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Meeting Abstracts

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Keynote Presentations

Enzymatic and Analytical Approaches to Improve Rapeseed Protein Ingredients

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Abstract

Rapeseed (*Brassica napus* subsp. napus) is a promising sustainable plant protein source; however, its application in food products is limited by anti-nutritional factors and incomplete characterization of its storage proteins. Cruciferin and napin are the two major rapeseed seed storage proteins and largely determine protein ingredient functionality. One important anti-nutritional factor is phytic acid, which binds minerals and reduces protein solubility. The impact of enzymatic phytic acid hydrolysis on rapeseed protein solubility was investigated. Rapeseed press cake extracts were treated with phytase and phosphatase at 40 °C for 60 min, followed by pH adjustment (pH 4 - 9). Reversed-phase high-performance liquid chromatography analysis showed that phytase treatment significantly increased cruciferin solubility at pH 4 by up to 6-fold ($p \leq 0.05$), while napin solubility was only marginally affected. Elemental analysis revealed increased soluble phosphorus, indicating improved mineral bioavailability. Thus, phytase treatment enhances the functional properties of rapeseed protein by improving its dispersion and solubility. To enable detailed characterization of rapeseed protein ingredients, a targeted selected reaction monitoring liquid chromatography–tandem mass spectrometry method was developed and validated for the quantification of napin, cruciferin, and, notably, their isoforms using synthetic peptide standards. Application of this method to protein isolates, extracts, and a commercial rapeseed protein product revealed distinct protein compositions and variant distributions among samples. Together, these results demonstrate that enzymatic phytate degradation improves rapeseed protein functionality, while targeted liquid chromatography–tandem mass spectrometry provides a robust tool for resolving protein heterogeneity. Combined, these approaches support the development and optimization of rapeseed proteins for plant-based food applications.

Innovation in Mixing Dough: Bread, Biscuit, and Cake Applications

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Abstract

Recent innovations in mixing concern the use of pressure/vacuum-mixing using selected gas(es). This allows controlling the void fraction and the structure of the dough. Recent application will be detailed with bread, poundcake and biscuits. The use of carbon dioxide was successfully used to suppress chemical leavening in poundcake, whereas limitations appeared with bread and biscuits. Nitrogen is a neutral gas with low solubilization, whereas dioxygen may play a major role in the structuration of the gluten network for bread in particular. The key point concerns the partial pressure of each gas, which will yield a certain amount of solubilized gas. Gas may also be solubilized in the liquid phase prior to mixing. Applying gas pressure in the mixer's headspace yields initial void fraction with can reach 0.25; this must be accommodated in the process at follow in particular for bread-dough fermentation. Vacuum is usually applied at the end of mixing and plays a major role in controlling the final void fraction and the gas cell size's distribution. Perspectives will be proposed as a conclusion.

Fair Skin is a Risk Factor for Cholelithiasis

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Abstract

Cholelithiasis (gallstone formation) imposes a significant global health burden. It causes high morbidity, necessitates frequent hospitalization, and incurs very high costs. Still, the pathogenesis of gallstone formation remains incompletely understood. Different dietary components have been linked to an increased risk of gallstone formation. However, study results are not always consistent. Moreover, they cannot explain the initiation of gallstone formation, when a basic nucleus (nidus) forms from which gallstones can grow. Long-term clinical observations suggest that fair skin is a risk factor for cholelithiasis, but the connection between skin color and gallstone formation remains unclear. The discovery of reactive melanin precursors has led to the hypothesis that some of these compounds could be excreted through bile and contribute to gallstone formation. Experimental evidence indicates that individuals with light skin who are exposed to ultraviolet radiation excrete more of these compounds from their cutaneous melanocytes. A clinical study showed that fair-skinned individuals who enjoy sunbathing are at a very high risk of developing cholelithiasis. Patients with psoriasis, often treated with ultraviolet radiation and seeking sunlight for its healing effects, also show a significant increase in gallstone formation. Most gallstones are asymptomatic, but some patients may develop symptoms soon after formation. If sunlight influences gallstone pathogenesis, higher hospital admission rates for cholecystectomy should be expected in summer, which is supported by studies showing peak rates during this season. It is proposed that skin fairness should be considered a genuine risk factor for cholelithiasis, but only after ultraviolet tanning.

Oral Presentations

Valorization of an Underexploited Soy Sauce Industry Co-product as Novel Flavor Enhancer and Salt Reducing-agent

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Abstract

This study investigated the potential of soy sauce cake (SSC) as novel flavor enhancer and salt-reducing agent for the food industry. SSC is the solid co-product obtained following mechanical pressing of fermented soybeans to extract soy sauce. 110,000 tons of SSC are produced per year worldwide, with only a fraction used as low-value stream. The nutritional, metabolomic, proteomic and electronic-tongue profiles of SSC were analyzed. Four meat-based sausages were formulated at full or 25% reduced-salt levels and characterized by sensory (trained panel) and instrumental analyses (Texturometry, colorimetry, water activity, and moisture analyses): full salt, full salt with SSC, reduced salt and reduced salt with SSC. Reduced salt-SSC sausages showed a similar sensory profile to full-salt products, whereas the reduced salt formulation exhibited significantly lower overall taste, saltiness, umami, meaty-taste, mouthfeel, chewiness, and juiciness intensities and lower sensory quality than the full salt control ($p < 0.05$). The maintenance of flavor in reduced salt-SSC was due to the high concentrations of umami and flavor-enhancing compounds reported in SSC, including glutamate, aspartate, dipeptides and carboxylic acids. The electronic-tongue analysis of SSC showed a high saltiness and medium umami and sweetness taste profile. The maintenance of texture in reduced salt-SSC resulted from the high levels of fiber (18%), starch (7%) and proteins (22% including glycinin's, conglycinin's, and oil-body proteins) in SSC. This study demonstrated for the first time an upcycling solution to the environmental impact of SSC disposal as industry waste. This work highlighted the unique potential of SSC to address the technical challenges associated with meeting current salt reduction targets, including sensory impact and requirements for clean-label, sustainable and competitive salt-reducing agents.

Occurrence of Maillard Reaction Products During Green Extraction of *Lycium barbarum* Polysaccharides Using Deep Eutectic Solvents

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Abstract

Deep eutectic solvents (DESs) are widely recognized as green and efficient extractants for food polysaccharides; however, the risk of triggering the Maillard reaction (MR) remains largely unexplored. This study investigated the occurrence of MR during the extraction of *Lycium barbarum* polysaccharides using eight common DESs. While DESs significantly improved extraction yields (7.4% - 23.7%) and purities (42.5% - 85.3%) compared to hot-water extraction, all DES-extracted *L. barbarum* polysaccharides exhibited pronounced browning. Specifically, the browning indices were 2.8 to 7.3 fold higher than those of the aqueous control. Spectroscopic analyses (Ultraviolet–visible spectroscopy, fourier transform infrared spectroscopy, and X-ray photoelectron spectroscopy) confirmed the incorporation of characteristic MR product signatures. Targeted chemical profiling revealed substantially higher levels of intermediate MR product (e.g., 5-hydroxymethylfurfural, methylfurfural, glyoxal, and methylglyoxal), advanced glycation end products, and melanoidins in DES extracts compared to the aqueous control. These findings highlight potential safety concerns associated with "natural" DESs and underscore the need to shift the paradigm from "efficient-green" to "safe-green" extraction technologies.

Effect of Salt on the Cryoprotective Performance of Cod Protein Hydrolysates in Frozen Cod Mince

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Abstract

Prolonged frozen storage reduces the quality of perishable seafood. Conventional sucrose/polyol and phosphate cryoprotectants used in surimi are effective but may contribute sweetness, calories, and health-related concerns. Fish protein hydrolysates (FPHs), produced by enzymatic hydrolysis of seafood by-products, have shown cryoprotective potential; however, their performance depends on enzyme type and formulation conditions. Because salt is essential in muscle-food processing but may alter protein-water interactions, this study investigated how 1% (w/w) sodium chloride affected the cryoprotective efficacy of cod FPHs in minced Atlantic cod (*Gadus morhua*) stored at -20 ˚C for 4 months. Cod FPHs were produced using Alcalase® AF, FoodPro® PNL, or Corolase® 8000. Samples were prepared without additives or with 5% (w/w) FPH, sucrose-sorbitol (1:1, w/w), sodium chloride, or their combinations. Quality changes were assessed by color, texture profile analysis, low-field nuclear magnetic resonance, sodium dodecyl sulfate–polyacrylamide gel electrophoresis, calcium-dependent adenosine triphosphatase activity, differential scanning calorimetry, protein carbonyl content, pH, and water content. FPH addition reduced frozen-storage deterioration in cod mince, particularly by limiting texture changes and shifts in water distribution. Salt lowered pH and increased adhesiveness and cohesiveness, while enhancing the ability of FPHs to suppress hardness increases and transverse relaxation time changes, indicating improved water retention. However, salt also increased yellowness and reduced redness, suggesting possible promotion of pigment or lipid oxidation. Sodium dodecyl sulfate–polyacrylamide gel electrophoresis showed protein degradation in all samples after storage. In salted mince, FPHs were needed to preserve myofibrillar integrity, as salt alone showed no significant calcium-dependent adenosine triphosphatase protection. Alcalase® AF- and FoodPro® PNL-treated FPHs provided the strongest myofibrillar protection, while Alcalase® AF-treated FPH showed the lowest protein carbonylation trend.

Extraction and Characterization of *Opuntia ficus*-indica Mucilage as a Sustainable Thickener for Food Applications

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Abstract

The interest in the search for plant-based thickeners obtained through processes with low environmental impact is driving the development of more sustainable food additives. The prickly pear (*Opuntia ficus*-indica) is a crop with low water demand, and its mucilage has thickening properties comparable to commercial hydrocolloids. The aim of this study was to extract and characterize mucilage from prickly pear pads using different extraction techniques. Conventional extraction by heating was carried out, and alternative techniques of microwave- and ultrasound-assisted extraction, as well as combined treatments, were also explored. Subsequently, two experimental separation methods were applied: direct centrifugation and alcoholic precipitation with ethanol (1:3). The characterization of the extracted mucilage included total carbohydrate content, total polyphenols, antioxidant capacity (2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)), fourier transform infrared spectroscopy spectroscopy, and thermal analysis (Differential scanning calorimetry and thermogravimetric analysis). The highest yields were obtained by conventional extraction (5.51%), especially at medium-high temperatures (60 – 80 °C) and moderate nopal/water ratios (1:3 - 1:5). Ultrasound-assisted extraction yielded high returns (up to 5.3%) in short times (10 min), while microwave-assisted extraction yielded lower returns. Fourier transform infrared spectroscopy and thermal analyses showed significant differences in composition and thermal stability depending on the extraction method and degree of purification. Prickly pear mucilage's with different properties were obtained depending on the method applied. Ultrasound-assisted extraction could be a promising alternative due to its time efficiency, although further studies on purification and rheological behavior are required to validate its application in the food industry.

Mycoprotein as Novel Sustainable Emulsifier and Stabilizer with Application as Fat-reducing Agent

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Abstract

This study investigated the potential of mycoprotein from the Quorn process as novel sustainable emulsifier and stabilizer in full-fat and fat-reduced mayonnaise. The three fermentation streams (broth, biomass and centrate co-product) were mixed high-shear mixed, high-pressure homogenized or sonicated to investigate the impact of fungal filament length reduction on functionality. The functional properties of the samples were assessed in model foams and emulsion systems. Three mayonnaise formulations were then prepared at either full fat or 30% fat reduction and characterized by sensory and instrumental methods: egg control (egg as emulsifier, starch as stabilizer), vegan control (pea protein as emulsifier, starch as stabilizer) and mycoprotein mayonnaise (unprocessed broth as emulsifier-stabilizer). The sonicated centrate exhibited the highest foaming ability, however foams prepared with unprocessed broth proved the most stable (160 min). Emulsions prepared with broth and biomass samples exhibited suitable oil droplet sizes (17 - 26 μm), however only unprocessed broth mayonnaises proved stable. The full-fat and reduced-fat mycoprotein mayonnaises showed similar sensory intensities and acceptability to the egg-based controls, whilst the vegan control formulations displayed significant losses in appearance, taste, texture and acceptability ($p < 0.05$). Micrographs of the foams, emulsions and mayonnaises showed the coating of air bubbles and oil droplets by fungal filaments and the presence of mycelium networks. The results highlighted that surface-active agent from mycoprotein contributed to emulsion and foam formation, whilst intact broth filaments acted as stabilizer. This study demonstrated for the first time the unique combined emulsifying and stabilizing properties of mycoprotein with application as fat-reducing agent.

