility and functional properties due to the formation of large protein aggregates during its production process, including acid precipitation, drying, and storage. Deamidation via PG, an enzyme derived from Chryseobacterium proteolyticum, converts glutamine residues into negatively charged carboxyl groups, improving protein characteristics without causing undesirable structural changes such as trans-glutamination or degradation of asparagine residues.

Both dairy and plant proteins have been subjected to enzymatic deamidation. However, enhancing the functional properties of plant proteins, such as SPI, is particularly important as they frequently present challenges for use in nutritional products due to their larger molecular sizes, poor solubility, and less desirable sensory attributes. This research focused on treating intact SPI (SPI-I) and hydrolyzed SPI (SPI-H) with PG to enhance their solubility, emulsification efficacy, emulsion stability, and calcium binding capacity.

Characterization of the deamidated proteins revealed significant improvements: reduced hydrodynamic diameter, increased protein solubility and zeta-potential, decreased surface hydrophobicity, and altered molecular weights for both SPI-I and SPI-H. Additionally, enzymatic deamidation enhanced the emulsifying activity and stability of emulsions produced with deamidated SPI-I, as well as the calcium binding capacity of deamidated SPI-I, offering promising benefits for nutritional enrichment.

In conclusion, PG deamidation enhances the functional properties of SPI, suggesting its potential application in nutritional products. Further research is recommended to optimize the deamidation process, assess its feasibility for large-scale commercial production processes, and explore its applicability to other protein sources.

PO4. Optimisation of plant-based milk alternatives through the use of specific pea protein fractions

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Due to their structure, plant proteins differ from milk proteins in terms of their emulsifying capacity, especially in milk alternatives, where additional hydrocolloids are sometimes used to support the stabilisation of the emulsifier. This is partly due to the different stabilisation mechanisms of the individual protein fractions, whose effectiveness and interaction still need to be better clarified.

The aim of the study was to characterise the emulsifying properties of individual protein fractions from pea and thus identify possibilities for improving stability. For this purpose, the pea protein fractions albumin, vicilin and legumin were isolated and incorporated into a model system based on a dairy alternative.

The emulsion stability was analysed by measuring the oil droplet size distribution and microscopy as well as visual assessment of the creaming behaviour. At pH 7 under varying salt concentrations, the interfacial properties were characterised using shear and dilatation rheology.

Results show, that there was a correlation between the interfacial properties of the pea protein fractions and the emulsion stability. In particular, the separate use of vicilin as an emulsifier led to stronger interactions at the interface and higher emulsion stability compared to pea protein isolate.

PO5. Functionalization of commercial pea and fava bean protein ingredients intended for acid gelation by preheating

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Commercial protein isolates and concentrates are important powder ingredients to produce a variety of plant-based foods. However, before further use, powders need to be dispersed and dissolved to be fully functional as an ingredient in a specific application. Generally, this can be achieved by dissolving at high temperatures or at high shear rates. This study investigated the effects of preheating treatments of commercial pea protein isolate (PPI), pea protein concentrate (PPC), and fava bean protein concentrate (FPC) on the structural and rheological properties of acid-induced gels. Protein dispersions (5% w/w) were preheated at 65°C, 80°C, and 95°C for 5, 30, and 60 minutes, followed by glucono-δ-lactone (GDL)-induced gelation.

Rheological analyses revealed that preheating significantly enhanced gel strength (storage modulus, G') across all protein ingredients. Increasing the preheating temperature (65°C to 95°C) had a greater impact on gel strength than extending the duration (5 to 60 minutes), with FPC showing the most pronounced increase in gel strength compared to PPI and PPC.

The mechanisms underlying this increase in G' varied among the protein types. For PPI, after preheating, the particle size (D32 and D43) decreased while the solubility and hydrodynamic size (Z-average) increased. Considering its highly denatured status indicated by DSC, preheating dissociated larger insoluble aggregates into smaller soluble forms, confirmed by DLS, that contributed to gelation. For PPC and FPC, after preheating, their particle size (D32 and D43) and hydrodynamic size (Z-average) increased while their solubility decreased. SDS-PAGE and intrinsic fluorescence spectroscopy revealed that PPC and FPC had more open, unfolded structures after preheating, with the formation of aggregates—particularly of legumin—being more prominent at higher temperatures. Considering their relatively native status, preheating denatured the protein in PPC and FPC, promoting interactions and aggregation.

Overall, this study provides insights into tailoring the acid-induced gels of commercial pea and fava bean protein ingredients through preheating in aqueous conditions. This controlled thermal treatment may be required for unlocking the gelling properties of commercial protein ingredients.

PO6. Transformation of Microcrystalline Cellulose into Functional Pickering Particles via Deep Eutectic Solvent and Ultra-High-Pressure Homogenization

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Nanocelluloses are nanosized features of crystalline or fibrillar form that exert interesting intrinsic properties such as high surface area, crystallinity, wettability, and mechanical strength. Owing to their nanoscale size and good wettability, nanocelluloses can also be applied as solid interface stabilizing agents known as Pickering particles. Green chemistry-inspired solvents such as deep eutectic solvents (DES) have gained a lot of ground against organic solvents as they are inexpensive, low vapor pressure, non-flammable, chemically stable, recyclable, biodegradable, and toxicologically well-characterized. High-pressure-homogenization is a common physical process used to breakdown the cellulose structure but a process pressure above 1500 bar is rarely found in previous studies. Therefore, this work aimed to explore the potential of combined DES – ultra-high-pressure homogenization (UHPH) for transforming microcrystalline cellulose (MCC) into Pickering particles for food, nutraceutical, and drug delivery applications.

Based on preliminary results, choline chloride (ChCl) mixed with glycerol, urea, malic acid, oxalic acid, and formic acid, at a molar ratio of 1:2, 1:2, 1:2, 1:1, 1:2, respectively, were chosen for DES pretreatments, which were conducted at 90°C for 1h. Then, cellulose samples were washed by Milli-Q water three times and dialyzed for 48 hours to remove any residual DES matter. In the UHPH step, a pressure of 2500bar was applied, and all the cellulose suspensions (0.5 % w/w) were processed for a total of 20 cycles while aliquots were collected at 5, 10, and 15 cycles. The morphological changes in cellulose during UHPH were monitored through dynamic light scattering (DLS) and optical microscopy. The 20-fold UHPH processed nanocelluloses were further investigated through scanning electron microscopy, atomic force microscopy, Fourier transform infrared spectroscopy (FTIR), and X-ray diffraction. Their steady state flow behavior and dynamic rheological properties were also tested. Moreover, we assessed the ability of the obtained nanocellulose samples to stabilize o/w Pickering emulsions.

DLS and microscopic assessments demonstrated a significant decrease in cellulose particle size with an increasing number of processing cycles. The ChCl-glycerol and ChCl-urea groups exhibited thinner cellulose fibers compared to the other groups, indicating their high cellulose-swelling efficiency during pretreatment. After the deep eutectic solvent (DES) pretreatments, the crystallinity of cellulose increased, which might be related to the reduction of the amorphous regions. However, after UHPH, the crystallinity decreased, as the high pressure effectively disrupted the crystalline regions of cellulose. In addition, we found that cellulose suspensions in the ChCl-glycerol, ChCl-urea, and ChCl-formic acid groups were more viscous, with rheological behavior resembling cellulose nanofibrils. In contrast, the other two groups exhibited behavior closer to cellulose nanocrystals, likely due to organic acid hydrolysis resulting in shorter cellulose particles. In the emulsion case study, all cellulose samples with DES pretreatments and $\geq$ 10 cycles, showed an excellent performance in stabilizing emulsions, as no phase separation was observed after two months of storage at ambient temperature. Thus, we conclude that the combination of DES and UHPH is an efficient strategy to produce nanocellulose Pickering particles.

PO7. Properties of heat-induced gels from binary mixture of pea, soy and rapeseed proteins

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Gel properties of plant proteins rely on a balance of attractive and repulsive interactions. These interactions are influenced by protein source and a protein's involvement in these interactions. Customising gel properties can be achieved by mixing plant proteins that differ in charge distribution and their ability to form disulfide bonds and hydrophobic interactions. During heat induced gelation, pea protein is known to primarily form hydrophobic interactions while soy and rapeseed proteins may form extra disulfide bonds due to a higher cysteine content. Additionally, the highly charged N-terminus of soy β-conglycinin (α,α') and, to a lesser extent, pea convicilin, promote electrostatic repulsion, which enables more controlled gelation[1–3].

The aim of our study was to investigate the heat induced gelation of binary mixtures from pea, soy and rapeseed protein in comparison to their individual protein counterparts. To this purpose pea, soy and rapeseed protein dispersions as well as their binary mixtures were prepared from protein isolates with low degrees of denaturation. Protein concentration was 10% (w/w) in all dispersions. Gelation was carried out in a rheometer at defined heating and cooling rates of 10 K/min from 25 °C to 95 °C and 0.5 K/min from 95 °C to 25 °C with a holding time of 15 min at 95°C. After cooling, frequency- and amplitude-sweeps were performed to further characterise the rheological properties. Gel solubility tests were conducted subsequently to elucidate the protein interactions in the gels.

Results showed distinct synergistic effects in mixed soy - rapeseed protein gels as indicated by gel strength ratios according to Guidi et al.[4]. This might be due to increased involvement of soy 11S protein fractions via disulfide bonds in the mixed gels as indicated in gel solubility test. Slight synergistic effects in mixed soy - pea protein gels and linear mixing effects in mixed pea - rapeseed protein gels were indicated by gel strength ratios, and the predominent hydrophobic interactions were unchanged in those mixed protein gels according to gel solubility results. The varied heat-induced gel rheological properties by differently mixed plant proteins suggests a potential for customising gel properties in food applications.

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PO8. Impact of chlorogenic acid or essential oils of carrageenan-alginate edible films on structural, functional and release properties.

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Active packaging based on natural biopolymers and active extracts are of great interest for both scientists and industries [1]. Alginate- and carrageenan-based films containing natural antioxidants (chlorogenic acid, fennel and rosemary essential oils, EOs) have been developed for active packaging for fish preservation. Beside their effect on fish preservation, active compounds affect the film structure and release properties. Both the film-forming solutions and obtained dried films were characterized in terms of miscibility, pH, zeta potential, and Fourier transform infrared spectroscopy (FTIR), DPPH antioxidant activity [2], barrier properties and release kinetic behaviour in model simulants [3], respectively. The aim is to better understand the relationships between film-forming solution and film characteristics on the application targeted properties. 2nd Fick's low according to Crank [4] model have been fitted to kinetic data modelling of mass transfer.

Addition of EO or antioxidants into biopolymer film forming solutions influenced viscosity of solutions showing non-Newtonian behaviour and good miscibility.

All films with added functional compounds showed good antioxidant activity. The higher antioxidant activity of the chlorogenic acid is related to the presence of the OH in meta position on their aromatic groups. The interactions involved between antioxidants and biopolymer chains are able to control the release mechanism and thus it should be considered for an optimized active film.

Release kinetics of chlorogenic acid and EOs display very different behaviours. The diffusion coefficients (D) of chlorogenic acid was lower than that with EOs. This can be explained by the probable plasticization or lubrification of the biopolymer network by the essential oil. The FTIR analysis of films confirms the assumptions based on the macroscopic properties. Hydrocolloids materials made from marine-sourced biopolymer associated to active compounds from halophyte plants have thus a great potential for application as active packaging biopolymers for food, with special interest in fresh or lightly processed fish preservation.

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PO9. Release of allyl isothiocyanate from antifungal hydrogels based on sodium alginate and β-cyclodextrin inclusion complexes

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Stimulus-responsive hydrogels have been proposed as promising functional materials for food packaging [1]. The incorporation of antimicrobial agents into these materials could contribute to reduce food waste provoked by microbial growth during storage. A previous study demonstrated that β-cyclodextrin: allyl isothiocyanate (β-CD:AITC) inclusion complexes (IC) were humidity-responsive agents with the ability to be used in the development of antifungal packaging materials [2].

The aim of this work was to evaluate the release of AITC from alginate hydrogels loaded with β-CD:AITC. The materials were obtained by external gelation method with 5% and 10% (w/w) of IC. The release of AITC to aqueous and fatty food simulants as well as to headspace was assessed through UV-spectrometry and HS-GC, respectively. Moreover, the antifungal capacity against *Botrytis cinerea* was tested in a headspace system. Diffusion (D) and partition (Kp) coefficients in food simulants were calculated from Crank equations [3].

Diffusivity from films into simulants was not affected by the IC concentration; however, transfer was higher and faster in the fatty food simulant. This fact was explained by structural changes in the materials due to dehydration in contact with low water content simulant, measured thanks to the weight loss. Furthermore, the kinetic release of AITC to headspace was IC concentration dependent. Materials with higher IC concentration showed humidity-responsive activity, i.e., high humidity triggered a greater AITC release percentage. This behaviour was consistent with the humidity-responsive characteristic of the biopolymer. Differences between materials in the release of AITC to headspace is explained by the distribution of IC into hydrogels observed through scanning electron microscopy analysis. Finally, hydrogels showed antifungal activity against *B. cinerea* at 4°C and 20 °C. A total inhibition of the fungal growth at both temperatures was evidenced, reaching a fungicidal effect with the highest IC concentration. These results showed the usefulness of the alginate hydrogels loaded with β-CD:AITC and their humidity-responsive capacity for antifungal packaging proposes. Wet active coatings based on hydrocolloids could therefore be suitable for hydrated foods like meat or dairy fresh products.

