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BOOK OF ABSTRACTS

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Impact of 3-Nitrooxypropanol on Milk and Butter Quality in a Pasture-Based Dairy System

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The effects of methane-reducing feed additives on milk and dairy product quality remain poorly understood. This study evaluated the impact of 3-nitrooxypropanol (3-NOP) supplementation on milk composition, fatty acid profiles and butter functionality in a pasture-based dairy system. Thirty lactating dairy cows were assigned to either a control (n = 15), or a 3-NOP treatment (80 mg/kg dry matter intake; n = 15) for four weeks. Cows grazed on pasture during the day and received a grass silage buffer at night, with 3-NOP delivered via silage. Pooled milk samples were collected weekly to yield n = 4 replicate samples for analyses. Butter was produced from pooled bulk milk for three consecutive weeks to yield n = 3 replicate samples per treatment. Supplementation with 3-NOP showed no significant effect on gross milk composition ($p > 0.05$). However, concentrations of de novo fatty acids including C8:0, C10:0 and C12:0 increased ($p<0.05$), while C16:0 decreased ($p > 0.0$). Butter produced from 3-NOP supplemented milk contained greater concentrations of short chain fatty acids and linoleic acids (CLA; $p< 0.05$). Thermal analysis also revealed a lower crystallisation maximum temperature (16.63 vs. 17.36°C; $p = 0.041$) in butter samples. These findings demonstrate that 3-NOP can be incorporated into pasture based dairy systems without compromising milk quality while subtly modifying butter functionality through changes in milk fat composition.

Effects of circular feed ingredients in grower-finisher pig diets on pork retail lipid oxidation and colour stability

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Alternative diets and feeding strategies may influence pork composition and oxidative stability. Thirty gilts from a 2 × 2 factorial trial received control or alternative diets, replacing approximately 40% of conventional ingredients with former food products and rapeseed co-products, offered in wet or dry form (6-8 pigs/treatment). *Longissimus lumborum* samples in modified-atmosphere (80% O_2/20% CO_2) packaging were subjected to illuminated retail display for 7 or 14 days *postmortem*. Instrumental colour, myoglobin redox forms and thiobarbituric acid-reactive substances (TBARS) were assessed. Display period significantly increased yellowness, chroma and metmyoglobin at day 14 while oxymyoglobin and redness decreased from day 7 to day14. TBARS was significantly higher for alternative (0.318± 0.019 mg MDA/kg) compared to control diet (0.232± 0.021 mg MDA/kg). Despite a significant feed form × day interaction, TBARS did not differ between feed forms on day 7 but was higher with wet (0.329± 0.021 mg MDA/kg) than dry feeding on day 14 (0.221± 0.019). While lipid oxidation overall was low, the alternative diet and wet feeding increased lipid oxidation at day 14, highlighting storage stability as a consideration when evaluating alternative feeding strategies.

Hydrothermal-Assisted Recovery of Humic Substances from Dairy-Processing Sludge Digestate

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Dairy-processing sludge digestate is an underutilised resource. Increasing biomethane production across Europe highlights the need for sustainable digestate management and renewable substitutes for conventional geological sources of humic substances. This study evaluated hydrothermal-assisted alkaline extraction of humic acid (HA) and crude fulvic fractions. Triplicate extractions used 0.1 M potassium hydroxide at a 1:40 solid-to-liquid ratio, comparing 121 °C treatment (30–120 min) with conventional extraction (960 min). Recovered humic acids were characterised using elemental and spectroscopic analyses to evaluate compositional and functional changes following treatment. At 30 min, HA recovery increased from 6.67 ± 0.37% to 9.13 ± 0.09% (dry basis; 1.37-fold; $p < 0.05$); longer treatments provided no significant gain. Crude fulvic-fraction recovery rose from 38.28 ± 0.35% to 77.57–78.23% across hydrothermal conditions ($p < 0.001$). Carbon and nitrogen concentrations in recovered HA increased from 44.49% and 9.45% to 48.09% and 10.17%, respectively, while humic functional groups were retained. Extraction time decreased by 96.9%, although electrical energy demand increased. Mild hydrothermal extraction therefore enhances humic-substance recovery and processing speed, supporting circular valorisation of dairy digestate.

Upcycling Salty Whey in Cheddar Cheese Production: Absorption and Recovery

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This study investigated upcycling of salty whey by reintroducing it into Cheddar manufacture as a salting medium. Cheese milk was standardised to one of two protein:fat levels (3.61:3.80, PFL1; or 4.75:5.00, PFL2) and salted by one of four strategies: conventional dry salting (DS, 2.75% w/w); salty whey concentrated by adding dry salt, with 35% (AS-35) or 70% (AS-70) of salt as dry salt; and salty whey concentrated by rotary evaporation (RE). Cheeses for all eight treatments were made in triplicate, and salt absorption and salt recovered to cheese or lost to whey were quantified. Moisture content (36.30-37.88%) did not differ among treatments; pH was lower in AS-70 (5.20±0.06) compared to DS cheeses (5.40±0.02) at PFL1 ($p<0.05$). Salting method, protein:fat level and their interaction affected salt absorption and recovery ($p<0.001$); for both PFL1 and PFL2, the % salt absorption and % salt recovery to cheese were highest (2.10-2.17%; 76.4-78.8%, respectively) for DS > AS-70 (1.84-1.87%; 66.8-67.4%) = RE (1.74-1.87%; 63.1-68.0%) > AS-35 (1.41-1.61%; 50.8-58.5%). Higher protein and fat (PFL2) contents in cheese milk showed greater salt absorption and recovery for treatments AS-35 and RE ($p<0.05$) but not for AS-70 or DS. In conclusion, elevating salt content in salty whey, by salt addition or evaporative concentration, can be used to partially replace dry salting, supporting circular, lower-waste Cheddar production.

Predicting *Listeria monocytogenes* growth in semi-soft, ricotta and processed cheese

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Listeria monocytogenes is a significant food safety concern in ready-to-eat cheese products linked to several listeriosis outbreaks. Predictive microbiology (PM) tools are widely used to estimate *L. monocytogenes* growth and multiple generic and cheese-specific models are available for different cheese products. We evaluated the ability of models to predict the growth of *L. monocytogenes* strains in three cheese types (semi-soft, ricotta and processed cheese). Growth rate data was generated at 4.1, 9.6 and 19.8°C for five *L. monocytogenes* strains selected on the basis of organic acid tolerance in laboratory media and isolate source. Strains also spanned Lineages I and II and included strains recommended by the EURL-Lm technical guidance document. Growth occurred under all conditions except in processed cheese at 4.1°C. The PM tools (ComBase, PMP, FSSP and Sym'Previus) over-predicted growth in all three cheeses (Bf 1.24–4.16), whereas cheese-based models gave the closest prediction (Bf 1.08–1.24). However, none of

the evaluated models adequately described growth in processed cheese at abuse and room temperatures. Strains with higher organic acid tolerance grew significantly faster in semi-soft and ricotta cheese but not processed cheese, whereas isolate source and lineage showed no clear association. The results confirmed the value of using specific models over generic models for predicting *L. monocytogenes* growth in cheese.

Unlocking Chickpea Fibre: Fractionation Approaches for Sustainable Dairy Alternatives.

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The development of sustainable, fibre-rich foods is essential to address growing food demand and the environmental impact of food production. Legumes offer a promising alternative due to their nutritional value, high dietary fibre content, and lower environmental footprint, particularly in plant-based dairy alternatives. This study aimed to characterise four chickpea fractions obtained through milling and sieving (fine flour, semolina, hull, and wholemeal flour) and evaluate their suitability for plant-based cream cheese alternatives. The fractions were characterised for their nutritional and techno-functional properties, and the resulting alternatives were evaluated for their physicochemical, textural, and rheological properties. Larger particle sizes were associated with higher dietary fibre contents (fine flour: 24.30%; hull: 51.98%) and lower carbohydrate contents (fine flour: 32.97%; hull: 12.85%). All alternatives were high in dietary fibre. Coarse flour produced significantly the highest spreadability (22.14 ± 1.50 g.s, p-value < 0.05). Rheological analysis indicated weak-gel behaviour, with a G'/G" ratio below 10 and a complex viscosity-frequency slope ranging from -0.88 to -0.95. These findings highlight the potential of chickpea fractionation to develop sustainable, fibre-rich cream cheese alternatives, with particle size influencing their nutritional and functional properties.

Emerging processing technologies and *Bacillus licheniformis* fermentation modulate faba bean protein structure and functionality

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Faba bean protein isolate (FBPI) is a promising ingredient for plant-based and hybrid meat products, but a research gap remains regarding the effects of emerging processing technologies, alone or combined with fermentation, on its functionality. This study evaluated ultrasound bath (10 or 20 min), high-pressure processing (HPP; 200 or 400 MPa), microwave (250 or 1000 W) and thermal plasma (5 or 10 min) treatments on FBPI. Treated and untreated FBPI slurries were fermented with *Bacillus licheniformis* at 37°C and 200 rpm for 24 h in two independent runs. Fermentation reduced water-holding capacity, oil-holding capacity, gel water-holding capacity and solubility (all $p<0.001$), with solubility decreasing from 13.7 ± 0.3% to 6.8 ± 0.3%. HPP improved unfermented gel-forming efficiency, lowering least gelation concentration from 18% to 16% at both intensities. Microwave-fermented samples showed the greatest surface hydrophobicity, indicating greater exposure of hydrophobic regions, which may influence aqueous dispersibility. Fermentation shifted the zeta potential from −33.8 to −26.3 mV ($p<0.001$) and increased the random-coil content from 24.3% to 28.4% ($p=0.013$), indicating structural reorganisation. SDS-PAGE indicated proteolytic breakdown of major protein fractions following fermentation. Intensity effects were limited and technology-dependent, whereas fermentation predominantly influenced FBPI structure and functionality.

Sub-lethal UVC-LED (265 nm) exposure selects for tolerant *Listeria monocytogenes* with cross-protection to Far-UVC (222 nm)

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UVC-LED (265 nm) and Far-UVC (222 nm) are promising interventions to reduce the prevalence of *Listeria monocytogenes* in food production settings. This study investigated the adaptive potential of UVC-sensitive *L. monocytogenes* under repeated sub-lethal UVC-LED and Far-UVC exposure. UVC-sensitive strain (F1109-17) was selected from a previously characterised collection of Irish isolates. The strain was passaged with three parallel cultures under repeated sub-lethal doses of UVC-LED or Far-UVC alongside an unexposed passaged control. Recovered isolates were re-screened for UVC-sensitivity. The 265 nm-

evolved isolates (n = 7) were significantly more tolerant to 265 nm, with a mean increase of Δ 1.4 ± 0.2 log CFU/mL compared to the passaged controls. Three of these also showed significant but variable cross-tolerance to 222 nm ranging from Δ 0.9 to 2.9 log CFU/mL (BH-adjusted $p < 0.05$). Far-UVC-evolved isolates (n = 6) showed < 0.5 log change at either wavelength, with no significant tolerance gain. Sub-lethal 265 nm exposure can select for tolerant *L. monocytogenes* with partial cross-protection to 222 nm, whereas 222 nm exposure did not select for tolerance. Future research should investigate if combined treatments could mitigate the risk of adaptation. Genomic characterisation of these isolates will provide valuable data on mechanisms of UVC tolerance in this pathogen of public health concern.

Solvent- and pH-mediated molecular interactions governing the structure and properties of zein-chitosan blend films

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Protein-polysaccharide bi-polymer systems are promising candidates for developing hydrophobic film surfaces. However, their incompatibility in solvents can induce segregative phase separation, which governs film properties. Mainly, solvent composition and pH drive the nature of phase separation, understanding their effects is imperative. This study investigated the effects of ethanol concentration (70%, 80%, and 90%) and pH (unadjusted, 3, and 9) on zein-chitosan bi-polymer blends and their corresponding solvent-cast films. Zeta potential measurements revealed increased electrostatic stabilisation with decreasing ethanol concentration, with the highest values observed at pH 3, followed by unadjusted pH and pH 9. Enhanced interactions at pH 3 were further supported by the lowest glass transition temperature of the zein-chitosan blends. Changes in zein secondary structure were evident, particularly in β-sheet content. β-sheet content decreased at 90% ethanol (76.7% to 54.6%) and 70% ethanol (69.7% to 58.2-61.2%), whereas it increased at 80% ethanol (59.5% to 64.1%). Complex formation between zein and chitosan quenched fluorescence intensity and induced a blue shift from 307 to 305 nm. The resulting films exhibited tensile strengths ranging from 4.2 to 15.9 MPa, with the highest value obtained at 90% ethanol, while maintaining elongation at break values of 114-133%. Films prepared in 90% ethanol and pH 3 exhibited the highest contact angle (102.82°). These findings demonstrate that zein-chitosan bi-polymer blends in 90% ethanol at pH 3 can form hydrophobic films with high tensile strength and elongation at break, highlighting their potential for biodegradable packaging applications targeting moisture-sensitive foods.