New Methods for the Recovery of Bioactive Substances from Hops: Application of Natural Deep Eutectic Solvents

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Abstract

Nowadays, new extraction techniques are being developed in line with the principles of green analytical chemistry, promoting safer and more sustainable methods. This includes the use of non-toxic, recyclable solvents. Natural deep eutectic solvents are low-cost, biodegradable ionic solvents composed of a hydrogen bond donor and acceptor. Owing to their low melting point, low volatility, and high thermal stability, they are considered efficient green solvents for bioactive compound extraction. In the present study natural deep eutectic solvents are used as extraction solvents to obtain secondary metabolites from *Humulus lupulus* (L.) (hops), cv. Columbus, *in vitro* cultivated. Lactic acid and glycerol are selected as hydrogen bond donors, while sucrose and choline chloride are as hydrogen bond acceptors. Experiments were designed according to a mathematical model using MODDE Pro v13.00 software for design optimization and response prediction through statistical modeling. After the extraction, the samples were analyzed with ferric reducing antioxidant power and Folin-Ciocalteu assays, in order to respectively determine the antioxidant activity and quantify the polyphenol content. The obtained extracts were subsequently characterized by liquid chromatography–mass spectrometry to define their phytochemical profile, identify and quantify the main bioactive compounds. Finally, the extracts were then tested to evaluate their potential antimicrobial activity against selected pathogenic microorganisms, and the anti-biofilm potential was assessed as well.

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Occurrence, Degradation and Culinary Processing Effects on Glycoalkaloids in Potatoes

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Abstract

Glycoalkaloids (GAs) are toxic secondary metabolites naturally occurring in potatoes (*Solanum tuberosum*), the major toxins being α-solanine and α-chaconine (collectively referred to as "solanine"). Their concentrations may vary depending on potato cultivar, post-harvest handling and processing conditions. Due to safety concerns associated with increased dietary intake of GAs, the EU established an indicative level of 100 mg/kg as the sum of α-solanine and α-chaconine in potatoes and processed potato products (Commission Recommendation (European Union) 2022/561); monitoring of GAs, including their toxic degradation products, was recommended. This study investigated the occurrence and degradation of GAs in 150 traditional and newly bred potato cultivars grown in the Czech Republic. In addition to the parent GAs, their degradation products (including β-solanine, ß-chaconine, γ-solanine, γ-chaconine, and solanidine) were monitored in disintegrated potato tubers using ultra-high-performance liquid chromatography coupled with high-resolution mass spectrometry. GA degradation rates differed among potato cultivars; on average, "solanine" concentrations decreased by approximately 20% after 1 h, accompanied by the formation of corresponding degradation products. These compounds were also observed in thermally processed potatoes (baked and fried). Overall, the findings provide deeper insight into GA stability during various processing practices and may contribute to improved risk assessment related to dietary intake of not only parent GAs but also their toxic degradation products, which are not routinely monitored.

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Impact of Biscuits Baking on Flavor Significant Phenolics Introduced by Enriching with Sunflower Protein

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Abstract

Search for sustainable food sources with a low carbon footprint is inevitably linked to a changing portfolio of products in global food markets. Unsurprisingly, the interest in plant-based protein products has increased significantly in recent decades. Beyond traditional sources such as wheat (*Triticum aestivum* L.), soybean (*Glycine max* (L.) Merr.), and pea (*Pisum sativum* L.), other sources of plant-based protein, including sunflower (*Helianthus annuus* L.), are gaining increasing attention. In this study, we investigated the effect of enriching biscuit dough with commercial sunflower protein. The research focused on the critical assessment of sensory properties and safety of biscuits prepared from dough to which sunflower protein was added. We performed ultra-high-performance liquid chromatography–high-resolution mass spectrometry profiling of phenolics, flavonoids, and other secondary metabolites co-isolated during plant protein production, as these compounds can be responsible for a bitter or astringent taste ("off-flavor"), thus adversely influencing consumer acceptance. This research enhances the understanding of sensory aspects of plant-protein-enriched foods. The relationship between dough composition in relation to protein concentrate addition and acrylamide content was also evaluated. To mitigate acrylamide formation, vacuum baking was tested as an alternative technology to conventional baking. The results will be presented and discussed in more detail during the presentation.

Milk-derived Proteins in the Confectionery Industry: Knowledge, Applications, and Alternatives

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Abstract

Consumer demand for snacks has increased in recent years, with high-protein products among the most sought-after options. Milk proteins are widely used in confectionery for their high nutritional value, balanced amino acid profile, and neutral sensory characteristics. They also provide key technological functionalities, including emulsification, thickening, gelation, and foaming. However, industrial processing conditions and compositional differences can modify protein structure, leading to variability in chemical, physical, and biofunctional properties and, consequently, protein functionality. This variability is critical in complex formulations, where interactions with other ingredients affect protein performance. This study investigates commercial milk protein powders, focusing on their chemical, physical, and biofunctional properties and behavior in high-protein confectionery cream systems. After techno-functional characterization and screening of 13 samples, selected ingredients were tested in model creams at 10% protein content, and the best performers were used to develop 20% high-protein prototypes. Functional behavior was evaluated through viscosity, texture, and physical stability during storage, along with sensory and microbiological analyses. Results show that protein type and concentration significantly influence cream structure and rheology. At 10% protein content, cream prototypes exhibited balanced processability, while increasing to 20% resulted in higher viscosity and reduced processability. At 20%, some formulations were closer to the reference standard, with differences among samples reflected in consistency and sensory perception. These findings highlight relationships between protein properties and functionality in complex matrices, supporting the development of high-protein confectionery products with improved technological, sensory, and nutritional quality.

Rheological Analysis of Model Sauces with Functional Flour and Chemically Modified Starch Using an Updated Quemada Approach

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Abstract

Functional flours and starches (FF&S) are used as texturizing ingredients in food preparations. Their performance is often assessed by measuring the swelling power, which is calculated as the ratio of the mass of gelatinized FF&S to the original mass of FF&S. This approach does not reflect the effective performance of the starch itself or the volume occupation ratio of FF&S. Indeed, the texturizing performance should be based on effective starch concentration in FF&S, as it's the main contributor to the viscosity of the final product. Specifically, flour contains starch, proteins, lipids, and water; these were determined to adjust dosage of FF in a model recipe according to the effective starch content. Two parallel investigations were conducted, initially, a model sauce was formulated with FF concentrations of 4%, 6%, and 8%, alongside 4% chemically modified starch. The relative viscosity of these formulations was measured under shear flow conditions at 10 s^{-1}. Subsequently, a revisited version of the swelling power, introducing the water holding ratio, as a more precise indicator, was used to determine the volume fraction and the viscosity of the continuous phase of the gelatinized FF&S. These findings were incorporated into an updated relative viscosity model based on Quemada's work. This revised model also considers two additional parameters: random close packing, using Farr and Groot's methodology with particle size distribution data and intrinsic viscosity (Quemada's parameter), by fitting the measured flow parameters of model sauces and the volume fraction of FF&S. This approach offers a more objective method for evaluating the performance of FF&S.

New Application for Food Composition and Physical Property Data in Nutrition Evaluation and Food Authentication: Food Data Modeling and Visualizing

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Abstract

Food composition and physical properties data are widely applied in scientific research, health education, food design, quality standardization control, standardizing and labeling, usually on base of descriptive statistics, parameters, mostly like mostly as mean, and standard deviation. While, beyond traditional statistical parameters, modern chemometrics, multi-omics data matrix processing, and multivariate algorithms, i.e., algorithm artificial intelligence-machine learning, enable direct visualization of nutrition properties and provide much more comprehensive analytical results. Almost all food categories, including non-scientific classifications such as brand, possess their unique fingerprints, or we can name as inner barcode or QR code or identification number can identify themself. Each category of food has certain specific nutrient profiles (fatty acids, amino acids, minerals, carotenoids, peptides, and isotopes), physical property indexes (texture, color, flavor...), and instrumental fingerprints (optical, chromatic, mass and nuclear magnetic resonance spectra). These data matrices can be correlated with multiple food categories: species/breed; geographical origin; farming and feeding patterns (organic vs non-organic, pasturing/grass feed vs barn/grain feed); processing methods (traditional vs modern, heating, homogenizing, and fermenting); and even industrial/commercial sorting (different brand, price grade, product series, and special declarations). Food data modeling provides new methodology for food evaluation, food integrity and authenticity discrimination, further supporting high level standardization, regulation and protection of precious species/breeds, geographical indication, organic, grass feed, traditional and certain brands. This innovative approach can also be applied in farming and feeding protocols improvement. We have conducted important preliminary studies on inner Mongolian meat and milk authentication that clearly demonstrate this potential.

Absorbance-transmission and Fluorescence Excitation-emission Matrix and Machine Learning - Driven Detection of Mineral Oil Aromatic Hydrocarbons Presence in Olive Oil

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Abstract

Mineral oil aromatic hydrocarbons (MOAH) are critical chemical contaminants in the food industry, posing significant health risks. In the olive oil sector, contamination frequently occurs during harvesting and processing through accidental contact with mechanical equipment and industrial lubricants. The coupled high-performance liquid chromatography- gas chromatography-flame ionization detector method is the gold standard for MOAH analysis, but it is time-consuming and resource-intensive, limiting its suitability for routine screening. This study evaluates absorbance-transmission and fluorescence excitation-emission matrix (A-TEEM) spectroscopy combined with machine learning as a rapid detection tool for MOAH in virgin olive oil. Five different commercial lubricants, identified as primary contamination sources, were used to spike virgin olive oil. A robust dataset of 1000 samples were generated, featuring MOAH concentrations ranging from 0.5 to 5.0 ppm, alongside uncontaminated controls. Prior to A-TEEM analysis, all samples underwent solid phase extraction to isolate the target aromatic fractions and minimize matrix interference. To process multidimensional spectral datasets, parallel factor analysis was applied to isolate the underlying chemical components within a three-dimensional tensor. The scores from these isolated components were then used to train and validate a suite of machine learning classification algorithms: random forest, support vector machine, k-nearest neighbors, classification and regression trees, logistic regression, and a single-layer neural network. The predictive models Random Forest and the single-layer neural network achieved outstanding accuracy, both yielding an F1 score exceeding 98%. These results confirm that A-TEEM spectroscopy, paired with targeted sample cleanup and machine learning models, offers a highly effective and scalable routine screening method for MOAH contamination.

Metabolic Profile and Body Composition Analysis in Rugby Players According to Gender, Playing Position, and Age Group

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Abstract

Rugby is a high-intensity sport that combines repeated explosive efforts with prolonged endurance demands. Despite the importance of metabolic adaptations for optimizing performance, preventing injuries, and developing individualized training and nutritional strategies, the metabolic profile of rugby players has received limited scientific attention. This pilot study aimed to analyze body composition using bioelectrical impedance analysis and assess the metabolic profile of rugby players, while evaluating differences in energy demands according to playing position, sex, and age group. A cross-sectional, analytical, observational pilot study was conducted involving 32 rugby players competing at the first and second national divisions (16 males and 16 females). Body composition was assessed using direct segmental multifrequency bioelectrical impedance analysis (InBody 720), while resting metabolism was evaluated using the PNOE portable metabolic analyzer during a 10 min seated assessment. Statistical analyses were performed using Statistical Package for the Social Sciences Statistics Version 29.0. The results demonstrated that sex, age, and playing position significantly influenced both metabolic profile and body composition. Forwards exhibited a lower respiratory exchange ratio than backs, indicating greater reliance on fat oxidation as an energy substrate. Additionally, forwards presented a higher percentage of body fat in both male and female groups. These findings reflect the distinct physiological and metabolic demands associated with different playing positions. In conclusion, body composition and metabolic characteristics vary significantly according to sex, playing position, and age. These findings support the need for individualized training, recovery, and nutritional strategies tailored to each player's physiological profile in order to enhance athletic performance, reduce injury risk, and delay the onset of fatigue.

