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Meeting Abstracts

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Keynote Presentations

Technological Solutions for Food Packaging Systems in a Circular Economy

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Abstract

The use of plastic packaging in the food industry is under increasing scrutiny due to its environmental impact. With production having tripled over the last 30 years, almost 400 million metric tons of plastics are produced annually, accounting for 4.5% of global greenhouse emissions. Over 99% of these plastics are derived from fossil-based polymers, which persist in the environment for hundreds of years, posing significant ecological risks. The food and beverage sector is the largest consumer of single-use plastic packaging, yet transitioning away from plastic entirely is impractical due to its crucial role in food preservation, safety and hygiene. A circular economic approach, wherein plastic packaging is reused multiple times before closed-loop recycling, offers a promising strategy for mitigating environmental impacts within food provision. However, several technical challenges hinder widespread implementation, including the need for effective cleaning validation, prevention of cross-contamination, and assessment of packaging integrity to ensure safety, suitability for automated systems and consumer acceptance. Currently, no commercially available solutions comprehensively assess the suitability of every pack for reuse. This work explores the application of ultraviolet induced fluorescence imaging (UVIFI) combined with deep learning (DL) models to automate the detection of residual food contamination and assess packaging condition. Utilizing UVIFI of fluorophores within foodstuffs and polymers enables the real-time detection of residual fouling across the full food contact area and analysis of pack integrity. The developed system enables automated defect classification, facilitating reliable verification of packaging suitability for reuse. Results demonstrate the potential of integrating UVIFI and DL for accurate defect identification. Such a technological solution supports scalable circular economy reuse systems and could underpin environmental impact limitation in the food sector.

Beyond "Use By" Dating of Food to Avoid the Paradox of Waste of Safe Products: The Case of Fresh Pasta

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Abstract

Introduction: Dating food and shelf-life concept was introduced to determine in a scientific and objective manner the end of the commercial life of food products mainly for shelf stable food products like canned meat and vegetables, intermediate moisture and dried foods. Nevertheless, the concept has been subsequently applied to the perishable and highly perishable foodstuffs where the main concerns are about food safety mainly due to microbial growths. Every year in Europe many millions of tons of food still in good hygienic conditions are lost or wasted along the food chain and 10% of those are estimated to be related to the food dating.

Purpose: Aim of this speech is to highlight as the shelf-life evaluation and the dating of some products generally considered as "perishable" and thus labeled as "Use by Date", could go beyond that concept if the processing conditions and the treatments involved production diagram are correctly studied, where "hurdles" concept is the key to obtain the product safety. Then the management of the process and storage along the food chain must be strictly controlled with hygienic design, hazard analysis and critical control points and good manufacturing practice application. Following those principles, also considering the com-

pulsory pasteurization step given by the Italian legislation, the fresh pasta can be considered not more as "strictly perishable" with use of "Use by Date" labeling but with possibility to adopt a "Use Prefer by Date" indication on the pack.

Methods: Based on the review of more recent literature on shelf life evaluation of fresh pasta types, both flat and filled pasta (like ravioli or tortellini) and taking into account both quality and safety approaches, relating to the microbial growth of possible contaminant species and their survival after processing, the key elements for the discussion on the evolution of dating concept has been highlighted. Particular attention was placed to the research carried out in an industrial environment, also taking into account some chemical physical properties after treatment and during storage. Furthermore, the European Food Safety Authority Guidance on date marking and related food information gives important information on this topic.

Results: Due to the strict and controlled application of well-defined flow diagrams, pasteurization(s) treatments, the hygienic design of pasta formation and packaging steps as well as the use of modified atmosphere packaging and a refrigerated regime of the supply chain, the shelf life of the industrial fresh pasta (regulated and well defined by a specific Italian national law) is nowadays mainly related to chemical and physical quality parameters like texture and sensorial properties, rather than to microbial growths. In addition, EFSA reports give clear indications regarding how the production factors can influence the date marking decision ('use by' date or when a 'best before' date is appropriate). In fact, the decision needs to be taken on a product-by-product basis, considering the product characteristics (intrinsic, extrinsic, and implicit factors), processing and storage conditions.

Conclusion: Owing to the technological and knowledge development in the fresh pasta industrial processing, the dating of those foods could be defined using an "Use prefer by" rather than an "Use by Date" indications under the responsibility of the company's quality control directors, giving to the producer more possibilities to reach different markets and to avoid wastes of still safe products.

Novel Freezing Technologies for Enhancing Frozen Food Quality

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Abstract

There has been interest in food industry to adapt processing techniques to improve shelf-life, safety, preservation and functionality of foods. High pressure processing (HPP) is one such technique that has received great attention from research, development and application point of view. Much of the early attempts focused on the preservation and safety of foods dealing mostly with high pressure destruction of spoilage and pathogenic bacteria in foods flooding the literature with microbial destruction and enzyme inactivation related works. Subsequently the focus moved to other areas like product development, functionality, kinetic acceleration of various chemical and enzymatic processes. Even non-food areas were focused on HPP. This presentation will focus on another novel area of high-pressure impregnation of functional/nutrients into a food matrix to impart certain specific processing applications like nutrient enhancement, quality improvement, acidification (low acid foods for acidified thermal processing), addition of salts (texture formation, facilitating ohmic heating), hydration (chickpeas), removing anti-nutrients (chickpeas and soybeans) etc. This research highlights HPP for many nontraditional food processing applications.

Increasing the Storage Temperature of Frozen Foods by 3 °C: Impact on Kinetics of Quality Loss

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Abstract

Frozen storage temperature plays an important role in preserving the initial quality of frozen foods. -18 °C is the international standard for frozen foods storage; it has been established based on the 0 °F (-17.8 °C). The "level of frozenness" (LOF) represents the percentage of freezable water that is effectively frozen at a given temperature. At -18 °C, most foods do not reach 100% LOF (usually in the range of 95% LOF) and the 100% LOF is reach around -30 °C. The University of Birmingham, United Kingdom, in collaboration with the International Institute of Refrigeration launched the "3 °C MORE" initiative aiming at increasing the frozen foods storage temperature from -18 °C to -15 °C. The rationale of this proposal lies in a reduction of the energy expected to reach 10%. This contribution proposes a review of the current regulations in link with selected "emerging" subzero temperature storages such as chilling, super chilling and supercooling. Regarding the 3 °C more initiative, existing models based on quality loss (High quality loss and practical storage life) have been considered for different food commodities. It was found that shifting the frozen foods storage from -18 °C to -15 °C would yield in a shelf-life reduction of 30%. In the case of vitamin C, data obtained with green peas and spinach shows that a reduction of 55 to 60% of the shelf-life must be expected. These expecta-

tions do not accommodate temperature oscillations during storage and transport, which may accelerate quality loss. Guidelines are proposed to mitigate the expected reduction of quality loss such as reinforced temperature stability, packaging and others.

Oral Presentations

Production of High-added Value Products from By-products of the Sugar Production Process

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Abstract

In the sugar production process from sugar beet, several by-products are generated, mainly exhausted sugar beet pulp and molasses. Sugar beet pulp is produced in larger quantities (500 kg of wet pulp from 1 ton of sugar beet), and is generally used in livestock feed, although in non-livestock areas it usually ends up in landfills. It consists mainly of polysaccharides, such as hemicelluloses, cellulose and pectin, with low lignin, protein, mineral and fat content. As regards molasses, they contain 50% sugars, mainly sucrose, and another non-sugar fraction that includes minerals, vitamins, proteins, etc. The composition of these by-products makes them valuable raw material for the production of high-added value products through biorefinery processes. Enzymatic hydrolysis is a process that breaks down lignocellulosic biomass through the action of enzymes, producing hydrolysates rich in sugars. These hydrolysates can be used for the production of bioproducts through fermentation using the suitable microorganism. In this work, exhausted sugar beet pulp and molasses were mixed in different proportions to be subjected to enzyme hydrolysis using the commercial enzyme cocktail Cellic Ctec to produce hydrolysates rich in fermentable sugars, which can be fermented to high-value products like ethanol, with widespread applications, in industries such as food, biofuels, medicine, chemicals, etc.

Effectiveness of a Minimal Processing Technology Combined with Biodegradable Packaging to Produce a New Ready-to-eat Vegetable: Fresh Cut Fennel

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Abstract

Among the ready-to-eat products, fresh cut fennel is currently not present on the market, because its conservation is considered particularly difficult due to the rapid and progressive browning and loss of freshness that affect the characteristic leaves after cutting. This leads to a deterioration considered unacceptable by the consumer. On the other hand, current environmental policies require a reduction of conventional plastic that could be critical, especially for ready-to-eat products. This research contributes to providing new knowledge on the production of fresh-cut fennel, evaluating the effectiveness of an anti-browning solution, composed of 2% ascorbic acid and 1% calcium chloride, and biodegradable packaging, based on polylactate (PLA), in fennel quality preservation. Physical-chemical, microbiological and sensorial parameters were monitored during the storage time at 4 °C. Biodegradable packaging allowed to preserve the quality of fennel, similarly to plastic material, in particular microbiological safety and visual and sensorial acceptability up to 10 days, thus identifying PLA as a valid and possible alternative to conventional plastic, with promising results from the point of view of sustainability of food production.