Insights into the coordinated roles of CO_2 evolution and *in situ* generated sodium salts across gluten protein, dough development and steamed bread quality in a chemically leavened system

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The quality of chemically leavened steamed bread depends on both carbon dioxide evolution for dough expansion and the *in situ* generated sodium salts for dough network development. However, whether the stoichiometric proportions defined by the chemical reaction provide the optimal functional balance between these two contributors remains unclear. This study investigated the coordinated roles of carbon dioxide evolution and *in situ* generated sodium gluconate by establishing different GDL-$NaHCO_3$ reaction levels together with salt supplementation systems. Dough rheology, protein structural characteristics, interfacial behavior, moisture distribution, and steamed bread quality were comprehensively characterized under these reaction conditions. Moderate reaction levels (1.5%) enhanced protein unfolding, disulfide bond formation, and dough network viscoelasticity. Salt supplement further significantly enhanced ($P <$ 0.05) dough development, producing the highest dough height (34 mm) and specific volume (2.63 mL/g). In contrast, insufficient reaction levels generated inadequate CO_2 for dough expansion, whereas excessive reaction levels induced extensive protein aggregation, larger gas cells, and reduced gas retention despite sodium gluconate supplementation. Consequently, the 2.0% samples exhibited larger cell areas and an uneven crumb structure. Overall, optimal steamed bread quality was achieved when CO_2 generation was balanced with dough viscoelastic development rather than maximized independently. These findings

provide new insights into the coordinated regulation of gas evolution and dough network formation during chemical leavening and offer guidance for designing yeast-free cereal products.

Unlocking Bioactive Potential: Fungal and Insect Bioconversion for Functional Food Ingredients

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The InnoProtein project explores innovative and sustainable strategies for converting food industry by-products into valuable protein rich and bioactive ingredients. This study investigates two bioconversion approaches, fungal solid-state fermentation and insect bioconversion, assessing their potential to enhance the functional properties of food waste, focusing on antioxidant, antimicrobial, antidiabetic and antihypertensive activities. B-grade cereals and legumes (rice, soy, and lupin pomace) were subjected to solid-state fermentation using *Aspergillus* species, while *Hermetia illucens* (Black Soldier Fly) and *Tenebrio molitor* (Yellow Mealworm) larvae were reared on bakery and dairy waste, alongside conventional control diets. Methanolic extracts were analysed for total phenolic and flavonoid content, antioxidant capacity, antimicrobial activity, alpha-amylase inhibition and ACE inhibition. Both bioconversion approaches enhanced antioxidant properties, with significant increases observed in phenolic and flavonoid content and antioxidant activity ($p < 0.05$). Insect larvae exhibited antimicrobial activity, particularly *T. molitor,* alongside moderate alpha-amylase inhibition, with higher inhibition observed in larvae reared on waste diets. Solid-state fermented biomass demonstrated low alpha-amylase and ACE inhibition but exhibited significantly greater antimicrobial activity compared with the unfermented substrates ($p < 0.05$). These findings highlight fungal fermentation and insect bioconversion as complementary approaches for enhancing the bioactive properties of food industry waste and by-products. By improving antioxidant and antimicrobial potential, these strategies demonstrate opportunities to transform underutilised waste streams into valuable functional ingredients, contributing to more sustainable food systems.

Dry-fractionated faba bean fractions as a clean-label structuring ingredient for fermented dairy analogues: composition, gel properties and structure-function relationships

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Designing plant-based yoghurt analogues requires understanding how biopolymer composition and matrix heterogeneity determine gel network formation. This study evaluated four stone-milled faba bean fractions, fine (FF), coarse (CF), hull-enriched coarse (HCF), and wholemeal (WF), as sole structuring agents in fermented yoghurt alternatives. Fraction composition, techno-functional properties, fermentation performance, and gel characteristics were assessed; Pearson correlations explored structure-function relationships. All formulations supported *Streptococcus thermophilus* growth to 8.00–8.30 log CFU/mL after 4-5 h. Frequency sweeps revealed predominantly elastic behaviour (G' > G") for FFYG, CFYG, and WFYG yoghurts; WFYG had the highest storage modulus. FFYG showed the lowest loss tangent (0.182 ± 0.01), highest firmness (10.4 ± 0.3 N), consistency (146 ± 17.25 N·s), and water-holding capacity (98 ± 1.9%). HCFYG had the lowest water-holding capacity (70 ± 1.1%). Dietary fibre correlated negatively with titratable acidity ($r = -0.99$), digestible starch positively with firmness ($r = 0.97$), particle size negatively with water-holding capacity ($r = -0.99$), and water solubility index negatively with consistency ($r = -1.00$). Dry fractionation by stone milling therefore offers an approach to tailor faba bean composition and fermented gel properties without added structuring agents.

Interfacial properties of oil-water emulsions prepared using blends of skim milk and faba bean protein for use in hybrid fat-filled milk formulations

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For sustainability reasons, animal-plant protein mixtures are gaining increasing interest. This study investigated interfacial behaviour and protein displacement in hybrid emulsion systems. Five fat-filled milk emulsions were formulated using skim milk (SM) and faba bean protein concentrate (FBPC) at ratios of 75SM:25FBPC, 50SM:50FBPC and 25SM:75FBPC, along with SM and FBPC controls. The interfacial protein

load was quantified, and protein profiles were assessed using SDS-PAGE densitometry on the treated cream phase. Interfacial protein load did not differ significantly among the 100SM, 75:25, 50:50, and 25:75 formulations, with values of 1.15 ± 0.03, 1.28 ± 0.08, 1.19 ± 0.06, and 1.92 ± 0.17 mg/m^2, respectively, with the exception of the 100FBPC system, which exhibited a significantly higher interfacial protein load (4.03 ± 0.49 mg/m^2). The findings indicate that SM proteins exhibited greater competitive adsorption at the oil-water interface than FBPC proteins in hybrid emulsions, with casein and whey proteins progressively dominating the interfacial layer. Densitometric analysis revealed composition-dependent changes in interfacial protein distribution, with a progressive shift from globulin-dominant profiles in FBPC-rich systems to casein- and whey protein-dominant profiles in SM-rich systems. These findings suggest preferential interfacial adsorption of SM proteins and potential displacement of FBPC globulins in hybrid emulsions.

A multi-analytical approach to characterize chemical profiles of Irish Pot Still Spirits during cask maturation

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Cask maturation is a key determinant of whiskey flavour, driving the extraction and transformation of flavour compounds (congeners) from wood. These changes are influenced by factors including spirit composition, wood origin, cask volume, previous cask use, and thermal treatment. This study investigated potential markers of flavour development during the maturation of Irish Pot Still whiskey. Two Irish Pot Still spirits from different distilleries were matured in various cask types and analysed using FTIR-ATR, Raman spectroscopy, UHPLC-DAD, and chemometric methods. Multivariate analysis revealed clear differences between the spirits, with 90.5% of total variation explained by PC1 and PC2, highlighting the influence of mash bill composition. Congener profiles also varied across cask types, demonstrating the effects of wood origin and previous cask use. UHPLC-DAD showed a progressive increase in ten maturation congeners, including furanic and phenolic aldehydes, as well as phenolic acids. The highest concentrations were observed in new European oak and ex-sherry casks compared to ex-bourbon casks. Smaller casks (250 L) produced higher congener levels than 500 L casks, reflecting a greater wood surface-area-to-liquid ratio. Overall, maturation was shown to be an additive process strongly influenced by cask characteristics and congener evolution.

Vegetable oil type and inclusion level influence functionality and sensory quality of high-protein plant-based beverages

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High-protein plant-based beverages are formulated to optimise protein delivery, while the lipid fraction remains underexplored.

This study reveals the effect of oil type and inclusion level on techno-functionality, nutritional value and sensory properties of a high-protein faba bean–oat beverage. Therefore, rapeseed-, sunflower-, flaxseed-, walnut oil and a high omega-3 oil-blend were singly added at 0.0% (control), 1.5%, 3.0% and 4.5% (w/w) to the faba bean–oat protein beverage. Fatty acid composition, physical stability, microstructure, viscosity during shearing and descriptive sensory profile were determined. Oil inclusion level increased whiteness index and viscosity, and reduced separation by an average of 3.7-fold. Oil-containing beverages were significantly more acceptable than the control, with the most favourable outcomes at an inclusion range of 1.5–3.0%. Within this range, fatty acid profile determined sensory characteristics. Rapeseed oil enhanced beany flavour owing to oleic and arachidic acids. Sunflower oil, rich in linoleic acid (55.2–57.7%), increased oily mouthfeel. Each oil type reduced bitterness and grittiness, whereas higher polyunsaturated fatty acid concentrations (63.8–74.2% of total fatty acids) increased aftertaste. At 1.5% inclusion, flaxseed oil and the omega-3-rich oil blend provided 40.8% and 29.7% n-3 fatty acids, respectively. In conclusion, selecting oil according to fatty acid profile is an essential strategy for balancing fatty acid composition and sensory acceptability.

Acid casein as a protein ingredient for high protein thermo-reversible gels

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Growing demand for clinical nutrition and high protein foods create opportunities for dairy protein ingredient valorisation. This study explored the potential of acid casein variants for use in high protein applications. Acid casein was solubilized at 20% protein (w/w) to produce thermo-reversible caseinate gels. The functional properties of sodium (NaCN), potassium (KCN), calcium (CaCN) and mixed caseinates (MixCN), prepared using equal volumes of all three hydroxides were compared. Caseinates were prepared by alternating additions of respective hydroxides and acid casein under high shear at 80°C until pH 6.3 was attained, while CaCN was prepared at 40 °C. Experimental measurements were performed in duplicate. The viscosity of caseinates measured over a 2 h period at 80°C showed the highest viscosity for MixCN (3080.9 ± 40 mPa.s) and lowest for NaCN (525.5 ± 137 mPa.s). CaCN measured at 80°C formed an irreversible gelled matrix. The heat stability of caseinates at 140°C showed no coagulation occurred for NaCN and KCN after 30 min, whereas MixCN and CaCN coagulated within ~7.5 min and ~1.5 min, respectively. The zeta potential of caseinates ranged from -44 mV to −24 mV and increased in the order NaCN, KCN, MixCN and CaCN. Caseinates offer huge potential as vehicles for high protein thermo-reversible gels, but their mineral content may necessitate blending with other dairy proteins to improve nutritional suitability.

Correlating protein, nitrogen and amino acid content

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Dairy products contain amino acid-derived nitrogen (AAN) and non-amino acid nitrogen (NAAN). Therefore, when measuring protein (which is commonly defined as amino acid content) *via* nitrogen analysis, AAN and NAAN need to be carefully fractionated from each other. This study evaluated 12% (w/v) trichloroacetic acid protein precipitation, commonly used to measure non-protein nitrogen in milk, for its ability to produce fractions of AAN and NAAN. When applied to sweet whey, 12% (w/v) trichloroacetic acid protein precipitation produced a soluble fraction comprising 12% of the products' total nitrogen content. This represents a 12% discrepancy between reference analysis methods which merely rely on total nitrogen analysis for protein measurement. However, further investigation revealed that 7.9% of sweet whey's AAN (i.e. protein) was present in the soluble non-protein nitrogen fraction, due to the presence of unprecipitated Caseinomacropeptide, as determined by peptide and amino acid analysis. To minimise this error, different mixtures of trichloroacetic and phosphotungstic acids were trialled to improve the separation of AAN and NAAN in dairy products. A solution of 12% (w/v) trichloroacetic acid with 0.6% (w/v) phosphotungstic acid was developed, reducing AAN inadvertently measured as NAAN in sweet whey to 1.4% of its total nitrogen. At this low level, sources of NAAN, present in the AAN fraction give an effect of similar (and opposite) scale, indicating the limit of accuracy in nitrogen-derived protein analysis has been met.

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Effects of Milk Fat Globule Membrane Supplementation on Physical and Cognitive Function in Older Adults: A Systematic Review

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Milk fat globule membrane (MFGM) is a dairy-derived ingredient rich in bioactive lipids and proteins that may support a variety of health attributes including physical and cognitive function. Herein we have evaluated the effects of bovine-derived MFGM supplementation on physical and cognitive function in adults aged ≥ 60 years. PubMed, Embase, Scopus, Web of Science, and the Cochrane Library were searched for randomised controlled trials comparing MFGM supplementation with placebo. From 11,667 records identified, seven randomised controlled trials involving 443 participants were included. Six studies assessed physical outcomes, and one assessed cognition. Five of six physical function studies reported improvements in at least one neuromuscular or performance-related outcome following MFGM supplementation, typically alongside exercise. However, between-group effects were inconsistent and one study found no additional benefit for gait outcomes. The cognition study reported improved episodic memory following MFGM-enriched milk consumption in older females. Current evidence suggests that MFGM may support selected physical and cognitive outcomes in older adults. However, the evidence base remains limited and heterogeneous, highlighting the need for larger, longer-term randomised controlled trials. These findings support the growing academic and industry interest in MFGM's potential as a value-added dairy ingredient and provide a rationale for further work on the recovery, concentration, and characterisation of MFGM-rich fractions from dairy streams for development of novel functional ingredients to promote healthy ageing.