Development and Functional Characterization of a Ready-to-use Therapeutic Food Enriched with Bioactive Peptides from Hydrolyzed Buffalo Whey: Nutritional, Rheological and Intestinal Health Effects

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Abstract

Malnutrition remains a major global health challenge, particularly among children, contributing to morbidity and mortality. Ready-to-use therapeutic foods (RUTF) are effective in managing acute malnutrition but often lack bioactive compounds capable of providing additional health benefits beyond basic nutritional support. Buffalo whey, a by-product of the dairy industry, is highly digestible and rich in amino acids, α-lactalbumin, and ß-lactoglobulin. Through enzymatic hydrolysis, whey can be converted into peptide-rich fractions containing bioactive molecules with potential health-promoting properties. This study aimed to develop an innovative functional RUTF enriched with hydrolyzed buffalo whey (SIB) at three substitution levels (SIB 4%, SIB 6%, and SIB 8%) and evaluate its physicochemical, nutritional, and biological properties. Liquid chromatography-electrospray ionization-tandem mass spectrometry peptide profiling confirmed the presence of bioactive sequences in SIB. *In vitro* assays on intestinal cell models (including cancerous human colorectal adenocarcinoma cell line and human ileocecal colorectal adenocarcinoma cell line, and non-cancerous human colonic epithelial cell line) demonstrated that SIB significantly reduced intracellular reactive oxygen species and modulated the renin–angiotensin system by decreasing angiotensin-converting enzyme 1 and increasing angiotensin-converting enzyme 2 expression, suggesting potential anti-inflammatory effects relevant to environmental enteric dysfunction. SIB 8% exhibited the highest protein content with a favorable lipid profile, with predominance of monounsaturated and polyunsaturated fatty acids (oleic, linoleic, and α-linolenic acids), while maintaining appropriate rheological properties and pseudoplastic behavior. To mimic malnutrition, cells were subjected to starvation, significantly reducing cell survival. Interestingly, *in vitro* digested SIB 8% significantly increased human colonic epithelial cell line viability, indicating a protective effect during nutritional stress. Overall, SIB enrichment enhances both nutritional and functional value of RUTF, representing a promising strategy for addressing childhood malnutrition while promoting dairy by-product valorization.

Food-relevant Mediterranean Plants as Sources of Neuroprotective Phytochemicals Targeting α-synuclein Aggregation

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Abstract

The search for plant-derived bioactive compounds with potential neuroprotective properties is gaining increasing relevance in food chemistry and nutraceutical research. In this study, 60 plant species representatives of the Italian Mediterranean flora were collected and evaluated through a combined phylogenetic and high-throughput screening strategy using a yeast model expressing human α-synuclein, a protein whose aggregation is a key molecular feature of Parkinson's disease. This integrated approach enabled the identification of four species, *Allium lusitanicum*, *Salvia pratensis*, *Verbascum thapsus*, and *Glaucium flavum*, whose extracts, characterized by untargeted metabolomic profiling, displayed strong inhibitory activity against α-synuclein amyloid aggregation *in vitro* and in neuroblastoma cells overexpressing the protein. A size-exclusion chromatography affinity

workflow coupled with mass spectrometry revealed acteoside, a phenylpropanoid glycoside abundant in the edible plant *V. thapsus*, as the metabolite directly interacting with α-synuclein and effectively suppressing its fibrillation. Acteoside also reduced oxidative stress in neuroblastoma cells exposed to α-synuclein fibrils and activated the nuclear factor erythroid 2-related factor 2 antioxidant pathway. Furthermore, dietary administration of acteoside improved motor performance and decreased protein carbonylation in a Drosophila Parkinson's disease model, indicating its capacity to mitigate oxidative damage. These findings highlight Mediterranean edible and medicinal plants as valuable sources of bioactive phytochemicals and support the potential of acteoside as a promising nutraceutical candidate for the development of food-based strategies aimed at counteracting protein aggregation and oxidative stress associated with Parkinson's disease-related neurodegeneration.

Controlled Salt Release from Microcapsules in Meat Matrices for Sodium Reduction

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Abstract

Concentrating sodium in specific areas has been found to heighten perceived saltiness, allowing for an overall reduction in sodium content without diminishing flavor intensity or saltiness. However, because sodium chloride dissolves and diffuses so readily, it tends to spread out during processing, cooking, and storage, ultimately becoming uniform and losing the intended sensory impact. To overcome this challenge, salt microencapsulation has emerged as a promising approach. By embedding sodium chloride in controlled-release matrices, microencapsulation prevents premature dissolution and enables targeted release during consumption, potentially preserving spatial heterogeneity and enhancing flavor perception. There is a notable lack of integrated research examining how wall materials, ultrasound-assisted homogenization, and food processing conditions influence the performance of salt microcapsules in meat systems. In particular, the extent to which these technologies can deliver controlled, non-uniform salt release—maintained even after cooking or storage—and contribute to sodium reduction remains insufficiently investigated. Our study fills this gap by thoroughly assessing how salt microcapsules perform in both model systems and actual meat products. Through this integrated approach, the goal is to connect microcapsule design and processing conditions with effective sodium reduction, enhancing salt perception by controlling its spatial distribution within complex food matrices. The main findings highlight the ability of salt microcapsules to create a heterogeneous salt distribution within the meat matrix, a feature influenced by the wall material, the method of incorporating the microcapsules, and the processing and storage conditions of the food.

Protective Effects of Nitro-fatty Acids from Virgen Olive Oil on Cardiovascular Risk in Non-alcoholic Fatty Liver Disease

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Abstract

Non-alcoholic fatty liver disease (NAFLD), characterized by liver fat deposition without alcohol consumption, represents the most prevalent chronic liver disease worldwide associated with an increased risk of cardiovascular disease. Virgin olive oil (VOO) is one of the main sources of lipids in the Mediterranean diet and may reduce cardiovascular risk by unknown mechanisms. We have demonstrated that VOO is a source of nitro-fatty acids (nitroalkenes, NO_2-FAs) that are formed during gastric digestion and represent bioactive molecules exerting potent anti-inflammatory actions. The aim of this work was to study the capacity of NO_2-FAs-derived from VOO in protecting mitochondrial dysfunction in cardiomyocytes in NAFLD. We used a murine model of NAFLD induced by a high-fat diet, supplemented with and without nitrite, in the presence and absence of VOO. Heart biopsies were used to analyze mitochondrial function by the respiratory control ratio using high- resolution respirometry and the enzymatic activity of mitochondrial transport chain complexes. Supplementation of VOO in the presence of nitrite, a condition that favors the formation of NO_2-FAs, improved mitochondrial function in heart biopsies, which correlated with the improvement in adenosine triphosphatase activity and serum lipid profile. These findings reinforce the idea that NAFLD extends beyond the liver, affecting systemic metabolism and increasing cardiovascular risk. Our data suggests that NO_2-FAs formed after VOO consumption represents a novel mechanism for the cardioprotective actions observed of this functional food. Given their ability to modulate mitochondrial function and inflammation, NO_2-FAs represent a promising therapeutic approach for patients with NAFLD at high cardiovascular risk.

Development of Gelatin-based Active Packaging with Rosemary and Cinnamon Essential Oils for Shelf-life Extension of Perishable Foods

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Abstract

This study investigated the development of gelatin-based active packaging films incorporated with rosemary and cinnamon essential oils and their application in extending the shelf life of fresh shrimp. Gelatin solutions were prepared and enriched with selected concentrations of rosemary and cinnamon essential oils, known for their antimicrobial and antioxidant properties. The resulting active formulation was uniformly coated onto polyethylene terephthalate trays to create functional packaging systems. Fresh shrimp samples were placed in the coated trays and stored under refrigerated conditions to evaluate the effect of gradual release of active compounds on product quality. Physicochemical, microbiological, and sensory attributes of the shrimp were monitored during storage. The active films exhibited controlled release behavior, allowing sustained diffusion of bioactive compounds into the package headspace and shrimp surface. Compared to control samples, shrimp stored in trays with active coatings showed significantly reduced microbial growth, delayed lipid oxidation, and better retention of freshness indicators such as color, odor, and texture. The combination of rosemary and cinnamon essential oils demonstrated a synergistic effect, enhancing overall preservation efficiency. These findings suggest that gelatin-based coatings enriched with natural essential oils can serve as an effective active packaging strategy for seafood preservation. The approach offers a biodegradable and safe alternative to synthetic preservatives while improving the shelf life and quality of perishable products like shrimp.

Integration of Pulsed Electric Fields and High-power Ultrasound for Improved Industrial Potato Processing

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Abstract

The present contribution summarizes the main outcomes of the joint industrial CONTROLFRIT project, developed by the companies BrioUltrasonics and Reproinox, which aimed to evaluate the feasibility of integrating pulsed electric fields (PEF) and high-power ultrasound into industrial potato chip processing to reduce acrylamide formation while maintaining product quality and process efficiency. Both technologies were implemented as pre-treatments prior to frying but at different stages of the production line. PEF was applied to whole potatoes before cutting, promoting cell electroporation and facilitating subsequent mass transfer processes. high-power ultrasound was incorporated into the potato washing stage to intensify the removal of reducing sugars and other acrylamide precursors, providing an efficient alternative or complement to conventional blanching with lower water and energy requirements. Laboratory-scale experiments demonstrated that the individual application of both PEF and high-power ultrasound significantly reduced the concentration of acrylamide precursors in potato slices before frying. Moreover, the sequential application of both technologies revealed a clear synergistic effect, as PEF-treated potatoes became more susceptible to ultrasonic-assisted washing, leading to a greater extraction of precursor compounds than either treatment applied individually. The promising laboratory results supported the design and construction of industrial-scale prototypes by both companies. These demonstration units have been successfully integrated into commercial potato chip production lines and are currently being optimized and validated under real processing conditions. The project represents an important step towards the industrial implementation of combined emerging technologies for producing safer potato chips with reduced acrylamide content while preserving productivity and product quality.

Ultrasound-intensification of Green Olives Debittering: Kinetics, Structure, and Mechanisms

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Abstract

Debittering green olives is challenging because of the long time needed and the effluents produced. Ultrasound-assisted alkaline-debittering (UAD) were performed in green olives and solid models (agar-alginate + olive leaves extract). Kinetics parameters of phenolic compounds hydrolysis were enhanced in UAD compared to conventional process, decreasing phenolic compounds from 42.52 to 14.34 mg gallic acid/g of sample by half of time. The sodium hydroxide penetration rates were also enhanced, evidenced by colorimetric reactions. Ultrasound also had a greater effect on the structure of the olives, decreasing the final hardness (4.25 N vs 6.01 N for control) and puncture energy (0.731 J vs 1.045 J for control). Electronic microscopy indicated a higher rupture of the cell walls by using ultrasound due to the cavitation bubbles collapse and the erosion effects at solid-liquid interface. No significant changes were observed in the olive color in both processes. In the model systems, debittering rate also showed to be ca.42% higher in UAD compared to the control system. Similar trend was observed for sodium hydroxide penetration. Experimental results showed that ultrasound played a more important role in mass transfer than in the phenolic compound hydrolysis itself, enhancing the diffusion of these compounds towards the liquid medium by up to ca. 13% with slight effects in the texture. Moreover, non-detectable effects of ultrasound were observed in the phenolic compounds already released in the aqueous medium. The results observed demonstrated the potential advantages of UAD: shorter processing time, less matrix interferences and making the chemical usage and wastewater generation lower.

Ultrasound-assisted Extraction and Colloidal Properties of Black Chickpeas Protein Isolates for Food Applications

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Abstract

The valorization of underutilized legume varieties offers a strategic opportunity to enhance agrobiodiversity while supporting the development of sustainable protein ingredients with distinctive techno-functional properties. This study evaluated the impact of ultrasound-assisted extraction (UAE) on the physicochemical and techno-functional properties of protein isolates obtained from two neglected black chickpea (*Cicer arietinum* L.) cultivars from Sicily (Southern Italy), selected for their tolerance to drought and high temperature. Protein isolates were produced by conventional alkaline extraction and ultrasound-assisted extraction (20 kHz, 80% amplitude, 5 - 15 min) under identical conditions (pH 9, 1:10 w/v). Their physicochemical and colloidal properties were evaluated in model oil-in-water emulsions prepared by high-pressure homogenization. Ultrasound significantly improved extraction efficiency, increasing protein extraction yield (20 - 27%) and recovery (17 - 23%) while producing highly pure (85 - 91%) and soluble (74 - 94%) protein isolates. Fourier transform infrared spectroscopy analysis revealed structural rearrangements, including reduced intermolecular β-sheet content and increased α-helix content; amino acid profiling revealed an enrichment of hydrophobic residues, consistent with enhanced interfacial activity. These structural changes translated into improved emulsifying performance. Emulsions prepared with 1% (w/v) protein and 5% (v/v) oil exhibited excellent electrostatic stability (ζ-potential ≈ -30 mV) over 10 days. Ultrasound-treated isolates produced significantly smaller droplets (≈0.60 μm) than standard samples (≈0.81 μm), indicating superior stabilizing capacity. The enhanced emulsifying performance was further supported by confocal laser scanning microscopy and cryo-transmission electron microscopyanalyses, which revealed a finer and more homogeneous microstructure. Overall, these findings demonstrate that ultrasound-assisted extraction is an effective strategy for obtaining highly functional black chickpea protein isolates suitable for next-generation plant-based food formulations.