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An Inclusive Innovation Approach for Designing Cellular Agriculture Value Chains Towards a Sustainable Food System

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Abstract

Cellular agriculture (CA) is an emerging sector that aims to provide alternative proteins through cell culture technologies. While the field faces several technical, economic, and regulatory barriers, its development is mainly driven by sustainability narratives particularly the reduction of environmental impacts linked to conventional livestock production. However, sustainability in food systems is not only determined by environmental and economic dimensions, but also includes social aspects such as public acceptability, fairness, and accountability. The social dimension of sustainability is often overlooked in innovation processes, undermining the transformative potential of novel food technologies and increasing the risk of socio-technical misalignment. To enable a socially responsible transition, decision-making in the innovation cycle must be participatory, inclusive, and reflexive, ensuring that societal values are embedded from the early stages. This is especially relevant for the CA sector, given its disruptive nature and its relation to culturally sensitive domains such as meat consumption. This research proposes an Inclusive Innovation approach tailored to the design of value chains in the CA context. The aim is to generate design guidelines that embed stakeholders' values and capabilities into early-stage decisions, shaping the development of CA within the broader food system. Methodologically, the approach integrates bioprocess design scenarios with sustainability assessment and ethical reflections to explore trade-offs and synergies between technical and social goals. In addition, frameworks such as value-sensitive design and capability-sensitive design are used to support the systematic integration of diverse stakeholder perspectives, which remain underexplored in CA literature. The result of this research is a conceptual and methodological pathway for identifying sustainability trade-offs and value tensions in early innovation stage for CA. The expected outcome is a set of actionable guidelines to support researchers, engineers, and policymakers in navigating the responsible development of alternative proteins towards a more inclusive and sustainable food system.

Sustainable Approaches in the Preservation of Cherry Tomatoes Aimed at Reducing Food Waste and Plastic Use

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Abstract

Sustainability in the food industry is increasingly driving the development of innovative strategies aimed at reducing environmental impact while preserving product quality. The implementation of new methodologies and the use of innovative materials such as biopolymers derived from renewable and compostable resources meet the current demand for reducing the environmental impact of industrial processes, possibly improving, by appropriate targeted actions, the shelf life of foods. As a key component of the Mediterranean diet, tomato (*Solanum lycopersicum* L.) is one of the most consumed fruits highly appreciated for its nutritional properties. Nevertheless, its postharvest shelf life is limited due to its climacteric nature, which makes it susceptible to rapid deterioration caused by biochemical processes, with consequent production of food waste. Recently, increasing attention has been directed to the valorization of agri-food by-products, such as those from the citrus industry, as natural sources of bioactive ingredients to be reused in different fields. The present research has deepened the combination of the use of bio-packaging (biopolymers and edible coating) and a lemon pomace extract in extending the shelf life of cherry tomatoes, resulting in a sustainable approach for the reduction of plastic that effectively preserved cherry tomato quality by reducing microbial growth, limiting weight loss and maintaining the firmness while promoting a circular economy through the valorization of an industrial by-product.

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Development of Porcine and Warm Water Fish Gelatin Blends with Gelan or Sodium Alginate as Food Contact Materials

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Abstract

This study investigated the effects of addition of gellan gum (GL) and sodium alginate (SA) at three different concentrations 0.01%, 0.05% and 0.1% (v/v), with glycerol levels 20% and 30% (w/w) on the mechanical and barrier properties of porcine and warm water fish gelatin films. Films were prepared using the solution casting method and analyzed for tensile strength, elongation at break, water vapor transmission rate (WVTR) and structural integrity after cheese contact. For porcine gelatin, at 20% glycerol, a significant improvement in the tensile strength was observed at all GL and SA concentrations. However, at 30% glycerol, only 0.01 and 0.05% GL containing films showed a significant improvement in the tensile strength. A significant reduction in the WVTR was observed at all SA concentrations and 0.01% GL addition at 20% glycerol for porcine gelatin films, while no significant change was observed for 0.05% GL addition and an increase was observed for 0.01% GL containing films. On the other hand, no improvement in the WVTR was observed for the 30% glycerol containing films irrespective of the GL and SA concentration for porcine gelatin films. For warm water fish gelatin films most improvements were observed at 20% glycerol. Food contact study conducted using Norwegian brown cheese showed that, tensile strength decreased for both warm water fish and porcine gelatin films after contact with cheese. However, addition of GL and SA to warm water fish and porcine gelatin improved strength retention compared to glycerol addition alone after cheese contact.

Gelation of Acid Milk Gel with and without Addition of Fish Gelatine, Investigated from Macroscopic to Microscopic and Nanoscopic Levels

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Abstract

This study investigated the physical and structural characteristics of acid milk gel across multiple scales, both with and without the incorporation of fish gelatin (FG) at a low concentration (0.5%, w/w). The gel formation process utilized reconstituted skim milk at 40 °C with glucono-delta-lactone (2% w/w), followed by cooling (from 40 to 4 °C, at 1 °C/min), annealing (4 h at 4 °C), and subsequent cold storage (up to 7 days at 4 °C). The analysis employed small- and large-oscillatory shear rheology and texture analysis (deformation and repeated compression test) at the macroscopic level, passive particle tracking (with 1.0 μm probe particles) at the microscopic level, and small-angle X-ray scattering (SAXS) at the nanoscopic level. The inclusion of FG resulted in a slight reduction in the viscoelastic properties (G′ and G″) at the conclusion of incubation. Moreover, there was a more pronounced increase in the G′ of acid milk gel with FG when the sample was maintained at 4 °C for 4 h post-gel formation during the annealing phase. Regardless of FG addition, the samples exhibited strain-hardening behavior under large deformations. Particle tracking did not reveal sample-dependent behavior of the probe particles, indicating a developing network with high porosity (>1 μm) until the late stage of incubation. After 7 days of cold storage, the particles in the sample without FG exhibited sub-diffusive movements, whereas those with FG did not, reflecting the enhanced water-binding capacity of FG. The time-resolved SAXS profiles of the milk gels during acid-induced gelation did not display significant differences related to FG addition. Texture analysis revealed different stress relaxation and viscoelastic behavior in samples with and without FG, indicating that FG addition primarily affects the macroscopic properties of acid milk gel rather than its microscopic and nanoscopic structure.

Biochemical, Hydrothermal and Texture Characterizations of Lentils and Chickpeas for Pulse-based Model Foods

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Abstract

Increasing the proportion of pulses in daily diets is a relevant strategy to meet nutritional needs while preserving soil fertility. Various approaches are considered to increase pulse attractivity, ranging from traditional foods (e.g., cooked seeds) to more technologically innovative ones (e.g., meat analogs), each requiring significant research effort. Determining the relationships between the biochemical composition of pulses and their functional properties is one of the main bottlenecks to better handle food models with varied textures. To this end, different batches of chickpeas and lentils (26 and 18 respectively) have been studied for their composition and hydrothermal properties. The content of major macronutrients (proteins, starch, and cell wall polysaccharides), water content, were determined. Hydrothermal properties were first assessed by cooking time distributions determined using an adapted Mattson cooker device. Mean cooking time, determined by the inflexion point of these distributions, varied between 17 and 30 min for lentils, and between 16 and 46 min for chickpeas. The shorter the cooking time, the more homogenous the batch is. Based on these first results, a screening of the batches was performed to select ten most different ones, for each species, using principal component analysis and ascendant hierarchical classification. Hydration kinetics and texture analyses performed on these selected batches allowed determining specific relationships, which underlined the role of cell wall polysaccharides. These components and their organization appear to influence not only water diffusion into the seed during cooking, but also its mechanical properties. This presentation will give an overview of the main results obtained to identify the seed-related determinants that affect culinary quality, both in whole seeds and in other food models.