Does the composition of the maternal diet influence the gut and vaginal microbiome in pregnant women at risk of spontaneous preterm birth in early pregnancy?:

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Maternal diet during pregnancy is a modifiable risk factor increasingly recognised for its role in shaping pregnancy outcomes. The maternal gut and vaginal microbiome have been linked to risk of sPTB, yet the relationship between dietary patterns and these microbial communities remains poorly understood. This study aimed to explore whether different dietary patterns in early pregnancy were associated with maternal vaginal and gut microbiome composition in women at high risk of sPTB (n=167). At 16 weeks' gestation, stool samples and vaginal swabs were collected for shotgun metagenomic sequencing. Participants completed food frequency questionnaires to calculate five dietary indices: AHEIP, MD, PHDI, DASH, and DII. Gut microbiome beta diversity differed between 'High' and 'Low' AHEIP and DII groups ($p=0.02, R^2=0.01$). Vaginal CST distribution also differed significantly between high and low AHEIP groups ($p=0.012$). In conclusion, greater adherence to AHEIP was associated with differences in vaginal microbiome profiles, while AHEIP and DII were associated with gut microbiome composition in early pregnancy.

Direct comparison of *in vitro* and *in vivo* protein digestibility using ^{15}N-labelled faba bean and *Chlorella vulgaris* proteins

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Population growth and environmental pressures are driving a shift towards alternative proteins, such as plant and single-cell proteins. However, protein content alone does not determine their nutritional value, as differences in amino acid composition and protein structure can reduce the digestibility compared with

animal proteins. In line with the 3Rs principle (Replacement, Reduction, Refinement), accuracy in *in vitro* digestion models is needed more than ever. The INFOGEST method is now adopted as an ISO method for *in vitro* digestible indispensable amino acid score method. However, very little direct comparison with the results from human intervention studies are available. Moreover, in conventional *in vitro* and *in vivo* digestion analysis, it is necessary to corrected for endogenous nitrogen (from digestive enzymes) vs. dietary nitrogen. Using ^{15}N-labelled foods can overcome this limitation. This study therefore aimed to benchmark the INFOGEST QUANT method against a human study conducted in France using the same ^{15}N-labelled foods. ^{15}N-labelled faba bean extrudate and *Chlorella vulgaris* smoothie were prepared as in the human intervention trial and digested following the INFOGEST Quant method. Total nitrogen and ^{15}N enrichment were measured by elemental analysis–isotope ratio mass spectrometry (EA-IRMS). Amino acid composition was determined by ultra-high-performance liquid chromatography (UHPLC), and ^{15}N enrichment of individual amino acids was determined by gas chromatography–combustion–isotope ratio mass spectrometry (GC-C-IRMS). Results showed that endogenous protein, mostly from digestive enzymes, accounted for more than 60 % of the total nitrogen in the *in vitro* digesta. Without isotopic correction, nitrogen digestibility was 78.58 ± 1.19% for faba bean and 71.92 ± 0.25% for *C. vulgaris*. After ^{15}N correction, these values increased to 80.23 ± 0.91 % and 77.47 ± 0.32 %, respectively, moving closer to the human data (82.62 ± 5.59 % and 87.94 ± 1.52%, respectively). Amino acid digestibility gave an even more accurate prediction for faba bean, with no significant difference between *in vitro* (80.08 ± 5.37 %) and *in vivo* (84.10 ± 4.73 %), whereas it was lower *in vitro* (89.91 ± 0.61 %) than *in vivo* (93.34 ± 1.43 %). Differences in individual amino acids were found for lysine in faba bean and for histidine, lysine and serine in *C. vulgaris*. In conclusion, the INFOGEST Quant method provides a good prediction of human protein digestibility. However, the large contribution of endogenous protein can lead to significant errors in true protein digestibility. In addition, differences in cleavage sites between the porcine enzymes used *in vitro* and human digestive enzymes may contribute to the differences between *in vitro* predictions and human data.

From Fermentation to Gut Hormone Signaling: Unravelling the Bioactive Peptide Potential of Aspergillus oryzae-Fermented Lupin.

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Driven by the growing demand for sustainable proteins, *Lupinus albus* has emerged as a promising alternative to imported soy, offering high-quality protein, dietary fiber, healthy lipids and bioactive compounds with hypolipidemic, antioxidant and hypoglycemic properties. However, antinutritional factors (ANFs) limit protein digestibility and bioavailability. Fermentation offers a promising strategy to overcome these limitations while enhancing nutritional functionality. Beyond ANF reduction, lupin-derived peptides and conglutins exhibit gastrointestinal bioactivity, modulating enteroendocrine signaling through GLP-1 stimulation and DPP-4 inhibition. Nevertheless, how fermentation-driven structural changes influence host metabolic signaling remains largely unexplored. This study aimed to a) evaluate the enteroendocrine response in human colon *ex vivo* models ($n = 16$ donors) exposed to *in vitro* digests of fermented *L. albus*, and b) Characterize fermentation-derived bioactive peptides associated with gut hormone secretion by LC-ESI-MS/MS, comparing non-fermented lupin with solid-state and submerged fermented matrices. Our findings reveal that fermentation induced distinct GLP-1 and PYY secretion profiles, associated with matrix-dependent differences in peptide abundance and diversity.

Identification and Isolation of Pathogenic Bacteria in Irish Spinach Producing Farms, and its Implications for Food Safety

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Leafy greens play an important role in a healthy diet, yet some have been linked to foodborne outbreaks involving pathogens such as Shiga toxigenic *Escherichia coli* (STEC), *Listeria monocytogenes*, and *Salmonella enterica*. The detection of these organisms on fresh produce suggests gaps in safe primary food production or along the supply chain, enabling contamination routes that pose significant risks to consumer health. This study aims to detect and characterize these three pathogens and identify potential contamination points within Irish spinach growing farms. A sampling campaign was conducted between

April and July 2026 in Irish farms. Samples from fresh produce, their environment and storage and processing facilities were collected. Bacteria were extracted by homogenization with PBS, then centrifugated, and incubated in a selective enrichment broth overnight at 40°C. Samples were screened using two complementary Multiplex PCR protocols targeting virulence and species-specific genes associated with the targeted bacteria. All samples were also plated for isolation on selective and differential media, and had the DNA extracted for 16S rRNA gene sequencing. Out of the tested samples, 48% were positive for at least one *E. coli*-related marker, with around 11% positive for at least one STEC-related marker. The highest positivity rate for *E. coli*-related markers was observed in soil samples (61%), then spinach (50%), followed by fertilizer and water (33.3%). By assessing the microorganisms surrounding the spinach leaves, this study can help identify potential pathways through which foodborne pathogens enter food growing systems, contributing to improved risk assessment and food safety strategies.

Salmonella Survival in Commercial Irish Duck Meat and Chicken Broiler Niches

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Despite decades of farm-level interventions, *Salmonella* remains a challenge for poultry farming. Once introduced, *Salmonella* can persist through multiple rounds of cleaning and disinfection. Historically, research has focussed on survival niches on chicken farms, but with duck meat representing a new, fast-growing industry, not much is known on *Salmonella* survival on duck farms. To investigate this, a range of samples including faeces, drinking water, and soil taken from the concrete apron border in front of the house doors were collected from a chicken broiler and duck meat farm. The samples were inoculated with a cocktail of six *Salmonella* serovars relevant to Irish poultry and stored at 4°C and 14°C for 30 weeks, with periodic testing for *Salmonella* to determine survival. For duck farm samples, the time taken for *Salmonella* to decrease by 90% (D_{90}) at 4°C and 14°C, respectively, was 30.8 and 6.4 days in faeces, 6.1 and 3.7 days in water, and 21.0 and 11.3 days in soil. For chicken farm samples, the D_{90} at 4°C and 14°C, respectively, was 7.7 and 2.0 days in faeces, 15.0 and 12.7 days in soil, and 8.4 and 8.1 days in water. After 30 weeks, *Salmonella* was still detected in both chicken and duck soil samples at both temperatures, and duck faeces at 4°C. These findings identify soil contamination and faecal waste storage as critical niches for *Salmonella* contamination.

The Protective Effects of _Nannochloropsis oceanica_ against Oxidative Stress in Intestinal Epithelial Cells

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Nannochloropsis oceanica is a bioactive-rich microalga with potential to modulate intestinal epithelial function and immune responses, but the direct gastrointestinal effects of its extracts remain unclear. This study evaluated whether *N. oceanica* extracts protect intestinal porcine epithelial cells (IPEC-J2) from oxidative stress. IPEC-J2 cells were exposed to hydrogen peroxide (H_2O_2; 0.8–1.4 mM), with or without microalgal extracts. Cell viability, membrane leakage, intracellular reactive oxygen species (ROS), antioxidant enzyme activities, mitochondrial function using a Seahorse analyser, mitochondrial ROS, and mitochondrial membrane potential were assessed. Expression of genes related to nutrient transport, barrier integrity, and inflammation was also measured. Bioaccessibility was assessed by identifying compounds released during digestion. Compared with H_2O_2 treatment alone, *N. oceanica* significantly increased cell viability ($P < 0.05$), improved membrane integrity ($P < 0.05$), reduced intracellular ROS ($P < 0.05$), and maintained superoxide dismutase, catalase, and glutathione peroxidase activities ($P < 0.05$). The extracts preserved mitochondrial bioenergetics ($P < 0.05$), maintained mitochondrial membrane potential ($P < 0.05$), and reduced mitochondrial ROS ($P < 0.05$). Genes related to nutrient transport and barrier integrity were upregulated, while inflammation-related genes were modulated. Digestion released amino acids, peptides, and phenolic compounds. Cask maturation is a key determinant of whiskey flavour, driving the extraction and transformation of flavour compounds (congeners) from wood. These changes are influenced by factors including spirit composition, wood origin, cask volume, previous cask use, and thermal treatment. This study investigated potential markers of flavour development during the maturation of Irish Pot Still whiskey. Two Irish Pot Still spirits from different distilleries were matured in various cask types and analysed using FTIR-ATR, Raman spectroscopy, UHPLC-DAD, and chemometric methods. Multivariate analysis revealed clear differences between the spirits, with 90.5% of total variation explained by PC1 and PC2, highlighting the influence of mash bill composition. Congener profiles also varied across cask types, demonstrating the effects of wood origin and previous cask use. UHPLC-DAD showed a progressive increase in ten maturation congeners, including furanic and phenolic aldehydes, as well as

phenolic acids. The highest concentrations were observed in new European oak and ex-sherry casks compared to ex-bourbon casks. Smaller casks (250 L) produced higher congener levels than 500 L casks, reflecting a greater wood surface-area-to-liquid ratio. Overall, maturation was shown to be an additive process strongly influenced by cask characteristics and congener evolution.In conclusion, *N. oceanica* extracts mitigated oxidative injury in intestinal epithelial cells, with findings consistent with improved redox balance and mitochondrial function. These findings support further evaluation of *N. oceanica* as a functional food ingredient.

Growth dynamics of cold-adapted *Listeria monocytogenes* on refrigerated spinach

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Listeria monocytogenes can survive and grow under refrigeration, posing a food safety concern in ready-to-eat leafy vegetables. Although challenge studies assess its growth potential, outcomes may vary with strain physiology, leaf characteristics and environmental conditions. Strains differ in their ability to grow at low temperatures in vitro, but whether these differences occur on leafy vegetables remains unclear. This study investigated the growth of *L. monocytogenes* strains with contrasting cold-growth phenotypes on spinach at 7 °C and their relevance to strain selection in challenge testing. Eight *L. monocytogenes* strains, previously phenotypically characterised for low-temperature growth in vitro, were evaluated on four organically produced spinach varieties: Prickly (four strains), Butterflay and Ratel (eight strains), and Renegade F1 (seven strains). Following European Union Reference Laboratory guidelines, spinach leaves were inoculated with approximately 100 CFU/g of *L. monocytogenes* to simulate post-processing contamination, and *L. monocytogenes* was enumerated over seven days at 7 °C. On Prickly spinach, all four *L. monocytogenes* strains increased by 2.5–2.9 $\log_{10}$ CFU/g after seven days of incubation. On Butterflay spinach, *L. monocytogenes* counts increased by 1.1–1.8 $\log_{10}$ CFU/g. In contrast, counts remained relatively stable on Ratel. On Renegade F1, changes in *L. monocytogenes* counts over time differed significantly between strains. These findings suggest that strain selection and spinach variety may influence growth behaviour of *L. monocytogenes* under refrigeration. Future challenge studies should consider these factors by testing strains with strong cold-growth potential across different spinach varieties to assess worst-case scenarios.