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PO10. Adhesion properties of *Lacticaseibacillus rhamnosus* GG to microalgal proteins

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The adhesion of probiotic bacterial cells to the surrounding matrix is an important aspect for the development of food supplements. Apart from food matrix *per se*, bacterial adhesion strains or species dependent whilst the cellular surface architecture is also of paramount importance. *Lacticaseibacillus rhamnosus* GG (LGG), one of the most common species used in probiotic supplements, is well-known for its strong adhesion properties to dairy proteins. The surface of LGG cells is composed of exopolysaccharides and pili, which consist of three subunits: one major subunit, SpaA, and two minor subunits, SpaB and SpaC[1]. SpaC, located at the tip and along the pilus shaft, is a well-established key protein mediating specific adhesive interactions with whey proteins[2]. Two major mechanisms have been proposed for SpaC-mediated adhesion: a) a zipper-like adhesion mechanism involving multiple SpaC molecules, and b) nanospring properties that enable pili to withstand high forces[3]. However, due to increasing consumer awareness about sustainable food proteins, the trend of replacing dairy proteins is steadily growing. A promising alternative to milk-derived proteins is microalgal proteins, such as those obtained from Arthrospira platensis (spirulina) and Chlorella vulgaris. These proteins are attractive due to their high protein content (60-70%) and the presence of phytochemicals (e.g., carotenoids, polyphenols, chlorophylls), along with their high biological value, sustainability, and eco-friendly nature[4]. In a recent study, we demonstrated that proteins obtained from spirulina could protect LGG during processing, storage, and gastrointestinal digestion as effectively as whey proteins[5]. However, the mechanisms underlying the interactions between the food matrix and LGG remain unclear. Therefore, the present work reports on the interactions between LGG and proteins derived from spirulina and chlorella, employing atomic force microscopy (AFM) using the worm-like chain model. For comparison, whey and pea protein isolates were also studied.

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PO11. Success and failure in mayonnaise preparation in the kitchen [1]

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The combination of near-infrared spectroscopic techniques (HSI or hyperspectral imaging) with advanced image analysis allows noninvasive, quantitative analysis of slow mixing phenomena. This is illustrated in a small study to monitor the preparation of homemade mayonnaise, specifically concerning the major challenge of "breaking" the emulsion. The context of the phenomenon in terms of the physics of mixing is explained as well.

This study demonstrates that the Kullback–Leibler divergence metric, when applied to HSI data, enables quantitative tracking of emulsion mixing dynamics and can be used to quantify emulsion homogeneity and identify phase inversion during mayonnaise preparation if manual oil addition proceeds too quickly. This approach holds promise for real-time monitoring of emulsion quality in industrial settings where the state of the emulsion cannot always be determined visually.

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PO12. Influence of the Corona surface treatment on antioxidant-PLA films coated with gelatine-based layer incorporating different phenolic compounds.

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Despite the favorable mechanical properties and film appearance of polylactic acid (PLA), its poor barrier properties have limited its application in the food industry [1]. Biopolymer coatings have emerged as effective solutions to enhance the barrier properties of PLA films [2]. Gelatin coatings are a sustainable and eco-friendly option that provides excellent oxygen barrier properties while being safe for food contact. Further improvement is necessary due to high-water sensitivity and poor mechanical properties of gelatin coatings. Crosslinking using cold plasma and natural chemical crosslinking agents can address these challenges [3,4].

Thus, the study aimed to understand the impact of cold plasma treatment on the functional properties of gelatin-based coatings containing natural antioxidants as potential crosslinkers.

The gelatin coatings, with and without antioxidants, were applied onto a commercial PLA film using the casting method. Subsequently, some films were treated with the corona discharge process at 450 W. Various property characterizations, including solubility in water, water absorption capacity, water contact angle, surface interactions, and oxygen and UV barrier properties of the coated films, were evaluated. Plasma and antioxidant treatments did not result in any improvements in water sensitivity. Significantly, the antioxidant treatment enhanced the oxygen and UV barrier properties of the coated films. Plasma treatment also produced varying effects on the UV barrier properties of antioxidant-containing films. In conclusion, while minimal crosslinking was induced in gelatin coatings by plasma and antioxidant treatments, some film properties showed enhancement after both interventions. This study contributes valuable insights into optimizing gelatin coatings for enhanced performance in PLA-based food packaging applications.

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PO13. Exploring germination-induced changes in the composition, protein properties, functionality, and oleosome behaviour of soybeans.

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Aim:

This project aims to understand how germination affects the physicochemical composition and structural integrity of soybean oleosomes and proteins, focusing on their rheological properties.

Method:

Oleosomes (lipid droplets or oil bodies) are natural oil-containing structures within plant seeds. Despite its essential role in seed physiology, the transformations undergone by oleosomes during germination remain incompletely understood. In this research, we germinated soybeans and extracted oleosomes and proteins. Afterwards, we studied their composition and functional properties using a particle size distributor (Mastersizer), SDS-page and CLSM. Further characteristics were analyzed using differential size calorimetry and other rheological instruments.

Results:

Oleosomes seem to remain intact up till a certain degree of germination. They remain intact largely due to their distinctive protein and phospholipid membrane. Within the protein fraction, glycinin and β-conglycinin composition modifications contribute to functional outcomes. Furthermore, germination significantly enhances the solubility of proteins, underscoring its potential to improve protein functionality.

Conclusion:

Germination has the potential to improve and alter protein molecular properties, which enhance properties, such as solubility and bioavailability of proteins. The excellent lubricant properties of oleosomes, combined with germination, can potentially optimize functional and nutritional applications in the food and biotechnology industries.

PO14. Development of a chromatographic profiling method for the analysis of heteroexopolysaccharides in yoghurt

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Lactic acid bacteria from the genera *Streptococcus*, *Lactobacillus*, *Lactococcus* and *Leuconostoc* have been used as starter cultures in fermented foods for a very long time. During fermentation, some of these bacteria produce heteroexopolsaccharides (HePS) which for example influence the viscosity of yoghurt.[1] The produced HePS are complex polysaccharides consisting of a repeating unit of at least 3 monomers. Frequently occurring monosaccharides are glucose, galactose, rhamnose, and *N*-acetyl-galactosamine. Due to differences in monosaccharide composition, linkage position, and branching of the main chain, a wide variety of different HePS occurs. The molecular structure as well as varying molecular weights determine the technofunctional properties of these polysaccharides.[2] The aim of the described work was therefore to develop a chromatographic profiling method for selected HePS that enables the structural analysis in a short time and with a high sample throughput. Since texturizing starter cultures are already in use in fermented milk products,[1] we developed a sample workup which allows the application of the method for the analysis of yoghurt.

First, various conditions for partial acid hydrolysis were tested and the resulting low molecular weight compounds were analyzed by high-performance anion exchange chromatography coupled with pulsed amperometric detection and mass spectrometry (HPAEC-PAD/MS^2). By using suitable conditions, it was possible to detect characteristic products for the selected HePS. Various sample workups were tested for the isolation of the HePS fraction from yoghurt, for example the separation of proteins with proteases or by trichloroacetic acid. Although the isolated polymers were not completely pure, it was possible to detect the characteristics oligomers after partial acid hydrolysis. The application of the method to different commercial yoghurt samples demonstrated that some of the selected HePS can be found in yoghurt. Therefore, the chromatographic analysis of HePS in pure form or in fermented foods after partial acid hydrolysis proved to be a promising approach for supplementing to existing methods, for structure elucidation, and for a rapid detection of HePS in food.

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PO15. Sustainable Pectin Extraction from Wet Apple Pomace: Physicochemical and Structural Characterization, Water Holding Capacity

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Agro-food industries generate substantial amounts of non-edible waste and by-products, which offer significant potential for upcycling into valuable active phytochemicals. Apple pomace, a by-product of juice production, has gained attention as a promising raw material for food applications due to its viscosity, water-holding capacity, and high pectin content[1].

The yield and properties of pectin are heavily influenced by the extraction method, as its structure determines its physicochemical properties and functional applications[2]. This study takes a novel approach by eliminating the energy-intensive drying step commonly used in pectin extraction, a process known to degrade bioactive compounds[3]. Instead, it focuses on efficiently extracting pectin from wet apple pomace, aiming to preserve its functionality while reducing energy consumption.

Both conventional and innovative processing techniques will be applied, including microwave-assisted extraction, enzymatic extraction, ultrasound-assisted extraction, and their combination methods. By employing these approaches, this study seeks to advance sustainable pectin extraction and enhance its applicability in food systems. A key focus is the water-holding capacity (WHC) of pectin, a critical property in food hydrocolloids. The research investigates how different extraction methods impact WHC and explores the underlying mechanisms. Ultimately, this study provides a sustainable approach to pectin extraction while optimizing its functionality for food applications.

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PO16. The Use of Agarose as a Gelator in Oil Solidification Processes: A Review

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Innovative hydrogels are a modern alternative to solid fats of vegetable origin, such as trans fats and hydrogenated oils. Among potential oleogelators, agarose, a prominent marine-derived polysaccharide derived from red algae, occupies a special place. Agarose, a key component of agar, acts as a gelling agent. Its isolation from the agar structure makes it more homogeneus, which translates into excellent gelling properties. In addition, agarose is distinguished by its reversible thermo-gelation ability, exceptional mechanical properties, high bioactivity and switchable chemical reactivity, allowing it to functionalize in various applications. Thanks to these characteristics, agarose is considered a promising ingredient for stabilising vegetable oils, making it a highly attractive solution for producting innovative hydrogels[1].

Agarose consists of long linear chains composed of repetitive dimers of galactose and 3,6-anhydro-L-galactose. A key feature of agarose is its ability to form gels with high stability due to spatial networks maintained by hydrogen bonds and hydrophobic interactions. Agarose is characterized by high purity and a more homogeneous structure, which translates into substantial gelling properties[2]. Agarose-based gels exhibit thermal and mechanical stability, outperforming agarose-based gels in this regard[3]. By using agarose gels, it is possible to reduce the use of additional emulsifiers or stabilizers, which promotes the creation of more natural and healthy products.Moreover, agarose gels are already used in various industries, including food and pharmaceuticals, where they are appreciated for their stability, purity and exceptional structural properties[4].

Despite the promising properties of agarose, its application has some challenges. Produce, which may limit its widespread commercial use. The structure of gels on agarose is less stable, but it exhibits greater flexibility than agar gels, which may be preferable in some applications[5].

In conclusion, agarose has excellent potential as an innovative oleogelator, offering stability, naturalness and versatility for industrial applications. Challenges, such as production costs and differences in structure compared to agar, do not derail its potential, but point to the need for further research into optimizing the process of its use. In the long term, agarose could become a key ingredient in of transforming the vegetable fat market into more sustainable and healthy solutions.

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PO17. The process of solidifying different types of oil (rapeseed, pumpkin, hemp) using agarose as a single oleogelator

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Hydroleogels an innovative form of solidified oli, were prepared using agarose as the only oleogelator with great potential in designing stable structures. Was the study aimed to analyse the interaction of agarose with three types of oils (raspeseed, pumpkin, hemp) and evaluate the effect of its concentration (1% and 2%) on oli binding capacity, colour stability and mechanical hardness. Measurements were carried out 24 hours after preparation and after five days of storage, which made it possible to assess the temporal stability of the tested structures. The results highlight the significant influence of agarose concentration and oil type on some of the physical characteristics of the hydroleogels.

Regarding oil-binding capacity, hemp oil hydroleogels showed the highest initial retention (98.28% at 2% agarose) and minimal changes over time, while for rapeseed oil, 2% agarose provided a retention stability of about 92% after 5 days of storage, while a decrease in binding capacity from 82.15% to 65.45% was observed for 1%. Pumpkin oil had the lowest initial retention (66.03% with 1% agarose), but a higher agarose concentration substantially improved this parameter to 92.5%.

Colour analysis showed that the higher agarose concentration (2%) resulted in an overall improvement in colour stability and less change in the L*, a* and b* parameters over time. Rapeseed oil hydroleogels at 2% agarose were the most stable in colour (change in L* from 85.2 to 88.7, b* from 4.8 to 5.0). Pumpkin oil was characterized by the changes in yellow intensity (b* increased from 11.5 to 19.6), especially at the lower concentration of agarose (1%). In the case of hemp oil, brightness (L*) increased independently of agarose concentration, indicating the dominant effect of storage time.

Hardness tests showed that 2% agarose significantly increased the mechanical properties of the hydrogels. Hydroleogels with rapeseed oil showed the most significant increase in hardness with increasing agarose concentration (from 2.53 N to 12.48 N). In comparison, hemp oil provided the highest initial hardness at 1% agarose (3.90 N). The most stable structures of all parameters studied were obtained for rapeseed oil hydroleogels at 2% agarose, while pumpkin oil hydroleogels at 1% agarose had the least stability.

The results obtained confirm the potential of agarose as a versatile material for the formation of hydroleogels, emphasizing the importance of optimizing the concentration of agarose and selecting the appropriate oil depending on the intended application. Despite the clear influences of different oils on the formation of structures, agarose successfully enabled the formation of hydroleogels in each case, demonstrating its good binding properties and potential to use as a universal oleogelator.

PO18. EFFECT OF HIGH HYDROSTATIC PRESSURE IN THE THICKENING AND EMULSIFYING PROPERTIES OF CITRUS POMACE

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Citrus pomace is composed of skin, pulp and seed and contains cellulose, hemicellulose, pectin, protein, lignin, soluble sugars and essential oils. Cellulose may act as an emulsifier due to its amphiphilic properties and also increase the viscosity of the continuos phase as emulsion stabilizer. Pectin possess gelling and stabilizers properties, and the protein residues in the pectin confer it emulsifying properties.An application to revalorize untreated citrus pomace is its employ as emulsifier and stabilizer.

Emulsion gels have been developed as replacers of conventional fat rich in saturated fatty acids. Liquid oils rich in mono- and polyunsaturated fatty acids and low in saturated fatty acids gain semisolid structure due to their formulation into emulsion gels, and are a promising healthy alternative.