Intelligent Quality Control of Food-grade Paraffin Wax Odor using an Electronic Nose

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Abstract

Food-grade paraffin wax, a petroleum-derived product, is widely used in the food industry as a preservative and additive (e.g., in chewing gum, fruits, and cheese). To ensure compliance with U.S. Food and Drug Administration regulations, paraffin wax undergoes a rigorous quality control process, including purification processes such as high-temperature hydrogenation, to remove sulfur and aromatic compounds. Among the critical quality control parameters for food-grade paraffin wax, odor intensity plays a pivotal role, as the presence of undesirable odors may indicate impurities affecting product safety and acceptability. Traditionally, odor assessment is conducted using the ASTM D1833 sensory panel method, which relies on subjective human evaluations. However, this method presents limitations, such as variability between panel assessments, slow response times, and potential health risks due to prolonged exposure to volatile organic compounds and semi-volatile organic compounds. To address these challenges, this study explores the suitability of a Headspace-mass spectrometry electronic nose in combination with advanced supervised machine learning algorithms (Gaussian support vector machine, random forest, partial least squares regression, and support vector regression) for the automatic and objective detection and quantification of food-grade paraffin wax odor. A Box–Behnken design and response surface methodology were first employed to optimize headspace generation variables by using the total ion spectrum as a response variable. This novel approach provides a comprehensive aroma profile, overcoming the constraints of traditional gas-sensor-based electronic noses and the targeted analyte approach of conventional gas chromatography–mass spectrometry. The most efficient models (Gaussian support vector machine and support vector regression) were integrated into a prototype interactive web application to share these models and for broader accessibility and implementation. The proposed method enhances objectivity, reproducibility, and efficiency of paraffin wax odor analysis, offering a robust alternative to ASTM standards and contributing to improved quality control in the food and petrochemical industries.

Detection and Quantification of Fruit Juice Adulteration Using Fourier Transform Infrared Spectroscopy and Headspace-Gas Chromatography-Ion Mobility Spectrometry Combined with Machine Learning

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Abstract

Fruit juice adulteration remains a significant concern in the food industry, often involving the addition of water, sugars, or lower-cost fruit juices. This study presents an innovative analytical approach based on fourier transform infrared spectroscopy (FT-IR) and headspace-gas chromatography-ion mobility spectrometry (HS-GC-IMS), combined with machine learning (ML) algorithms, to identify and quantify adulteration in fruit juices. The methodology was evaluated using 100% freshly squeezed pineapple, orange, and apple juices adulterated with grape juice at concentrations ranging from 5% to 50%. Spectroscopic data from FT-IR and HS-GC-IMS were independently analyzed using various ML algorithms. Supervised classification models achieved 100% accuracy in detecting adulteration using FT-IR with support vector machine (SVM) and linear discriminant analysis (LDA) models. For HS-GC-IMS, SVM achieved 95.45% accuracy, followed by LDA at 93.18%. Regression algorithms were then employed to quantify adulteration levels, with FT-IR demonstrating superior performance over HS-GC-IMS. Support vector regression models yielded the best results, with FT-IR achieving an R^2 of 0.995 and root mean square error (RMSE) of 1.243, while HS-GC-IMS achieved an R^2 of 0.987 and RMSE of 1.831. This approach offers significant advantages over conventional methods, such as gas or liquid chromatography coupled with mass spectrometry, which rely on identifying individual compounds. Unlike these traditional methods, it provides a more sustainable, cost-effective, rapid, and portable solution. Additionally, the use of ML models allows for automation, reducing the need for qualified operators. To facilitate its application, a prototype web application has been developed to share the FTIR models with other users.

Application of Extractive Techniques for Obtaining Bioactive Compounds from Mushrooms

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Abstract

Bioactive compounds in mushrooms have gained increasing attention due to their health-promoting properties, including antioxidants, anti-inflammatory, and neuroprotective effects. This study focuses on the optimization of extraction techniques to obtain bioactive compounds such as tryptophan, phenolic compounds, and alkaloids from different mushroom species using eco-friendly methods like ultrasound-assisted extraction (UAE) and microwave-assisted extraction (MAE). UAE was optimized through a Box-Behnken design considering factors such as methanol percentage, temperature, ultrasound amplitude, cycle, and sample-to-solvent ratio. The extraction efficiency was evaluated by quantifying total phenolic compounds using the Folin-Ciocalteu method and assessing antioxidant activity through 2,2-diphenyl-1-picrylhydrazyl and 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) assays. Optimal conditions enabled the simultaneous extraction of phenolic compounds and antioxidant compounds, with differences of less than 5% compared to single-method extractions, confirming the method's efficiency. Furthermore, tryptophan content was quantified in 26 wild mushroom samples from the Lactarius and Boletus genera using UHPLC-DAD-FLR, with concentrations ranging from 0.042 to 0.742 mg/g. Hierarchical cluster analysis revealed a correlation between tryptophan levels, mushroom species, and bioactive properties. Additionally, MAE and UAE were applied to extract psilocybin and psilocin from Psilocybe cubensis, achieving optimal conditions at 50 °C, 60% methanol, and a 0.6 g:10 mL sample-to-solvent ratio within 5 min, ensuring a rapid and efficient process. UAE obtained better extraction yields than MAE, but there was a higher conversion of psilocybin to psilocin in the extraction process. The results highlight mushrooms' potential as sustainable sources of natural bioactive compounds, supporting their application in the food, pharmaceutical, and cosmetic industries. The developed extraction methods provide reliable and eco-friendly tools for obtaining high-value compounds, promoting their use in functional foods and nutraceuticals.

Benchtop Nuclear Magnetic Resonance for Grape Quality Assessment and Fermentation Monitoring

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Abstract

Ensuring high-quality wine production requires rapid and reliable analysis of grape batches, with a focus on key parameters such as sugar and acid content, rot indicators, and pH levels. Traditionally, fourier-transform infrared spectroscopy has been used for this purpose, relying on statistical models to correlate spectral data with reference analyses. However, this indirect approach can introduce inaccuracies. High-field nuclear magnetic resonance (NMR) spectroscopy offers a compelling alternative, providing direct, calibration-free quantification of chemical species without the need for extensive sample preparation. Despite these advantages, the size, cost, and cryogenic cooling requirements of high-field NMR limits its practical application in routine grape and wine analysis. Recent advances in compact benchtop NMR instruments offer increased portability, flexibility, and ease of use. However, their lower magnetic field strength reduces spectral resolution, making the quantification of complex mixtures such as grape juice and wine more challenging. To address this limitation, this study explores the use of an 80 MHz benchtop NMR spectrometer in combination with a model-based data processing approach for grape quality assessment. We demonstrate that benchtop NMR can not only provide rapid evaluation of key wine parameters but also estimate the pH value of juice and wine samples directly from the spectral data. Additionally, we show that using water suppression sequences enables precise analysis of rot-related compounds, such as acetic acid and gluconic acid, in grape samples. Furthermore, the benchtop NMR spectrometer was used to monitor fermentation processes, highlighting its versatility in both quality assessment and production control.

Fluorescent Detection of Antibiotics in Dairy Products and Household Water Using Biocompatible Doped Carbon Dots

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Abstract

The identification of antibiotic residues in food and water is essential for public health and environmental protection. This study involved the synthesis of carbon dots (ADCDs) utilizing L-arginine and diethylenetriamine as nitrogen-rich precursors to amplify fluorescence characteristics. The structural and chemical content of ADCDs was validated using X-ray diffraction, fourier-transform infrared spectroscopy, and X-ray photoelectron spectroscopy, confirming effective doping and surface functionalization. The synthesized H-CDs demonstrated robust fluorescence, superior water dispersibility, and remarkable photostability, facilitating the selective detection of ampicillin in milk and tap water. The study of the actual sample exhibited elevated recovery rates (82.00% - 98.77%) alongside a low relative standard deviation, so validating the sensor's precision and consistency. Cytotoxicity investigations, including MTT (3-(4, 5-dimethylthiazolyl-2)-2, 5-diphenyltetrazolium bromide) assays and fibroblast proliferation analysis demonstrated over 80% cell viability, confirming the biosafety of the created nanomaterial. The integration of green synthesis, intrinsic doping and fluorescence-based sensing offers a cost-effective and efficient method for antibiotic monitoring. This study positions ADCDs as a viable sensing platform characterized by high selectivity, operational ease, and the potential for incorporation into portable detection devices for real-time monitoring in food safety and environmental contexts.

Exploring the Influence of Masticatory Behavior on Pasta Preferences: Opportunities for Innovation in Food Products

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Abstract

According to the International Pasta Organisation, Italy is the first country for pasta yearly consumption. Although pasta producers strive to meet consumer preferences, the role of oral mouth behaviors (OMB) in pasta preference remains unexplored. In a frame of product development of innovative bronze-drawn pasta shapes with a pasta company, we developed research: 1) to study which texture attributes maximize the intensity perception of the overall pasta flavor (OFI); 2) to assess how the OMB affected pasta preferences. Two sensory tests with regular pasta consumers (test 1: n = 110, eight samples existing on the market; test 2, n = 100, five innovative pasta shapes), including liking, OFI, Rate-all-that-apply and a questionnaire on OMB (envisaging four main food manipulating oral behaviors: chewing, crunchy, sucking and smooshing) were conducted. In test 1, samples significantly differed in liking, OFI, and sensory properties. Results of the first test were used to develop innovative samples with short shapes, not smooth (having superficial lined/rough), and requiring an accentuated masticatory chewing behavior (either due to a high density, or to elasticity, or to the thickness) in order to maximize the OFI of the samples evaluated in test 2. The newly developed pasta shapes were homogenous for liking and OFI, differing only for a few sensory textural attributes (hardness and amassment). However, all innovative pasta shapes had an increased liking and OFI than samples in test 1. A cluster of consumers liking more the tubular-shaped shapes preferred a 'crunchy' OMB compared to the cluster liking more the roundish-shape pasta samples, indicating that individual variability in pasta oral processing affects preference. Studying individual variability can contribute to industrial product innovation.