POSTER PRESENTATIONS

Effect of temperature and ionic strength on instantaneous acid coagulation of milk and caseinate systems

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Acid coagulation of milk proteins is well characterised for slow acidification, as in yoghurt manufacture, but this understanding may not fully translate to rapid acidification of milk applied in acid casein manufacture. This study investigated instantaneous coagulation behaviour of casein micelles and caseinate as a function of pH, temperature and ionic strength. For this purpose, pasteurised (PSM) and heated (HSM 95 ℃ for 15 minutes) skim milk and control and chymosin-treated sodium caseinate (NaCas) were diluted 50-fold into 25 mM acetate or citrate buffers (pH 4.0–5.5, containing 0–100 mM NaCl) at 5–40 ℃ and immediately checked visually for coagulation. For PSM, coagulation pH (pH_c) increased notably with increasing temperature and with increasing buffer ionic strength (I). For HSM, pH_c shifted to higher pH values, and its dependence on temperature was notably lower than for PSM. The pH_c for NaCas was also higher than for PSM and showed lower dependence on temperature and ionic strength. Chymosin treatment of NaCas, to hydrolyse κ-casein, removed all temperature dependence of pH_c. The findings suggest that the dependence of pH_c on temperature and ionic strength in casein-based systems may be proportional to the proportion of particle stabilisation derived from κ-casein.

Interactive Effects of Fat Emulsion Type on the Quality Characteristics of Plant-Based Burgers

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The development of plant-based meat alternatives with desirable nutritional, technological, and sensory properties remains a significant challenge, particularly in achieving appropriate texture, cooking stability and visual appeal while reducing saturated fat. This study investigated the interactive effects of different fat emulsion gels on the quality characteristics of plant-based burgers. The objective was to develop and evaluate emulsion gels formulated using 40% rapeseed oil with either amaranth flour, rice bran or soy protein isolate at inclusion levels of 15% and 20%, and to determine their effects on proximate composition, colour stability, rheological behaviour, texture profile and cooking loss. Seven burger formulations were evaluated, including a control containing 50% water and 50% oil, with analyses conducted in triplicate. SPI formulations exhibited the highest protein contents (16.42 ± 0.15% and 16.13 ± 0.35%) and the lowest fat contents (4.37 ± 1.68 and 4.33 ± 0.07 g/100 g), whereas rice bran treatments showed the highest moisture content (67.78 ± 0.23%) and fat retention (6.70 ± 0.21 g/100 g). Colour evaluation demonstrated that 20% amaranth enhanced redness, while 20% SPI provided the greatest colour stability during 14 days of storage. Rheological analysis revealed superior viscoelastic properties in 20% amaranth burgers, with storage modulus values reaching 25.8 kPa indicative of strong elastic networks. Texture profile analysis showed that amaranth treatments produced the softest burgers, reducing hardness from 14,249.8 g in the control to 1,922-2,076 g. The lowest cooking losses were observed in SPI burgers (25.46-25.93%), compared with 45.90% in the 20% amaranth treatment. In conclusion, fat emulsion type significantly influenced the nutritional and technological quality of plant-based burgers. SPI-based emulsions provided the most balanced overall performance through enhanced protein content, improved cooking yield, and superior colour stability, while amaranth emulsions promoted strong viscoelastic properties and increased redness. Rice bran emulsions offered intermediate functionality and enhanced moisture retention, demonstrating their potential as alternative fat structuring systems in plant-based meat products

***Moringa oleifera* leaf powder – ingredient characterisation, techno-functionality in milk matrices and application in paneer cheese**

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Moringa oleifera leaf powder is rich in protein and fibre and relatively low in fat, making it appealing as a food fortificant. This study characterized the moringa powder and evaluated how its properties influenced dairy matrices. Moringa powder was characterized for water and oil holding capacities, particle size

distribution and protein profile. pH, total titratable acidity, foaming properties, particle size distribution, and emulsion/dispersion stability were evaluated at 1%, 5% and 10% powder inclusion in deionized water, low-fat milk and whole milk. The powder was then incorporated into full-fat and low-fat milk at 1% and 5% during paneer cheese preparation and colour, moisture, water activity and hardness were evaluated. The powder showed 283.9±12.9% water holding capacity and wide particle size distribution. Increasing concentration of powder decreased pH (6.7±0.05–6.08±0.01) and increased titratable acidity (1.83±0.04–4.02±0.02meq$_{\text{lactic acid/g}}$), foaming and emulsion properties changed based on inclusion level and the matrix. Moringa powder inclusion resulted in darker, greener paneer; moisture content increased and water activity remained unchanged. Hardness decreased significantly in low-fat milk paneer (21.45±4.26 N – 5.60±0.96 N) while having limited effects on whole milk paneer. The results demonstrate that moringa powder has potential as a fortificant, but its effects are strongly influenced by both inclusion level and milk matrix used.

Valorising faba bean (*Vicia faba L.*) through solid-state fungal fermentation: A review

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Faba bean (*Vicia faba* L.) is a protein-rich, nitrogen-fixing pulse mainly used as animal feed. However antinutritional compounds, including vicine and convicine, a beany flavour and a globular protein structure, limit its digestibility, consumer acceptance and functionality. Faba bean is attractive as a low-carbon, alternative protein ingredient. Solid-state fermentation (SSF) is the growth of selected microbes on a moist, solid substrate with minimal free water and is used for biotransformation across industries. This review examined whether SSF, using food-grade fungi, could valorise faba bean into a functional protein ingredient. As whole-seed fermentation studies are limited, evidence from faba bean fractions and other legume seeds fermented using *Rhizopus oligosporus* or *Aspergillus oryzae* was compared. Reported effects include protein concentration increases of up to 20%, 47–57% lower fermentable sugars, reduced beany off-flavour and improved techno-functional properties. Outcomes were strain-, substrate- and process-dependent. These changes could support meat analogues and other food applications by improving nutrition, texture and sensory properties. Under European Food Law, safety controls must cover the raw bean (contaminants such as mycotoxins and pesticides), the fermentation process (starter strain identity, toxin production, microbiological hazards) and the final product. In conclusion, solid-state fermentation offers a promising route to improve faba bean nutrition, functionality and sensory aspects, but whole-seed studies are needed to confirm these benefits and ensure safety and regulatory compliance from raw bean to final product.

Unravelling the effect of the Maillard reaction in modulating the emulsifying properties of rapeseed cake protein

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Rapeseed press cake is a promising source of sustainable protein, but its use is limited by poor techno-functional properties. Conjugating proteins with polysaccharides through the Maillard reaction can improve their functionality. However, it is not well understood how this reaction progresses under mild wet-heating conditions. This study characterised the time course of conjugation between rapeseed cake protein (RCP) and maltodextrin. RCP-maltodextrin solutions (pH 8.0) were heated at 70 °C for 0.5-48 h. After 48 h, the pH had fallen from 8.00 to 6.77, the total colour difference was 20.84, and the browning index was 74.44. Amadori compounds and melanoidins also increased. Densitometric analysis of SDS-PAGE profiles showed that high-molecular-weight bands (>180 kDa) peaked at 24 h and then fell significantly, by about 50%, at 48 h ($p < 0.05$). Together these results confirm that the reaction progressed. FTIR, UV-visible and fluorescence spectroscopy showed that conjugation modified the structure of RCP. Conjugation also reduced particle size and increased both the absolute zeta potential and the polydispersity index. As a result, the conjugates had better emulsifying activity and emulsion stability than unmodified RCP. These findings support using RCP-maltodextrin conjugates as natural emulsifiers, for example to encapsulate hydrophobic bioactive compounds.

Beyond Lactose: Evaluating Delactosed Permeate as a Functional Food Ingredient in Dairy Heat Induced Gels

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Delactosed permeate (DLP), a dairy co-product generated after lactose crystallisation and dairy filtration processes, remains underutilised despite its composition. This study aimed to evaluate DLP as a functional ingredient by assessing its powder stability and exploring its potential as an ingredient for gelation and thread extrusion when combined with whey protein isolate (WPI). The chemical composition of DLP, for example protein was determined in triplicate. Three freeze-dried formulations (DLP, DLP with maltodextrin and DLP with milk protein isolate) were compared with liquid DLP for water activity, colour and the microstructure was assessed using light microscopy. Heat-induced gelation was evaluated using WPI (8% w/w) formulations with the addition of liquid DLP ranging from 3–10% w/w. Preliminary thread extrusion assessments of the heat induced gels was investigated. Water activity of the freeze-dried powders decreased from 0.935 in liquid DLP to 0.357 ± 0.003 after freeze-drying, and further to 0.192 ± 0.033 with maltodextrin and 0.070 ± 0.003 with MPI. Freeze-drying increased lightness (L*) from 70.33 to 87.90, while microscopy showed differences in lactose crystal morphology. At 8% WPI, 6% and 10% liquid DLP formed irreversible gels, whereas 3% DLP showed pH-dependent reversibility. Liquid-DLP formulations produced more continuous extruded threads, while freeze-dried systems exhibited poorer extrudability. These findings highlight DLP's functional properties and its potential as an ingredient in a basic dairy matrix.

Towards Sustainable Cocoa Alternatives: Is It Possible?

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The increasing vulnerability of conventional cocoa production has intensified interest in alternatives capable of reproducing the technological, sensory, nutritional and functional roles of cocoa in food products. This study examined the emerging science of cocoa replacement and established a framework for evaluating alternative ingredients across the product-development chain. Publications from 2006 to September 2026 were screened using predefined eligibility criteria, with 23 studies included in the final synthesis. The evidence remains fragmented across ingredient selection, processing, formulation, functionality, sensory performance, storage, safety, regulation and environmental assessment. Processing emerged as a key determinant of performance. However, integrated validation across formulation, sensory quality and shelf life remains limited. Storage stability was assessed in few studies, while safety, regulatory considerations and quantitative environmental assessments were inconsistently addressed. Cell-cultured cacao represents a pathway based on controlled cultivation of *Theobroma cacao* cells, but its feasibility depends on scalability, production costs, culture-medium requirements, regulatory acceptance and resource use.

The influence of partial depletion of micellar calcium phosphate on the rennet coagulation properties of milk

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Micellar calcium phosphate (MCP) is critical in the assembly of casein micelles. Substantial decrease of pH causes extensive MCP solubilization and consequently, casein dissociation. However, partial solubilization of MCP can be achieved without immediate disintegration and changes in the physico-chemical properties of casein micelles. This study investigated the effect of MCP on the renneting of casein micelles. For MCP adjustment, the pH of reconstituted skim milk was adjusted to values in the range 6.3 - 6.8, followed by subsequent dialysis of the samples against the original skim milk to restore the pH value and the mineral composition of the serum phase. The samples were analysed for turbidity, particle size distribution, zeta potential, hydration, soluble casein, mineral content and rennet coagulation properties. The samples showed progressive, steep decline of renneting ability as MCP decreased, with complete inhibition at the lowest MCP value. Although the analysis showed that the physico-chemical properties of the micelles were almost unaffected, the soluble casein in samples with lower MCP content was significantly increased, which could be correlated to the loss of rennet coagulation. These results indicate

that minor changes in MCP content can inhibit rennet coagulation, suggesting its importance for the techno-functional properties of the casein micelles.

A Farinograph guided approach for assessing the baking performance of wheat flours

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Loaf volume is a key measure of wheat baking quality, but baking tests often apply a fixed mixing time or leave the end point to the baker's judgement, although flours differ in their mixing requirements. This study developed a mini-baking test in which the Farinograph set water addition and mixing time for each flour and mixed the dough. Four commercial flours (biscuit flour, baker's flour, strong flour (Kluut) and wholemeal flour) were characterised by RVA, Glutomatic, GlutoPeak and Mixolab. Water addition was determined by titrating the full formulation to 500 BU, and each dough was mixed at 63 rpm for its Farinograph stability time. Specific loaf volume ranged from 2.23 to 4.34 mL/g and differed significantly among all four flours, with between-batch coefficients of variation of 1.2–3.1%. Among the refined flours, higher mixing stability was associated with higher specific volume, whereas lower dough stiffness (G') was associated with higher volume across all four flours. Wholemeal flour showed the highest stability but the lowest volume, highlighting the limitations of mixing stability alone as a predictor of baking performance. Farinograph-guided mini-scale baking shows potential for assessing wheat flours; validation across more wheat varieties is now required for use in breeding programmes.