Probiotics and Postbiotics: Consumers' Knowledge and Perception

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Abstract

Nowadays, there is a growing concern about the relationship between nutrition, health, and personal well-being. Consumers are increasingly seeking foods that provide adequate nutrient ratios and contribute to improved health. In this regard, foods containing probiotic microorganisms and postbiotic foods are positioned as ideal candidates to provide this functionality. The objective of this study was to evaluate consumers' knowledge and perceptions of food products containing probiotics and postbiotics. To this end, a survey was conducted to determine the actual consumer' knowledge of the term's "probiotic" and "postbiotic" and to study the perception of foods containing probiotic microorganisms and their metabolites. The findings indicated that consumers demonstrated a more profound comprehension of the concept of "probiotic" in comparison to "postbiotic". Although most products marketed with the claim "with probiotics" are fermented foods, consumers value the labels "food with natural ferments" and "food with *Lactobacillus*" more positively. Despite the widespread lack of awareness of postbiotics, those consumers who were familiar with the term showed a positive predisposition toward including them in their diet, recognizing their beneficial health effects. These results highlight the need to implement communication and food education strategies aimed at clarifying the concepts of "probiotic" and "postbiotic", as well as supporting their effects through accessible and scientifically validated information on product labels.

Drying Intensification by the Combined Application of Pulsed Electric Fields and Ultrasound

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Abstract

The high moisture content of agri-food products and by-products requires stabilization processes to avoid degradation reactions that compromise their quality. Among the most used techniques for this purpose highlights the drying. However, conventional methods like convective drying or freeze-drying are energy-intensive and slow, prompting the development of intensification strategies such as pulsed electric fields (PEF) pretreatments or ultrasound-assisted drying. Ultrasound application during drying further accelerates drying by reducing internal and external mass transfer resistance, particularly at moderate temperatures, and can improve certain quality attributes, though its effects vary depending on the product internal structure and conditions. PEF pretreatment induces electroporation, facilitating moisture release and shortening drying time. It also alters the structure and texture of food matrices, with effects depending on treatment intensity and product type. The most used parameter to measure the effects of PEF in internal structure is cell disintegration. However, this index alone is insufficient to fully describe these structural changes, requiring complementary measurements. The combination of PEF, a treatment that induces structure modifications, with an ultrasound-assisted drying, a technique which effects depend on product structure, could be a more effective strategy. In this sense, the results obtained in different products show the greatest reduction in drying time without significantly compromising product quality. However, optimal processing conditions must be determined individually for each product to balance efficiency and quality.

A Brief Overview of Our Experience with High Power Ultrasound in the Processing of Food Products

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Abstract

This presentation provides a brief overview of our experience with ultrasound in food processing across a range of food matrices. It begins with studies on the use of ultrasound to improve the tenderness and quality of meat products, particularly beef and lamb, focusing on whether ultrasound could accelerate post-mortem tenderization and provide practical applications for the meat industry. The presentation then examines the use of ultrasound to accelerate meat curing and improve the quality of cured pork products, where ultrasound was investigated as a mass-transfer enhancement technology for industrial curing processes. Further work explored the optimization of ready-to-eat edible crab processing using ultrasound as a process-intensification tool. Although focused on crustaceans, this research addressed many of the same engineering challenges encountered in meat processing, including heat and mass transfer, microbial inactivation, product quality preservation, and processing efficiency. The

presentation also highlights extensive work on ultrasound and ultrasound-based hurdle technologies in minimally processed beverages and dairy systems. These studies demonstrated the potential of ultrasound not only for microbial preservation but also for modifying physicochemical, structural, rheological, and sensory properties of foods. Additional research investigated ultrasound and thermosonication as decontamination technologies for poultry and fish products, focusing on the ability of these technologies to reduce microbial contamination while maintaining product quality. Overall, the work demonstrates the considerable potential of ultrasound-assisted technologies as sustainable process-intensification tools for improving food safety, processing efficiency, and product quality across diverse food systems.

Application of Emerging Green Technologies in Food Processing: Current State of Research and Barriers to Industry Adoption

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Abstract

Worldwide consumers request more fresh, natural, safe, value-added, and nutritional foods that respond to their lifestyle. Plants are a very interesting source for various food ingredients, such as protein, active compounds and natural aroma. Conventional food technologies are reputed in altering food quality and emitting greenhouse gases. However, various green emerging technologies, such as ohmic heating, ultrasound, pulsed electric field and microwave, membrane distillation, etc. are very interesting gentle promising processes for food processing while preserving their high quality that targeted consumer preferences. High eco-efficient scores of these technologies related to low energy, water consumption and processing cost as well as greenhouse gases emission shown their high-performance compared to conventional technologies. These technologies are a major key to the economic and environmental sustainability development of food industry. However, there is a gap for a wide industrial adoption for most of these emerging technologies. The main purpose of this presentation is to provide an overview of the current state of global research on the application of these technologies in food processing and the divergences seen in research conducted by various teams worldwide. The development cycle of these technologies and their current level of maturity will be discussed. Then, the identification of key gaps between research and industry, as well as the barriers to the adoption of these technologies on an industrial scale will be supplemented. An overview of some recognized industrial applications for the most developed technologies will be provided. Finally, a list of recommendations will be formulated to guide the advancement of research on these technologies for industrial purposes.

Investigating Low-intensity Pulsed Electric Field as a Novel Approach to Enhance Growth Kinetics and Improve Metabolites Production of *Lactobacillus delbrueckii* subsp. *Bulgaricus*

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Abstract

This work investigates the effect of pulsed electric field (PEF) parameters on the growth and metabolism of Lactobacillus *delbrueckii* subsp. *bulgaricus*, a key starter culture in fermented food production. Also, the impact on exopolysaccharides synthesis has been evaluated. Cells from an overnight culture have been inoculated in de Man, Rogosa and Sharpe broth at 37 °C in a continuous flow bioreactor. After two hours, which has been preliminarily estimated to be the lag phase duration, bacterial cells in the log phase were periodically exposed to six low intensity PEF treatments throughout the fermentation time, until the eighth hour. A multi-factorial experimental design was employed to evaluate the influence of PEF parameters - in particular specific energy (0.5, 1.0, 2.8 kJ/kg), pulse width (3 and 5 μs) and treatment frequency (every 30 and 60 min) on microbial performances. Growth was assessed via plate counting on Man, Rogosa and Sharpe agar during the fermentation time and acidification rate via pH measurements every hour. Exopolysaccharides production was also measured and produced exopolysaccharides were characterized in terms of particle size; physico-chemical changes of the growth media during the fermentation process were evaluated through rheological tests and molecular mobility with low-resolution proton nuclear magnetic resonance. The results showed that exposure to specific combination of PEF parameters can positively affect both the growth rate and phenotypic characteristics of *L. delbrueckii* subsp. *bulgaricus*, with significant differences in viable cell counts, a greater pH reduction and significant differences in viscosity and protons' molecular mobility during fermentation compared to the non-PEF-treated samples.

Enhancing the Techno-functional Properties of *Limnospira platensis* Proteins via High-Pressure Homogenization: A Sustainable Clean-label Approach

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Abstract

The growing demand for sustainable and alternative protein ingredients in food systems has increased interest in *Limnospira platensis* (Spirulina), a cyanobacterial biomass rich in proteins and phycobiliproteins, well known for their antioxidant, anti-inflammatory and anticancer properties. The presence of its cell wall influences the availability of proteins and their techno-functional properties. This study investigates how protein structural changes induced by high-pressure homogenization (HPH, 20 - 100 MPa) affect the techno-functional properties of Spirulina proteins, in comparison with chemical extraction. In particular, protein yield, solubility, phycobiliprotein recovery, emulsifying and foaming properties, thermal stability, and rheological behavior were evaluated. Progressive disruption of the native filamentous matrix was observed with increasing homogenization pressure, enabling enhanced protein accessibility and modifying their aggregation state. At moderate pressures, particularly at 50 MPa, significantly improved protein yield and ability to stabilize oil–water interfaces and air–water interfaces, resulting in better emulsifying and foaming behavior. At the same time, HPH promoted the release of phycobiliproteins, with supernatant fractions enriched in C-phycocyanin and higher purity compared with alkaline extraction highlighting HPH's potential for value-added pigment recovery. Thermal analysis showed that moderate mechanical treatment preserved protein stability, while higher pressures led to partial unfolding and aggregation. Rheological measurements indicated the formation of weak but more elastic protein networks after moderate HPH treatment. Overall, the results show that HPH is a scalable, low-solvent method for developing Spirulina-based functional ingredients that enable the production of clean-label plant proteins with optimized techno-functional properties.

Targeted Phenolics Removal from Rapeseed Protein Matrices Using Electrodialysis

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Abstract

Rapeseed (*Brassica napus*) is an abundant oilseed crop with strong potential as a sustainable source of plant proteins. However, its utilization in food systems is limited by the high content of phenolic compounds, which contribute to bitter and astringent flavors, readily oxidize to quinones causing browning, and interact with proteins to form complexes that reduce functionality and nutritional availability. The predominant phenolic compounds in rapeseed are sinapic acid (SA) and its choline ester sinapine (SP), which account for approximately 95 - 99% of total phenolics. Electrodialysis is an electro membrane technology that separates charged species under an applied electric field. Originally developed for wastewater treatment, electrodialysis is increasingly applied in food processing to concentrate, purify, or modify food ingredients. The present study aimed to selectively remove SA and SP from model rapeseed matrices. After electrodialysis treatment 140 min for SP and 90 min for SA, removal efficiencies reached 83.3 ± 1.6% and 93.6 ± 1.1%, respectively. Diffusion/membrane adsorption controls performed without an applied voltage showed decreases of only 55.3 ± 1.7% for SP and 43.3 ± 18.8% for SA over the same period, indicating that electromigration was the dominant transport mechanism. Recovery in the concentration reached 5.5 ± 0.2% for SP and 21.6 ± 2.0% for SA. Combined SP–SA solutions showed similar trends. Overall, the current work demonstrates a gentle method to remove unwanted phenolic compounds from rapeseed protein matrices, highlighting electrodialysis potential to mitigate protein–phenolic interactions and enhance protein purity.

Application of Cold Plasma on Fresh Cut Carrots for the Inactivation of *Arcobacter* spp., an Emerging Food-borne Zoonotic Pathogen

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Abstract

Cold plasma is an emerging non-thermal technology with significant potential for microbial inactivation in food products. In this study, the effectiveness of two cold plasma configurations, cold atmospheric plasma (CAP) and plasma activated water, was evaluated against two strains of *Arcobacter butzleri* (BZg74 and BZs206) artificially inoculated onto freshly cut carrots. Both treatments significantly reduced the contamination levels of the tested strains. Among them, *A. butzleri* BZg74 exhibited greater sensitivity to plasma treatment, showing reductions higher than 2 log CFU/g after 20 min of CAP exposure and reaching values below the detection limit after 30 min. In contrast, strain BZs206 showed a maximum reduction of approximately 2 log CFU/g after 30 min of treatment. Regarding the indigenous microbiota, CAP treatment produced significant reductions of about 1.5 log CFU/g in mesophilic bacteria after 20 min and in enterobacteriaceae after 30 min. Conversely, plasma activated water washing achieved a rapid antimicrobial effect, with a significant reduction of 1.3 log CFU/g in the mesophilic population after only 5 min of treatment. Product quality evaluation revealed that CAP treatment had a stronger impact on carrot quality, causing greater deterioration in color, pH, and dry matter content as treatment time increased. In comparison, plasma activated water treatment better preserved the quality attributes of the product. Moreover, peroxidase inactivation was strongly influenced by the plasma configuration used, highlighting the complex interaction between plasma reactive species and food matrices. These findings emphasize the importance of optimizing processing parameters according to the specific quality characteristics and preservation requirements of the treated food product.

Rice Aging Determines the Structural Response of Rice Flour to Ultrasound Processing

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Abstract

Rice aging modifies starch organization and may alter the response of rice flour to ultrasound treatment. This study investigated whether fresh and aged rice flour respond differently to optimized ultrasound processing. Time and ultrasound amplitude were selected as independent variables and were optimized using response surface methodology combined with a central composite rotatable design. The optimized parameters were characterized by functional, thermal and structural analyses. Under optimized conditions, ultrasound-treated aged rice flour and fresh rice flour exhibited significant improvements in their functional properties compared with untreated samples. Scanning electron microscopy revealed marked microstructural modifications induced by ultrasound, including fissures, surface erosion, and starch disaggregation. Differential scanning calorimetry and fourier-transform infrared spectroscopy analyses indicated that moderate ultrasound treatment promoted a more ordered starch structure, whereas hydrothermal treatment disrupted starch crystallinity. In addition, treated samples showed lower gelatinization enthalpy and narrower gelatinization temperature ranges. However, fresh and aged rice followed different structural pathways. While fresh rice flour particles changed from intact granules to flattened and fused structures, suggesting enhanced molecular mobility and amylose leaching, aged rice flour showed a lower amylose leaching after treatment. Furthermore, ultrasound-treated aged rice flour exhibited reduced starch disaggregation compared with untreated samples. Principal component analysis demonstrated a clear separation between treated and untreated samples, highlighting strong correlations between physicochemical and microstructural changes. Overall, ultrasound treatment effectively enhanced the functional properties of rice flour, with the magnitude of the effects strongly influenced by the initial structural organization established during rice aging.