Advanced Analytical Strategies for the Authentication of Honey

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Abstract

Stingless bee honey (Meliponini) is a unique natural product with distinctive characteristics, such as higher acidity and slower crystallization compared to *Apis mellifera* honey. Despite its growing recognition, it remains underrepresented in international regulations. This study explores innovative analytical approaches to characterize stingless bee honey, focusing on volatile and proteomic profiling to determine authenticity and geographical origin. The objective of this study is to support quality control measures, enhance market recognition, and contribute to fair trade practices. By applying techniques such as headspace solid-phase microextraction with gas chromatography-mass spectrometry and ultra-high performance liquid chromatography-mass spectrometry orbitrap, this study aims to identify specific markers that define the unique attributes of this honey. These findings provide valuable insights into the unique properties of stingless bee honey, promoting its differentiation in global markets and encouraging the development of specific regulatory frameworks. Additionally, awareness of its characteristics can help protect traditional production methods and ensure sustainable commercialization.

Post-fire Metal Content Analysis in *Morchella* Mushrooms: Health Implications and Safety Concerns

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Abstract

Many studies have demonstrated that mushrooms are not only nutritious but also provide various health benefits, including anti-tumor, anti-inflammatory, and antioxidant properties. This makes them a vital component of modern gastronomy, valued for their unique texture and flavor. Among edible mushrooms, those of the genus *Morchella* are particularly esteemed for their culinary and commercial significance, often regarded as a luxury item by chefs and food enthusiasts alike. Following the devastating fire in Sierra Bermeja (Malaga, Spain) in 2021, there was a remarkable fructification of *Morchella* mushrooms, which were collected in large quantities and ended up being marketed and consumed without control or traceability. However, wildfires can significantly alter the physical and chemical properties of the soil, potentially impacting the mineral composition of the mush-

rooms that grow in these areas. In this study, the levels of essential and non-essential metals in *Morchella* mushrooms collected from the fire-affected region, alongside samples from various non-burnt locations were determined. The corresponding fruiting soils were also analyzed in this fungal genus. Using microwave-assisted acid digestion and three analytical techniques-flame atomic absorption spectroscopies, inductively coupled plasma optical emission spectroscopy, and inductively coupled plasma mass spectrometry-we found that *Morchella* samples from the burned area exhibited significantly higher concentrations of elements such as iron, magnesium, aluminum, chromium, and nickel compared to those from other regions. Furthermore, by calculating the estimated daily intake of metals and the health risk index, we concluded that the *Morchella* mushrooms from the Sierra Bermeja fire area pose a potential health risk due to their elevated metal content. Given the unique characteristics of wild *Morchella*, it is crucial to handle them with caution to ensure food safety and protect public health, especially when harvested in large quantities from unstable environments like fire-affected areas.

Characterization of Black Legume Flours as Ingredient for Food Applications

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Abstract

Following the European Union initiatives to identify and enhance the consumption of alternative and sustainable plant-based protein sources, legumes emerge as a key solution, combining high nutritional value with low environmental impact. Moreover, the valorization of underutilized varieties represents an innovative approach to promoting biodiversity conservation and sustainability in food systems. This study aims to investigate the potential of Sicilian neglected black legume varieties as a source of sustainable protein-rich ingredients, offering innovative solutions for the food industry. Black legumes, including chickpeas and lentils, were milled and the obtained flours were analyzed to evaluate their chemical-physical characteristics, nutritional profile, technological properties, and phenolic compound content. Besides, the analysis of fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAPs), which are carbohydrates poorly absorbed and responsible for digestive difficulties, has been carried out. The chemical-physical analyses revealed a high protein content and a balanced nutritional profile; technological assessments demonstrated promising functional properties, such as water and oil absorption capacities, foaming, and emulsifying abilities, which are critical for formulating different food products. Moreover, the flours exhibited a significant presence of phenolic compounds, indicating potential antioxidant benefits. Carbohydrate analysis, performed by high-performance anion-exchange chromatography with pulsed amperometric detection, allowed us to obtain the complete FODMAPs profile to evaluate if these flours could be compatible with low-FODMAP dietary requirements broadening their applicability for consumers with specific nutritional needs. Black legume flour could be used as protein-rich ingredients aligning with the principles of biodiversity conservation by encouraging the cultivation of neglected legume varieties, which are well-adapted to local climates and resistant to environmental stressors. This study highlights the importance of exploring underutilized crops and developing more diverse and resilient food systems. Integrating these flours into food formulations makes it possible to create new, functional, and health-promoting products while preserving local agrobiodiversity and supporting regional agricultural practices.

Relations Between the Synthesis of the Bioactives Tyrosol, Hydroxytyrosol and Melatonin and Volatile Compounds by *Saccharomyces Cerevisiae*

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Abstract

Yeasts, particularly *Saccharomyces cerevisiae*, are effective bioreactors, attracting significant interest for industrial applications in producing various molecules. This study focused on the production of bioactive compounds-hydroxytyrosol (HT), tyrosol, and melatonin (MEL)-by *S. cerevisiae* and their relationship with volatile compounds in fermented must. Results showed an inverse correlation: higher concentrations of HT and MEL in fermented must were associated with lower amounts of volatile compounds. This trend was most notable for higher alcohols, particularly 2-phenylethanol (2-PE), and esters. Furthermore, using

a modified Aro4pK229L *S. cerevisiae* QA23 strain that overproduces HT led to must with higher levels of 2-PE and its corresponding esters, but with significantly lower levels of key esters like ethyl hexanoate and ethyl octanoate. These findings suggest that *S. cerevisiae* may adopt different strategies to manage cell stress and toxicity, potentially linked to its nitrogen metabolism. One pathway might involve detoxifying through the production of higher alcohols and their conversion to esters, while another could be focused on synthesizing antioxidant molecules like MEL and HT.

Antioxidant Properties of Extracts Obtained Through a Sequential Approach from Red Seaweed *Palmaria palmata*

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Abstract

Lipid oxidation remains a major challenge in food engineering, particularly in products rich in polyunsaturated fatty acids, as it accelerates quality deterioration. Traditionally, synthetic antioxidants such as butylated hydroxytoluene (BHT) have been used to mitigate this issue. However, growing concerns about their potential health risks have sparked interest in alternative solutions. As a result, the search for safe, natural antioxidants, especially from sources like seaweed, has intensified, presenting a promising strategy to combat lipid oxidation while promoting sustainability in food systems. Aligned with this trend, in the present study, seaweed extracts were obtained by pretreating *Palmaria palmata* biomass in aqueous solutions of varying pH (3, 6, and 9), followed by sequential enzymatic/alkaline extractions. The extracts (Ext3, Ext6, and Ext9) were analyzed for their *in vitro* antioxidant properties. Furthermore, their efficiency in maintaining the oxidative stability of 5% omega-3 algal oil-in-water emulsions was evaluated over 21 days. Emulsions fortified with seaweed extracts effectively inhibited primary oxidation, as indicated by significantly lower peroxide values than the control at day 21. This may be due to their radical-scavenging activity, supported by *in vitro* 2,2-diphenyl-1-picrylhydrazyl scavenging and Fe^{2+} chelating properties. The control emulsion had high levels of secondary oxidation volatile compounds, particularly 1-penten-3-ol, (E,E)-2,4-heptadienal, and 2-ethylfuran at day 21, while seaweed extract-protected emulsions had significantly lower concentrations of all volatile compounds ($p < 0.05$). While BHT performed best at reducing volatiles by day 21, Ext_3 was significantly more effective in the initial phase of oxidation ($p < 0.05$), likely due to its higher molecular weight peptides and carbohydrate content than the other extracts ($p < 0.05$). These findings suggest that seaweed extracts can oxidatively stabilize omega-3 emulsions and may offer comparable protection to synthetic antioxidants at higher concentrations.