SMACC+: Sustainable Microalgae and Cyanobacteria-based Bioactive Compounds for Cosmeceutical and Nutraceutical Applications

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SMACC+ is a pioneering interregional European project within the Atlantic Area programme, aiming to transform the cosmeceutical and nutraceutical industries using bioactive compounds and biopolymers from microalgae and cyanobacteria. The project addresses challenges in the sustainable utilization of microalgae, promoting waste reduction and a circular bioeconomy. It also aims to strengthen the competitiveness of the blue biotechnology sector by valorising industrial biomass waste into high-value ingredients through pilot-scale activities based on biorefinery principles. To achieve these objectives, the project is structured into four work packages. First, industry requirements, market opportunities and regulatory frameworks will be assessed to establish a strategic foundation aligned with sustainability principles. Second, sustainable biomass cultivation and production will be optimized, alongside the optimization of green extraction and recovery processes to maximize the yield of valuable bioactive compounds, including lipids, carotenoids, proteins, peptides and polysaccharides while minimizing the environmental impact. Third, sustainable bioactive formulations for dermocosmetic and nutricosmetic applications will be developed and validated using the recovered fractions. Finally, the environmental and economic sustainability of development process will be evaluated through life cycle and techno-economic assessments, while promoting knowledge transfer, industrial adoption and public awareness of sustainable blue biotechnology. The project aims to develop a sustainable, high-value ingredients from microalgae and cyanobacteria, demonstrating innovative pilot-scale processes, industrial applications and strengthening the Atlantic blue bioeconomy.

Resolving candidate microbial dark matter in aquaponics via taxonomy-independent clustering of full-length 16S rRNA gene sequences

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Aquaponics systems are closed-loop food production models and a One Health interface. While system stability depends on microbial communities, conventional metagenomic workflows rely on reference-based taxonomic assignment, causing biologically coherent but uncharacterised sequence populations, termed microbial dark matter, to remain unresolved. To resolve these populations, thirty-two samples were collected across an operational aquaponics facility, followed by DNA extraction and 16S sequencing using Oxford Nanopore. Reads were analysed using NaMeco, a taxonomy-independent pipeline that clusters

sequences in sequence space before taxonomic assignment, preserving populations irrespective of their representation in reference databases. Results were compared with a conventional reference-based profiling workflow. NaMeco resolved multiple sequence clusters lacking close reference representatives, accounting for 12–21% of reads and enriched within solid waste compartments. Among these, one of the most abundant lineages was a Legionellaceae variant sharing only 88% identity with its closest reference. Solid waste compartments also concentrated taxa associated with fish and human disease, including *Aeromonas* spp., *Edwardsiella tarda* and *Plesiomonas shigelloides*. In contrast, reference-based profiling fragmented or misassigned many divergent sequences, preventing their recognition as coherent biological populations. By separating biological structure discovery from taxonomic annotation, taxonomy-independent clustering enables previously unresolved microbial populations to be retained, characterised and tracked across complex environments. This provides a practical framework for investigating candidate microbial dark matter while supporting biosecurity monitoring in One Health production systems.

Valorization of Agro-Industrial Residues for Lactic Acid Bacteria Cultivation and Biosurfactant Production

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Transitioning toward a circular bioeconomy requires both discovering sustainable bioproducts and replacing costly synthetic growth media. This study integrates parallel, complementary outcomes from two independent initiativesfunded by the Vicerectory of Research, UCR), focused on strain isolation, and Irish Aid funded focusing on sustainable media replacement. Within the first stream, ten lactic acid bacteria (LAB) strains isolated from agricultural residues (pineapple, coffee, cocoa) were screened for biosurfactant production using drop-collapse, oil-displacement, and emulsification index (E_{24}) assays, employing a PBS secondary incubation to eliminate false positives from Tween 80 interference present in commercial media. In parallel, the second stream formulated prototype media from pretreated cheese whey, coffee husk extract, and spent *Saccharomyces cerevisiae* autolysate, evaluating growth performance across 24-h multi-well. The initial screening identified five active strains, led by *Lacticaseibacillus paracasei* subsp. *tolerans* 2A-2B, which achieved maximum oil displacement, strong drop-collapse, and a mean E_{24} of 90.0%. Simultaneously, preliminary findings on prototype media sustained strong cell proliferation with linear kinetics ($R^2 = 0.915$-0.945), though ongoing validation aims to confirm targeted metabolite synthesis. Jointly, these parallel findings prove that agro-industrial side-streams can independently supply both functional strains and sustainable cost-effective growth media within a single circular framework.

Beyond Compliance: Regulatory Challenges for Bio-Based Food Packaging

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Introduction: EU-funded projects such as Bio2PEs are developing bio-based and biodegradable materials derived from agri-food waste streams for food packaging and agricultural applications. However, the regulatory implications of these innovations remain poorly understood. **Objective:** To identify legislative requirements and potential barriers to the commercialisation of emerging bio-based materials intended for food-contact, food-packaging and related applications. **Methods:** A regulatory mapping and gap analysis was conducted to evaluate European legislation, standards and certification requirements relevant to novel materials, biodegradation technologies and future end-use applications. The assessment considered bio-based polyethylene and polyester materials, polyethylene-degrading enzymes, and advanced functionalities including antimicrobial, self-healing, insect-repellent and recycled-content applications. **Results:** Key legislative instruments included Regulation (EC) No 1935/2004, Regulation (EC) No 2023/2006, REACH (EC) No 1907/2006 and the Packaging and Packaging Waste Regulation (EU) 2025/40. Requirements were dispersed across multiple frameworks, many originally developed for conventional plastics. Emerging initiatives, including the Ecodesign for Sustainable Products Regulation and Digital Product Passports, are increasing emphasis on traceability, circularity and environmental claim substantiation. Food-contact safety assessment, migration testing, sustainability claim substantiation and end-of-life validation emerged as the principal evidence gaps. Commercialisation challenges arise primarily from generating the data needed to support compliance rather than from a lack of applicable legislation. **Conclusion:** While regulatory frameworks exist, the regulatory landscape for bio-based and biodegradable materials remains fragmented and evolving. Early regulatory assessment can improve

preparedness, reduce innovation risk and support the commercialisation of sustainable food-contact and food-packaging solutions.

Effects of pH and pepsin on *in vitro* gastric coagulation of milk proteins and mineral distribution in infant formula model systems

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Gastric coagulation of milk proteins is closely associated with pH and pepsin-mediated proteolysis, and may influence protein digestion and absorption in infants due to their low gastric acid and pepsin secretion. However, systematic comparisons of acid-induced and pepsin-induced coagulation behaviors during gastric digestion under infant conditions remain limited. This study investigated coagulum structure, and distribution of proteins and minerals during *in vitro* digestion of model infant formula systems, with and without pepsin, using dynamic light scattering, confocal laser scanning microscopy, high-performance liquid chromatography, sodium dodecyl sulphate-polyacrylamide gel electrophoresis, and inductively coupled plasma mass spectrometry. With decreasing pH, casein micelles gradually dissociated in gastric digesta prepared without pepsin, while protein aggregation occurred at pH 5.3, concomitant with decreasing percentage of non-sedimentable caseins and increasing proportion of sedimentable phosphorus in digesta. For the digesta prepared with pepsin, protein aggregates already formed at pH 6.5, accompanied by a lower percentage of non-sedimentable caseins and higher proportions of sedimentable calcium and phosphorus, compared to those prepared without pepsin. These findings indicate that pepsin-induced coagulation hinders the release of proteins and minerals during gastric digestion. Modulating coagulation behavior may be a potential strategy to improve digestibility of infant formula.

***Salmonella* Control on Irish Layer Farms: Identifying Sources, Transmission Pathways, and Effective Intervention Strategies**

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Salmonellosis remains one of the most common bacterial foodborne illnesses worldwide, with clinical symptoms including diarrhoea (which may be bloody), abdominal cramps, fever, nausea, vomiting, and headache. In Ireland, 419 confirmed cases of salmonellosis were reported in 2025. Poultry are recognised globally as an important reservoir and source of human *Salmonella* infections, highlighting the importance of effective control measures throughout the poultry production chain. The effectiveness of Ireland's Salmonella Control Programme, which incorporates routine sampling and testing of poultry flocks, relies on the implementation of appropriate biosecurity measures, the maintenance of high hygiene standards, and the adoption of targeted control strategies where necessary. However, the multiple potential sources and transmission routes of *Salmonella* present ongoing challenges to its prevention and control within poultry production systems. This project aims to strengthen *Salmonella* control in the Irish egg production sector through an integrated, multidisciplinary approach. The research will identify potential sources of *Salmonella*, investigate its survival and dissemination pathways on Irish layer farms, and examine the dynamics of transmission within layer flocks and its prevalence in eggs. In addition, the project will develop and evaluate targeted control interventions across the production chain, from feed mills to retail, while exploring the theory, knowledge, and practical implementation of biosecurity measures on Irish layer farms. The evidence-based insights and practical strategies developed will improve *Salmonella* prevention and control, enhance biosecurity practices and strengthen food safety and public health protection across the Irish egg production chain.

Influence of casein to whey protein ratio on thermoreversible gelation of concentrated milk protein dispersions

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Concentrated casein-rich dispersions form gels on cooling and regain flow on warming (thermoreversible gelation), offering potential for temperature-responsive textures in high-protein nutritional products. Incorporating whey protein isolate (WPI) can diversify protein composition but may alter gelation behaviour. This study characterised thermoreversible gelation in 20% (w/w) protein dispersions containing milk protein isolate (MPI) and WPI. Five MPI:WPI formulations (20:0 to 16:4 g protein/100 g dispersion) were

investigated, with MPI-only dispersions at corresponding MPI-derived protein concentrations included as references. Gelation and melting were assessed using oscillatory rheological temperature sweeps (n = 3). Across the MPI:WPI formulation series, gelation onset temperatures decreased from 27.1 ± 0.81 to 15.6 ± 2.47 °C, melting onset from 32.7 ± 0.79 to 19.5 ± 2.32 °C, and final storage modulus (G') at 4 °C from 1710 ± 144 to 53.8 ± 20.1 Pa. At matched MPI-derived protein concentrations of 17–19%, WPI-containing dispersions exhibited higher gelation and melting onset temperatures ($p < 0.05$) than MPI-only references, without significant differences in final G' ($p > 0.05$). These findings indicate that differences in gelation and melting temperatures did not necessarily correspond to differences in final gel strength, highlighting opportunities to tailor thermoreversible behaviour in concentrated milk-protein systems.

PFOS Detected in Infant Formula Available in Ireland: Assessment of PFAS Exposure Risk to Infants

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Per- and polyfluoroalkyl substances (PFAS) are persistent synthetic chemicals characterised by highly stable carbon-fluorine bonds, with extensive industrial applications. Current exposure estimates and human biomonitoring indicate that the tolerable weekly intake (TWI) of 4.4 ng/kg bw/wk is often reached and exceeded. Such estimates however are based on incomplete occurrence data, indicating the problem is likely worse than current estimates show. Infants represent a particularly vulnerable population. Exposure begins *in utero*, through transplacental transfer and continues postnatally through breastfeeding and consumption of infant formula. At present, there is a distinct lack of data on PFAS concentrations in infant formula sold in Ireland, hindering accurate dietary exposure calculations. In the present study, PFAS were extracted from twelve standard and specialised infant formulas purchased from Irish supermarkets and analysed via high resolution liquid chromatography-mass spectrometry against 30 known PFAS standards. PFOS was the only compound detected with concentrations ranging from 0.004 to 0.035 ng/mL in the analysed extracts. Estimated exposure from formula consumption ranged from 0.36 to 2.80 ng/kg bw/week. When comparing with the TWI of 4.4 ng/kg bw/week, the highest estimate represents a non-negligible fraction (~64% of TWI), highlighting the need for continued monitoring of PFAS in the Irish food system.

Preliminary assessment of *Brassica* by-products and opportunities for valorization

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Brassica vegetables are widely consumed in Ireland, and their production generates substantial quantities of by-products that remain underutilized. An estimated 30-50% of cauliflower and cabbage crops and approximately 43% of Brussels sprout crops may be discarded during harvesting or processing. This study characterized the proximate composition, phenolic content, and *in vitro* antioxidant activity of *Brassica* by-products to assess their potential as food ingredients. Samples were collected from two Irish farms and classified by crops and plant part. The samples were dried and analyzed for proximate composition, other minor compounds and antioxidant activity. Proximate composition varied across crops and plant parts by 72%, 35%, and 76% for protein, carbohydrates, and fat, respectively, using the highest value as a reference. Phenolic content and antioxidant activity showed also high variation across crops and plant parts assessed in this study, with kale by-products and Savoy cabbage highest and lowest antioxidant capacity, respectively. Through detailed characterization, the results of this study indicate that *Brassica* by-products still hold potential to be used for further revalorization for food applications, for example generating ingredients that can be used in novel food formulations, and further chemical characterization and consumer testing could assess the potential for their future utilization, representing an ideal opportunity within the circular bioeconomy.