Lactic Fermentation Enhances Hempseed Cake Flour as a Functional Ingredient for Fresh Pasta: Techno-functional, Sensory, and Predicted Glycemic Index

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Abstract

Hempseed cake is a nutrient rich by product characterized by limited techno functional performance, largely attributable to its high content of insoluble dietary fiber, including lignin, and by herbaceous notes with a bitter aftertaste that can affect consumer acceptance. These characteristics can restrict its use in food applications. This study explored the potential of lactic fermentation with *Lactiplantibacillus plantarum* to enhance the functional and nutritional properties of hempseed cake flour and to evaluate its suitability as an ingredient in fresh pasta. Fermentation significantly increased the release of bound phenolic compounds and improved antioxidant activity (2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) and ferric reducing antioxidant power assays) with respect to raw flour, while promoting partial conversion of insoluble dietary fiber into soluble fiber. Techno-functional properties were also modified, with reduced oil- and water-holding capacities but enhanced water solubility, swelling behavior, and stability of foams and emulsions. The fermented flour was incorporated into fresh pasta formulations at 20% (w/w) with durum wheat semolina. The formulation showed satisfactory cooking quality for the hemp-enriched pasta in terms of hardness, cooking loss, water absorption, and swelling index. Cooked pasta displayed a medium-low predicted glycemic index and significantly lower total phenolic content than the fermented hemp flour, while maintaining appreciable electron-transfer-based antioxidant activity. Sensory analysis indicated moderate consumer acceptability, although the potential health benefits of hemp flour positively influenced overall liking. In summary, lactic fermentation effectively transformed hempseed cake from a little-used by-product into a functional ingredient with improved nutritional value and potential applications in low-glycemic fresh pasta.

The Role of Flours and Leavening Systems on the Formation of Acrylamide in the Technological Process of Baked Products: Cases Studies of Bread and Biscuits

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Abstract

Acrylamide (ACR) formation in bakery products is commonly addressed through enzymatic treatments, particularly asparaginase addition. However, such strategies may increase process complexity and cost, raising the need for alternative approaches based on intrinsic process design. This study investigates the potential of enzyme-free ACR mitigation by acting on raw materials and fermentation systems. The role of free asparagine, the main precursor of ACR, was evaluated across flour, doughs, and final baked products. Results demonstrated that flour selection is a critical factor, with organic flours exhibiting lower asparagine content compared to conventional ones, thereby reducing the potential for ACR formation. Additionally, flour refinement level significantly influenced asparagine concentration, with type 2 flours showing higher precursor levels. The choice of leavening system emerged as a key technological driver. Biological leavening systems, including baker's yeast and sourdough, enabled modulation of asparagine content during fermentation, reducing ACR formation without the need for enzymatic treatments. In contrast, non-fermented systems showed higher ACR levels, confirming the importance of fermentation-driven precursor depletion. ACR formation was primarily localized in the crust, highlighting the role of thermal processing conditions. Overall, the results demonstrate that effective ACR mitigation can be achieved through the combined optimization of flour selection and biological leavening systems, avoiding the use of exogenous enzymes. This work provides a sustainable and industry-oriented strategy for improving food safety in bakery products while maintaining process simplicity and product quality.

Suitability of Enzymatically Extracted Proteins from Wheat Bran as Stabilizers of Sustainable Oil-in-water Emulsions

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Abstract

Growing demand for plant-based foods and sustainable production systems has stimulated the valorization of food by-products as sources of functional ingredients. Wheat brand, the major cereal processing by-product, represents a promising source of value-added proteins recovered through sustainable extraction strategies. This study aimed to develop and characterize oil-in-water emulsions stabilized by enzymatically extracted wheat bran proteins combined with Tara gum to obtain systems suitable for plant-based beverages applications. Two protein extracts (CTR and Op2) were evaluated at three protein concentrations (1.25, 2.5, and 5%, w/w). Emulsions were prepared by ultra-Turrax homogenization and characterized for physical stability, particle size distribution, rheological behavior and color. Emulsions formulated with 5% protein extracts showed the highest stability, with turbiscan stability index (TSI) values close to 4 and no phase separation after 48 h of storage. In contrast, CTR 1.25% emulsions (TSI ≈ 15) exhibited clarification and flocculation phenomena during storage. All systems displayed shear-thinning behavior, while viscosity increased with protein concentration. Op2 emulsions exhibited higher initial viscosity, likely due to their greater protein yield, although a gradual decrease was observed during storage. Particle size distributions were mainly in 1 - 10 μm range, with 5% formulations showing smaller and more homogeneous droplets than lower-protein systems. Storage promoted droplet aggregation, particularly in less stable emulsions. Colorimetric analyses highlighted the influence of wheat bran pigments on emulsion appearance and stability. Overall, wheat bran protein extracts combined with tara gum promoted the formation of stable and structured oil-in-water emulsions, highlighting their potential as sustainable ingredients for plant-based beverage applications.

Process Optimization of Oat Protein Extraction for Scalable Ingredient Production

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Abstract

Cereals, particularly oats (*Avena sativa* L.), have gained increasing attention as alternative protein sources due to their attractive nutritional profile and desirable sensory properties. This study aimed to optimize protein extraction conditions to produce oat protein ingredients with improved purity, extraction yield and functional properties. Wet extraction process was employed, and the optimal conditions for alkali extraction and acid precipitation were determined using response surface methodology. Maximum extraction yield was achieved by suspending oat flour in water at a 1:8 ratio, adjusting the pH to 9.45, and incubating at 50 °C for 60 min. After centrifugation, proteins were concentrated from the soluble fraction by isoelectric precipitation at an optimal pH of 5.8. To ensure process scalability, resuspension conditions of the resulting protein pellet were screened (solids content 12.5 - 17.5%, pH 6 - 8, and temperature 4 - 50 °C). Rheological characterization was performed to ensure viscosity remained compatible with pumping requirements during process scale-up. Finally, two pasteurization treatments (70 °C or 82 °C for 2 min) were compared to evaluate their effects on the ingredient properties. The oat protein extract achieved a purity of 68.9 ± 0.05% and an extraction yield of 70 ± 2%. Protein composition was characterized by sodium dodecyl sulfate–polyacrylamide gel electrophoresis and amino acid profiling, confirming enrichment of the protein fraction during extraction. Solubility and oil- and water-holding capacities were strongly influenced by the pH applied during resuspension prior to drying. Overall, the optimized production process enables the production of oat protein ingredients with targeted functional properties suitable for diverse food applications.

New Biodegradable Materials Based on Nature-sourced Polysaccharides

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Abstract

Nature-sourced biodegradable polymers can be utilized as active films, coatings and delivery systems. Such materials respond to customer demands for safe and healthy approaches and satisfy environmental concerns. Among biopolymers, polysaccharides are considered particularly promising candidates since they are sustainable, safe, and hypoallergenic materials that are also abundant and inexpensive. An important advantage of polysaccharides is that their defined chemical structure allows rational modification and precise tuning of their properties. We utilize covalent modifications and non-covalent approaches (sonochemical deposition, layer-by-layer design, and nanoemulsification) to control physicochemical properties and functionality of the resulting biodegradable materials. In this lecture, we will present delivery systems based on modified polysaccharide derivatives that could encapsulate molecular cargoes of various polarities (from highly hydrophobic to ionic compounds) in aqueous and lipid environments and transport them through biological barriers, opening up numerous potential applications in various fields such as medicine, cosmetics, food and agriculture. In addition, we will present polysaccharide-based active films and packages that can be used in food, agriculture and other applications. Finally, we will be presented with polysaccharide-based edible coatings that can protect food products from physical, mechanical and microbial damage.

Sustainable Valorization of Licorice Root by Enzyme-assisted Extraction: From Cell Wall Disruption to Enhanced Functionality

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Abstract

The increasing demand for sustainable extraction technologies and low-impact production processes has driven the development of innovative strategies for the valorization of plant-derived materials. This study investigated the potential of enzyme-assisted extraction (EAE) to modulate the functional, structural, and techno-hygroscopic properties of licorice (*Glycyrrhiza glabra* L.) root extracts, to develop clean-label ingredients with enhanced functionality. Four tailored enzymatic cocktails, combining cellulase, xylanase, pectinase, and either laccase or ligninase, were designed according to the polysaccharide composition of licorice root cell walls and compared with conventional hot-water extraction. EAE significantly influenced the distribution of solids between pellet and supernatant fractions, indicating extensive cell-wall disruption and enhanced solubilization of bioactive compounds. Extracts were characterized by high-performance liquid chromatography-diode array detector quantification of glycyrrhizin, together with pH and °Brix measurements, confirming process reproducibility. Zeta potential analysis revealed high colloidal stability (≈ −30 mV) in enzymatically treated extracts, with values strongly influenced by pH. Functionally, EAE improved glycyrrhizin recovery and antioxidant activity, while enhancing oil retention and foaming capacity, likely due to increased extraction of saponin-rich fractions. Thermogravimetric analysis showed a two-stage degradation profile, with an initial mass loss between 100 and 380 °C associated with glycyrrhizin and flavonoid decomposition, followed by polysaccharide degradation between 380 and 600 °C. Dynamic vapor sorption highlighted the typical sigmoidal behavior of amorphous plant matrices and high hygroscopicity (0.9 - 1.0 g H_2O/g dry powder at 90% relative humidity), depending on the enzymatic treatment. Overall, EAE proved an effective approach for tailoring the quality and functionality of licorice extracts for food and nutraceutical applications.

Circular Valorization of Castanea Sativa Burs: Linking Phytochemical Screening with Sustainable Bio-based Applications

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Abstract

Chestnut (*Castanea sativa* Mill.) burs are an abundant agro-industrial by-product rich in phenolic compounds with promising applications in sustainable bioeconomy strategies. This study compared conventional solid–liquid extraction and ultrasound-assisted extraction, using water and 80% ethanol as solvents, to understand the influence of extraction conditions on the phytochemical profile and biological properties of chestnut bur extracts. Four extracts (CSB1–CSB4) were characterized by liquid chromatography–mass spectrometry for phytochemical screening. Antioxidant activity was assessed using 2,2-diphenyl-1-picrylhydrazyl, 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid), and ferric reducing antioxidant power assays, together with total phenolic and total flavonoid contents. Antimicrobial activity was evaluated against foodborne pathogens by determining the minimum inhibitory concentration, while *in vitro* cytotoxicity was assessed to investigate potential limitations for food applications. The extracts were mainly characterized by gallic acid, flavonol glycosides (quercetin, kaempferol, and isorhamnetin derivatives) and one hydrolysable tannin derivative. Gallic acid was the predominant low-molecular-weight phenolic compound in all samples. Ultrasound-assisted extraction combined with 80% ethanol produced the most diverse phenolic profile, whereas conventional extraction demonstrated greater industrial applicability. Antioxidant activity ranged from 1.61 - 5.75 mmol trolox equivalent antioxidant capacity (TEAC) g^{-1} (2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)), 3.05 - 9.54 mmol TEAC g^{-1} (2,2-diphenyl-1-picrylhydrazyl), and 0.06 - 0.85 mmol TEAC g^{-1} (Ferric reducing antioxidant power), while total flavonoid contents and total phenolic varied between 29.80 - 201.64 mg CE g^{-1} and 127.65 - 838.97 mg GAE g^{-1}, respectively. The extracts showed antimicrobial effects against various foodborne pathogens (minimum inhibitory concentration: 0.781 - >25 mg mL^{-1}) but exhibited significant cytotoxicity, limiting their direct food application. Nevertheless, these extracts constitute promising green feedstocks for cellulose nanocrystal isolation, supporting the development of sustainable packaging materials within a circular bioeconomy.