Purification and Identification of Cardosins A and B in the Pistils of *Cynara cardunculus* L. During Floral Development

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Abstract

Proteolytic enzymes are widely used in biotechnology due to their broad applications in food processing, pharmaceuticals, cosmetics, leather, and textile industries. Specifically, in the food sector, proteases are valuable tools for managing processing technologies, as they can selectively act on substrates, enhancing their rheological, nutritional, and organoleptic properties. In the dairy industry, chymosin-a protease extracted from the abomasum of ruminants-is commonly used for milk coagulation, producing high-quality cheeses. However, the limited availability of the enzyme has driven research into alternative coagulants, including microbial and plant-based options. The main plant-based coagulant used for artisanal ewe's cheese in European countries such as Italy, Spain, and Portugal is derived from the cardoon flowers of *Cynara cardunculus*. This study aims to optimize the extraction and stabilization processes to improve their effectiveness in milk coagulation. Additionally, the purification and identification of cardosin A and B were conducted to establish the optimal flowering period for harvesting. The results indicate that *C. cardunculus* extracts exhibit strong potential as milk-clotting agents for cheesemaking. Chromatographic analysis using a Mono-Q column revealed at least two cardosins with milk-clotting activity. The most abundant protease was cardosin A at every flowering stage, while the most active in terms of coagulation was cardosin B. Based on the concentration of cardosin B, the optimal flowering stage for harvesting pistils is 10 days after the flowering begins. Concluding, the present study allowed the identification of the optimal flowering stage for pistil collection to maximize milk coagulation efficiency. The analytical technique employed successfully purified and characterized the variability of cardosins A and B in pistils during different flowering stages.

Reformulation of Bakery Products with Nutritional and Sustainability Benefits Using a Novel Palm Shortening Substitute

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Abstract

The food industry is looking for sustainable alternatives to palm shortening (PS), however there is currently none that is functional, nutritionally balanced and cost competitive. We previously showed that a novel sustainable ingredient (named PALM-ALT) composed of rapeseed oil (RO), defatted linseed meal and beta-glucan was able to mimic palm fat functionality. This current study assessed the feasibility of this novel PS substitute in a range of bakery applications (oatcake, biscuit, cookie, and bread). The lines and beta-glucan components were co-processed with RO via high-shear mixing. The PALM-ALT ingredient was characterized by rheology, oil droplet size distribution and microscopy. The bakery products were prepared with either PS, RO, or PALM-ALT and characterized by trained and consumer panels, instrumental analyses (texturometry, colorimetry, moisture, and water activity) and microscopy. The PALM-ALT ingredient displayed a stable emulsion-gel structure, with average droplet size of 32 µm. Linseed proteins contributed to forming oil droplets, whilst linseed mucilage, beta-glucan and observed aggregates of linseed proteins and/or beta-glucan further stabilized the emulsion. The PALM-ALT products qualified for reduced saturated fat claims, whilst the biscuit formulation also met a reduced total fat claim. The PALM-ALT formulations showed similar sensory and instrumental profiles to their PS controls. In contrast, the RO products proved darker than PS controls ($p < 0.05$). The RO oatcake was softer, the RO biscuit and cookie were harder, and the RO bread was denser and moister than their controls ($p < 0.05$). Finally, the RO oatcake and cookie exhibited lower sensory quality than their controls, whilst the RO biscuit and cookie displayed lower acceptability than their controls ($p < 0.05$). This study highlighted that PALM-ALT was able to replace PS in bakery formulations with maintenance of their sensory profiles, whilst providing nutritional and sustainability benefits. Current work focuses on upscaling the PALM-ALT production.

Targeting Protein Aggregation Using a Cocoa-bean Shell Extract to Reduce A-synuclein Toxicity in Models of Parkinson's Disease

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Abstract

Neurodegenerative diseases are among the major challenges in modern medicine, due to the progressive aging of the world population. Among these, Parkinson's disease (PD) affects 10 million people worldwide and is associated with the aggregation of the presynaptic protein α-synuclein (α-syn). Here we use two different PD models, yeast cells and neuroblastoma cells overexpressing α-syn, to investigate the protective effect of an extract from the cocoa shell, which is a by-product of the roasting process of cocoa beans. The liquid chromatography–electrospray ionization–quadrupole time-of-flight mass spectrometry and nuclear magnetic resonance analyses allow the identification of amino acids (including the essential ones), organic acids, lactate and glycerol, confirming also the presence of the two methylxanthines, namely caffeine and theobromine. The present study demonstrates that the supplementation with the cocoa bean shell extract (CBSE) strongly improves the longevity of yeast cells expressing α-syn, reducing the level of reactive oxygen species, activating autophagy and reducing the intracellular protein aggresomes. These anti-aggregation properties are confirmed also in neuroblastoma cells, where CBSE treatment leads to activation of AMPK kinase and to a significant reduction of toxic α-syn oligomers. Results obtained by surface plasmon resonance assay highlight that CBSE binds α-syn protein in a concentration-dependent manner, supporting its inhibitory role on the amyloid aggregation of α-syn. These findings suggest that the supplementation with CBSE in the form of nutraceutical may represent a promising way to prevent neurodegenerative diseases associated with α-syn aggregation.

Opportunities and Drawbacks in Agri-food Waste Upcycling: The Case Study of Olive Leaf Extract

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Abstract

The agriculture and food sectors are among the largest generators of waste globally. Upcycling food by-products represents a promising strategy to reduce waste across the food supply chain, while simultaneously addressing food insecurity. This study explores the technical challenges and requirements faced by food technologists when integrating upcycled ingredients into product development, focusing on olive leaf extract (OLE) as a case study. Critical aspects include the need to ensure the absence of toxic compounds in raw materials, the use of environmentally sustainable extraction methods, the stability of the extract during storage, and the functional enhancement of target food products through nutritional and biomedical validation. Additionally, maintaining the safety, nutritional quality, and sensory integrity of the final products remains a central concern. Our findings highlight the pressing need for clear regulations and standardized guidelines to enable the safe and effective use of upcycled ingredients such as OLE in food applications. By addressing both the potential and the limitations of upcycling, this work contributes to the broader discourse on sustainable food systems. The insights provided aim to support stakeholders, including industry professionals and policymakers, in fostering innovation through appropriate regulatory frameworks and consistent labeling standards.

Optimizing Sugar-reduced Ice Cream: A Physicochemical and Sensory Approach

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Abstract

The current study examines how alternative sweeteners, such as trehalose, erythritol, and isomalt, can enhance sucrose-reduced ice cream's physical, chemical, and sensory characteristics. It evaluates how these sugar substitutes, replacing sucrose at two different concentrations (15% and 30%), influence key factors such as air incorporation (overrun), melting resistance, emulsification stability, and overall sensory characteristics. The results showed that overrun values varied significantly depending on the type and concentration of sweeteners used. Specifically, substituting 30% of the sucrose with isomalt increased the air incorporated into the mixture. In contrast, higher concentrations of erythritol resulted in reduced air entrapment. Regarding meltdown behavior, trehalose and erythritol at 30% substitution levels displayed melting patterns similar to the control sample, whereas isomalt notably accelerated the melting rate. Regarding emulsifying properties, polyols negatively affected emulsification, leading to reduced stability compared to sucrose, while trehalose partially retained emulsifying activity. Despite structural differences, all formulations were well accepted, with trehalose-based ice cream achieving the most balanced sensory ratings, while isomalt formulations scored lower in creaminess and sweetness. The study confirms that substituting sucrose with alternative sweeteners significantly impacts ice cream structure and sensory perception. Trehalose was the most promising sugar substitute, maintaining good texture and stability while preserving sensory attributes. Erythritol and isomalt displayed potential but required formulation modifications to achieve optimal sensory and structural performance. The results underline the importance of selecting the proper sugar substitute and concentration to perform a well-balanced sugar-reduced ice cream formulation.

Noni and The Advanced Glycation End-products

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Abstract

Noni (Polynesian language: Drug from heaven; Scientific name: *Morinda citrifola*) had appeared in Shen-Nong Herbs Catalog, the ancient Traditional Chinese Pharmaceutical Catalog about 2,000 years ago. However, it was totally ignored until its health-promoting functions were discovered during the past 20 years by the US Tahitian Company. It is such an interesting encounter between the East-West and Ancient-modern civilizations. The major health-promoting ingredients within Noni fruit were found to be Iridoids, a type of monoterpenoids found in a wide variety of plants. Their major health-promoting functions

are to resolve the damage caused by the advanced glycation end-products (AGE). Therefore, Iridoids are the natural inhibitors of AGEs. Iridoids, the health-promoting molecules, can also be found in many other fruits such as blueberries, cranberries, and olives. Within human cells, some proteins are called glycosylated proteins, with precise enzyme-catalyzed specific sugar modifications. Those proteins with irregular sugar modification are called the glycated proteins. Only the glycated proteins will eventually form AGEs through Millard reactions. Those AGE molecules can induce inflammation processes in human body that play critical roles in several chronic diseases including neuro-degenerative diseases and cancer.