A multi-product processing strategy for gluten-free foods using Irish-grown faba beans

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Gluten-free products are often low in protein and fibre, and there is a clear need for more nutritious alternatives. This study aimed to establish a fundamental processing strategy for Irish-grown faba beans, which could be adapted for use in the development of a range of gluten-free products. Pre-treatments consisting of germination and roasting, were applied, and their effect on the nutritional and functional properties of the resulting milled faba bean flour was evaluated. Pre-treated Irish faba bean flour was

compared with untreated Irish faba bean flour, a commercial faba bean flour and a wheat flour. Pre-treatments changed the proximate composition of the flour, significantly increasing protein (from 27 to 28 g/100 g) and fibre content (from 8 to 13 g/100 g)($p<0.05$), and reducing antinutrients, particularly vicine and convicine levels. Starch pasting properties of the treated flours were modified, with an overall reduction in viscosity and significantly lower gel hardness ($p < 0.05$), indicating starch breakdown during germination/roasting. Water holding capacity increased significantly ($p < 0.05$), suggesting better moisture retention in the final products. This base process was successfully adapted to breakfast cereal flakes and waffles, showing that pre-treating faba bean grains is a versatile strategy to produce more nutritious gluten-free foods, while adding value to a crop mainly grown in Ireland for animal feed.

Modification of blended plant protein systems: exploring the potential of water kefir fermentation as a bioprocessing strategy

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Complementary protein blending and subsequent bioprocessing offer a promising strategy to enhance the nutritional and functional properties of plant-based ingredients. This study investigated the effects of water kefir fermentation (24–72h) on Oat–Pea and Oat–Faba beverages formulated to optimise essential amino acid composition. Microbial growth, metabolite production, physicochemical characteristics, and techno-functional properties were assessed against unfermented controls. Fermentation significantly reduced pH and total soluble solids while increasing total titratable acidity, microbial growth, and metabolite production. Acetic acid bacteria, lactic acid bacteria, and yeast populations increased from approximately 6.1 to 8.6 log CFU/mL each within 24h. Fermentation also significantly improved beverage stability, reducing separation rates from 0.59 to 0.15%/min (Oat–Pea) and 0.46 to 0.16%/min (Oat–Faba) after 24h, alongside reductions in viscosity and particle size distribution. Two-way ANOVA identified fermentation time as a significant factor influencing all measured parameters, whereas formulation type primarily affected techno-functional properties. Overall, fermentation induced the most pronounced changes within the first 24h, substantially improving beverage physical stability, while extended fermentation primarily promoted further acidification, partial recovery of foaming capacity, and progressive changes in protein profiles. Ultimately, this study highlights the potential of water kefir fermentation to modify plant-based protein ingredients, providing insights to guide their application and integration into sustainable food systems

Impact of Pretreatment on Substrate Characteristics for Solid-State Fermentation of the brown seaweed *Sargassum muticum*

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Sargassum muticum is an invasive brown macroalgae found along the Atlantic coast that can be valorised as a sustainable source of food ingredients. Solid-state fermentation (SSF), the growth of microorganisms on a solid substrate with little or no free water, is a promising bioprocess for upgrading underutilised biomass. This study investigated the impact of autoclave, deep eutectic solvent (DES), and sequential DES-autoclave pretreatments on the physicochemical and biochemical characteristics of S. *muticum* and its subsequent SSF with *Aspergillus oryzae* at 30°C for 72h (n=3). Moisture, ash, reducing sugars, soluble protein, amino groups, colour and dry-mass recovery were determined. Overall, pretreatments altered both substrate composition and the subsequent fermentation performance. Pretreatment significantly affected ash content and colour, with autoclaving producing the greatest colour difference relative to untreated biomass. Reducing sugar content showed a significant pretreatment x fermentation interaction. Autoclaved biomass showed the highest pre-fermentation concentration (10.06±3.32 mg glucose/g DW), which decreased to 4.67±0.80 mg GE/g DW following fermentation. Soluble protein increased significantly following fermentation of DES and DES-autoclave-pretreated biomass, from 54.93±3.37 to 64.56±1.31 mg/g DW and from 48.31±2.95 to 67.87±2.94 mg/g DW, respectively. Amino groups also increased significantly following fermentation of DES and DES-autoclave-pretreated samples. DES-SSF showed the highest dry-mass recovery (89.32±1.50%), compared with autoclave-SSF (84.79±2.34%) and DES-autoclave-SSF (82.13±2.34%). DES pretreatment produced the strongest proteolytic response during SSF. In conclusion, pretreatment choice impacted biochemical and physical outcomes, offering different routes for substrate valorisation.

Effect of Alkaline Extraction pH and Ultrasound Treatment on the Functional Properties of Oat and *Palmaria palmata* Proteins

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Demand for sustainable protein ingredients has increased interest in plant and marine proteins. However, their use in food formulations, especially high-protein bars, is limited by functional properties affecting hydration, oil retention and dispersibility. This study investigated the effects of extraction pH and ultrasound on the functional properties of oat and *Palmaria palmata* protein fractions. Oat proteins were extracted by alkaline solubilisation and isoelectric precipitation at pH 10, 11 and 12, while *P. palmata* proteins were extracted at pH 12, with and without ultrasonication. Suspension solubility at pH 7 was determined gravimetrically after dispersion, equilibration and centrifugation, while water-holding capacity (WHC) and oil-holding capacity (OHC) were measured after hydration or oil equilibration and centrifugation. Analyses were conducted in triplicate, with whey protein concentrate (WPC 80) used as control. Functional properties differed significantly among the oat fractions ($p < 0.05$). Increasing extraction pH from 10 to 12 increased WHC from 10.55 to 13.55 g/g, while solubility peaked at pH 11 (28.00%). OHC was highest at pH 10 (26.07 g/g). For *P. palmata*, ultrasonication increased WHC (10.50 to 12.77 g/g) and solubility (9.67 to 10.50%), but reduced OHC (25.07 to 16.53 g/g) ($p < 0.05$). All extracted fractions showed higher values for these properties than WPC 80. These findings prove that extraction conditions influence protein functionality and provide a basis for selecting oat and seaweed protein fractions for high-protein bar formulations.

Linking composition and microstructure to protein digestion of commercial oral nutritional supplements

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Protein-enriched oral nutritional supplements (ONS) play a vital role in clinical nutrition, particularly during cancer treatments, helping to offset cancer cachexia. Variations in formulation, protein sources and matrix structure influence protein hydrolysis and bio-accessibility during digestion. This study aimed to characterise the composition and physicochemical properties of commercially available ONS and investigate their in-vitro protein digestion characteristics. Ten products representing different formulations, physical forms (liquid, semi-solid) and protein sources were selected. Their particle size, protein molecular weight distribution, and physical properties were characterised. After *in-vitro* digestion, digesta were analysed for changes in particle size and protein molecular weight distribution, while the bio-accessible fraction was assessed for protein solubility and free amine release. Products varied in composition, matrix structure and digestion behaviour. Weaker intermolecular interactions, resulting in a looser food structure were associated with greater protein hydrolysis, although this relationship was not consistent across all formulations. Collagen-containing products exhibited high solubility but comparatively low free amine release, demonstrating that solubilisation did not necessarily correspond to greater protein hydrolysis. Differences between products with similar protein sources highlighted the influence of formulation and ingredient interactions. Digestion reduced elastic properties while increasing particle size, indicating that particle growth did not necessarily reflect matrix integrity. Overall, greater enzyme accessibility and subsequent protein hydrolysis were observed in products with reduced protein intermolecular interactions and less structural complexity.

Weisselle cibaria MG1 impact on faba bean flour and in a bread system

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Exopolysaccharides (EPS) produced by lactic acid bacteria during sourdough fermentation can act as natural hydrocolloids, offering a clean-label alternative to conventional bread improvers. This study evaluated whether dextran synthesis by *Weissella cibaria* MG1 during faba bean flour fermentation could modulate sourdough properties and enhance the technological and nutritional quality of wheat bread. Faba bean flour was fermented with *W. cibaria* MG1 in the presence of sucrose (15%, flour basis) to promote dextran synthesis (SF+). A non-sucrose-supplemented sourdough fermented with the same strain

was used as the control (SF−). Dextran production increased the apparent viscosity of the SF+ by approximately 300% relative to SF−. Fermentation also increased total phenolic compound availability and radical-scavenging activity, while modifying phytic acid concentration. Furthermore, four bread formulations were prepared. Compared with all control formulations, bread containing EPS+ faba bean sourdough (SFB+) showed significantly higher specific volume, higher number and percentage area of crumb cells and lower crumb hardness. Moreover, owing the hydrocolloidal properties of dextran contributed to a slower staling rate, highlighting improved technological behaviour. These findings demonstrate that *in situ* dextran synthesis by *W. cibaria* MG1 in faba bean sourdough is an effective approach to valorise faba bean flour and improve the technological properties of wheat bread, while potentially increasing its nutritional value.

The MSCA-DN MICROSUNSET – A focus on research and training on micronutrients in our food and diet

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MICROSUNSET (Micronutrients in Sustainable and Nutritious Diet) is a European MSCA Doctoral Network working to improve understanding of micronutrient delivery in sustainable diets. Hidden hunger remains a challenge in Europe and may be affected by the transition towards more plant-based diets. While plant foods provide many essential nutrients, the amounts available to the body can depend on the food source and how it is prepared or processed. Edible plant materials left unused during food production may offer opportunities to make better use of existing resources, broaden the range of ingredients for future foods and support a more circular food system. Within this network-wide context, research on upcycled leafy side-streams as potential sources of iron and zinc will reveal their potential as fortificants in food products contributing to sustainable diets. Therefore, the food matrix and the upcycling process needs to be carefully considered, to facilitate nutrient retention and their availability in the body. Examining these factors will inform on how such materials might be integrated in future foods. By bringing together expertise in nutrition, food science and processing, MICROSUNSET supports interdisciplinary research towards resource-efficient foods and healthy, sustainable diets.

Physicochemical and Microbiological Performance of Zein–Chitosan Blend Films for Food Packaging Applications

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Zein–chitosan blend films were developed by solution casting as potential biobased alternative materials for food packaging. Chitosan and zein solutions were blended, cast onto plates, and dried under controlled conditions to obtain films. The films were characterised for thickness, surface wettability by contact-angle analysis, water-vapour (WVP) and oxygen (OP) barrier properties, and tensile mechanical performance. Surface and cross-sectional morphology were examined by scanning electron microscopy (SEM), while atomic force microscopy (AFM) provided surface topography and roughness information. Differential scanning calorimetry (DSC) was used to assess thermal transitions and material compatibility. Microbiological performance was evaluated using disk diffusion and agar slurry assays following ASTM Standard Methods, which assessed inhibition zones and microbial reduction upon direct contact with the films, respectively. These complementary approaches enabled evaluation of both diffusible antimicrobial activity and contact-dependent antimicrobial performance. A screening life-cycle assessment (LCA) compared the environmental profile of the resulting zein–chitosan blend films with selected commercial packaging films, considering raw material, film production, and end-of-life scenarios. Overall, the blend films showed potential as biopolymeric packaging materials, with performance dependent on the balance between chitosan and zein ratios, barrier behaviour, and mechanical integrity. The microbiological results supported their potential as active packaging materials thanks to the inner antibacterial properties of Chitosan; while the LCA identified environmental trade-offs for formulation and process optimisation. This integrated physicochemical, microbiological, and environmental approach provides a foundation for the further development of zein–chitosan films as alternatives to conventional petroleum-based food-packaging materials.

The application of Response Surface Methodology for the Development of Sustainable Antimicrobial Active Absorbent Pads using Fish Gelatin and Natural Antimicrobials for Shelf-Life Extension of Salmon fillets

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The objective of this study was to develop sustainable, antimicrobial fish gelatin (FG)-based absorbent pads using response surface methodology (RSM) to extend the shelf-life of salmon fillets. The effects of FG concentration (15–25%, w/v), glycerol concentration (10–20%, w/w), pH (4–10) and natural antimicrobial (NAM) combination of oregano (OEO) and thyme (TEO) essential oils (0–8×$MIC_{OEO/TEO}$) on antimicrobial activity and water absorption capacity (WAC) of the absorbent pads were assessed using a Draper-Lin small composite design comprising 19 different formulations. RSM optimization identified the optimal formulation as 20% (w/v) FG, 15% (w/w) glycerol, pH 4 and 8×$MIC_{OEO/TEO}$ to maximize both antimicrobial activity (against *Pseudomonas fluorescens* (*P. fluorescens*), *Staphylococcus aureus* (*S. aureus*) and salmon microbiota) and WAC. The optimized pads achieved >99.9% reductions in *P. fluorescens*, *S. aureus* salmon microbiota, while exhibiting significantly higher ($p < 0.05$) WAC than commercial absorbent pads. When applied to modified-atmosphere-packaged salmon fillets stored at 4°C, the optimized pads extended product shelf-life by ~ 3 days relative to commercial pads, based on microbiological counts and total volatile basic nitrogen values. In addition, they effectively reduced exudate accumulation while maintaining comparable drip-loss control. Life cycle assessment demonstrated significantly lower environmental impacts for the optimized pads across multiple categories, including abiotic resource depletion, global warming potential, ozone depletion, human toxicity, ecotoxicity, photochemical ozone formation, acidification and eutrophication. These findings demonstrate that FG-based antimicrobial absorbent pads offer an effective and environmentally sustainable packaging solution for enhancing salmon quality and reducing food waste through shelf-life extension.