The effect of high hydrostatic pressure technology in the thickening, gelling and emulsifier properties of citrus pomace obtained from clementine was investigated. Various pressures and times were evaluated. Sunflower oil emulsion gels were prepared using untreated and treated clementine pomace, and the effect in the rheological properties, particle size distribution, microstructure and texture properties investigated. Conclusions are obtained about the effect of high hydrostatic pressure in the structure and functionality of citrus pomace and in its suitability to be applied as emulsifier and stabilizer in the manufacturing of emulsion gels suitable as conventional fat replacers.

The work is a contribution towards healthier fat alternatives based on vegetable clean label ingredients, and a valorization of unpurified clementine byproducts contributing to circular economy.

PO19. Developing Strategies for the Production of Potato Protein Aerogels

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The demand for sustainable plant-based food materials has driven research into innovative protein-based aerogels. These materials present high porosity, large surface area and lightweight structure, showing promise in personalized supplementation and as food-grade delivery systems (Abdullah et al., 2022). Although many studies focus on aerogels derived from animal proteins, the use of plant proteins is still relatively unexplored. Potato protein is a promising and sustainable alternative, aligning the increasing emphasis on reducing environmental and health impacts with the accommodation of diverse dietary preferences. Aerogels' structural stability is crucial for food applications, enabling controlled moisture absorption and bioactive compound release. The aim of this study was to develop various strategies for potato protein aerogel production. Three distinct gelation methods were explored: thermal gelation (at 90 °C for 15 minutes), enzymatic crosslinking (1 % (w/v) transglutaminase), and chemical crosslinking (0.4 % (w/v) genipin). Additionally, to further improve the stability and integrity of the aerogels, a water-resistant ethylcellulose coating was tested. A comprehensive characterization of the produced aerogels was conducted, encompassing the analysis of properties such as porosity, water and oil absorption capacity, mechanical strength, microstructure and thermal properties. This allowed to compare the effectiveness of different production techniques and to determine which strategy offers the best technological properties. These findings pave the way for future sustainable, functional and innovative applications in the field of food-grade aerogels.

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PO20. Effect of exopolysaccharides on the processing properties of Einkorn wheat

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Ancient grain varieties such as Einkorn (*Triticum monococcum*) have gained significant importance in recent years due to their nutritional properties and suitability for people suffering from non-coeliac gluten sensitivity. However, the underutilization of Einkorn wheat has been mainly attributed to its low cultivation yields, as well as its poor processing properties, limiting the industrial bread production. Up to now, Einkorn bread continues to be produced manually and blended with other ingredients, due to its high dough stickiness and low kneading and fermentation tolerance. To address these challenges, the main aim of this study was to investigate the influence of two exopolysaccharides (dextran, water kefir grains) on the dough rheology and baking properties of Einkorn wheat. First results showed that increasing dextran concentration significantly reduced dough firmness, stickiness, and stability, while enhancing water absorption, dough softening, and elasticity. In contrast, doughs prepared with water kefir exhibited a higher dough stability, firmness and yield point compared to those with dextran. In terms of bread quality, the highest dextran concentrations yielded breads with highest specific volume, whereas breads containing water kefir had smaller volumes but similar pore properties. While further research is needed, the findings demonstrated that water kefir grains influenced dough properties, particularly improving dough handling. These results suggest that incorporating exopolysaccharides could improve the technological properties of Einkorn wheat which would benefit industrial bread production.

Keywords

ancient grains, dextran, water kefir grains, dough rheology, bread quality

PO21. Evaluation of thickening effect of *sesbania* gum and carboxymethyl *sesbania* gum

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Sesbania, as an excellent crop for improving saline-alkaline soils, is widely cultivated in China. The endosperm of *Sesbania* seeds also contains a rich content of galactomannan, known as *Sesbania* gum. However, there is currently a lack of high-purity *Sesbania* gum products in China, and its poor dispersibility and solubility limitations restrict its industrial applications. Therefore, we conducted research on the extraction and purification methods of *Sesbania* gum and further characterized the differences between the purified *Sesbania* gum and other galactomannan gums - guar gum and locust bean gum, in terms of shear rheological properties, tribological characteristics, and extensional rheological behavior. Our results indicate that *Sesbania* gum can achieve the same thickening level as other gums, while exhibiting unique lubrication curves and good extensional rheological properties, demonstrating promising potential for industrial applications. In addition, we modified the *Sesbania* gum samples by carboxymethylation to address their poor solubility. The results showed that after modification, the sample's water solubility and solution transparency were significantly improved. At the same thickening level, the modified *Sesbania* gum exhibited superior lubrication and extensional properties.

PO22. Development of protein-polysaccharide complex-based emulsions and emulsion-gels for food applications.

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Oil-in-water (O/W) emulsions are widely utilised in food products such as salad dressings, mayonnaise, and sauces, where high emulsion stability under acidic conditions is required. Additionally, O/W emulsions can be used in gel form for potential applications as substitutes for animal fats, requiring high shape retention and oil release suppression. While egg yolk is one of the most commonly used food emulsifiers due to its high acid resistance and excellent emulsifying performance, its use imposes challenges related to flavor change and allergen concerns, making it unsuitable for individuals with egg allergies. Consequently, the food industry has seen an elevated demand for alternative emulsifiers that are natural, egg-allergen-free, and environmentally sustainable. In response to these industrial and consumer needs, the present study aimed to develop and characterise stable O/W emulsions and their corresponding emulsion gels using natural biopolymers. The investigation focused on molecular complexes formed between xanthan gum (XG) and either whey protein isolate (WPI) or soy protein isolate (SPI), providing insights into the role of protein-polysaccharide complexes in enhancing the functional properties of the emulsions and emulsion gels. Highly stable O/W emulsions were prepared by leveraging electrostatic interactions between WPI and XG. Through optimising preparation methods and conditions, required emulsifying performance of the protein-polysaccharide complex was achieved[1]. At pH 4.0, the WPI-XG complex formed nanoscale assemblies (～100 nm), with the ζ-potential of the complex (−37.3 mV) being significantly lower than that of WPI alone (+6.94 mV). Cryo-SEM imaging revealed fibrillar XG structures extending from the WPI globules. The emulsions stabilised with the WPI-XG complex exhibited enhanced storage stability over 28 days at 25℃. These findings highlight the potential of the complex as a natural, protein-conserving emulsifier for acidified food products.

O/W emulsion gels using SPI-XG complexes were further investigated for applications in plant-based processed meat products, addressing lipid leakage and texture improvement[2]. Building upon prior findings[1], stable O/W emulsions were prepared with SPI-XG complex at pH 4.0. By incorporating selected gelling agents, emulsion gels with enhanced properties were formulated. Rheological tests identified methylcellulose as a key ingredient contributing to heat resistance. Application tests on plant-based meat patties demonstrated that the emulsion gels effectively reduced weight loss during cooking/reheating, improved juiciness and enhanced texture compared to conventional liquid oils. These results underscore the potential of SPI-XG based emulsion gels in developing plant-based, clean-label processed food products.

These findings support the potential of protein-polysaccharide complexes, particularly under acidic conditions, in designing functional emulsion systems. Such systems can enhance flavor and texture perceptions while promoting environmental sustainability, thereby contributing to the development of highly functional and consumer-preferred food products within the industry.

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PO23. Effect of pH and heating on the physicochemical, interfacial and emulsifying properties of hemp seed protein isolates

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The employment of biosurfactants in food-related applications has gained increasing attention due to their natural origin, biocompatibility, and biodegradability. Among various biosurfactants, proteins have emerged as a particularly promising category due to their functional versatility and sustainability, aligning with the growing consumer demand for natural and clean-label ingredients. Indeed, these amphiphilic molecules, capable of reducing surface and interfacial tension, play a crucial role in enhancing the texture, stability, and shelf life of food products (Chutia & Mahanta, 2023; Riaz et al., 2022).

This study explored the potential of hemp seed protein isolate (HPI) heat-induced self-assemblies (i.e., fibrils or aggregates) as surface-active ingredients for food industry applications, emphasizing their functional properties and interface stabilizing mechanisms of action. In particular, the study focused on the effect of pH (2; 7; 10) and heating (80 °C for 30 min) into the structure-function relationship of protein biosurfactants, emphasizing how their unique molecular structures contribute to their physicochemical, interfacial and emulsifying properties. Our findings demonstrated that HPI self-assemblies prepared at pH 2 actively reduced the interfacial tension and create a strong viscoelastic membrane at the o/w interface and thus, enhancing emulsion stability. On the other hand, HPI self-assemblies prepared at pH 7 and 10 had a comparable techno-functionality, stemming from their physicochemical and microstructural characteristics similarities. In these conditions, proteins achieved lower values of interfacial and emulsifying activities compared to acidic conditions. In the end, heating treatment slightly improved physicochemical properties of the proteins in all of the different conditions but didn`t show significant differences in emulsion stability values. The results of this study can provide the food industry with a source of alternative proteins which present great biotechnological potential and added value.

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PO24. Solubilisation of galactans from the red seaweed *Pyropia columbina* during processing and their impact on the rheological properties of suspensions

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Marine seaweeds hold great potential as sustainable, nutritious food ingredients, offering solutions to challenges posed by climate change. Edible red seaweeds, including *Pyropia* and *Porphyra* species, are traditionally consumed and have attracted significant scientific interest due to their rich biochemical composition, which is linked to various health benefits such as antioxidant, immunomodulatory, and antiviral properties. *Pyropia* species[1] are distributed worldwide, from tropical to cold waters, and are a source of porphyran, a sulphated polysaccharide that consists of alternating 1,3-linked β-d-galactosyl units and 1,4-linked α-l-galactosyl 6-sulphate units, which can be replaced by a small amount of 3,6-anhydro-α-l-galactosyl units. This compound is known for its bioactive properties, making it an important functional ingredient.

This study investigates the solubilisation of galactan-rich compounds from *Pyropia columbina* using food processing conditions, including thermal and high shear treatments. Thermal treatments (45–90°C) increased viscosity of the liquid phase of the dispersions, due to the release of cellular components, while high shear treatment alone did not affect viscosity. However, combining thermal and high shear treatments enhanced viscosity of the dispersions. The soluble phase contained 16-22% protein and was enriched in galactose (80-90% of total monosaccharides). Microstructural analysis using confocal scanning laser microscopy (CSLM) showed that thermal treatment did not significantly affect the thick extracellular matrix (ECM) of this seaweed, whilst high shear reduced particle size and disrupted the ECM solubilising the sulphated galactans into the water phase. Rheological testing indicated that the seaweed dispersions showed a range of textures from liquids ($\tan\delta$ > 1) to soft gels (G’ > G’’). These results show how food processing impacts the structure and physico-chemical properties of *P. columbina*, showcasing its potential as a sustainable source of functional ingredients for food formulations with potential health benefits.

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PO25. The impact of pH-induced electrostatic interactions on the properties of lysozyme amyloid fibrils-WPI composite gel

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Nanofibers, when embedded in a gel, function similarly to fillers in composites. The overall viscoelastic properties of a composite gel are determined by the interplay between the individual characteristics of the filler and the continuous gel matrix, including their rheological features and ratio, as well as potential interactions between them. Reactive fillers can enhance the rheological attributes of a composite gel by binding and attaching to the gel matrix. This study aims to investigate the impact of lysozyme amyloid fibrils (LZ-AF) at concentrations up to 1% w/w on the rheological properties of a 12% w/w whey protein isolate (WPI) gel at pH 2 and 7. WPI and LZ-AF were chosen due to their ability to form electrostatic assemblies at neutral pH, as they are oppositely charged. Spectrophotometric and dynamic light scattering techniques were used to study the interactions between WPI and LZ-AF in dilute solutions at various pH values. The rheological, microstructural, and functional properties of WPI gels embedded with LZ-AF at acidic and neutral pH were investigated and compared.

The average contour length of LZ-AF was determined to be 4937 ± 230 nm. At pH 7, WPI and LZ-AF were negatively and positively charged, respectively, while the mixed proteins had a net positive charge at pH 2. The addition of 1% LZ-AF resulted in a 2.3-fold increase in the elastic modulus of the WPI gel at pH 2 and a 68.2-fold increase at pH 7. This indicates that the reinforcement effect of LZ-AF on the strength of the WPI gel was more significant at neutral pH than at acidic pH, reflecting the pH-dependency of the bond strength between LZ-AF and WPI. The value of tan δ was independent of LZ-AF concentration at pH 2, while in neutral conditions, it was strongly affected, reaching a minimum (0.0968 ± 0.0006) in the presence of 0.5% w/w LZ-AF. The lower value of tan δ at pH 7 compared to pH 2 indicates higher structural stability with long-lasting intermolecular bonds. All of the acidic composite gels had a transparent appearance with a fine-stranded microstructure, as evidenced by the CLSM images. However, the neutral composite gels became increasingly turbid with the increase in LZ-AF concentration. Furthermore, the CLSM images revealed the presence of random and particulate protein aggregates with a significantly larger diameter than that of individual WPI proteins in the neutral composite gels. The acidic LZ-AF-containing hydrogels exhibited a high water holding capacity (WHC), while the composite hydrogels prepared at pH 7 had a coarse and porous microstructure that allowed for oil adsorption. Overall, the incorporation of LZ-AF significantly modified the rheological, microstructural, and functional properties of WPI gels at both pH 2 and 7. However, the mechanism of action for LZ-AF differed depending on the pH, with the formation of LZ-AF and WPI heteroprotein electrostatic complex at neutral pH compared to a repulsive protein mixture at acidic pH.