Chemical Composition, Quality and Shelf-life of Bread Enriched with Protected Designation of Origin Voghiera Black Garlic Powder

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Abstract

Refined and never pungent, Voghiera garlic protected designation of origin (PDO) is an important product in the North of Italy, which obtained the PDO trademark in 2010 and for some years this product has also been sold as black garlic, with an interesting market. Black garlic is a processed garlic product prepared by heat treatment of whole garlic bulbs (*Allium sativum* L.) at high temperature under high humidity for several days, resulting in black cloves with a sweet taste. In the last years, there was an increase in the tendency to incorporate fruits and vegetables into bread. Cereals and cereal-based products have been the election foodstuff to enrich the diet into functional compounds with the aims to modify and improve food taste and preserve human health. The purpose of this study was to evaluate quality, chemical and functional compositions of bread enriched with different percentages of Voghiera black garlic powder, without forgetting the shelf-life of the products. The analyses conducted on black garlic powder, compared with white garlic, showed important changes in composition, the sulfur compounds decreased to trace level, while the polyphenol content and antioxidant activity increased when garlic was processed. The data obtained from the analysis of breads showed that black garlic powder increased ash and fiber, corresponding to a decrease of carbohydrates in bread enriched with black powder compared to white bread. Total polyphenol, total flavonoids contents and related antioxidant activity increased as the amount of black garlic powder increased. Moreover, black garlic powder improved the shelf-life of products, reducing the yeasts, mold and bacteria growth and water loss, causing on the other side an increase of acidity and color intensity, which led at higher concentration to a lower acceptability and palatability by the consumer. These results indicated that black garlic powder may be considered a very interesting product to improve the antioxidant properties and bread shelf-life, giving also interesting sensorial properties to bread.

Unveiling the Bioactive Potential of Fermented Vegetables: A Metabolomic Approach Using High-resolution Mass Spectrometry

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Abstract

Fermented vegetables are foods that undergo a lactic fermentation process, during which strains of lactic acid bacteria (*Lactobacilli*) convert the carbohydrates present in vegetables into lactic acid. This transformation significantly alters their flavor while enriching them with beneficial properties. The combination of vitamins, minerals, fiber, antioxidants, phytochemicals, bioactive peptides, and organic acids makes these foods particularly powerful for health. The study involved the production of fermented vegetables in the laboratory, using both spontaneous and controlled fermentation. The resulting preparations were then analyzed using liquid chromatography coupled with high-resolution mass spectrometry, a technique that enables untargeted screening of analytes within the sample by leveraging accurate mass measurement at 140,000 full widths at half-maximum (calculated for m/z 200, 1.5 Hz) and fragmentation patterns. The study confirmed the presence of numerous bioactive compounds, highlighting a complex metabolic profile enriched by the fermentation process. The identified compounds include phenolic compounds, organic acids, peptides, and other secondary metabolites, many of which are associated with antioxidant, anti-inflammatory, and gut health-promoting properties. This research further underscores how fermentation can enhance the nutritional and functional value of vegetables, making them a promising component of a health-conscious diet.

Advanced Extraction Method for the Recovery of Bioactive Compounds from Enological By-products (Winemaking Lees)

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Abstract

Winemaking lees are one of the most important by-products of the vinification process, containing a significant amount of polyphenols and anthocyanins. These compounds are highly valued for consumer health due to their antioxidant properties and for their role in color stabilization. This study focuses on the development and optimization of a microwave-assisted extraction (MAE) method for the recovery of total polyphenols and anthocyanins from vinification lees. This advanced technique enables the production of high-quality extracts, achieving higher yields with lower solvent, time and energy consumption, making it more environmentally friendly. The research was conducted using a Box-Behnken experimental design along with a response surface methodology to evaluate four key extraction parameters: solvent concentration, temperature, sample-to-solvent ratio, and pH. The obtained extracts were analyzed using UV-Vis spectrophotometry, measuring absorbance at 520 nm for anthocyanins and applying the Folin-Ciocalteu method for total polyphenols. The results indicate that the most influential variables for anthocyanin extraction are solvent concentration and sample-to-solvent ratio, whereas total polyphenol extraction is primarily influenced by temperature and sample-to-solvent ratio. To reduce costs, time, and work, a multi-response optimization was performed to determine a set of conditions that allow the simultaneous extraction of both compound families, revealing no significant differences compared to individual extractions and showing similar efficiency. Moreover, this method exhibited a high level of precision, confirming its reliability; and a short extraction time (5 min). Finally, the optimized multi-response methodology was successfully applied to different real lees samples, demonstrating that grape color (red or white) and origin, directly influence the content of these bioactive compounds and highlighting its practical applicability. This study demonstrates that MAE under optimum conditions is an efficient and sustainable technique for recovering valuable bioactive compounds from vinification lees, providing a potential alternative for valorizing these by-products in the food, pharmaceutical, and cosmetic industries.

Date By-product Polysaccharides Enhance Gut Health via Microbiota-dependent Metabolic Pathways and Immune Stability: *In Vivo* Study

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Abstract

This study evaluated the immunomodulatory and gut microbiota-modulating potential of date pomace (DPP) and date seed (DSP) polysaccharides in a BALB/c mouse model over a two-week oral administration period (200 µL daily, 4 mg/mL). Flow cytometry analysis of mesenteric lymph nodes (MLNs) revealed no significant alterations in the cellular composition of $CD45^+$ immune cells, including B cells ($CD19^+$), T cells ($CD3^+$, $CD4^+$, $CD8^+$), and myeloid cells ($CD11b^+$), compared to controls. This suggests biocompatibility and a lack of disruptive immunomodulation at the MLN level. Metagenomic sequencing of fecal microbiota demonstrated that Pseudomonadota (Proteobacteria), Firmicutes, and Bacteroidetes constituted over 90% of the gut microbial community. DSP and DPP promoted Pseudomonadota and Bacteroidetes dominance while reducing Firmicutes abundance, indicating anti-obesogenic potential through a lowered Firmicutes-to-Bacteroidetes ratio. Metabolomic profiling via KEGG, COG, and MetaCyc pathway analyses revealed enrichment of carbohydrate degradation pathways linked to short-chain fatty acid (SCFA) production (acetic, propionic, and butyric acids) and biosynthesis of amino acids, lipids, coenzymes, and vitamins. Spearman's correlation and network analyses highlighted suppression of opportunistic pathogens (*Klebsiella oxytoca*, *Acetatifactor muris*) and enhanced positive interactions among SCFA-producing taxa (*Bacteroides caecimuris*, *Limosilactobacillus reuteri*), supporting gut barrier integrity. Functional predictions underscored the role of DPP and DSP in upregulating metabolic pathways critical for energy metabolism, microbial diversity, and intestinal homeostasis. These findings demonstrate that by-product polysaccharides act as prebiotics, modulating gut microbiota composition and metabolic activity without perturbing systemic immune cell populations. DPP and DSP improve gut health by promoting beneficial microbes and inhibiting pathogens.

Pre-processing and Thermal Treatment Modulate Structure, Solubility, and Digestibility of Fava Bean Protein Isolates: A Structure–function Perspective

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Abstract

Fava bean (*Vicia faba L.*) is gaining attention as a sustainable plant protein source; however, the structure–function–digestibility relationship remains underexplored, especially regarding process-induced modifications. This study investigates the effects of pre-extraction steps (soaking, dehulling) and post-extraction thermal treatment on the structural and functional properties of fava bean protein concentrates and their digestibility. Simulated gastrointestinal digestion was conducted using the standardized INFOGEST static model to evaluate *in vitro* protein digestibility and digestible indispensable amino acid scores (DIAAS). Pre-processing notably affected total phenolic content (TPC): soaking increased TPC to 7.34 ± 0.19 milligrams of gallic acid equivalents per gram of dry matter (mg GAE/g DM), while dehulling and coarse milling reduced it to 6.44 ± 0.15 and 5.63 ± 0.09 mg GAE/g DM, respectively. Thermal treatment (100 °C, 30 min) induced extensive protein aggregation, as confirmed by sodium dodecyl sulfate–polyacrylamide gel electrophoresis (reducing and non-reducing conditions) and size-exclusion chromatography, identifying aggregates in the 500 - 2000 kDa range. Liquid chromatography-tandem mass spectrometry analysis following tryptic digestion revealed a greater diversity of unique peptides in heated samples. Secondary structure analysis showed a reduction in α-helices and an increase in β-sheet content post-heating, indicating structural rearrangements. Digestibility-including total nitrogen, free amino groups ($R\text{-}NH_2$), and total amino acids-improved with thermal treatment. Notably, isolates from dehulled beans showed the highest digestibility (88.5 - 93.6%) and *in vitro* DIAAS (up to 136%), classifying them as high-quality protein sources. This study highlights how targeted processing strategies-both pre- and post-extraction-can optimize the nutritional quality and functional properties of fava bean protein. These insights support the development of more effective plant-based protein ingredients in food formulations.