Poster Presentations

Structural Changes in Apricot Flesh After Osmotic Dehydration in Sucrose, Xylitol, and Erythritol Solutions and Convective Drying Assessed by Computer Vision and Artificial Intelligence

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Abstract

The objective of this study was to evaluate changes in apricot flesh subjected to sequential osmotic dehydration and convective drying, with particular emphasis on the type of osmotic agent applied. Fresh apricot samples in quarters were osmotically dehydrated in sucrose, xylitol, and erythritol solutions, and then convectively dried. Structural modifications in the apricot flesh were analyzed using computer vision techniques, including image acquisition and texture feature extraction. The obtained image descriptors were subsequently used in discriminant analysis supported by artificial intelligence algorithms, enabling classification and differentiation of samples according to the applied osmotic solution. The results demonstrated that the type of osmotic agent led to distinct structural modifications in apricot tissue after convective drying, which were reflected in the extracted

image texture parameters. Artificial intelligence models achieved high classification accuracy, confirming the effectiveness of the proposed approach for distinguishing between samples treated with different osmotic solutions. The findings highlight the potential of integrating computer vision and artificial intelligence into food processing research, particularly for the assessment of structural quality changes in dried fruit products and the analysis of alternative sweetening agents in osmotic dehydration processes.

Acknowledgments: This research was funded in whole by the National Science Centre within the framework of the research project entitled "Predictive modeling of changes in physicochemical properties of osmotically dehydrated sour cherries and apricots during drying by different technologies using computer vision and artificial intelligence" (OPUS-29), grant number: 2025/57/B/NZ9/02080.

Relationships Between Image Parameters and Physicochemical Properties of Osmotically Dehydrated and Dried Apricots

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Abstract

This study aimed to investigate the relationships between selected image-derived features and physicochemical properties of osmotically dehydrated, hot-air dried apricots. Fresh quartered apricot samples were subjected to osmotic dehydration using the xylitol solution, followed by hot-air drying under control conditions. Image analysis was performed on high-resolution digital images to extract image texture parameters. Physicochemical analyses included the determination of dry matter, moisture content, water activity, pH, acidity, color, total soluble solids, sugars, and carotenoids. Correlation and regression analysis were applied to determine associations between image features and measured quality attributes. The results indicated strong correlations between image textures and other properties. Predictive models based on selected image features achieved satisfactory accuracy for estimating selected physicochemical properties of osmotically dehydrated and dried apricots. The findings demonstrate that non-destructive image analysis can effectively support rapid assessment of quality changes in dried apricots. This approach may be useful for process monitoring and quality control in food dehydration technologies. Overall, image-based evaluation provides a fast, objective, and cost-effective alternative to conventional laboratory measurements, enabling improved industrial scalability and supporting the development of smart food processing systems in a real-time applications framework implementation.

Acknowledgments: This research was funded in whole by the National Science Centre within the framework of the research project entitled "Predictive modeling of changes in physicochemical properties of osmotically dehydrated sour cherries and apricots during drying by different technologies using computer vision and artificial intelligence" (OPUS-29), grant number: 2025/57/B/NZ9/02080.

Characterization and Fermentation of Oat Beverages and Oat Okara for Sustainable Food and Feed Applications

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Abstract

Plant-based ingredients are central to current trends in food innovation and sustainability, with oat-based beverages gaining enormous popularity as dairy alternatives in the past decade. The growing demand for these oat beverages inevitably results in accumulation of the respective side stream, oat okara, which is nutritionally rich, but highly perishable. This study characterizes the chemical composition of both oat beverages and oat okara, focusing on protein, fat, ash, starch, soluble sugars, and fiber content to better understand their potential as fermented food and/or feed ingredients. Moreover, oat beverages, with different starch hydrolysis levels, are fermented using commercial starter cultures to assess the influence of sugar composition on fermentation performance. In parallel, oat okara is processed with commercial silage cultures to evaluate whether fermentation could improve the microbial stability and shelf life of this side stream. The results show compositional differences between oat bases, particularly on glucose, maltose and malto-oligosaccharide composition and reveal the potential of commercial starter cultures in robust fermentation processes, despite those compositional differences. Also, fermentation with commercial silage cultures is a proposed solution for the upcycling of oat okara. This research aims at the development of novel and sustainable oat-based ingredients with minimal processing.

Chemical Characterization of Innovative and Sustainable Sheep Meat-based Salami

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[2]*Department of Agriculture, Food, Environment and Forestry, University of Florence, Firenze, Italy*

Abstract

The preset study aims to valorize sheep meat through innovative processing. This meat has a low-fat content and a favorable lipid profile, rich in polyunsaturated fatty acids as ω-3, ω-6 and conjugated linoleic acid. Within the international project "MoreMedDiet – More on the Adoption of a Healthy Mediterranean Diet," this study aimed to investigate the chemical characteristics of sheep meat-based salami. Two formulations were developed, one based on sheep meat and pork fat, and the other on sheep meat and a plant-based fat substitute. Three replicates (A, B, and C) of each formulation were prepared and analyzed after 0, 21, and 28 days of ripening. A commercial ripened salami was included as reference. Chemical characterization focused on volatile organic compounds and lipid oxidation. Volatile organic compounds were analyzed by headspace solid-phase microextraction coupled with gas chromatography–mass spectrometry, and lipid oxidation was determined using the thiobarbituric acid reactive substances assay. The volatile organic compound profiles differed between the two formulations: alcohols, aldehydes and esters were more abundant in the pork-fat salami, whereas terpenes were mainly associated with the plant-based salami, while ketones and carboxylic acids were detected in both. Lipid oxidation increased during ripening and progressed more markedly in the pork-fat salami, consistent with previous reports of progressive malondialdehyde accumulation. Overall, these findings highlight the potential of sheep meat for developing innovative products and diversifying sustainable Mediterranean food systems.

Black Papper (*Piper nigrum*) and Cardamom (*Elettaria cardamomum*) Exert Potent Anti-cancer and Immunomodulatory Functions

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Abstract

Immunonutrition is recognized as a notion whereby a dynamic interplay exists between nutrition and immunity. We investigated the potential immunomodulatory effects of *Piper nigrum* and *Elettaria cardamomum*. Splenocyte proliferation was assessed by [3H]-thymidine incorporation. Cytokine profiling was assessed by enzyme-linked immunosorbent assay, while nitrite production was assessed by Griess assay. Using YAC-1 lymphoma cells, the potential of *P. nigrum* and *E. cardamomum* extracts to promote natural killer cytotoxic activity was examined by JAM assay. *P. nigrum* and *E. cardamomum* extracts significantly enhance splenocyte proliferation in a dose-dependent, synergistic fashion. *P. nigrum* and *E. cardamomum* extracts significantly enhance and suppress T-helper 1 cells cytokine release by splenocytes, respectively. Conversely, T-helper 2 cells cytokine release by splenocytes is significantly suppressed and enhanced by *P. nigrum* and *E. cardamomum* extracts, respectively. Based on interleukin-6 and tumor necrosis factor-alpha release by macrophages, *P. nigrum* and *E. cardamomum* extracts exert pro-inflammatory and anti-inflammatory effects, respectively. Consistently, nitrite production by macrophages is significantly augmented and reduced by *P. nigrum* and *E. cardamomum* extracts, respectively. *P. nigrum* and *E. cardamomum* extracts significantly enhance natural killer anti-tumor activity. *P. nigrum* and *E. cardamomum* possess potent immunomodulatory, anti-inflammatory, and anti-tumor properties. We anticipate that *P. nigrum* and *E. cardamomum* ingredients may be employed as effective therapeutic agents in regulating diverse immune reactions implicated in various diseases including cancer (Figure 1).

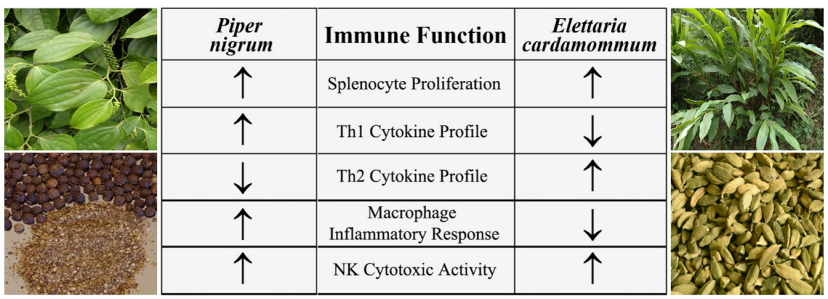


Figure 1: Comparative immunomodulatory effects of *P. nigrum* (black pepper) and *E. cardamomum* (cardamom) extracts.

Technology for Replacing Soybean Meal with Protein Feed Made from Yellow Pea and Corn

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Abstract

Corn grain constitutes a vital source of plant-based nutrition and serves as a valuable ingredient in many food products. Within the agricultural industry, corn harvest surpluses offer significant opportunities for innovative solutions. Due to the fact that the amino acid profile of cereals is not fully balanced for animal feeding, soybean meals are most often added to improve the biological value of corn-derived feed. In Poland, most soybeans are imported due to the unfavorable climate for cultivation; however, the pea is an alternative legume successfully grown in local climatic and soil conditions. Growing peas improves soil structure and allows for the reduction of nitrogen fertilizers in subsequent corn crops. By intercropping corn and peas, both crops can be harvested efficiently, processed in an innovative manner, and secured as animal feed. The aim of this work was to characterize new preparations for animal nutrition obtained by the simultaneous processing of corn and peas. This study explores an innovative biotechnological approach to reducing reliance on imported soybean meals by utilizing locally adapted crops. Results indicate that this yellow pea-corn matrix provides a sustainable, cost-effective, and ecologically beneficial alternative to soybean-based nutrition.

Evaluation of the Nutritional Value of Protein Feed Made from Peas and Corn as an Alternative to Soybean Meal

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Abstract

This study evaluates new animal feed obtained in biotechnological approach that aims for reducing reliance on imported soybean meals by utilizing locally adapted crops. While soybean meals are the industry standard for balancing the amino acid profiles of cereal-based feeds, its cultivation is often restricted by regional climates. Therefore, the aim of this work was to evaluate the nutritional value of animal feed obtained in biotechnological process that refines corn and peas. The simultaneous processing of these raw materials involves moisturizing, crushing, and mixing in optimal proportions, followed by enzymatic treatment in an aqueous environment. The study focuses on a comprehensive analysis of the protein content, amino acid profile, carbohydrates, and fiber within the developed preparations. These nutritional parameters were evaluated across different processing conditions—including variations in enzymatic treatment and raw material proportions—to determine the optimal settings for maximizing biological value. Crucially, the resulting nutritional data were compared against the soybean meal standard, the traditional benchmark for animal nutrition.

Dry Fractionation of Vegetable Flours for the Production of Protein Concentrates

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Abstract

Air classification is a sustainable dry fractionation technology that allows the production of plant protein concentrates without the use of water or chemical solvents. Compared to conventional wet extraction processes, this technology reduces water consumption, energy demand, and wastewater generation, making it an environmentally friendly alternative for obtaining plant-based protein ingredients. The aim of this work was to apply ultrafine milling and air classification to different flours — faba bean, lupin, red lentil, and rice — in order to evaluate their potential for protein enrichment. Ultrafine milling reduced particle size and facilitated the separation of components during air classification, generating fine and coarse fractions with clearly differentiated compositions. The results showed that the fine fractions were significantly enriched in protein, especially in legume flour. Lupin flour increased from 27.5% protein in the initial sample to 59.2% in the fine fraction, while red lentil flour increased from 26.9% to 60.5%. Faba bean flour also showed protein concentration, increasing from 29.9% to 46.6%. In contrast, rice flour showed almost no improvement, with almost no change in the protein content. These findings demonstrate that dry fractionation by air classification is an effective strategy for producing protein-enriched fractions from plant materials. However, the efficiency of the process strongly depends on the initial protein content of the raw material, among other parameters. Flours

with higher initial protein levels allowed the production of fine fractions containing more than 50 - 60% protein, whereas low-protein materials such as rice did not achieve significant enrichment.

Extraction of Oleosome Fraction from Grape and Pumpkin Seeds by Mild Processing

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Abstract

Oleosomes are natural lipid storage structures present in oilseeds and nuts, consisting of triglycerides surrounded by a phospholipid monolayer and proteins, which provide high physicochemical stability. Conventional oil extraction methods usually destroy these structures, reducing their natural functionality and stability. Therefore, the development of mild extraction processes capable of preserving intact oleosomes is of increasing interest to produce natural emulsions from agro-industrial by-products. The aim of this work was to develop a cold-pressing extraction process to recover oleosomes while preserving their native structure from grape and pumpkin seeds, and to compare the behavior of both materials during processing. The process consisted of seed hydration, cold pressing, homogenization of the liquid fraction, and centrifugation to obtain an oleosome-rich cream phase. Important differences were observed between both matrices. Pumpkin seeds showed higher hydration capacity and produced a more fluid fraction, allowing the successful recovery of a stable oleosome cream after centrifugation. In contrast, grape seeds required higher mechanical effort during pressing, resulting in partial oleosome disruption, leading to oil release after centrifugation. Compositional analyses revealed higher protein content in pumpkin fractions, potentially contributing to greater oleosome stability, whereas grape seed fractions showed higher levels of polyunsaturated fatty acids, associated with more fluid and mechanically fragile structures. Differential scanning calorimetry and microscopy analyses confirmed that pumpkin samples presented a more homogeneous and stable lipid organization, while grape seed fractions showed a more heterogeneous matrix and greater structural disruption. These results demonstrate the potential of cold pressing as a sustainable strategy for recovering natural emulsified lipid structures from food industry by-products.