PO26. Enzymatic degradation of Pickering protein-based microgels – a strategy to induce demulsification

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Pickering emulsions stabilized by food-grade particles have gained growing interest due to their exceptional stability and safety, showing significant advancements over conventional emulsions. However, the process of demulsification, critical for releasing active ingredients from those stable droplets on demand, has received limited attention to date. By adjusting parameters that influence desorption energy such as the radius of the Pickering particle, and/or the wettability of the Pickering particles, it is possible to detach the particles from the interface[1]. The aim of this study was to understand the demulsification of Pickering emulsions using particle dissolution approach *i.e.* reducing the size of the particle by enzymatic degradation of the Pickering particles. We hypothesized that trypsin, a specific protease, will kinetically reduce the size of a model protein-based Pickering particle (whey protein microgel, WPM), which will ultimately modulate demulsification. The capability of trypsin to digest WPM (12 wt% protein) was monitored under pH 7.0 conditions and the particle degradation was assessed using dynamic light scattering, pendant drop tensiometry, sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE), atomic force microscopy (AFM) and interfacial shear rheology. Results demonstrated that the exposure to trypsin led to a notable decrease in WPM particle size by 41%. A similar trend was observed in reducing both interfacial tension and shear viscosity which, however, had a time dependence of enzymatic treatment. Thus, enzymatic degradation of the particles exhibits promise of thinning the interfacial film which could potentially contribute to the coalescence of Pickering emulsions' droplets when WPM is used as a Pickering stabilizer. Ongoing studies are exploring enzymatic treatment on WPM-stabilised Pickering emulsions, focusing on their behaviour during hydrolysis by trypsin and on how interfacial thinning affects demulsification as a function of hydrolysis time.

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PO27. Origins of polysaccharide conformation and viscoelasticity in miscible heterogeneous solvent

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Polysaccharide polymers constitute the fundamental building blocks of life and display a diverse set of conformations; the origins of which need further understanding. Utilising a model high molecular weight, high Trouton ratio bottlebrush-like 'pectin' polysaccharide extracted from okra (*Abelmoschus esculentus*) mucilage, we combine theoretical (molecular dynamics simulation) and experimental (extensional rheology, dielectric relaxation spectroscopy, calorimetry, and neutron scattering) investigations, to unveil the underlying microscopic hydrodynamic origins of polysaccharide conformation. In miscible heterogenous solvents of water and glycerol (cosolvent), we observe that the polysaccharide chain undergoes a non-monotonic conformational transition from flexible-to-extended-to-collapsed configurations, resulting in pronounced viscoelastic responses. Molecularly structured water molecules within ca. 0.40 nm of the chain surface are observed with an increase of glycerol in the solvent composition. We postulate that this increased water elicits an entropically unfavourable dynamic solvent heterogeneity, which is ameliorated by swelling and collapse of polysaccharide chains. Together with elastic fixed window scans on the thermal backscattering spectrometer IN13 (Institute Laue-Langevin, France), we demonstrate water's confinement near pectin chains. Our results offer new insights applicable to fundamental biopolymer science and biomaterial engineering, previously inaccessible through mean-field assumptions.

PO28. 3D Printing for Nutrient-Enriched Gluten-Free bio-inks

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Polysaccharides and plant proteins, owing to their abundance in nature, are among the most promising natural materials for replacing synthetic polymers in various applications. Moreover, they are cost-effective, easy to process, and biodegradable, making them ideal for food applications. 3D food printing is an emerging technology that has been receiving significant interest for its ability to produce customized food products with tailored shapes, flavors, colors, and textures 1,2. Recently, to meet 3D printing requirements and enhance product characteristics and shelf stability, structural compounds such as hydrocolloids are often added to modify matrix properties, followed by further processing 2. Within this context, drying with freeze or oven drying method comprises a common post-processing method for food processing and storage for managing the characteristics of 3D printed products 3.

The objective of this study was the development of an advanced customized extrusion 3D printer setup for producing gluten-free foods designed as enrichment substrate matrices for incorporating industrial agricultural by-products, such as olive leaves and stems. Characteristically, food bioinks were primarily developed using starches from various botanical sources (potato, corn), plant protein concentrates (pea, rice, fava), and the hydrocolloid κ-carrageenan at different concentrations, and were assessed for their potential as functional food matrices. For this reason, the prepared 3D printed structures were subjected to two different drying operations (air and freeze drying). The extrudability (appearance-dimension closest to the CAD designed geometric model) and the mechanical strength as a function of shrinkage were used to determine extruded samples printability, where significant differences were demonstrated with respect to bioink composition. According to our results the incorporation of agro-bioproducts did not seem to interfere with printability in comparison with the control samples, while significant differences were demonstrated as a function of composition. All in all research findings suggest the potential use of post processing techniques and the use of agricultural industrial by-products as functional ingredients, for improving the nutritional content in 3D food printing applications.

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PO29. The impact of Moderate Electric Fields on amyloid fibril aggregate formation

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Amyloid fibril aggregates (AFA), are protein superstructures with versatile applications, including drug delivery systems and food hydrogels enhancement. Thue to their amyloid nature, they can also serve as models for studying and treat protein misfolding diseases such as Parkinson's and Alzheimer's[1]. The use of high temperatures can naturally promote the formation of these fibrils in acidic, protein-based foods during thermal processing[2]. Food proteins, such as β-lactoglobulin (BLG), can act as semi-conductors in aqueous solutions, allowing alternating and regulated electrical currents to flow. Depending on the strength and frequency of the electrical waveform, electrochemical reactions and internal heat dissipation—also referred to as the ohmic heating (OH) effect—occur when subjected to moderate electric fields (MEF). According to recent research, MEF and the resulting OH can change the unfolding, denaturation, and molecular interactions of globular proteins like BLG, changing their dynamic behavior and playing a crucial role in AFAs formation[3]. MEF provides rapid and volumetric heating with precise temperature control at high temperatures, offering the potential to induce structural changes in proteins under conditions that have not yet been thoroughly explored. This work aims to evaluate the impact of MEF-induced OH at a temperature beyond traditional applications on AFA development, with a focus on its effects on protein behavior, aggregation, and fibril formation, to uncover potential applications and limitations. Under a MEF (< 10 V/cm) at 20 kHz, OH was delivered to WPI aqueous solutions (1% m/v, pH 2) for 0.5h–6 hours at 100°C.The development of BLG fibrils was tracked and characterized through advanced spectroscopic methods, including intrinsic and extrinsic Thioflavin T (ThT) fluorescence, circular dichroism, and detection of degree hydrolysis. Results show that MEF affects unfolding, denaturation, and molecular interactions—all of which are essential for the synthesis of AFA—and thus the dynamic behavior of BLG. The study shows that MEF after 3h of heating at 100 ºC, the maximum amount of AFA was produced, which was marked by a reduction in intrinsic fluorescence and surface hydrophobicity as a result of tertiary structure disruption. Structural analysis revealed an increase in random coil structures along with partial loss of β-sheet, α-helix, and turn formations. These findings demonstrate MEF's ability to rapidly promote AFA formation under specific thermal conditions, highlighting its potential in biotechnological applications such as food texture enhancement, drug delivery systems, and therapeutic approaches for protein misfolding diseases.

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PO30. Research on the texture and antioxidant properties of model protein-hydrocolloid-salt emulsions

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In order to create the base to sausage analogues, rapeseed oil-water emulsions contain: protein, carrageenan, methylcellulose and sodium chloride were tested. The experiment was planned using the response surface methodology for three variables: protein, oil and carrageenan concentrations. Research work consisted of 15 variants for each kind of plant protein: soy, potato and pea. The concentration of protein and oil in the emulsions ranged 10% - 20%, carrageenan 1% - 3%. In all variants, the concentration of methylcellulose and salt was at the same level, 1,5% and 1% respectively. The emulsions were heat treated at temperature of 90°C. An analysis of the texture properties such as hardness, elasticity, gumminess, chewiness, cohesion, of the emulsions was performed by Zwick/Roell testing equipment. The analysis showed that the primary texture properties are influenced by the concentration of protein and carrageenan. The hardest systems are obtained in the case of potato protein, while soy and pea proteins gave values of 30% and 50% lower. A six-person team analysed the texture profile of the systems according to the PN-ISO 11035, 11036 standards, including the identification and selection of descriptors. Analysis of antioxidant activity of emulsions were carried out by ABTS and FRAP methods.

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PO31. Exploring the rheological properties of hydrocolloid-mucin binary systems

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A large number of studies lately have focused on the extensional rheology of polymers, as it plays a significant role on bolus flow during swallowing and the sensorial properties of hydrocolloids. Additionally, shear rheology is of importance as thick liquids assist in treating various oropharyngeal diseases such as dysphagia and dry mouth. In that respect, the effect of concentration and mucin on the shear and extensional rheological properties of 4 different hydrocolloids (guar gum, xanthan gum, carrageenan gum and pectin gum) was evaluated. It was found that the relaxation time and break up time remained constant for small hydrocolloid concentrations for all gums while an increase in values was mainly observed at the highest concentrations. The influence of mucin was more significant for guar gum solutions, where relaxation and disintegration times increased at low concentrations and decreased at higher concentrations. The values for the carrageenan values increased with the addition of mucin, but not significantly, while addition of mucin xanthan solutions did not have any impact. As expected, all polysaccharides solution exhibited a shear thinning behavior but it was not that apparent in the case of pectin. Above a certain concentration while a significant increase in viscosity was observed with an increase in concentrations of the gums studied.

PO32. Understanding the structuring behaviour of plant-based proteins during extrusion using high-temperature shear cell and near-infrared spectroscopy

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Plant-based meat analogues can be used to stimulate the consumption of plant-based proteins instead of animal proteins, which has beneficial environmental and health effects. High-moisture extrusion (HME) is commonly used to produce these meat analogues with a fibrous structure resembling that of meat. Even though this technique has been used since the 1980s, the mechanism behind the fibrous structure formation remains unclear, making process and quality control challenging. One of the main reasons for this is the ingredient properties, as well as the processing parameters can affect the product quality and the influences of these parameters are strongly interrelated. Therefore, this research aimed at developing methods to disentangle the effects of the processing parameters during the different processing steps of HME on the fibrous structure formation. To do so we used a high-temperature shear cell (HTSC) to study the different processing steps during HME: 1) mixing and hydrating, 2) thermomechanical treatment, and 3) cooling. HTSC processing consists of the same unit operations as extrusion, but allows individual control over the various processing parameters, such as deformation rate, processing temperature and residence time.

Our results show that mixing affects the final product structure but that this effect was influenced by the ingredient formulation and was different for soy protein concentrate, soy protein isolate-wheat gluten and pea protein isolate-wheat gluten products. Additionally, the application of shear during cooling in the HTSC showed that the shear stresses in the cooling die is not a prerequisite for fibrous structure formation from pea protein isolate-wheat gluten mixtures. To measure the overall intensity of the thermomechanical treatment we developed a new parameter, "equivalent shear-cell-temperature", by combining the HTSC and near-infrared (NIR) spectroscopy. This parameter can be used to quantify the effects of barrel temperature, screw configuration and screw speed on the thermal process intensity and final product structure. We also applied NIR spectroscopy to measure the composition of meat-analogue like systems containing oil. In conclusion, the application of HTSC and NIR spectroscopy to study structuring in the HME can give valuable insights in the structure formation mechanism during HME and can thus enable developments towards more efficient processing of meat analogues with better textural properties.

PO33. Thicker than water: exploring the diverse relatives of *Plantago ovata* to address the narrow hydrocolloid functionality of psyllium in food and the gut

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Psyllium husk (PH), a heteroxylan (HX)-rich material milled from the surface of *Plantago ovata* seeds, is known for its high viscosity and gelling capacity making it a widespread fibre supplement and hydrocolloid in foods. However, PH applications face challenges, including hydration adjustment difficulties and sensory issues like gumminess. These arise from HX's unique rheological and water-holding behaviours, which were previously poorly understood.

Over the past decade, we have employed various plant science strategies to uncover the drivers of PH quality, making significant advances in its development and genetics[1]. However, we have also demonstrated that *P. ovata* has extremely limited genetic variation, resulting in a narrow range of HX properties for tailored applications. Through fractionation and advanced rheological techniques, *P. ovata* HX has been shown to form 'physical gels', with substitutions playing a critical role in network formation and rheological behaviour[2]. With this considered, we have explored dozens of alternative *Plantago* species and discovered that HX is shared as the most abundant polymer, but importantly their substitution levels, and subsequent rheological and water absorption behaviours, vary widely. Adding whole seed flour from several diverse *Plantago* species to gluten-free bread showed that the texture- and dough rheology-enhancing properties partly independent of HX *content* and chemistry and were more strongly associated with the *proportion* of more gel-like (greater *G'* and lower tan δ) HX fractions[3]. One species that we have named Australian Psyllium (AP) showed particularly potent hydrocolloid behaviour (even compared to PH) so we have employed fractionation and binary starch-HX gel fabrication to probe this further, showing that AP HX and AP HX-starch gels had extremely high resilience under dynamic oscillatory deformation, with flow points and flow transition indices double that of *P. ovata* HX and HX-starch gels. Applying AP *in vivo*, these advantages provide more potent dietary fibre functionality, reducing cholesterol levels more than *P. ovata* in mice fed an obesogenic diet.

Exploring the diverse relatives of *P. ovata*, we show that this is a richer resource for targeted hydrocolloid functionality. Future work will compare AP and *P. ovata* HX chemistry and rheology more deeply to uncover the underlying mechanisms, as well as exploring broader hydrocolloid applications.

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PO34. Evaluation of physicochemical and rheological properties of bread containing beta-glycans from different sources.