The Role of Hydrolysis on the Fibrillization of Walnut Protein: Self-assembly Behavior, Structural Characteristics

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Abstract

This study comparatively investigated the effects of heating time (pH 2.0, 90 °C, 0 - 12 h) on self-assembly behavior, structural characteristics of walnut protein fibrils (WPF) and walnut protein hydrolysate fibrils (WPHF). The results showed that the thioflavin T fluorescence in WPHF increased rapidly during the initial heating phase (0 - 2 h), suggesting that hydrolysis pretreatment promoted fibril formation. After heating for 12 h, WPHF exhibited higher surface hydrophobicity than WPF, with a red shift in λ_{max} from 343.2 - 345.0 nm, indicating enhanced intermolecular interactions within the fibrils. More flexible fibrils were observed in the WPHF. FiberAPP analysis showed that the periodicity of WPHF increased to 87 nm. These results offer valuable insights about the structural characteristics and formation mechanisms of walnut protein-based fibrils, supporting walnut protein applications in food industries.

Sensory Requirements of Polish Consumers Towards Fruit and Vegetable Juices

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Abstract

The analysis of the factors influencing the consumer appeal of food products is crucial in their development. Therefore, this study aimed to determine the sensory requirements of polish consumers for juices. This study aimed to apply consumer tests and the sensory profiling method to assess the sensory quality of vegetable and fruit juices. This analysis also aimed to map consumers, including healthy individuals on vegan and omnivore diets, as well as those with Crohn's, diabetes and hypertension. Profiling research was conducted in collaboration with sensory experts, and consumer analysis was performed with a team of untrained

sensory consumers (n = 1400). All participants (consumers and experts) evaluated all products. The following juices were evaluated: apple, orange, cherry, banana, blackcurrant, pear, chokeberry, cranberry, strawberry, tropical fruit, apricot, peach, pineapple, pomegranate, raspberry, sea buckthorn, rosehip, carrot, carrot with fruit, tomato, and multi-vegetable. The research was conducted in the sensory analysis laboratory at the Department of Gastronomic Technology and Functional Food, Poznań University of Life Sciences. People declared the highest preference for apples, pomegranate, and tropical fruit juices, and the lowest preference for rosehip, sea buckthorn, and cranberry juices. A positive correlation was confirmed between changes in overall desirability and taste desirability. This was true for all juices evaluated and all consumer groups studied. This was true for healthy individuals of all ages, regardless of gender, diet, or diabetes status. This trend was not confirmed for individuals with Crohn's disease. It was found that the high intensity of sweet and fruity flavors typical of the raw material type is associated with high desirability of juices. In contrast, the high intensity of bitter, astringent, and metallic flavors reduces this desirability.

Simulation-assisted Multi-objective Optimization of Low-moisture Food Extrusion

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Abstract

Due to the complexity of low-moisture extrusion processing, the high number of variables, and their strong interdependence, experimental approaches typically require numerous iterations with off-line product testing. These methods are resource-intensive, time-consuming, and demand expertise regarding process and product. To address these challenges, this study presents an extended closed-loop optimization framework which, in addition to automatic product characterization and multi-objective optimization, also integrates process simulation, with the overall aim of configuring the process conditions of the extruder for achieving specific product characteristics. The closed-loop process started with an initial data set used by the Thompson sampling efficient multi-objective optimization algorithm to create surrogate models. Based on these models, new process settings were proposed and initially evaluated with a one-dimensional extrusion simulation to assess their technical feasibility. Only the settings validated by the simulation were tested in physical trials, where the extrudates were automatically characterized using a robotic analysis system that employs gravimetric and visual techniques. The measured product data was then fed back into the algorithm to update the models and suggest the next set of process parameters. This iterative cycle continued until predefined product targets were met. The process variables optimized were the barrel zone temperatures, screw speed, feed moisture, and feed rate. Target objectives included total throughput, bulk density, shape and expansion ratio of the extrudates. This simulation-assisted closed-loop strategy not only enabled efficient convergence toward desired product properties within few iterations but also expanded the feasible design space by safely exploring critical process conditions. This approach demonstrates the value of integrating simulation and active learning in accelerating the development and optimization of direct expanded food products.

Improving Wood Packaging Performance with Hydrophobic and Antimicrobial Coatings: Beeswax and Beeswax-lignin Case Study

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Abstract

The growing demand for food packaging solutions has driven significant advancements in materials and design to enhance product protection, quality, and safety. However, while various materials have been used for food storage, not all are environmentally friendly or sustainable. In this context, wood packaging has gained widespread recognition for its eco-friendly properties, durability, and excellent preservation qualities. To further improve its performance, inner coatings can be applied to address certain limitations, such as low hydrophobicity and direct interaction with food, without compromising food products' quality or safety. This study, conducted in collaboration with the Portuguese company Freshwood, which specializes in developing, manufacturing, and marketing lightweight food poplar wood packaging, aimed to formulate an active coating with hydrophobic and antimicrobial properties to reduce red fruit pigment absorption and potentially extend the shelf life of fruits during storage. Six different coating formulations of beeswax and beeswax supplemented with lignin were tested for their antimicrobial po-

tential against foodborne pathogens and spoilage microorganisms, as well as for their physicochemical properties when applied to wood. The results showed that the coatings exhibited high hydrophobicity, as confirmed by contact angle analysis (up to 136°), and effective antimicrobial activity, particularly in formulations with higher beeswax concentrations (up to 4%). Fourier transform infrared spectroscopy analysis further confirmed the successful incorporation of beeswax and lignin into the wooden surface. Additionally, a functional assay with raspberries demonstrated the coating's ability to reduce red berry juice pigment retention in wood packaging. This essay also validated the functionality of the coated packaging materials for red berries storage. Overall, the findings highlight the potential of wood-based packaging for fruit storage and demonstrate that incorporating bioactive coatings can significantly enhance packaging performance while ensuring product safety.

Specific Migration of Benzophenone and Bisfenol in Virgins and Post-consumer Recycled Paper

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Abstract

Bisphenol A and benzophenone have been identified as an endocrine disruptor and have been evaluated by health authorities worldwide. Both substances are contaminants presented in a wide variety of packaging materials. The objective of this work was to analyze virgin and post-consumer recycled paper, using five samples, four virgin (cardboard, cover, intermediate cover and core) samples and one recycled sample (cardboard). The samples were analyzed in relation to the migration of two substances by using HPLC-DAD-FLD (High-performance liquid chromatography coupled with diode array detector and fluorescence detector). Many substances used in food packaging production have specific migration limit as described in Brazil/Mercosur resolutions, including the two substances of this study, bisfenol A and benzophenone. The samples were conditioned at 50 °C for 24 h and then the simulant solutions were analyzed by HPLC-DAD-FLD. The simulants selected for the analysis were deionized water, representing aqueous food. An HPLC-DAD-FLD Agilent 1100 and 1200 series was used. The method of bisfenol A was validated according to European Standards 13130-13:2005. Benzophenone was validated according to DOC-CGE 008 by INMETRO "Guidance on validation for analytical methods", which is based on inter-national guidelines (e.g., ISO, IUPAC and EURACHEM). For the validation of benzophenone methodology, the parameters evaluated were the limits of detection and quantification in seven replicates, linearity (0.15 to 1.20 mg/kg), precision (repeatability and intermediary precision) in three different concentrations using seven replicates (low, medium, and high), and recovery in three concentrations also using seven replicates (low, medium, and high). The values obtained after specific migration of bisfenol A and benzophenone were below the limits of Brazilian resolution for recycled paper (0.6 mg of the substance/kg of food). Other samples have to be analyzed in order to confirm the quality of the recycled paper regarding the presence of these substances.

Rapid Screening of Unknown Illegal Additives in Foods by Ultra-high Performance Liquid Chromatography-high Resolution Mass Spectrometry

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Abstract

To this day, it is still a huge challenge to develop a method to rapidly and accurately detect the unknown illegal additives in food. In this study, a nontargeted screening method was developed to identify illegally added antihypertensive drugs (AHD) and nafils compounds based on a self-constructed AHD mass database and characteristic fragment ions identification using ultrahigh-performance liquid chromatography coupled with quadrupole/orbitrap high resolution mass spectrometry. Many kinds of food, such as compressed candies, honey, and liquid beverages were screened using this method. The samples were extracted with methanol and separated on an Acquity UPLC BEH C18 column (2.1 mm × 100 mm, 1.7 μm). The mobile phase employs a gradient elution system of acetonitrile and 0.1% formic acid in water. The detection is conducted in both positive and negative modes, a full mass scan/data dependent on MS2 mode was used to collect data for rapid screening and quantification. The limits of detection were 0.1 ~ 1 mg/kg, and the limits of quantification were 0.2 ~ 2 mg/kg. The average recoveries ranged from 82.5% to 117% at spiked levels of 2 ~ -10 mg/kg, with relative standard deviations of 0.9% ~ %-10.0% (n = 6). This method was fast, accurate and sensitive, making it suitable for the rapid identification and quantification of illegal additives in foods.