10-year Overview of Haloanisole and Halophenol Proficiency Testing in Wine

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Abstract

Haloanisole contamination is a serious problem for wine quality as these molecules are extremely odorous, and they alter wines in an irreversible way: even trace amounts of 2,4,6-triclhoroanisole, 2,3,4,6-tetrachloroanisole, pentachloroanisole, and 2,4,6-tribromoanisole can cause musty or moldy off-flavors in wine. Each of these haloanisoles have a similar odor but possesses different sensory thresholds. These compounds are not naturally occurring wine constituents. The origin of haloanisoles can be attributed to the biodegradation of 2,4,6-trichlorophenol, 2,3,4,6-tetrachlorophenol, pentachlorophenol, and 2,4,6-tribromophenol respectively, which can be found in winery environments. The main sources of halophenols are associated with treated materials (including contaminated corks or oak wood), environmental contamination, and sanitizing agents. Since the 2000s, research into haloanisoles and their precursors has expanded, and an increasing number of laboratories now offer this analysis for wines and spirits. At the same time, to meet the needs of these laboratories in terms of accreditation and quality control of the performed analyses, proficiency tests were proposed on this matter. This work presents an overview of the results obtained over 10 years of trials on different wines (white, red, rosé, and fortified) and spirits.

Green Extraction of Polyphenols from White Mulberry (*Morus alba*) using Choline Chloride-based Deep Eutectic Solvents

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Abstract

Deep eutectic solvents (DESs) have emerged as promising green alternatives to conventional organic solvents for extracting bioactive compounds from natural sources. In this study, the extraction performance of six DESs containing choline chloride (ChCl) and different hydrogen bond donors was evaluated and compared with methanol for the recovery of polyphenolic compounds from branches, leaves, and fruits of white mulberry (*Morus alba*). Ultrasound-assisted extraction was carried out under optimized conditions established for ChCl/glycerol DES, enabling a direct comparison of the extraction efficiencies of the investigated DESs. The extracts were characterized using a validated high-performance liquid chromatography method together with total phenolic content and total flavonoid content assays. Among the investigated solvents, DESs based on polyalcohol hydrogen bond donors showed the highest extraction efficiencies. ChCl/glycerol proved to be the most effective solvent for branch and leaf samples, whereas ChCl/ethylene glycol exhibited superior performance for fruit extracts. For most target polyphenols, at least one DES achieved extraction efficiencies comparable to or higher than those obtained with methanol. Lower extraction efficiencies were generally observed only for flavonoids. The results demonstrate that extraction performance strongly depends on both DES composition and plant matrix, highlighting the importance of solvent selection for specific applications. Overall, the findings confirm the potential of ChCl-based DESs as sustainable extraction media for recovering valuable polyphenolic compounds from white mulberry, supporting their use in greener extraction processes and the development of environmentally friendly technologies for natural product valorization.

Impact of Pretreatments and Dehydration Techniques on the Antioxidant Properties and *In Vitro* Digestion Behavior of Carrot By-product Powders

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Abstract

Transforming plant-based by-products into powdered ingredients through disruption, dehydration, and milling is a promising strategy for their valorization and use in functional foods. Due to their high content of dietary fiber and bioactive compounds, these by-products can be converted into value-added ingredients. Physical and biological pretreatments may enhance the extractability and bioaccessibility of these compounds, whereas drying conditions can strongly influence their stability and functionality. This study evaluated the effect of lactic acid fermentation, ultrasound, autoclave, and microwave pretreatments on the antioxidant properties and *in vitro* gastrointestinal digestion behavior of carrot by-product powders obtained by hot-air drying at 70 °C or freeze-drying. Hot-air-dried powders exhibited higher antioxidant properties than freeze-dried counterparts. Among them, ultrasound pretreatment significantly increased total phenolic and flavonoid contents, as well as antioxidant activity measured by the 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) assays. The highest recovery indices after digestion were observed for total phenols and flavonoids in fermented hot-air-dried powders (168 ± 14% and 155 ± 5%, respectively), for DPPH antioxidant activity in ultrasound-treated freeze-dried powders (772 ± 66%), and for ABTS antioxidant activity in microwave-treated hot-air-dried powders (319 ± 3%). The highest bioaccessibility values were found for total phenols (93 ± 8%) and antioxidant activity measured by DPPH (35 ± 6%) and ABTS (18.8 ± 0.9%) in ultrasound-treated freeze-dried powders, whereas fermented hot-air-dried powders showed the highest flavonoid bioaccessibility (66 ± 3%). Overall, both pretreatment and drying methods markedly influenced the antioxidant potential and bioaccessibility of carrot by-product powders.

Extrusion of Grape Pomace as a Valorization Strategy of Winery By-products: Structural and Techno-functional Characterization

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Abstract

Wine production generates large quantities of grape pomace, representing about 20 - 30% of processed grapes worldwide. Due to its high content of dietary fiber, phenolic compounds and other bioactive constituents, grape pomace has attracted increasing interest as a functional ingredient for food applications. Consequently, the development of value-added powdered ingredients has become an attractive strategy to facilitate their incorporation into food formulations. Among the different valorization strategies, extrusion has emerged as a promising thermo-mechanical technology capable of modifying fiber-rich materials, improving their techno-functional properties and expanding their potential as functional food ingredients. However, limited information is available on the structural and techno-functional properties of powders obtained from grape pomace extrudates. Therefore, this study aimed to evaluate the effect of extrusion on grape pomace formulations containing different grape pomace/corn semolina ratios (0, 5, 10, 20, 40, 80, and 100%). The resulting extrudates were characterized by expansion index and field emission scanning electron microscopy, while the powders were evaluated for particle size distribution, water absorption index, water solubility index, swelling capacity and water and oil holding capacities. Increasing grape pomace content progressively reduced the expansion index, which was accompanied by a transition from highly expanded matrices to denser and more compact microstructures. Moreover, extrusion significantly modified the techno-functional behavior of the powders, with formulations containing low and intermediate grape pomace levels exhibiting the most favorable functional performance. Overall, extrusion represents an effective strategy for producing value-added grape pomace powders with potential application as sustainable food ingredients.

Biotechnological Valorization of Lupin Seeds (*Lupinus albus*) Through Solid-state Fermentation with *Aspergillus oryzae*: Nutritional and Techno-functional Characterization

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Abstract

Solid State Fermentation (SSF) is an effective bioprocessing strategy to modify the composition and structural matrix of legumes, thereby enhancing both their nutritional and techno-functional profiles. This study evaluated the potential of a 72 h SSF process using *Aspergillus oryzae* to valorize non-debittered lupin seeds (*Lupinus albus*) as a functional food ingredient. Fungal growth kinetics were evaluated by glucosamine determination, while changes in macronutrient composition and techno-functional properties were assessed throughout fermentation. The results demonstrated successful substrate colonization, with glucosamine content reaching 117.24 ± 9.53 mg of glucosamine/g dm after 72 h fermentation. Total protein content increased by approximately 8% compared to unfermented substrate, likely due to dry matter loss via fungal cellular respiration, whereas crude fat content remained stable. The enzymatic activity of *A. oryzae* significantly improved the techno-functional properties of lupin seeds. Water absorption capacity increased by 17%, whereas oil absorption capacity exhibited no significant variations. Remarkably, the emulsifying activity index increased nearly threefold, from 5.40 ± 0.38 to 14.41 ± 1.95 m^2/g dry matter, as a consequence of enzymatic hydrolysis and peptide release. In conclusion, a 72 h SSF with *A. oryzae* successfully upgrades lupin seeds into a high-quality functional ingredient suitable for incorporation into complex food matrices.

Comparative Analysis of Squash Blossoms and Purslane: Relationship Between Their Proximate Composition, Photosynthetic Pigments, and Antioxidant Capacity

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Abstract

Mexico harbors a remarkable diversity of edible plants that have historically played a fundamental role in traditional diets and regional food systems. However, many of these species, including squash blossoms (*Cucurbita pepo*) and purslane (*Portulaca oleracea*), remain underutilized despite their recognized nutritional and functional potential. Therefore, this study evaluated squash blossoms (*C. pepo*) and purslane (*P. oleracea*) through proximate analysis, pigment content, and antioxidant capacity. Both species had high moisture content (>92%), although purslane had a higher fiber content (31.28%), whereas squash blossoms showed the highest protein content (31.53%). Regarding pigments, purslane was notable for its higher chlorophyll content (up to ~2950 µg/g dry matter) and greater antioxidant activity in the 2,2-diphenyl-1-picrylhydrazyl, 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid), and ferric reducing antioxidant power assays, while squash blossoms exhibited significant levels of carotenoids (~894 µg/g dry matter), associated with their coloration. Pearson's correlation analysis revealed significant relationships between pigments and color parameters, as well as between chlorophylls and antioxidant capacity (Pearson's correlation coefficient > 0.9). Principal component analysis clearly differentiated between the two species, associating purslane with higher antioxidant levels and squash blossoms with specific color properties. These results enable the exploration of the nutritional and functional potential of these foods, revealing new approaches for their revaluation as potential food ingredients.

Nutritional Composition and Micronutrient Profile of Iberian Dry-cured Ham from Two Commercial Categories

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Abstract

Iberian dry-cured ham is a highly valued traditional product worldwide, renowned for its unique sensory characteristics. Its quality and commercial classification are regulated by the Spanish quality standard established in the real decreto 4/2014, which defines four categories based on pig genetic purity, feeding, and production systems, identified by color-coded labels (Black, red, green, and white). Two categories were evaluated: White label (Iberian × Duroc, feed-fed, intensive system) and black label (100% Iberian, acorn-fed, extensive dehesa system). Vacuum-packed dry-cured ham slices (~100 g) from different industries were analyzed (four batches/category) for compositional characterization, including lipids, fatty acids, proteins, carbohydrates, sodium chloride, vitamins (E, B6, and B12), and minerals (Phosphorus, iron, copper, zinc, chromium, and potassium), to assess nutritional profile and potential nutrition claims. No significant differences in energy content, total lipids, fatty acid profile, proteins, carbohydrates, or salt were observed between the two categories. Vitamins were higher in hams from intensive systems, likely to reflect dietary fortification. Mineral analysis revealed significantly higher levels of iron, copper, chromium, and potassium in black label hams, highlighting the influence of feeding systems on composition. Both categories may carry several nutritional claims, including "high in protein, monounsaturated fatty acids, vitamin B12, and phosphorus" and "source of vitamin B6 and zinc." Notably, black label hams can also be declared a source of essential micronutrients, such as potassium, iron, copper, and vitamin E, further emphasizing their superior nutritional quality and reinforcing their status as a premium Iberian product.

Ohmic Heating Potential for the Pasteurization of Skim Milk: Effects on Microbial Inactivation, Milk Properties, and Protein Denaturation

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Abstract

Large volumes of skim milk and solids-non-fat milk are generated annually in Canada as byproducts of dairy commodities. Stabilization of skim milk quality is essential prior to the production of dairy products or its conversion into skim milk powder and milk protein concentrate through ultrafiltration/diafiltration processes. Conventional high-temperature short-time (HTST) pasteurization (72 ˚C for 15 s) is widely used to extend the shelf life. However, thermal treatment may adversely affect milk quality, particularly the proteins denaturation. The objective of this study was to evaluate the potential of ohmic heating as an alternative technology for reducing the microbial load of skim milk without affecting its properties compared to HTST processing. Ohmic heating known as green process operates in principle of voltage gradient that provides rapid, uniform, and energy-efficient heating with minimal greenhouse gas emissions. The effects of key process parameters, including treatment time, temperature, voltage gradient, and frequency, were investigated using a laboratory-scale ohmic heating system for further pilot-plant scale-up. Results revealed that the come-up time was influenced by both frequency and voltage gradient more than the target temperature for the temperature range studied (70 - 74 ˚C). Furthermore, ohmic heating demonstrated a higher microbial inactivation rate than conventional HTST pasteurization even at lower processing temperature. No significant changes were observed in milk composition, and protein denaturation following ohmic heating treatment. The sustainability performance of ohmic heating technology was also evaluated through eco-efficiency indicators, highlighting its potential as an environmentally friendly and effective alternative for skim milk pasteurization and processing.