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Beta-glucans have gained widespread recognition for their positive effects on human health, prompting their incorporation into functional bakery products to enhance their nutritional profile. The European Food Safety Authority (EFSA) has approved health claims for certain β-glucans[1], such as those derived from oats and barley, due to their cholesterol and postprandial glucose-lowering properties. Additionally, yeast-derived β-glucans have recently been approved as novel food ingredients[2], expanding their potential applications in food innovation. The aim of the present study was the development of functional breads by the exploitation of wheat flour enriched with b-glucan from two different sources: oats and baker's yeast (Saccharomyces cerevisiae). For this purpose, wheat breads were formulated, where a preparation containing 34% oat b-glucans was incorporated by replacing 16% of wheat flour (OBG) or a preparation containing 75% baker's yeast b-glucans by replacing 4,5% of wheat flour (YBG). A control bread (CB) exclusively prepared from refined wheat flour served as a reference sample. Chemical composition and physicochemical properties of dough and breads were evaluated. Sensory evaluation of the three bread samples was conducted by consumer acceptance test. OBG had significantly higher protein content, mainly attributed to the higher gluten addition needed for the preparation compared to those with yeast β-glucans, and control bread (p<0.05). OBG had a lower available carbohydrate and starch content compared to both YBG and control bread (p<0.05). The total fat and energy content of the three breads were similar. Physicochemical properties varied across samples. OBG bread demonstrated higher moisture content and specific volume compared to YBG and control breads (p<0.05). According to Texture profile analysis, OBG breads had lower values of hardness, cohesiveness, and gumminess, without reaching statistical significance. Scanning Electron Microscopy (SEM) analysis highlighted textural differences: control breads exhibited limited air-holding capacity, while OBG breads showed a more uniform structure with a higher porosity. In contrast, YBG showed heterogeneous textural attributes, having a low and inconsistent air-holding capacity that reflected the differences in porosity of the final product. The rheological properties of the test doughs also differed, with OBG showing higher elasticity and significantly greater values of viscosity compared to YBG and control. Concerning the color of bread crumb, lightness (L*) and a* value was significantly lower in YBG, compared to CB and OBG (p<0.05). The b* parameter was higher in OBG and YBG compared to CB (p<0.05). Sensory analysis of the test breads revealed superior organoleptic characteristics, including appearance texture and chewiness (p<0.05), with overall higher scores across most evaluated parameters compared to YBG and control breads.

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PO35. Effects of Flour Particle Size and Botanical Origin on the Physicochemical Properties of Bread and the Glycemic, Insulinemic and Appetite Responses of Healthy Adults.

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The consumption of bakery products made exclusively with finely milled conventional flours has been associated with increased postprandial blood glucose levels, increased hunger and reduced satiety[1]. Milling cereal grains and legumes disrupts their plant cell walls, increasing thus the accessibility of the encapsulated starch to the digestive enzymes[2,3]. In the present study the effects of flour origin (wheat or chickpeas) and particle size of three whole meal breads on physicochemical properties and postprandial glucose, insulin glucagon-like peptide-1 (GLP-1) responses and subjective appetite sensations (hunger, fullness, desire to eat) of healthy subjects, were evaluated. For this purpose, 30% of refined wheat flour (<100 μm) in bread prepared with wheat flour (WB) was substituted with larger particle size wheat d=1.8-2.0 mm (WGB), finely milled chickpea flour (<100 μm) (CFM) and larger particle size chickpea d=1.4-1.8 mm (CLP). WB served as a reference bread, with which all other test breads were compared. Chemical composition analysis was performed in all bread samples. The physicochemical properties (Color, Texture, Surface Porosity, Crumb grain structure, Specific Volume) of the four breads were measured. A randomized controlled crossover clinical trial was conducted, where 15 healthy volunteers (9F/6M, age 23.3±3.6 (SD) years, BMI 21.3±2.3 (SD) kg) participated. They consumed on four different occasions amounts of each bread yielding 50g of available carbohydrates. Venous blood samples were collected before consumption and after 30, 45, 60, 90, 120, 180 min. Subjective appetite ratings were assessed by Visual Analogue Scales (VAS). CLP bread had higher protein and fiber content, followed by CFM and WGB compared to WB. Physicochemical measurements revealed that WGB and CLP had higher crumb hardness, chewiness (p<0.05) and reduced porosity (p<0.05), compared to WB. Lightness (L*) was lower in all samples compared to WB (p<0.05). Postprandial glucose incremental area under the curve (iAUC) was significantly lower for CLP (p<0.05). Insulin responses were similar across all the breads, but GLP-1 iAUC was significantly elevated following CLP ingestion compared to WB (p<0.05). CLP consumption enhanced subjective appetite sensations, by suppressing hunger and desire to eat while increasing fullness postprandially, more effectively compared to WB, as assessed by VAS (p<0.05). These results indicate that incorporating coarse chickpea flour into bread can effectively lower postprandial glycemia and enhance the GLP-1 response. Such formulations may offer promising dietary strategies for glycemic control and appetite regulation.

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PO36. Effects of oat beta-glucans enriched white wheat bread on mildly hypercholesterolemic subjects with overweight/obesity following a hypocaloric dietary plan

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Objective: The study investigates the effect of consumption of white wheat bread enriched with oat beta-glucans on lipid profile as well as other metabolic parameters of mildly hypercholesterolemic adults with overweight/obesity. Methods: Oat beta-glucans enriched white wheat bread was developed by incorporating soluble beta-glucans preparation in bread formulation and the final product contained 2.1g beta-glucans/100g. The metabolic effects of the developed bread were evaluated by a single blind 8-week randomized clinical trial. Forty-one subjects with LDL-C levels 115-170 mg/dL and BMI 25-40 Kg/m^2 were randomly assigned to consume daily 4 slices (=120 g) of either the wheat bread enriched with oat β-glycans (OBG, n=21, 8M/13F) or a common isocaloric white wheat bread (WWB, n=20, 7M/13F) in the context of a mediterranean-style dietary plan, applying a caloric deficit of 500 kcal of their total energy expenditure. Lipid profile, anthropometric and clinical characteristics were evaluated at baseline and at the end of the intervention. Results: In both groups, a statistically significant decrease in body weight, BMI, fat mass, waist and hip circumference was observed (p<0.05). In OBG group there was a significant reduction in diastolic blood pressure while in WWB group there was a reduction in fat free mass (p<0.05). Total cholesterol (TC) and triglycerides' levels were reduced in both groups reaching statistical significance in OBG group (p<0.05 compared to baseline values for both parameters). The OBG group had also a trend towards lower LDL-C (p=0.058) and Apo-B (p=0.069). No significant difference in HDL-C was observed however, ApoA1 was significantly reduced at the end of the intervention (p<0.05). In WWB group, there was a decrease in HDL-C (p<0.05) and ApoA1 (p<0.05). Fasting glucose and triglycerides' concentrations were significantly lower in the OBG group, compared to WWB group at the end of the intervention (p<0.05). Conclusion: The systematic consumption of white wheat bread enriched with oat beta-glucans contributed to higher improvement of metabolic profile compared to that caused by the hypocaloric diet. The incorporation of bakery products with beneficial metabolic effects in a hypocaloric dietary plan of mildly hypercholesterolemic subjects with overweight/obesity could act complementary and enhance the positive effects of weight loss.

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PO37. Brewing yeast disintegration for protein release by horizontal disk milling.

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Background and motivation: Using side streams in food processing can be beneficial from an environmental perspective[1]. An increasing demand for alternative proteins requires an understanding of their functional performance[2]. In this study, we present an approach as how to disintegrate yeast cell from brewing process to access the proteins available in those cells by using a pilot plant ball mill. We study material properties changes of the processed yeast suspensions to evaluate the process and to allow for evaluation of possible effects of the processing on the proteins present in the yeast cells.

Materials and methods: The yeast cell disintegration was carried out on a LabStar horizontal ball mill in up to 6 passages. Passage process was chosen to allow for narrowest residence time distribution and correlating precisely the specific grinding energy with the observed material properties. Yeast suspension samples were taken after the respective passages for characterization. Changes to the yeast suspension structure were studied via rotational rheometry using a concentrical cylinder geometry as well as complementary laser diffraction and dynamic light scattering characterization. Possible changes to the protein structure were studied using differential scanning calorimetry

Results and discussion: Results are shown in the form of shear viscosity curves at shear rate ranging from 10^0 to 10^2 s^{-1}. An increase in shear viscosity with increasing number of passages is observed. A possible explanation is the release of cell components yielding an increase in dispersed particles, droplets and proteins and interaction of the latter. DSC curves covering a temperature range of 0 °C to 90 °C show an endotherm peak at approximately 61 °C. The are of this peak decrease is biggest after the 6^{th} passage which can potentially be linked to the degradation of cell material.

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PO38. Tribological model system testing of glycerol-water solutions as additives for consumer products.

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Background and motivation: Glycerol is used in pharmaceutical, food and personal care industry[1,2]. It is used as a sweetener and to modify food viscosity[1]. It is used a lubricant in oral care and personal care products[2]. In this study, a tribological model system testing approach is introduced to compare tribological system behaviour with the rheological properties of different glycerol-water solutions.

Materials and methods: Water-glycerol solutions with different glycerol concentrations were investigated using a tribological model system setup. A round-on-flat geometry was used. The balls were made from stainless steel and measuring 12.7 mm in diameter. The discs were made from a silicon elastomer and glued to the sample holder using an adhesive. Measurements were carried out in the form of Stribeck curve measurements. New specimen were used for every measurement.

Results and discussion: Coefficient of friction as a function of sliding speed and viscosity-corrected sliding speed (i.e. Stribeck curves) has been shown for multiple glycerol-water ratios that approximately collapse onto a master Stribeck curve. The results from this study suggest that the differences in the tribological behaviour found between the water-glycerol solutions can mainly be explained by differences in shear viscosity.

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PO39. Impact of production technology of bio-based coating emulsion and its application on kraft paper for food-contact packaging

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Coating with bio-based polymers applied to the paper surface can be a viable and environmentally friendly alternative to petroleum-based polymers for packaging applications.[1] This study explores the technical production and potential application of emulsions containing chitosan (Chi), whey protein concentrate (WPC) and candelilla wax (CW) as a bio-based coating material on the kraft paper (40 g/m^2) surface for food packaging. The studied coating emulsions were analyzed in terms of rheological behavior, particle size, zeta potential, polydispersity index and contact angle. In addition, air and water vapor permeability, grease resistance, and mechanical properties of the coated kraft paper were assessed after application in terms of their barrier performance. Once the optimized formulation had been selected through an experimental design, the impact of homogenization by ultra-turrax/ultrasound bath (lab scale) and by high-pressure homogenization (industrial scale) on their intrinsic properties and ability to be applied to the paper surface were compared. The grease KIT test yielded a result of 11/12 for the optimized coated paper versus 2/12 for uncoated, and oil Cobb value showed a ~82 % improvement. The minimum air permeability of the coated paper could reach to 0.9 ± 0.2 ml/min (Bendtsen test) and above 1410 s/100 ml (Gurley test), and the water vapor transfer rate and bursting strength of the optimized coated paper were 39.6 ± 1.4 kg.m^{-1}.s^{-1} and 260 ± 1 kPa, respectively. Overall, the Chi-WPC-CW-based emulsion yielded promising evidence for sustainable packaging development, since the optimized formulation showed high stability and improved the barrier properties when applied on the kraft paper surface.

Keywords: Chitosan, Whey Protein, candelilla wax, coating, paper packaging.

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PO40. On the impact of rapeseed phenolic compounds on the rapeseed protein gelation

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Rapeseed proteins are a promising alternative to animal-based proteins because they are widely produced and can be extracted from existing vegetable oil side-streams. For use in foods, it is important that these proteins can form gels to provide structure. However, co-extracted impurities, such as phenolic compounds may interfere with the protein network disrupting or enhancing it. Rapeseeds contain phenolic compounds in the form of phenolic acids in the kernel and condensed tannins in the hull. Condensed tannins are larger than the phenolic acids and have more ortho-hydroxyl groups, which were shown previously with pea proteins to lead to more interference with protein networks [1]. However, the structure of condensed tannins and phenolic acids varies per crop, which alters their reactivity. Phenolic acids of rapeseeds contain less ortho-hydroxyl groups, and the rapeseed condensed tannins are more linear than the phenolic compounds studied before. Therefore, we aim to clarify what is the impact of rapeseed condensed tannins and phenolic acids on the rapeseed protein gelation. To differentiate their impact on protein gelation, we extracted proteins from whole or dehulled seeds. Additionally, we studied model systems of isolated proteins and phenolic compounds. All mixtures were incubated at pH 7.0 or 9.0 to include oxidation reactions occurring primarily at alkaline pH.

Before gelation of the mixtures, no differences in protein aggregation were observed indicating only weak interactions of the phenolics with the proteins.

After thermal gelation of the dispersions, the protein extracts from whole seeds incubated at pH 7.0 resulted in gels with a slightly higher elastic modulus than the dehulled seed extracts. The stronger gels could be caused by co-extracted condensed tannins from the hulls. However, the gel-strengthening effect of the hull phenolic compounds was not observed in the model systems. So, co-extraction of condensed tannins with the proteins yields stronger gels than when these phenolic compounds are added to the protein extracts later in the model systems.

The incubation at pH 9.0 showed that phenolic compounds from rapeseeds can make protein networks with a slightly more elastic network when exposed to prolonged alkaline conditions.

Our findings demonstrate that rapeseed phenolic acids and condensed tannins affect the gelation of rapeseed proteins albeit faintly and differently. Therefore, dehulling or not dehulling the seeds can be an effective strategy to obtain protein extracts with finetuned functional properties.

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PO41. Food derived protein amyloid-like fibrils and their characterization

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The increasing interest in novel, more nutritious and more sustainable food consumption leads to the pursuit of new approaches to incorporate alternative proteins into the human diet more efficiently. Food-derived protein amyloid-like fibrils (PAFs) are rod-shape fibrous aggregates that formed under acidic conditions and high temperatures in prolonged processing times (Xu et al., 2023).Among the other applications, PAFs can be incorporated into emulsions to increase the stability due to their long length, flexibility and high hydrophobicity, depending on the protein type [2]. In this study, PAFs were produced from different protein sources – i.e., potato, green lentils, pea, spirulina and whey proteins – applying heating treatments at 90 ºC with a heating time of up to 10 hours. Their formation was evaluated through fluorescence microscopy, fluorescence intensity by ThT fluorescence assay, and changes in protein structure were followed through circular dichroism. The structure of PAFs were evaluated through transmission electron microscopy (TEM). Fluorescence intensity evaluation confirmed that the prolonged heating time showed increased fibril formation for whey, pea, and potato protein. Additionally, TEM analysis confirmed the formation of nanofibrils after 2h heating time. Thus, it was possible to produce protein nanofibrils using different sources of vegetable proteins. This study shows that, depending on the protein source, methodological aspects of fibril formation need to be carefully designed in accordance with the observed structural transitions.