Development of a Portable Multiplex Biosensing Platform for Marine Biotoxin Quantification Using Shape-Tailored Gold Nanoparticles and AI-Assisted Digital Colour Analysis

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Shellfish and fish are vital sources of protein and nutrition, but in certain circumstances, they accumulate marine biotoxins that cause high numbers of intoxications in humans every year. Different assays are available for the detection of these toxins, but these methods involve complex sample preparation and limitations in sensitivity and specificity. Therefore, there is a growing need for rapid detection, such as multiplex lateral flow immunoassays (LFIA), capable of simultaneously detecting multiple toxins with improved sensitivity and specificity to address practical challenges in seafood monitoring due to their cost-effectiveness and scalability. For the development of the LFIA strip, gold nanoparticles (AuNPs) of varying morphologies were synthesized using the Turkevich method, hydroquinone-mediated seeded growth (via 15 nm Au seeds), and a seedless approach employing increasing buffer ratios (R = [HEPES]/[$HAuCl_4$]). As a result, Spherical AuNPs of 15nm, 21 nm and 40 nm (red), Au nanopopcorns of 150 nm, Au Nanostars of 60 nm (blue) and 140 nm (purple), and Au Nanoflowers of 98 nm (blue) and 122 nm (purple) were synthesized and characterized using UV–Vis spectroscopy, DLS, and SEM. For bioreceptor development, both conventional monoclonal antibodies and recombinant nanobodies were investigated as alternative recognition elements for marine biotoxin detection. Recombinant nanobodies were successfully expressed in Escherichia coli, purified and evaluated for their potential application in lateral flow biosensing. Optimal antibody concentrations and conjugation pH conditions were established through checkerboard titration. For conjugation, the optimal pH and antibody concentration were determined via checkerboard titration. The target toxin was conjugated to BSA (carrier protein), and the conjugation was confirmed using FTIR, NMR spectroscopy, SDS Page, UV-Vis and thin layer chromatography. LFIC test strips were assembled, biochemically optimized, and validated using spiked samples. To enable on-site quantification, a mobile application was developed using Python programming and Streamlit, providing both single and multiplex detection modes. The app allows users to upload LFIA strip images, automatically crops the region of interest, and removes background noise to improve analytical accuracy. It then applies automated algorithms such as four-parameter logistic (4PL) and logistic regression models to convert color intensity into quantitative toxin concentrations. The app also enables users to input their

own standards for comparison and improved reliability, supports downloading results in multiple formats, and indicates whether the calculated concentration exceeds or falls below EU regulatory limits, demonstrating its practical application for rapid, on-site seafood safety monitoring, environmental monitoring and supports improved assessment and management of water bodies quality and decision-making.

Nanoparticle-Enabled Lateral Flow Biosensing for Marine Biotoxin Detection: A Systematic Review of Technological Advances and Emerging Trends over Two Decades

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Marine and freshwater biotoxins threaten public health and seafood safety due to their tendency to accumulate in fish and shellfish. This systematic literature review summarises findings from 51 peer-reviewed studies published between 2004 and 2025 that focus on nanoparticle-enhanced lateral flow immunoassays (LFIAs) for marine biotoxin detection. Included marine biotoxins includes Microcystin LR, saxitoxin, tetrodotoxin, brevetoxins, cyclic imines, domoic acid and okadaic acid. Gold nanoparticles (AuNPs) were by far the most used label, employed in ~75 % of studies, which consistently delivered the lowest limits of detection (LODs) as low as 0.03 ng/ml for okadaic acid detection. Despite increasing concerns over the co-occurrence of multiple toxins, ~88 % of the studies were based on single-analyte detection, only ~12 % employing multiplexed approaches. Statistical analyses of the studies, namely Kruskal–Wallis, Dunn's post hoc, correlation, and regression analysis, revealed meaningful trends. LODs have significantly improved over time, a marked reduction being observed after 2016. Kruskal–Wallis and Dunn's post hoc tests showed significant differences across variables such as nanoparticle size, assay duration, and toxin recovery. Spearman correlation results identified a moderately significant negative correlation of LOD with publication year ($\rho = -0.458$, $p < 0.001$), and a weaker significant correlation of LOD with assay time ($\rho = -0.301$, $p = 0.018$), while linear regression analysis identified publication year ($R^2 = 0.2441$, $p < 0.0001$) and nanoparticle size ($R^2 = 0.1072$, $p = 0.0264$) as significant predictors of assay sensitivity. Overall, this review underscores the central role of nanoparticle engineering, simplified assay workflows, and optimized design strategies in improving LFIA performance. The findings provide a valuable roadmap for advancing the development of portable, sensitive, and scalable biosensing platforms for marine toxin monitoring, seafood and water bodies safety surveillance.

Comparative assessment of protein extraction technologies and techno-functional characterisation of protein extracts and their enzymatic hydrolysates from farmed Irish brown seaweeds

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The increasing demand for sustainable protein sources has driven interest in seaweeds as alternative sources of functional proteins. Despite their potential, complex cell wall composition presents challenges for efficient protein extraction. This study comparatively evaluated conventional alkaline, ultrasound-assisted and hydrothermal-assisted extraction of proteins from farmed Irish brown seaweeds, *Saccharina latissima* and *Alaria esculenta*. Selected protein-rich extracts were enzymatically hydrolysed, and the techno-functional properties of the resulting hydrolysates were evaluated. Hydrothermal-assisted extraction achieved the highest protein extraction yields, reaching 33.63 ± 0.09% for *A. esculenta* and 19.25 ± 0.13% for *S. latissima*. In contrast, ultrasound-assisted extraction produced the highest protein contents, reaching 23.02 ± 0.22% for *S. latissima* and 18.32 ± 0.09% for *A. esculenta*. These extracts and prepared hydrolysates also exhibited favourable techno-functional properties, predominantly solubility (70.5-80%), water-holding (445.01-243.02%), and oil absorption (308.01-167.50%) capacities. Overall, this study highlights the potential of seaweeds as alternative protein sources and demonstrates the influence of extraction technology on protein recovery and techno-functional properties. Ultrasound-assisted extraction showed promise in achieving a favourable balance between protein content and functional performance. These findings support the further development of brown seaweed-derived protein extracts and hydrolysates as potential ingredients for food applications.

Sustainable valorisation of dairy processing side-streams: Engineering yeast cell factories to produce carotenoids from whey

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Dairy processing generates large volumes of whey-based side-streams that are underutilised despite their potential as lactose-rich substrates for microbial biotransformation. Precision fermentation offers a sustainable route to valorise these residues into high-value food ingredients. We aim to develop a *Saccharomyces cerevisiae* cell factory integrating lactose utilisation with carotenoid biosynthesis for whey-based fermentation. A heterologous carotenoid pathway was assembled using Golden Gate cloning and expressed in *S. cerevisiae BY4741*. Single- and multi-copy strains produced 4.05 ± 0.66 and 7.24 ± 0.70 mg carotenoids/g DCW, respectively, with significantly higher production in the multi-copy strain ($p = 0.0045$; $n = 3$) on glucose. In parallel, a secretion-tagged *LAC4* gene, encoding β-galactosidase from *Kluyveromyces lactis*, was introduced to facilitate lactose utilisation. *LAC4* -expressing strains maintained carotenoid production on glucose, indicating that *LAC4* expression did not substantially affect carotenoid biosynthesis. On lactose, engineered strains formed biomass, although carotenoid yields were lower than on glucose. β-galactosidase activity was detected predominantly in cell pellets, with limited activity in culture supernatants, highlighting opportunities to improve enzyme secretion and extracellular lactose hydrolysis. Overall, this work establishes a carotenoid-producing yeast platform for dairy side-stream valorisation, with further optimisation of *LAC4* secretion and lactose utilisation needed to support whey-based carotenoid production.

Integrated Recovery and Characterisation of Value-Added Ingredients from Boarfish Soudabeh Ghalamara, Rahel Suchintita Das, Eugenia Mazzara, Shay Hanon and Brijesh K. Tiwari
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Boarfish is an underutilised marine resource with potential for value-added ingredient production. This study aimed to develop an integrated processing approach to recover fish oil, protein-rich meal and peptide fractions, and evaluate their composition, functionality and antioxidant properties. Boarfish was steam-cooked (90°C, 30 min) and pressed to separate fish meal and stickwater. The soluble protein fraction underwent enzymatic hydrolysis with Alcalase (0.5%, 55°C, 60 min, pH 7.5), followed by microfiltration (0.02 µm) and ultrafiltration (3 kDa). All analyses were performed in triplicate, with results expressed as mean ± standard deviation. Fish meal contained 61.51 ± 1.00% protein on a dry basis and exhibited a water-holding capacity of 3.10 ± 0.56 g/g and a foaming capacity of 52.08 ± 1.45%. Protein content reached 76.20 ± 0.30% in the ultrafiltration retentate. The recovered oil contained 5.47 ± 0.15% eicosapentaenoic acid. Ferric reducing antioxidant power values ranged from 8.98–12.03 µmol Trolox equivalents/g in raw boarfish and fish meal, compared with 271.04–294.01 µmol Trolox equivalents/g in processed fractions. The hydrolysate supernatant and ultrafiltration permeate exhibited ABTS radical-scavenging activities of 126.41 ± 0.58 and 126.82 ± 0.94 µmol Trolox equivalents/g, respectively. These findings demonstrate the potential of integrated boarfish processing to produce value-added ingredients with desirable nutritional and functional characteristics and *in vitro* antioxidant activity.

Palate vs. preference: Mapping trained panel profiles against consumer acceptability for Irish honey
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Despite growing interest in the bioactive properties of Irish monofloral honeys, their complex sensory characteristics remain uncharacterised. This study provides the first comprehensive sensory evaluation of Irish honey quality, contrasting trained panel profiling with consumer perception. Three ivy and three heather monofloral honeys (sourced directly from beekeepers) were compared to four supermarket commercial blends. A trained panel (n=7; 26h training) developed a 58-attribute lexicon, identifying significant differences ($p<0.05$) in 50 attributes. Consumers (n=225; 98% 18–34y) evaluated a sample subset (heather n=2, ivy n=3, commercial n=4) for acceptability. PCA (64% explained variance) highlighted the associations of *medicinal*, *woody*, *smoky* and *bitterness* with heather honeys*, crystallised* mouthfeel and *green grassy* notes with ivy honeys. Commercial blends were the least complex, and associated with *sweetness* and *golden syrup* notes. Similar aroma and flavour associations were made by consumers, who associated heather and ivy honeys with *woody* and *earthy* notes (Correspondence Analysis, 85% explained variance). A two-way ANOVA revealed significant differences ($p<0.001$) in all affective-liking characteristics, where overall liking was significantly higher for the familiar commercial varieties (6.2±0.1)

than the ivy (4.1±0.1) or heather honeys (3.8±0.1). Ultimately, while Irish monofloral honeys possess unique functional benefits, the sensory attributes present a hedonic barrier for young consumers, highlighting the need for strategic blending or demographic-specific marketing. Expanding consumer testing across diverse age cohorts and integrating projective mapping will further support Irish beekeepers in understanding market preferences.

Aqueous-Phase Chemistry as the Sensing Frontier in Cheese: Harnessing Salt and Mineral Distribution, Casein Hydration, Machine Learning for IoT-Enabled Monitoring of Ripening and Functionality

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Cheese ripening and functionality depend on bulk composition and heterogeneous aqueous domains within the casein matrix, containing minerals and organic acids that influence pH, ionic strength, water activity and protein interactions. This review proposes a chemical profile-to-sensing-to-prediction framework linking aqueous-phase chemistry, structure and sensing. Moisture content is distinguished from aqueous-phase properties; while cheese juice, expressible serum and water-soluble extracts are considered as recovery methods, and acid-base buffering is also note as an analytical technique of interest. Key processes of interest include pH-dependent calcium-phosphate redistribution, mineral buffering, salt gradients, organic-acid metabolism and casein hydration, while nuclear magnetic resonance (NMR) may distinguish water populations by molecular mobility, which total-moisture measurements cannot reveal. Machine-learning approaches (compositional, imaging, spectroscopic) and sensors (ion-selective electrodes, dielectric, NMR, optical) are assessed, with challenges including matrix interference, sensor drift, calibration transfer, representative sampling and limited industrial validation. Combining aqueous-phase ionic, organic-acid and water-mobility descriptors may improve interpretable prediction of ripening and functionality. Existing Internet of Things applications monitor ripening rooms; future systems could track changes in cheese-matrix chemistry. Industrial implementation requires robust sensing and independent validation across batches and factories.