Application of Ultrasound to Enhance Carrot Waste Juice Fermentation by *Lactiplantibacillus plantarum* and Develop a Probiotic Powder

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Abstract

Low-intensity ultrasound induces transient permeabilization of microbial membranes, which enhances nutrient uptake, metabolite excretion, and overall fermentative capacity. The implementation of this strategy may offer considerable potential to optimize fermentation outcomes in the valorization of horticultural by-products. The present study investigated the effect of ultrasound applied during the lag phase on *Lactiplantibacillus plantarum* fermentation in a carrot waste medium. Samples were sonicated (20 kHz; 20%, 30%, and 40% amplitude; 20 min; 5 s ON/5 s OFF) while maintaining the temperature at or below 30 ˚C, prior to a 24 h fermentation at 37 ˚C. Microbial growth, total phenols, flavonoids, and antioxidant capacity (2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) and 2,2-diphenyl-1-picrylhydrazyl) were measured at 0, 6, and 24 h. The optimal ultrasound treatment was subsequently freeze-dried with 40%, 50%, or 60% maltodextrin. Although ultrasound did not alter growth kinetics ($p > 0.05$), it enhanced the release of bioactive compounds. Following fermentation, 2,2-diphenyl-1-picrylhydrazyl activity increased by 176 - 246% in sonicated samples compared to 8% increase in the control, and 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) activity increased by up to 26.8%. Based on these results, 30% amplitude was selected as the optimal pretreatment. Freeze-drying produced stable powders, with the ultrasound 30% and 60% maltodextrin formulation demonstrating the most favorable profile: 0.083% moisture, 0.084 water activity, 10.34 log colony-forming units/g, and maximum post-drying bacterial viability (71.96%). This formulation also achieved the highest 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) antioxidant activity (0.71 mg TE/g dry matter) and retention (30.53%). In conclusion, ultrasound-assisted fermentation with maltodextrin freeze-drying offers a promising technological alternative under a circular economy approach.

Antifungal Potential of Selected Essential Oils Against Strawberry-associated Fungi: Molecular Identification and *In Vitro* Screening

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Abstract

Fungal spoilage of fruits and vegetables during postharvest storage and transport contributes substantially to food losses worldwide. Among the fungal diseases affecting fresh produce, gray mold is particularly important in soft fruits, including strawberries, raspberries, and grapes. The growing interest in natural alternatives to synthetic preservatives has increased attention towards essential oils (EOs) as plant-derived bioactive compounds with potential antifungal activity. Their effectiveness depends on their chemical composition as well as the susceptibility of individual fungal species. Therefore, identifying EOs capable of inhibiting fungi responsible for fruit spoilage may provide a basis for their further characterization, formulation, and potential application in food preservation. The aim of this study was to evaluate the antifungal activity of 25 EOs against fungal strains isolated from naturally spoiled soft fruits. Strawberries (*Fragaria* × *ananassa*) were selected as the model fruit due to their high perishability and susceptibility to fungal infection (Figure 1). Fruits showing naturally developing fungal growth were incubated under controlled conditions. Individual fungal colonies were isolated, purified, and subjected to genomic DNA extraction. The internal transcribed spacer (ITS) region was amplified using the ITS1F and ITS4 primers and subsequently sequenced to molecularly identify the isolates. The isolated and identified fungal strains were then used to assess the antifungal activity of 25 EOs obtained from different botanical sources. Fungal growth in the presence of each EO was evaluated *in vitro* and compared with the corresponding controls. This approach was designed to determine differences in the susceptibility of the isolated fungal strains to individual EOs and to identify the most promising EOs for further studies on their potential use in the preservation of soft fruits.



Figure 1: Strawberry fruits with visible fungal growth used for fungal isolation.

Suboptimal Chickpeas for Protein Ingredients: Effects on Antinutritional Factors and Protein Digestibility

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Abstract

The increasing demand for sustainable protein sources, together with the urgent need to reduce food waste, has intensified interest in the valorization of underutilized raw materials through environmentally friendly technologies. In this context, suboptimal chickpeas—rejected from commercial markets due to physical or aesthetic imperfections—emerge as a promising and sustainable feedstock to produce value-added protein ingredients. Among processing strategies, dry fractionation stands out as a solvent-free and low-impact technology for obtaining protein-enriched fractions. This study aimed to evaluate the

effect of feedstock and dry fractionation on antinutritional factors and protein digestibility in chickpea flours. Specifically, the contents of phytic acid, tannins and trypsin inhibitors were quantified in commercial chickpea flour, flour derived from suboptimal chickpeas and their corresponding protein concentrate. In addition, protein digestibility was assessed by simulating gastrointestinal digestion using the INFOGEST protocol, followed by the determination of the degree of hydrolysis. The results showed that using suboptimal chickpeas did not affect the levels of antinutritional factors and improved protein digestibility, whereas dry fractionation increased antinutritional factor levels but did not alter protein digestibility. Overall, these findings indicate that valorizing suboptimal chickpeas through dry fractionation is a viable strategy for developing sustainable protein ingredients while maintaining adequate protein digestibility despite increased levels of antinutritional factors. Future work should explore pretreatment strategies to reduce these compounds and further optimize the nutritional quality of the resulting ingredients.

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Unveiling the Bioactive and Metabolomic Fingerprint of Red Macroalgae Scinaia furcellata and Asparagopsis taxiformis

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Abstract

Two red macroalgal species from the Adriatic Sea, *Scinaia furcellata* and *Asparagopsis taxiformis*, were subjected to comprehensive bioactive and metabolomic characterization within the marine bioprospecting project BioProCro. Matrix solid-phase dispersion using generally recognized as safe solvents (ethanol/water, 50:50 v/v) was applied as a sustainable extraction strategy under mild conditions. Bioactive potential was evaluated through total phenolic content (TPC) and antioxidant activity (2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) assay), revealing a striking contrast between the two species. S. furcellata emerged as a highly promising source of functional compounds, exhibiting a TPC of 3.0 mg gallic acid equivalent (GAE) g^{-1} and antioxidant activity of 7.5 mg trolox equivalent (TE)·g^{-1} (IC_{50} = 0.73 g·L^{-1}), ranking second among twelve macroalgae evaluated. In contrast, *A. taxiformis* showed markedly lower values (TPC: 0.22 mgGAE·g^{-1}; AA: 0.22 mgTE·g^{-1}; IC_{50}: 23 g·L^{-1}), consistent with previously reported limited reducing capacity. Targeted liquid chromatography–tandem mass spectrometry analysis identified key phenolic compounds including quercetin, myricetin and caffeic acid, with taxon-specific distribution patterns. Untargeted ultra-high-performance liquid chromatography–quadrupole time-of-flight metabolomics revealed a broader chemical landscape encompassing sulphated phenolics, organic acids, and amino acid derivatives such as taurine, detected at notably high levels in *S. furcellata*. The proposed detection of fatty acid esters of hydroxy fatty acids further highlights the underexplored chemical richness of Adriatic red algae. These findings position *S. furcellata* as a priority species for future bioprospecting, whilst contributing a robust metabolomic baseline for both taxa.

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From Fluence to Color: Understanding Pulsed Light Inactivation in Wine Matrices

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Abstract

The use of sulphites in wine is increasingly questioned by consumers and health authorities due to widespread exposure, while climate change and the shift toward low-input products further highlight the need for alternatives. This study investigates pulsed light technology as a decontamination method to reduce sulphite use. The aim was to assess the effect of ultraviolet-C dose on inactivation efficacy under static conditions and its dependence on wine characteristics. First, the applied fluence was measured using the iodide/iodate actinometer method. The actinometer underwent pulsed light treatment, and the dose (J/L) was calculated from spectrophotometry data. The first essays were conducted to evaluate the effect of fluence on the inactivation

of 3 strains of *Brettanomyces bruxellensis* (CBS2499, AWRI1499, AWRI1608) and one of *Saccharomyces cerevisiae* (FX10). The cells were treated under a total energy of 4 KV and a frequency of 3 Hz. Cell viability was measured by total plate count in yeast extract–peptone–glucose supplemented with biphenyl and chloramphenicol. Fluence had a significant effect on the inactivation level of the yeasts. The extent of the effect varied among strains. After, a fluence of 304 J/L was chosen to study the influence of color on the inactivation. Five different colored wine-like matrixes were prepared and inoculated with yeasts, then treated with pulsed light. For the matrix, pH and color were measured pre and post treatment. A decreasing tendency of pulsed light efficacy with increasing color intensity was observed. Regarding both characteristics, the pH and color index didn't change significantly after the treatment.

Valorizing Fermentation Carbon Dioxide for Ethanol Correction by Gas-liquid Stripping in Wines

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Abstarct

Reducing alcohol in wine has become a technological and sensory challenge, as consumer preferences shift toward lighter profiles. Conventional dealcoholization techniques (vacuum distillation, reverse osmosis, and spinning cone columns) remain energy intensive, require high investment and alter key aromatic compounds. In a sector committed to lowering its environmental impact, alternatives are increasingly needed. Fermentation derived carbon dioxide (CO_2), released during winemaking, represents an abundant resource with strong potential for valorization. This research investigates a CO_2 based gas liquid stripping process designed for ethanol correction in wines. By recycling fermentation CO_2 as the stripping gas, the method integrates alcohol adjustment within a circular and climate conscious framework. The work includes (i) modeling of gas liquid mass transfer, (ii) laboratory scale optimization using hydroalcoholic solutions, and (iii) validation on wines to limit chemical and aromatic impacts. A reduction of 1% (v/v) is evaluated, and optimizations using a membrane contactor are investigated. Optimization of the volumetric mass transfer coefficient (kLa) focused on gas flow, pressure and diffuser pore size is investigated. Smaller bubbles provided higher surface to volume ratios, enhancing interfacial area and increase ethanol stripping. Analytical results indicated moderate changes in tannins, anthocyanins, color intensity and polyphenols suggesting interactions between CO_2 stripping and wine macromolecules. Gas chromatography–mass spectrometry analyses showed a 10 - 20% decrease in higher alcohols and an 85% loss of total esters, reduced to 50% with membrane contactor. Although furthers optimization are required in terms of flow, pressure, temperature, CO_2 based stripping could represent in the future a solution for alcohol adjustment while reducing the carbon footprint of winemaking. This work demonstrates feasibility and outlines future directions for improving selectivity, aroma recovery and scale up.

Digestion Kinetics of Bioactive Compounds from Chokeberry Encapsulated in Water-in-oil-in-water Nanoemulsions and Their Health-promoting Potential

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Abstract

Double water-in-oil-in-water (W1/O/W2) nanoemulsions are promising delivery systems for the simultaneous encapsulation of hydrophilic and lipophilic bioactive compounds, improving their stability and gastrointestinal release. This study aimed to develop W1/O/W2 nanoemulsions co-encapsulating chokeberry (*Aronia melanocarpa*) polyphenols and carotenoids and to evaluate their digestion kinetics, bioaccessibility and health-promoting potential. Four W1/O/W2 nanoemulsion formulations were prepared using a two-step emulsification process. Polyphenols were incorporated into the internal aqueous phase (W1), carotenoids into the oil phase, and the external aqueous phase (W2) stabilized with either pectin or locust bean gum. All formulations exhibited good physicochemical stability, with droplet diameters ranging from 255 to 391 nm, and pulsed light below 0.40. Simulated gastrointestinal digestion revealed compound-dependent release profiles. Anthocyanins were released predominantly during the gastric phase, whereas phenolic acids, flavonols and flavan-3-ols were mainly released during the intestinal phase. Only flavan-3-ol fractions were detected in the dialyzable fraction, indicating their potential intestinal absorption. Polymeric procyanidins underwent progressive depolymerization, with the mean degree of polymerization decreasing from 6.5 - 8.3 to approximately 1.0 after intestinal digestion. Xanthophylls were gradually released, reaching the highest concentrations during the intestinal phase, whereas carotenes remained largely associated with the emulsion matrix. Nevertheless, both xanthophylls (0.30 - 0.61 mg/100 g) and carotenes (0.00 - 2.41 mg/100 g) were detected in the bioaccessible fraction. The nanoemulsions exhibited pronounced antioxidant activity (Oxygen radical absorbance capacity: 0.61 - 0.97) and

effective lipoxygenase inhibitory activity. These findings demonstrate that W1/O/W2 nanoemulsions are effective carriers for chokeberry phytochemicals, enabling controlled release and influencing the bioaccessibility of individual bioactive compounds during gastrointestinal digestion.

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