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PO42. Chitosan active coatings incorporating cloisite for improved PLA packaging film

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One of the strategies to overcome the drawbacks of biobased and biodegradable PLA packaging film is the deposition of thin hydrocolloid-based coatings. Indeed, hydrogel coatings can either reduce mass transfer through the films or serve as a support for bioactive molecules[1]. The application of chitosan-based coating containing allyl isothiocyanate (AITC) as active agent, on PLA films, is one of the efficient active releasing systems for food application[2].

The aim of this work is to understand how active chitosan coatings could affect the functional properties of PLA films. PLA films were previously prepared by cast extrusion process and corona treated. Chitosan coating solutions containing or not AITC were firstly prepared. The cloisite 30B was then dispersed in the coating solution. Coating-forming dispersions were then casted onto PLA film, using bar coating technique and dried (24h, 25°C, 50% RH).

The barrier and structural properties were determined as well as the release behavior of AITC from coating layer to food simulants. The incorporated Cloisite-Na+ and or AITC into chitosan network decreased the oxygen permeability by more than 9 times compared to neat PLA films. The presence of Cloisite-Na+ increases the tortuosity of the diffusion path for oxygen molecules within the chitosan layer. The water vapor permeability of coated film was not degraded by the hydrophilic character of the hydrocolloid layer. FTIR spectra revealed intermolecular interactions between AITC, chitosan and cloisite. The diffusion coefficient of AITC in the chitosan layer without Cloisite-Na+ was almost 10000 times higher than that of film containing the Cloisite-Na+ at 10%. In conclusion, active coating based on chitosan can offer a good way to improve barrier and functional properties of commercial PLA films.

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PO43. Tannia starch: functional and structural characterisation

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Tannia (*Xanthosoma sagittifolium*) is an underutilised tropical tuber crop with significant potential as a sustainable source of starch for food and industrial applications. This study presents a comprehensive characterisation of tannia starch, focusing on material preparation before and after extraction. The extraction process employed a combination of mechanical and physicochemical methods designed to preserve the starch's native properties while ensuring minimal structural alteration. A series of analytical techniques, including light and polarised microscopy, particle size analysis, differential scanning calorimetry (DSC), SEM, FTIR and amylose content determination, were employed to investigate the starch's structural, thermal, and compositional attributes. Pasting properties were also examined, where the extracted starch displayed a peak viscosity of 2573 cP, a moderate setback viscosity of 1170 cP, and a pasting temperature of 70 °C, indicating a unique balance between thermal stability and retrogradation tendency. Microscopic analysis revealed well-defined granule morphology with an average particle size of 3 μm. DSC highlighted a gelatinisation temperature greater than that of other traditional tuber starches (T_m ~ 83 °C, ΔH ~ 14 J/g solids for heated 30% w/w aqueous dispersions) such as potato (T_m ~ 63 °C) and tapioca (Tm ~ 67 °C); a minor second order-like transition before crystallite melting also occurred, indicative of the glass transition of the amorphous material of granular starch. These attributes underscore tannia starch's potential as a versatile and sustainable alternative for applications in food systems and beyond, particularly in regions with limited resources or specialised functional requirements.

PO44. Induction of whey protein fibrillar structures through high-temperature ohmic heating

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Whey protein amyloid fibrils (WAFs) when formed under acidic heating conditions demonstrate improved functionalities, such as increased viscosity, superior foaming ability, and enhanced emulsifying activity[1]. The structural arrangement and functional characteristics of WAFs can be influenced by a range of physical and chemical factors, including the method of heating. There remains a significant knowledge gap regarding how the effects of ohmic heating influence the functional and structural properties of proteins when applied at ultra-high temperatures (UHT). Ohmic heating, characterized by its volumetric heating mechanism and the presence of moderate electric fields (MEF), has the potential to alter the dynamic and structural behavior of whey proteins, affecting the formation of advanced structures such as WAFs[2]. This study aims to systematically explore the effects of ohmic heating at UHT on the structural properties of whey protein.

Experimental treatments were conducted within a temperature range of 50 °C to 165 °C, allowing for a comprehensive analysis of structural transitions. Parameters assessed included intrinsic fluorescence, surface hydrophobicity, secondary structure distribution, hydrolysis rates, and the formation of fibrillar aggregates. The key findings revealed the following: (i) exposure of hydrophobic core occurred between 90 and 120 °C; (ii) an increased hydrolysis rate and the appearance of unordered structures were observed from 130 to 165 °C; and (iii) fibrillar aggregates achieved a maximum yield between 95 and 110 °C. This study brings a novel perspective on UHT ohmic heating drives structural modifications in whey protein, offering a novel approach to hydrocolloid functionality enhancement. As an emerging food processing technology, ohmic heating demonstrates considerable potential for advancing protein ingredient design and expanding its applications in functional food systems.

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PO45. Plant Proteins and Their Non-Protein Components: Understanding Their Interplay with Different Starch Types during Hydrothermal Processing

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The transition from animal-based proteins to plant-based alternatives is essential to address environmental concerns and promote more sustainable food systems. However, when incorporated into carbohydrate-based foods, plant proteins may compete for the available water and alter the phase transitions of the involved biopolymers, affecting network formation and technological properties of derived foods. This study investigates the interplay between plant proteins and starch, key biopolymer in the human diet, during hydrothermal processing, aiming to provide insights about the mechanisms of such interactions for designing plant-based systems with enhanced functionality. Protein concentrates (50-53% protein) from sunflower, a by-product of oilseed extraction, and from lupin, a protein-rich legume with high fibre content, along with their purified protein isolates (80-90% protein), were used, possessing different native states and 11S/7S subunit ratios, with sunflower protein predominantly consisting of 11S and lupin containing both globulins, but with a higher proportion of 7S subunits. The proteins were extensively characterized in terms of molecular weight, globulin/albumin fractions, secondary structure, gelation and thermal properties, solubility and surface charge to establish structure-function relationships. To explore protein-starch interactions, wheat and potato starches were chosen due to their different molecular architectures and swelling kinetics. Protein-starch mixes were processed under high moisture, high temperature and low shear conditions with a 25% protein addition to the starch-based matrix. The resulting gel matrices were characterized in terms of microstructure, oscillatory rheology, retrogradation propensity, and water distribution (LF-NMR). Differences in network formation were observed in the mixed matrices depending on the protein source and its purity. Interestingly, protein isolates delayed starch swelling during early stage of hydrothermal processing, probably due to water competition needed for protein denaturation. Microstructural results showed phase separation and protein-rich domains in mixes with sunflower, likely due to the higher proportion of gel-forming 11S globulins, which hinder dispersion in the starch matrix because of their hydrophobic nature and disulfide bonds, in contrast to lupin's 7S globulins, more hydrophilic and with a more homogeneous distribution. Interestingly, all protein ingredients reduced the extent of starch retrogradation, likely due to spatial restriction and increased water-holding capacity, which may hinder cross-linking of starch molecules and moisture redistribution within the gel. Moreover, lupin protein, especially its concentrate due to the presence of fiber, was particularly effective in reducing free water and increasing weakly bound water within the mixed systems. Rheological analyses suggested that starch-starch interactions were the primary drivers of storage modulus (G') development, as shown by the higher G' of the starch control with the same solids content as the protein-starch mixes. However, protein-starch mixes exhibited different rheological behaviors based on the starch source. In potato starch mixes, lupin addition led to a higher G' than sunflower, whereas in wheat starch mixes, sunflower addition resulted in a higher G' than lupin proteins, regardless of its purity. All protein mixes increased tan(δ) compared to the control, resulting in a weaker viscoelastic gel. These results underscore the importance of considering the interplay of various interactions, including protein-protein, protein-starch, starch-water, and protein-water, which influence gel viscoelastic behavior. These findings advance the understanding of biopolymer interactions influencing food structuring during hydrothermal cooking and highlight the importance of protein intrinsic characteristics for optimizing the incorporation of sustainable plant proteins in food applications.

PO46. Enhancing Technological and Nutritional Value of Pea Protein Concentrate through Subcritical Water Hydrolysis

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The global demand for protein is projected to steadily increase in the coming years, driven by the growing world population and the shifts in food production and consumer diets. To address the current animal protein overconsumption and meet the sustainability demand, it is paramount to boost the production of high-quality, functional, and sustainable plant protein ingredients. Pea, *Pisum sativum*, is one of the main legume crops utilized to provide protein-rich ingredients in the plant-based food market. Pea protein concentrates are usually obtained through dry fractionation procedures, which involves preservation of the native protein structure at relatively high purity (~50% protein). However, dry fractionation also preserves high amount of non-protein components and antinutritional factors, which can impair protein functionality and nutritional value. In this work, pea protein concentrate (PPC) was hydrothermally treated by subcritical water to obtain enriched pea protein fractions with improved technological and nutritional characteristics. To achieve this, PPC was solubilized at 10% (w/w) water with and without 0.4 M NaCl addition prior subcritical treatment. Then, subcritical hydrolysis was conducted at 170 bar for 4 s at two different water temperatures, 200 ºC (T1) and 340 ºC (T2). After the treatment, the treated PPCs was also fractionated to evaluate the ratio and composition of soluble and insoluble fractions and the whole, soluble and insoluble fractions were further dried for analyses. In the protein concentrates, protein composition, structure and functionality were evaluated in terms of globulin/albumin composition (SDS-PAGE), molecular weight and aggregation (HPLC-MALS), degree of denaturation and stability (DSC, TGA), solubility and charge (Z-potential), foaming and gelation ability. Furthermore, the presence of phytic acid, antinutritional factor with high thermal resistance, and the release of free amino acids were analyzed to assess the effects of hydrolysis. Results indicated that protein denaturation occurred in all treatments, albeit the short exposure time. Meanwhile, water binding capacity and gelation of the ingredients were generally improved, especially in the insoluble fraction at low-temperature conditions (T1>T2) and salt-free treatments. Conversely, protein solubility improved under high-temperature conditions (T2>T1), with the greatest improvement observed in the presence of salt, although the increase was also observed without salt addition. This suggests that the partial hydrolysis of the fibre fraction also promoted the solubility of the protein within the matrix. Interestingly, subcritical water also increased the foaming ability of the treated PPC, although the long-term stability of the foams was reduced. Regarding phytic acid, it was primarily found in the soluble fraction, and its levels decreased during high-T2 treatments, indicating phytic acid (inositol hexaphosphate) was hydrolyzed under the most severe subcritical water treatments. As for free amino acids, the presence of salt at T1 promoted the release of amino acids, suggesting partial protein hydrolysis. At T2, free amino acid decreased in salt-free and salt containing conditions, likely due to thermal degradation and secondary reactions with other matrix components (i.e., Maillard). Therefore, results suggest that treating PPC with subcritical water influenced its technological and nutritional value based on treatment temperature and salt addition, increasing the offer of available plant-protein ingredients in the market for targeted food applications and functionalities.

PO47. Hemicellulose and xylooligosaccharides from olive stones: an innovative source for food applications

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Hemicellulose (HC), the second most abundant renewable component of lignocellulosic biomass, is recently gaining attention for its functional and technological properties, as well as for its potential as a source of prebiotic xylooligosaccharides (XOS), both promising features for food applications[1,2]. Among lignocellulosic biomasses, olive stones (OS) separated during the production of EVOO represent a rich but underexplored source of hemicellulose, comprising 20–30 wt% of their composition[3]. In this context, OS are an underutilized by-product, contributing to an annual waste generation of 4.1 to 5 million tons in the olive industry[4]. The extraction of HC from OS might represent a promising approach for valorizing this by-product, thus improving biomass utilization efficiency[5]. Based on these considerations, this study investigates OS as a novel source of HC, leveraging agro-industrial residues to obtain high-value ingredients. HC was extracted from olive stone powder (OSP), previously obtained from the drying, milling, and sieving of OS from a local oil milling facility. The extraction process involved alkaline treatment of OSP with NaOH, followed by acidification with HCl, and purification of the resulting HC via ethanol precipitation. The obtained HC was characterized for its chemical and physicochemical properties and then subjected to acid hydrolysis with HCl to produce XOS. Both HC and XOS were *in vitro* fermented with simulated human gut microbiota. Complete hydrolysis into neutral sugars showed that the main components of HC were xylose (94.8% w/w), glucuronic acid (4.4% w/w), and arabinose (1.1% w/w). In contrast, XOS were primarily composed of xylose (87.1% w/w), glucuronic acid (10.8% w/w), arabinose (3.0% w/w), along with smaller amounts of galactose (1.3% w/w) and rhamnose (0.6% w/w). Physicochemical characterization demonstrated that, despite HC exhibiting limited emulsifying and thickening capacities, emulsions prepared with different concentrations of XOS were stable over time. *In vitro* fermentation of HC and XOS resulted in significant short-chain fatty acid (SCFA) production, with acetic, propionic, and butyric acids predominantly derived from HC and formic, acetic, and propionic acids from XOS. These results highlight the potential of HC and XOS derived from OS as a multifunctional hydrocolloid and prebiotic source. This innovative strategy underscores its relevance for the food industry and the valorization of agricultural residues, aligning with sustainability and circular economy principles.

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PO48. Discovering novel emulsion-based functional foods: Use of black fig pectic compounds with grape seed polyphenols

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Aim:

Pectin is a universal food hydrocolloid with many uses including thickening, gelling, and emulsifying agent. Depending on the source, functional properties of pectin vary extensively. For instance, sugar beet pectin, shows unique emulsifying properties attributed to its high protein and ferulic acid contents which improve its surface-active properties.