Insights and new strategies advancing on lipid recovery from microalgae

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Microalgal biomass offers potential as a sustainable source of lipids, but their recovery is challenging as conventional extraction relies on hazardous solvents, such as methanol, chloroform and petroleum ether, raising concerns when the intended use of these lipids is for food applications. This study assessed food grade solvents combined with conventional and innovative technologies, namely ultrasound-assisted extraction (UAE) and microwave-assisted extraction (MAE) to recover lipids from commercially available microalgal biomass. Solvent concentration and operating conditions were screened, followed by comparison of extract yield, non-polar lipid recovery and radical-scavenging activity. Scanning electron microscopy was used to examine changes in the residual biomass. Morphology observations revealed method-dependent changes in the residual biomass, with ultrasound producing a porous surface and microwave treatment causing more pronounced fragmentation. Extraction method significantly affected recovery with MAE conditions explored achieving higher recoveries compared to UAE and comparable to those conventional methods currently considered as the industry's gold standard. The findings of this study suggest that these technologies enhance extraction through distinct disruption mechanisms and that both UAE and MAE combined with food grade solvents are valid solutions to replace conventional methods for the valorization of microalgal biomass in the future.

Effects of steaming on polystyrene nanoparticle behaviour in egg digesta and association with intestinal cells

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Cooking and food matrices may influence the gastrointestinal fate and cellular interactions of ingested plastic particles. This study examined whether adding polystyrene nanoparticles before or after egg

steaming influenced their behaviour during digestion and subsequent association with intestinal cells. Polystyrene nanoparticles (200 nm) were added before or after steaming, followed by simulated gastrointestinal digestion. Particle morphology was assessed by transmission electron microscopy. Caco-2 cells were exposed to diluted digesta in three independent experiments, with responses assessed by mitochondrial activity measurements, flow cytometry and fluorescence microscopy. Particles largely retained spherical morphology after cooking and digestion, although aggregates and surface-associated residues were observed. Fluorescence microscopy images showed a significantly lower number density of polystyrene when particles were added before steaming than after steaming. Particles added before steaming appeared as discrete aggregates associated with cell membranes, whereas particles added afterwards showed more widely distributed fluorescent particles. The timing of nanoparticle contamination relative to steaming influenced their aggregation during digestion and subsequent interaction with cells.

Digestibility of Protein Rich Plant-Based Beverages under adult and older adult INFOGEST digestive conditions

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Driven by global population ageing, coupled with sustainability concerns, there is a critical need to evaluate the nutritional efficacy of plant-based protein beverages for older adults. Five protein rich beverages were formulated using pea, faba bean and/or oat protein ingredients, and subjected to INFOGEST static *in vitro* digestion under the adult and older adult conditions. Digestibility was assessed by total nitrogen, o-phthaldialdehyde (OPA) and total amino acids (TAA) measurements. *In vitro* digestible indispensable amino acid ratios (DIAAR) and estimated scores were calculated using FAO adult reference values. TAA content was ranged from approximately 80 to 86 mg/g, with leucine the most abundant essential amino acid (~7 mg/g). All three digestibility estimates were high in the adult model. Nitrogen- and OPA-based estimates remained high in the older adult model, whereas TAA-based digestibility decreased to 47.3–75.0%. Most adult-model DIAARs exceeded 100% with sulfur amino acids identified as the first limiting amino acids. *In vitro* DIAARs were lower under older adult conditions ($p<0.05$). Normalization identified the faba bean–oat beverage as having the highest composite score (93.40/100). These findings highlight the importance of evaluating plant-based protein beverages underage-specific digestive conditions when developing foods for older adults

Effects of Naturally Derived Reduced-Sodium Sea Salt Replacers on the Physicochemical, Sensory and Microbiological Properties of Fresh Pork Sausages

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Naturally derived reduced-sodium sea salts offer lower sodium, potassium and/or magnesium enrichment, and potential clean-label benefits. This study evaluated the potential of two naturally derived reduced-sodium sea salts, SOLO (41% NaCl, 41% KCl, 17% Mg Salts) and SaltWell (65% NaCl, 30% KCl), as NaCl replacers in fresh pork sausages. Nine sausage formulations were prepared in three independent batches, including a standard NaCl control and sausages in which NaCl was replaced with SaltWell or SOLO at different replacement levels (25%-100%). Sensory evaluation involved 25 assessors. Both reduced-sodium sea salts progressively decreased sodium content without significantly affecting protein, moisture, fat or ash contents ($P > 0.05$). Instrumental color values and cooking loss were not significantly affected by salt replacement ($P > 0.05$). All sausage batters exhibited elastic-dominant behaviour, although SOLO treatments generally showed lower storage modulus values. Texture profile analysis indicated reductions in hardness and chewiness at higher replacement levels; however, these differences were not reflected in sensory firmness scores. Sensory acceptance testing showed no significant differences in overall acceptability, flavour or texture ($P > 0.05$). Total viable counts increased more rapidly in fully replaced formulations, particularly with SOLO. Overall, SaltWell and SOLO reduced sodium content while maintaining most physicochemical and sensory quality attributes of fresh pork sausages, although complete replacement, especially with SOLO, may require additional microbiological control strategies.

Impact of native and circular feed ingredients on myoglobin forms and surface colour stability of pork

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The drive towards sustainable pig production has increased interest in alternative feeds, yet their effects on pork quality over postmortem ageing period remain underexplored. This study examined how diet and feed form influences myoglobin forms and meat colour during ageing. *Longissimus* muscle samples collected from 30 gilts in a 2×2 factorial trial compared conventional and alternative diets (~40% replacement of conventional feed with oats, rapeseed meal, and bakery by-product), fed wet or dry. Colour was measured on bloomed vacuum-packaged meat at different postmortem days using HunterLab UltraScanPRO; reflectance data estimated myoglobin redox forms following AMSA guidelines. Wet-ageing increased redness and yellowness progressively over 14 days ($P<0.001$), neither diet nor feed form affected colour or myoglobin forms. Deoxymyoglobin (DMb)% declined over ageing period while oxymyoglobin (OMb)% increased (DMb:68.97±2.23% to 9.76±2.25%; OMb:21.0±1.82% to 75.8±1.82%; $p<0.0001$). Metmyoglobin remained stable for first 4 days, decreased on day 7 (7.39±0.69%; $p=0.0014$), and increased by day 14 (14.46±0.70%; $p<0.0001$). These findings suggest ageing as the main driver of colour and myoglobin changes, while transition to more sustainable pig diets produced meat comparable to standard diets in colour.

Integrated Ultrasound-Hydrothermal Assisted Extraction of Processed Brown Seaweeds for Fucoidan Recovery and Bioactive Potential

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Macroalgae have gained significant global attention across various industries due to their rich content of bioactive compounds. Fucoidan, a sulphated polysaccharide predominantly found in brown seaweeds, has attracted considerable interest owing to its potential applications. However, the complex biochemical composition of brown seaweed, including laminarin, alginate, proteins and phenolic compounds present significant challenges to fucoidan extraction and purification, often limiting its recovery and yield. In the current study, we access ultrasound-hydrothermal (US-HT)-assisted extraction followed by ethanol precipitation and ultrafiltration as two separate purification strategies for recovering fucoidan from pre-processed farmed seaweed namely *Alaria esculenta* and *Ascophyllum nodosum*, while characterizing composition and antioxidant activity of the recovered fractions. Compared to control, US-HT significantly improved the extraction yield ($p < 0.001$) from 6.71% to 21.48% in *A. esculenta* and from 20.34% to 65.67% in *A. nodosum*, raising crude fucoidan rich extracts to 114.56 and 511.65 mg/g, respectively. DPPH radical scavenging assay of fucoidan rich ultrafiltration retentate (IC_{50} 0.06 mg/mL) approached ascorbic acid (IC_{50} 0.023 mg/mL). In Conclusion, the study yields a comparative assessment on extraction method, and purification strategy to determine the yield and purity of fucoidan rich pre-processed seaweed.

Discrimination and characterization of the texture and flavor in commercial Chinese steamed breads collected from different region: An integrated analysis using multivariate statistical models

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Chinese steamed bread is an important staple in China with distinct regional characteristics. To elucidate regional diversity and support standardization, quality control, and product development, twelve regional breads were analyzed for physical and chemical properties. Specific volume, color, texture parameters, and volatile compounds were measured. Odor activity value analysis (OAV), orthogonal partial least

squares discriminant analysis (OPLS-DA), and random forest models were applied to comprehensively identify differential and key aroma compounds. Northern breads were darker, larger, firmer, and chewier than southern breads and showed higher proportions of alcohols (30.71-49.14%), followed by aldehydes, esters, and ketones. Across the twelve samples, fourteen key aroma compounds were consistently identified by convergent evidence from OAV, OPLS-DA, and random forest. These results establish a scientific baseline for Chinese steamed bread and clarify the chemical and textural features underlying regional diversity, providing actionable guidance for quality control and product development for producers.

Evaluating Food Security in Ghana: Insights for Policy Interventions Using the Annual Household Income and Expenditure Survey (AHIES)

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Urban households in sub-Saharan Africa are consistently more food secure than rural households, but the mechanism is rarely tested. One explanation holds that urban labour markets reward education more directly than rural ones. The objective was to test this explanation using data on 13,625 households in 1,000 enumeration areas from Ghana's nationally representative Annual Household Income and Expenditure Survey. Households spending more than 60% of total expenditure on food were classified as food access insecure. Linear and logistic models were fitted with survey weights and design-based variance estimation. Food access insecurity affected 31.5% of households (95% confidence interval 29.5 to 33.5%). Urban households had 2.43 times higher odds of being food access secure than comparable rural households (95% confidence interval 2.01 to 2.94), and this advantage persisted within every income quintile. Returns to education of the household head were significantly higher in rural than in urban households (odds ratio 1.35 versus 1.30; interaction P=0.009). Dependency burden predicted the continuous food expenditure share but not the binary outcome. The urban advantage is therefore not explained by greater returns to education in cities and more plausibly reflects differences in infrastructure, market access and transaction costs, and policy should prioritize rural connectivity and storage over differential investment in education.

Development and characterisation of antioxidant-active biopolymer films from C*hondrus Crispus* and *Sargassum* sp. extracts

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Active food packaging is gaining rapid traction, with renewable, film-forming seaweed polysaccharides emerging as promising base materials. Incorporating functional extracts into these biopolymer matrices tailors their mechanical properties while imparting vital antioxidant activity. This study evaluated the performance of solution-cast films combining carrageenan-rich *Chondrus crispus* extract (CC) with water-soluble *Sargassum* sp. extract (SA).CC was obtained using pilot-scale hybrid microwave–ultrasound-assisted extraction (2000 W microwave, 200 W ultrasound, 40 min), while SA was recovered by aqueous extraction (80 °C, 2 h). Extraction yields were 43.71 ± 1.45% and 28.54 ± 2.41%, respectively. Glycerol-plasticised films were prepared at CC:SA ratios of 100:0, 80:20, 60:40 and 40:60. Extracts and films were characterised by Fourier-transform infrared (FTIR), size-exclusion chromatography, ferric reducing antioxidant power (FRAP), tensile testing and scanning electron microscopy (SEM). Weight-average molecular masses were 1.54×10^6 g mol^{-1} (CC) and 1.06×10^6 g mol^{-1} (SA). Film FRAP response increased with SA content, from 1.36 (control) to 6.99, 9.15 and 12.93 at 20%, 40% and 60% SA, respectively. The 60:40 film had the highest elongation at break (120.6 ± 21.7% versus 81.7 ± 16.1% for CC), but lower tensile strength (8.69 ± 0.45 versus 14.30 ± 3.19 MPa). At 60% SA, tensile strength fell to 4.12 ± 0.14 MPa. SEM revealed a smooth CC control surface, whereas blended films showed greater roughness, salt crystal deposition and heterogeneous morphology as SA content increased. The strength reduction may reflect limited CC–SA compatibility and weaker matrix cohesion. The 60:40 formulation balanced flexibility and antioxidant response under the conditions tested, warranting further barrier and application testing.