In this study novel pectic material extracted from a newly cultured dark coloured fig species was characterized for its emulsifying properties. Moreover, effects of a basic phenolic extract on antioxidant capacity and stability of emulsions prepared by pectic compounds were investigated. The aim of this study is to test the emulsification properties of novel pectic materials and to determine effects of flavonoid rich grape seed extract (GSE) on stability and antioxidant capacity of obtained emulsions.

Method:

The pectic material is extracted from figs by hot acidic extraction method with citric acid and characterized in terms of its galacturonic acid content, esterification degree, total phenolic content, and sugar composition. Emulsions were prepared with 0.5% (w/v) fig pectin (FP) or citrus pectin (CP) with/without 0.5% (w/v) GSE. Emulsion stabilities were evaluated at high oil content environments (50%, v/v) for 14 days at 25°C together with particle size, zeta potential and apparent viscosity. Additionally, the antioxidant activity and total phenolic content of emulsions were evaluated during storage.

Results:

The obtained pectic material's galacturonic acid content (35%) was expectedly lower than CP (~75%). The homogalacturonan (HG) and rhamnogalacturonan-I (RG-I) content of pectic substances were calculated from the major sugar composition. The HG/RG-I ratio for FP (3.8) was similar to CP (4.4). Stability of emulsions for 0.5% FP were comparable with that of 0.5% CP during 14 days. The emulsion stability increased by 13% with the addition of 0.5% GSE. The droplet size decreased 55.9% with GSE while zeta potential remained unchanged. The antioxidant activity of FP emulsion with GSE increased 40-fold.

Conclusion:

Novel pectic materials from a newly cultured dark coloured fig cultivar showed a high emulsion stabilizing activity that could be improved in the presence of antioxidant grape seed polyphenols. Results are promising to develop novel emulsion-based functional foods.

PO49. Transformation of Microcrystalline Cellulose into Functional Pickering Particles via Deep Eutectic Solvent and Ultra-High-Pressure Homogenization

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Nanocelluloses are nanosized features of crystalline or fibrillar form that exert interesting intrinsic properties such as high surface area, crystallinity, wettability, and mechanical strength. Owing to their nanoscale size and good wettability, nanocelluloses can also be applied as solid interface stabilizing agents known as Pickering particles. Green chemistry-inspired solvents such as deep eutectic solvents (DES) have gained a lot of ground against organic solvents as they are inexpensive, low vapor pressure, non-flammable, chemically stable, recyclable, biodegradable, and toxicologically well-characterized. High-pressure-homogenization is a common physical process used to breakdown the cellulose structure but a process pressure above 1500 bar is rarely found in previous studies. Therefore, this work aimed to explore the potential of combined DES – ultra-high-pressure homogenization (UHPH) for transforming microcrystalline cellulose (MCC) into Pickering particles for food, nutraceutical, and drug delivery applications.

Based on preliminary results, choline chloride (ChCl) mixed with glycerol, urea, malic acid, oxalic acid, and formic acid, at a molar ratio of 1:2, 1:2, 1:2, 1:1, 1:2, respectively, were chosen for DES pretreatments, which were conducted at 90°C for 1h. Then, cellulose samples were washed by Milli-Q water three times and dialyzed for 48 hours to remove any residual DES matter. In the UHPH step, a pressure of 2500bar was applied, and all the cellulose suspensions (0.5 % w/w) were processed for a total of 20 cycles while aliquots were collected at 5, 10, and 15 cycles. The morphological changes in cellulose during UHPH were monitored through dynamic light scattering (DLS) and optical microscopy. The 20-fold UHPH processed nanocelluloses were further investigated through scanning electron microscopy, atomic force microscopy, Fourier transform infrared spectroscopy (FTIR), and X-ray diffraction. Their steady state flow behavior and dynamic rheological properties were also tested. Moreover, we assessed the ability of the obtained nanocellulose samples to stabilize o/w Pickering emulsions.

DLS and microscopic assessments demonstrated a significant decrease in cellulose particle size with an increasing number of processing cycles. The ChCl-glycerol and ChCl-urea groups exhibited thinner cellulose fibers compared to the other groups, indicating their high cellulose-swelling efficiency during pretreatment. After the deep eutectic solvent (DES) pretreatments, the crystallinity of cellulose increased, which might be related to the reduction of the amorphous regions. However, after UHPH, the crystallinity decreased, as the high pressure effectively disrupted the crystalline regions of cellulose. In addition, we found that cellulose suspensions in the ChCl-glycerol, ChCl-urea, and ChCl-formic acid groups were more viscous, with rheological behavior resembling cellulose nanofibrils. In contrast, the other two groups exhibited behavior closer to cellulose nanocrystals, likely due to organic acid hydrolysis resulting in shorter cellulose particles. In the emulsion case study, all cellulose samples with DES pretreatments and $\geq$ 10 cycles, showed an excellent performance in stabilizing emulsions, as no phase separation was observed after two months of storage at ambient temperature. Thus, we conclude that the combination of DES and UHPH is an efficient strategy to produce nanocellulose Pickering particles.

PO50. Enhancing the aqueous extraction of sunflower seed proteins by addition of NaCl or ultrasound treatment

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Valorizing food processing side streams (by-products of lower value) that still contain essential macro- and micronutrients is a promising way to enhance a sustainable food system. In particular, the demand for plant protein continues to grow, pushed by the need to contribute to a healthy environment. Oilseeds represent thereby a potential sustainable protein source.

This study evaluated a gentle fractionation of two press cakes obtained from cold pressing of either dehulled (protein-rich) or whole (fiber-rich) sunflower seeds to investigate the aqueous extraction of the proteins. It was proposed that the addition of NaCl or ultrasound treatments improve the extraction of proteins under native or alkaline conditions.

For the two matrices, aqueous dispersions with 5 g/L protein were prepared. The protein solubility was determined as a function of the pH (2-12) and after adding 1 M NaCl or the application of ultrasound. The soluble fractions were evaluated using SDS-PAGE.

By extraction in water, it was observed that proteins in both dehulled and whole press cakes exhibited relatively low solubility (13 and 22%, respectively) at their native pH (6.6 and 6.2 respectively), while at pH 11-12, they exhibited the maximum solubility (81 and 88%).

The addition of 1 M NaCl significantly increased the protein solubility at native pH to about 85% for both press cakes, while at pH 11, there was only a minor increase in solubility for dehulled press cake (92%) and no effect in the case of the whole cake. In contrast, ultrasound performed better at alkaline pH, resulting in protein solubility greater than 92%.

SDS-PAGE showed that sunflower albumins were soluble in acidic conditions, whereas helianthinin (family of globulins) were more soluble in neutral or alkaline media, which was similar for both tested press cakes.

This research provides fundamental knowledge about the behavior of soluble sunflower protein after different treatments, that is critical for developing innovative food ingredients. Future investigations will include enzymatic and mechanical treatments to improve protein extraction, besides their effects on protein quality and functionality.

PO51. Molecular Interactions and Gelation Dynamics in Alginate-Protein Bioinks: Towards Plant-Based Alternatives

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Alginate-protein composite gels are versatile materials widely used in food technology and biomedicine. Particularly, in 3D-bioprinting mixtures of alginate and gelatin are heavily used as scaffolds for cultured meat and organ models. Animal-derived gelatin provides critical functionalities in alginate-based bioink systems, such as providing cell adhesion motifs and enhancing the printability as well as elasticity of the bioink. Replacing gelatin with a plant-based protein presents significant challenges due to fundamental differences in their molecular interactions and phase behaviour with alginate. Therefore, this study investigates how the adverse protein characteristics of gelatin and pea protein effect the gelation behaviour of alginate and aims to gain a deeper understanding of the structure formation in alginate-protein composite gels. To do so, the molecular interactions between alginate and protein (gelatin or pea protein) were analysed in dilute solutions at pH 7 using zeta potential, viscometry, and turbidity measurements. Subsequently, oscillatory rheology time sweeps were conducted to characterise the effect of the proteins on the alginate gelation in concentrated systems. Two gelation approaches were applied: a slow internal gelation method using Ca-EDTA and D-glucono-δ-lactone, and a fast gelation method using insoluble calcium sulphate and a static mixer.

In dilute solutions, alginate and gelatin exhibited attractive interactions mainly driven by electrostatic forces.[1] In concentrated systems, the gelation of gelatin induced phase separation, accelerating alginate gelation compared to pure alginate gels. However, when gelatin remained ungelled (40 °C), it delayed the alginate gelation.[2] Conversely, alginate-pea protein mixtures exhibited electrostatic repulsion at pH 7, causing phase separation in dilute systems. The high viscosity in concentrated systems, prevented macroscopic phase separation, but the pea protein significantly delayed alginate gelation, similar to ungelled gelatin. Both proteins demonstrated antagonistic effects on the gel strength, with pea protein causing a more pronounced reduction. This might be attributed to the reduced ability of pea protein to contribute to the gel by forming a gel network itself, unlike gelled gelatin.

These findings highlight the challenges of substituting gelatin with plant-based proteins in alginate-based bioinks for 3D-bioprinting. To overcome the adverse effects of pea protein, higher alginate contents might be necessary, potentially comprising cell viability due to increased shear stress within the printing nozzle. Future studies should therefore investigate the impact of high viscosities, the behaviour of the bioinks under shear as well as the gel recovery to optimise plant-based alginate-protein bioinks for 3D-bioprinting applications.

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PO52. Towards tailoring the viscoelasticity of liquid-liquid interfaces in emulsions: understanding phospholipid-protein interactions at the oil-water interface

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Proteins such as β-lactoglobulin (β -LG) form strong and highly viscoelastic networks on the interface. The high molecular weight often results in a low diffusion rate within the emulsification step and, consequently, large oil droplet sizes in emulsions.

Phospholipids, which can carry either a positive or a negative charge depending on the system's pH, may be added to promote faster interfacial stabilisation. This is assuming they do not hinder the protein from adsorbing and interacting at the interface, as this would reduce the interfacial viscoelasticity.

While it is generally assumed that the co-existence of protein and PL can only be achieved if the PL concentration is low enough, it has been reported that some PL may interact with the protein, hindering the protein from desorbing even when the PL concentration is relatively high. The PL's molecular structure seems to impact the resulting interfacial structure and composition, which is yet not fully understood. In addition, the pH will affect the PL's headgroup charge, possibly impacting protein-PL interactions.

This study aimed to analyse the effects of the molecular structure of PL on the interaction with β-LG at the oil-water interface, taking the system's pH into account. PL with varying headgroups (choline PC, ethanolamine PE) and fatty acid chain (FA; C18:0, C18:1) were used. The interfacial rheological properties at various pHs were investigated within and outside the linear viscoelastic regime via dilatational and interfacial shear rheological measurements. Possible β-LG + PL interactions were tested via FTIR measurements.

In the case of β-LG + saturated PL, an increase in the storage modulus was measured, while the interface behaved predominately viscous in the case of β-LG + unsaturated PL. It is, thus, assumed that the unsaturated PL (at least partly) displaced the protein from the interface and or interfered with interfacial protein-protein interactions, weakening the interfacial protein network.

The saturated PL, on the other hand, co-exist with β-LG, allowing β-LG + PL interactions to occur. In dilatation and shear rheology, the PE 18:0 + β-LG (small headgroup, saturated FA) initially showed the stiffest interface, possibly due to the formation of a PE:18:0 sublayer at the interface. The storage modulus increased further with decreasing pH due to attractive interactions between β-LG and PL's charged headgroup.

PO53. The formation mechanism and applications of α-La@cAMP hydrogel

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Functionalized protein hydrogels, characterized by their excellent biocompatibility, biodegradability, and low toxicity, have demonstrated significant advantages in the fields of tissue engineering, drug delivery, and wound dressing. Cyclic adenosine monophosphate (cAMP), a crucial "second messenger" within cells, is involved in a variety of physiological processes, including cell differentiation, proliferation, apoptosis, metabolic regulation, neural signal transduction, and immune modulation. In this study, α-lactalbumin was mixed with the small molecule cAMP, and a transparent hydrogel was formed under heating conditions. Transmission electron microscopy (TEM) observations revealed that during gel formation, proteins aggregated into worm-like fibers, indicating that the formation of the hydrogel network is closely related to protein aggregation. ThT fluorescence experiments showed that the gel formation reached a plateau within 2 hours, revealing the rapid formation characteristics of the hydrogel network. ANS fluorescence probe experiments found that as the hydrogel forms, the hydrophobicity of the protein surface increases, indicating that conformational changes in the protein during gel formation expose hydrophobic groups, thereby promoting the formation of the protein hydrogel. ITC experimental results indicated that there is a strong interaction between the protein and the small molecule, with the binding process being driven by both enthalpy and entropy changes. The negative ΔH value and positive ΔS value suggest that the binding process is exothermic and entropy-increasing, further confirming that hydrophobic interactions play a key role in hydrogel formation. Meanwhile, leveraging the hydrogel's high surface hydrophobicity can significantly enhance the water solubility of the hydrophobic small molecule curcumin. This study lays the theoretical foundation for the design and development of new functional hydrogels and provides new ideas for the development of novel biomaterials and drug delivery systems.

PO54. The impact of deposition architecture in enhancing the barrier properties of polylactic acid films

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Creating innovative structures to enhance the barrier and functional properties of bioplastics is one of the most pressing challenges today. Bioplastics have been identified as a promising alternative to petroleum-based materials; however, their inherently low barrier properties remain a significant limitation for applications such as food packaging.

To address this issue, various deposition techniques have been explored, and alternative biopolymers are being investigated to develop solutions suitable for industrial applications. In this study, polylactic acid (PLA) film was used as a substrate model due to its low barrier properties. Two distinct deposition techniques—dip-coating and ultrasonic spray coating—were applied to create a multilayer system incorporating natural compounds, specifically chitosan and cellulose nanocrystals.

The architecture of the deposited compounds during the fabrication process played a crucial role in modifying PLA's permeability to gases (oxygen and carbon dioxide), water vapor permeability, as well as its thermal and mechanical properties. Interestingly, it was observed that the concentration of each compound (chitosan and cellulose nanocrystals) during the deposition process was not the decisive factor in altering PLA's barrier properties. Instead, the organization of the compounds during deposition was revealed to have a significant impact on surface morphology and layer properties. The molecular packing mode strongly influenced the permeability behavior of PLA, promoting optimal crystallization conditions that favor the formation of more impermeable structures.

Different techniques, including FTIR, SEM, AFM, contact angle measurements, colorimetry, XRD, DSC, TGA, and mechanical testing, were employed to evaluate the impact of the deposition process on the multilayer system's properties. This work contributes to the development of highly efficient, alternative, and economically viable biobased packaging materials by identifying the impact of molecular organization on the formation of different multilayer systems, which result in varying permeability performances of the material.

PO55. Formation of Heat-Induced Pressed Gels from Canola Press Cakes: Influence of Starting Materials, Stirring Conditions, and Carbohydrase Pretreatment

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Alternative plant protein sources provide promising solutions to address food insecurity and sustainability challenges. Inspired by soy tofu production method, pressed gels could be introduced as a robust and versatile approach to developing protein-rich plant-based products. This study explored the production of heat-induced pressed gels from canola cold-pressed cakes (CPC) and hot-pressed cakes (HPC) under different stirring conditions. Gels made from CPC exhibited higher yield and protein recovery compared to those from HPC. While carbohydrase pretreatment did not enhance yield or protein recovery, stirring during heating significantly improved protein recovery, reaching up to 38.3%. Additionally, stirring influenced textural properties by regulating aggregate size and compactness. The stabilization of pressed gels was attributed to a combination of hydrogen bonding, hydrophobic interactions, and disulfide bonds. Compared to canola press cake, the pressed gels contained lower levels of glucosinolates and phenolic compounds but higher amounts of phytic acid. A formation mechanism was proposed based on a nucleation-growth model, suggesting a shift from diffusion-limited processes in non-stirred gels to reaction-limited processes in stirred gels. Overall, this study highlights the potential of canola heat-induced pressed gels both as a functional food product and as a microstructured protein ingredient.

PO56. Opportunity of pulsed electric fields technology (PEF) to fabricate dysphagia friendly chickpea flour-based gels

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The ability of chickpea (Cicer arietinum) flour slurry (10% w/w) in forming dysphagia friendly gel under the influence of pulsed electric field (PEF) technology applied at 1-2 kV/cm electric field strengths and 410-500 kJ/kg specific energies was investigated in this study. Results showed that PEF treatment of chickpea slurry with specific energies above 410 kJ/kg was necessary to form soft gels after overnight cooling (24 h, 4°C). Hardness and rheological properties such as storage modulus and yield stress of the gel further increased with energy applied (from 0.35±0.01 to 2.94±0.19 kPa, from 195±42 to 2350±466 Pa and from 15.7±5.6 to 423.4±135.2 Pa, respectively), but the tested electric field showed no significant impact on gel characteristics. Notably, gels formed after higher field strengths application exhibited increased readily digestible starch (from 16.28±0.15 to 89.06±1.78 %) and a faster intestinal protein digestion rate (from 1.16±0.20 $\cdot 10^{-2}$ to 1.65±0.04 $\cdot 10^{-2}$ min^{-1}) during simulated gastrointestinal digestion. Findings from FTIR, DSC and light microscopy collectively revealed that gel formation was mainly attributed to starch gelatinization caused by a temperature increase due to Joule effect during PEF, while protein denaturation and aggregation became prominent in chickpea slurries after PEF-treated above 450 kJ/kg, resulting in a more solid-like gel formation. Overall, PEF technology has proven to be an effective and rapid method (44.4-227.4 ms) for producing chickpea gels with varying textural and rheological consistencies from a single ingredient, which can be particularly applicable for patients with different degrees of dysphagia, as highlighted by the wide range of IDDSI (International Dysphagia Diet Standardization Initiative) classification levels achieved with chickpea gels formed after PEF pre-treatment.

PO57. Insights into the impact of rice husk microfibrillar cellulose on the viscoelastic and thermomechanical properties of model ice cream mixes

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Improving the food industry sustainability has focused international research on the valorization of agricultural by-products, a significant portion of which are lignocellulosic materials. Microfibrillar celluloses are isolated cellulosic materials extracted from lignocellulosic sources mainly by mechanical treatment, such as high-pressure homogenization. Due to their high aspect ratio, wettability and capability to form entangled three-dimensional networks were investigated as fat substitutes, viscosity enhancers, and emulsifier agents in ice cream. However, a deep investigation into these products viscoelastic and thermomechanical properties is still missing. Therefore, this study aims to apply traditional and innovative thermo-mechanical tests to assess whether microfibrillar cellulose from agricultural by-products can successfully replicate the functional rheological properties granted by traditional gums in ice cream mixes.

For this study, several model ice cream mixes, formulated with microfibrillar cellulose derived from rice husk at concentrations of 0.2, 0.1, and 0.05%, and with xanthan gum (XG), guar gum (GG), and locust bean gum (LBG), at a concentration of 0.2%, has been produced. A comprehensive rheological characterization of the mixes was conducted using frequency sweep and steady shear viscosity tests.

Innovative analytical approaches not commonly applied in food rheology were explored. Time-temperature superposition was conducted to assess changes in dynamic rheological properties over temperature changes, including those involved in phase transitions, such as the glass transition and melting temperatures. Furthermore, LAOS tests were performed to propose a novel methodology for evaluating the rheological behavior of ice cream mixes subjected to high deformations, taking into consideration the mechanical stresses encountered during production (at the inlet temperature of the scraped surface freezer) and consumption (at serving temperature).

Frequency sweep test confirm the similarities between the gums and cellulose microfiber mixes. The storage moduli and the complex viscosity (G' and η* respectively) in the linear visco-elastic region (LVE) resulting from the different formulations containing gums were comparable with the 0.1 and 0.05% microfibrillar cellulose mixes. The formulations with gums and cellulose microfibers were compared through the Lissajous curves extracted from the LAOS tests, which represent a fingerprint of the viscous and elastic behaviors of a material. Similarities between the curves obtained from the GG, LBG, and 0.5% cellulosic formulations were found, while the mixes with XG showed elastic and viscous behavior between the 0.1 and 0.05% cellulosic formulations. These results suggest the feasibility of using cellulose microfibers as a thickening agent in ice cream production. From η* curves extracted at each temperature, a master curve was developed using the Arrhenius and the Williams-Landel-Ferry (WLF) models based on their applicability in describing the distinct kinetics behaviors associated with each phase transition, which can be used to predict the mechanical properties of the formulations at all the temperature included in the applied range.

PO58. The use of polysaccharides in food applications: unveiling the potentials and limitations

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Polysaccharides, bio-sourced polymers with desirable attributes such as biodegradability, non-toxicity, and film-forming ability, emerged as promising candidates for use in the food industry. In the present study, 9 polysaccharides from different natural sources (Hydroxypropyl methylcellulose (HPMC), Methylcellulose (MC), Hydroxypropyl cellulose (HPC), Low-methoxyl pectin (LMP), Sodium alginate (SA), Kappa-Carrageenan (KC), Chitosan (CHI), Pullulan (PUL) and Cationic starch (CS)) were investigated. These polymers were subjected to different characterizations including their rheological properties, barrier properties against oxygen, water vapor and light, mechanical properties, as well as stability upon storage. The findings indicate that, HPMC, MC and CHI exhibited high viscosity compared to the other tested polymer solutions. Except for cellulose derivatives (HPMC, MC, and HPC), 6 other biopolymers exhibit good oxygen barriers compared to conventional plastics. However, all of them display sensitivity to water vapor. The 12-month aging test revealed that the barrier properties of all tested polymers remained stable. In terms of mechanical properties, cellulose derivatives were able to form flexible films with lower Young's modulus and higher elongation than the others. Regarding the light barrier properties, all tested polysaccharides showed good transparency. Especially, LMP exceptionally blocked 98 % of UV light through its film. These characteristics suggest a significant potential for these polymers to serve as food additives and alternative food packaging materials.

Keywords: *Food additives, biodegradable polysaccharides, barrier properties, film aging*

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PO59. NextFoodPack project: Integrated design and evaluation of new-generation packaging to protect perishable food products

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The ambitious goal of France's anti-waste law No. 2020-105 is to drastically reduce the use of single use plastics by 2040. While this target can be met for rigid plastic packaging through mechanical recycling, this recycling method is not yet sufficiently mature for flexible plastic packaging, which accounts for 45 % of all food packaging. In this case, the only way to achieve a reduction is to replace flexible plastic films with more sustainable solutions, such as paper-based materials, monomaterial films, and bio-based compostable blends.In addition, the new European Packaging Packaging Waste Regulation (PPWR), adopted on April 24, 2024, sets a target of 55% packaging recycling rate by 2030. A key sector is modified atmosphere packaging (MAP) for perishable foods, such as meat and cheese, which represents a $15.9 billion market growing at a rate of 4.8% per year. MAP technology requires high gas barrier properties, necessitating major innovations. Current alternatives remain insufficient, and more in-depth assessments of health safety are needed, particularly for managing microbiological and toxicological risks.

The main objectives of the NextFoodPack project are:

· to design and optimize new flexible packaging able to meet the multiple requirements of MAP in terms of barrier properties, chemical and microbiological safety and whose end-of-life could be managed by developing innovative processes combining recycling and decontamination.

· to generate fundamental knowledge about formulation and generation of degradation products during processing and use, enabling a solid evaluation of toxicological safety using biotests able to evaluate cocktail effects, and original methods for rapid toxicological assessment.

· to create a software tool to manage microbiological risks and predict food shelf life in MAP.

· to develop an optimization tool integrating technical, environmental, health, safety, and social criteria to support the food and packaging industry make decisions to propose tailored and sustainable MAP for each specific use case.

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P60. Study on physical properties and gelation mechanism of mixed gelatin gels at varying storage times

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Gelatin is a versatile hydrocolloid and widely used as a gelling agent in food products. In recent years, fish gelatin has been highly appreciated as an alternative to mammalian-derived gelatin. This shift is driven by a desire to utilize marine resources more effectively, as well as to address religious and safety considerations. Because of low melting points, cold-water fish gelatin give the smooth mouth feeling, which is expected to broaden the range of food texture design, however, their low physical strength is limiting their applications. The improved physical strength and gelation mechanism of cold-water fish gelatin mixed with mammalian gelatin have been reported[1], however, it is desirable to develop fish/fish mixed gelatins to elucidate their gelation mechanism. In this study, we aim to mix gelatin from cold-water fish and warm-water fish with different melting points and investigate the physical properties and gelation mechanisms of mixed gelatin gels. Gelatin derived from scales of cold-water fish species with low melting point (OFS, Kenny & Ross) and tilapia scales with high melting point (TS, Nitta Gelatin) were used for the experiment. 12.2% gelatin solutions were prepared by dissolving gelatin powder in deionized water at room temperature, then subsequently, dissolved at 60℃. In dynamic rheological measurements, the sample was cooled to 2℃ and reheated. For micro-DSC measurements, the sample was cooled, stored at 5 °C for maximum of 2 weeks, and reheated. For the particle tracking measurement, 1.1 μm fluorescent particles were added to the samples, stored at 5 °C for 24 hours, and particles were observed with a fluorescence microscope.

In the dynamic rheological measurements, slight two-step melting was observed in the mixed gelatin gels. In the micro-DSC measurements, the melting peaks became larger and sharper during storage for all samples which suggests that the higher-order structure formation of gelatin progresses during storage. Additionally, in the mixed gel, two small melting peaks were observed during short storage, but a large peak appeared in the middle of the OFS and TS peaks after longer storage. This result indicates that the gelatin chains of OFS and TS which were in solution state immediately after cooling, formed a co-aggregated structure during storage. In the particle tracking measurement with samples after storage, fluorescent particles trapped at low temperatures started to diffuse near their respective melting temperatures in OFS and TS gels, whereas mixed gel started to diffuse near the melting temperature of the TS gel. This result suggests that TS chains are dominant in the network structure of approximately 1.1 μm in the mixed gel. In conclusion results of rheological and micro-DSC measurements revealed that two independent network structures are formed immediately after cooling. During cooling, some of the OFS and TS gelatin chains were still in solution state, and these chains formed co-aggregated structures upon storage. Also, it is indicated that that the TS chains are dominant in the network structure of the mixed gel, from the results of particle tracking.

References:

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P61. Gelation of gellan induced by trivalent and monovalent cations studied by NMR and particle tracking

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Gellan is a linear anionic polysaccharide that has been widely used in various food industries. Cations play a crucial role in producing transparent, hard and brittle gels from gellan solutions. The effect of addition of mono-valent and divalent cations has been widely investigated, however, there are only a few reports about the effect of addition of trivalent cations[1]. In this study, the effect of trivalent cation Fe^{3+} and monovalent cation K^{+} on the gelation process of a sodium salt form of gellan (DG, deacylated gellan gum) has been investigated by nuclear magnetic resonance (NMR) and particle tracking measurements. It has been found that Fe^{3+} shows weak gelation abilities of DG, and the gelation is greatly enhanced in coexisting Fe^{3+} and K^{+} solutions. From particle tracking measurements, the 1100nm particles were restricted at 35 ℃ and the 270 nm particles still continue the movement. It indicates that DG form the gel network structures at 35 ℃, but the network size is larger than 270 nm. This study reveals the gelation mechanism and network structure in gellan solution induced by Fe^{3+} giving a new insight into the gelation behaviour and mechanism of gellan as affected by metal ions including trivalent cations.

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