Comprehensive Two-phase Approach to Food Irradiation with Electron Beam for Enhancing Food Irradiation Efficiency

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Abstract

With a growing concern about food safety, now that the diversity of products with different physical and biochemical properties is increasing, the food industry would significantly benefit from a consistent approach to food irradiation which would ensure that irradiation is performed within the optimal dose range maximizing microorganism suppression without causing a negative impact on the food quality. Since food irradiation efficiency largely depends on the irradiation dose uniformity, the proposed approach involves the calculation of optimal irradiation parameters to ensure that products are irradiated within the optimal dose range which is determined using mathematically justified optimization function H(D) with the maximum H_{max} corresponding to the optimal dose D_{opt} at which the suppression of targeted microorganisms is maximized while minimizing the damage to non-targeted proteins, fats and carbohydrates. Our approach requires measuring dose dependencies of microorganism suppression and the extent at which nutrients in product are oxidized during irradiation. For a higher precision of optimal dose range the algorithm takes into account the whole array of microbiological parameters and quality criteria of the food product. The second phase of the comprehensive approach to food irradiation involves the calculation of the electron beam irradiation parameters, including the effective energy of electrons, electron beam scanning frequency, and conveyer belt speed, in order to ensure that the food product with the specified physical parameters, such as linear dimensions, density and shape, is irradiated within the optimal dose range. Using GEANT 4 database and our software DEMETRA by IRT allows us to calculate optimal irradiation parameters ensuring that the irradiated food product receives the specified absorbed dose, and the required dose uniformity is achieved throughout the product. This research was funded by the Russian Science Foundation, grant number 22-63-00075.

Molecular Compound Transformations in Biological Objects During Irradiation

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Abstract

Food and agricultural irradiation are effective solutions to numerous challenges like pathogen control and shelf-life extension. Ionizing radiation damage biological targets such as DNA and cell membranes in microorganisms, and non-targets biomacromolecules like fats, proteins, carbohydrates, causing significant cellular damage and functional changes. Irradiation process induces oxidative changes, generating various compounds that further propagate damage. This study explores molecular transformations in bio-objects after 1 MeV electron beam and 80 keV X-ray irradiation. Research has examined ionizing radiation effects with different physical properties on model compounds (volatile organic compounds, proteins, fatty acids, carbohydrates) and biological systems (food products). The samples were irradiated on UELR-1-25-T-001 (SINP MSU, Russia) and 1BPV 23-100 with RAD-100 X-ray tube (Burnasyan SRC-FMBC FMBA, Russia) at dosages 0.25-8 kGy. The VOC concentrations were determined using a gas chromatography-mass spectrometer Shimadzu GCMS-QP2010 ultra (Shimadzu, Japan). The native structure of BSA protein and omega-3 fatty acids were determined using a High-performance liquid chromatography Dionex Ultimate 3000 RSLC (Dionex, Germany) with tandem mass spectrometry Thermo Scientific Orbitrap Fusion Lumos (Thermo Fisher Scientific, USA). The denaturation of starch granules was determined using a spectrophotometry (UV-3000,

Shanghai Mapada Instruments Co., Ltd, China). Results show that the radiosensitivity of molecular compounds depends on factors like radiation type, dose, and molecular concentration. Irradiation of bio-objects produces unique volatile organic compounds. For each compound, there exists a characteristic compound whose concentration can indicate the extent of damage to the original compound. A method was developed to assess compound decomposition after irradiation by measuring dose-dependent volatile compounds, such as hexanal from hexanol. This approach could indirectly determine optimal radiation doses for bio-objects through unique volatile organic compounds concentrations. These insights are crucial for optimizing food irradiation and developing biomarkers for radiation processing.

Impact of Extraction Methods on the Anticancer Potential of White and Black Garlic Extracts

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Abstract

This study investigates the impact of extraction methods-cold extraction and maceration-on the antioxidant and anticancer properties of white and black garlic (*Allium sativum*) extracts. Physicochemical analyses showed that black garlic had significantly lower moisture (37.94%) and protein content (6.93%) compared to white garlic (69.33% and 11.16%, respectively), due to the Maillard reaction during fermentation. In antioxidant assays, the highest total phenolic content (3.72 mg GAE/g) was detected in black garlic extracted with water via maceration, while the highest total flavonoid content (3.00 mg RE/g) was found in the same sample group. 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity was also highest in this extract (3194.40 mg GAE/g), indicating superior antioxidant capacity. Cytotoxic activity was assessed on Caco-2 colorectal cancer cells using the MTT assay. Black garlic extracts obtained through cold extraction demonstrated the strongest cytotoxic effect, with IC_{50} values as low as 63.00 mg/ml (SET, 24 h) and 80.85 mg/ml (SSU, 48 h). In contrast, macerated black garlic samples showed variable effects, with some increasing cell viability at higher doses. White garlic extracts had generally weaker effects, with IC_{50} values ranging between 50.00 - 175.00 mg/ml, depending on solvent and extraction method. The results highlight that black garlic, particularly when extracted via cold aqueous methods, offers enhanced antioxidant and antiproliferative properties. While maceration increases phenolic and flavonoid yields, cold extraction better preserves cytotoxic compounds. These findings emphasize the importance of both garlic type and extraction technique in maximizing therapeutic potential against colorectal cancer.

Effect of Annurca By-product, Soluble and Insoluble Fibers on Techno-physical, Textural Properties, and Polyphenols Recovery of Wheat-based Crackers

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Abstract

The research investigates how incorporating Annurca apple by-product powder (ABP) and different fibers into crackers affects their nutritional and physical properties. It also examines how fibers influence the recovery of polyphenols during baking, potentially improving their retention in functional foods. This study developed five experimental fiber-enriched crackers using lemon-derived soluble and insoluble fibers combined with ABP. The addition of fiber influenced cracker thickness, volume, and texture. The phenolic profile of ABP was analyzed, identifying 59 compounds, with flavanols being the most abundant. Baking led to anthocyanin loss but increased hydroxybenzoic acids, while lemon fibers helped preserve flavanols. Dihydrochalcone, hydroxycinnamic acids, and flavan-3-ols recovery improved with pectin addition, while proanthocyanidin content decreased by fiber addition. The study highlights the importance of assessing fiber-polyphenol interactions in real food applications, suggesting that adding fiber and phenolic-rich by-products to bakery items can enhance dietary polyphenol and fiber intake, potentially benefiting gut health and bioavailability.

Monitoring of Persistent Organic Pollutants and Contaminants of Emerging Concern in Wild Macroalgae

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Abstract

Marine macroalgae have great nutritional value, being rich in proteins, fibers, minerals, vitamins, essential amino acids, and polyunsaturated fatty acids. These may contribute to a healthy diet and aid in the prevention of certain chronic diseases (e.g., diabetes, obesity, heart disease, and cancer). Additionally, these also have great potential for providing marine biotechnology solutions. However, seaweed may accumulate high contents of heavy metals and other contaminants from the environment. Persistent organic pollutants (POPs) and contaminants of emerging concern (CECs), including unregulated ones, pose a threat to food safety. Therefore, to ensure the safety and quality of macroalgae in food applications, in this work, 47 contaminants were monitored in 5 species of wild commercial macroalgae(*Himanthalia elongate, Undaria pinnatifida, Chondrus crispus, Laminaria* sp, and *Codium tomentosum*) and 5 species of wild macroalgae from the North Portuguese Coast (*Mastocarpus stellatus, C. crispus, Porphyra umbilicalis, Fucus vesiculosus,* and *C. tomentosum*). The analysis method, based on gas chromatography analysis, was validated according to the European Commission's SANTE framework and includes 25 POPs, namely brominated flame retardants, organochlorine pesticides, and polychlorinated biphenyls, 22 CECs (aliphatic hydrocarbons, organophosphate pesticides, and organophosphate esters). In macroalgae from the North Portuguese Coast, higher levels of aromatic hydrocarbons were found. For the remaining contaminants, trace amounts were found in all the samples analyzed, highlighting the importance of ongoing monitoring. This underscores the need for continued surveillance and regulatory action, which is essential to safeguarding public and environmental health in the context of these popular food ingredients.

Innovative Salty Biscuits Enriched with Fresh and Dried Bee Pollen: Chemical, Technological, and Sensory Characterization

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Abstract

Bee pollen is recognized as a potentially valuable functional food ingredient due to its rich content of essential nutrients and various bioactive compounds. Biscuits, both sweet and salty, are highly popular bakery products because of their long shelf life, quick consumption, and appealing taste and texture. This study aimed to evaluate the impact of bee pollen (both fresh and dried) on the chemical, technological, and sensory properties of salty biscuits. Biscuit formulations were prepared by replacing part of the flour with increasing amounts (5% and 10%) of fresh and dried bee pollen. Control formulation without pollen was also produced for comparison. Both the pollen and the enriched biscuits were analyzed to assess their chemical composition and sensory attributes, determining their potential as fortified products. Among the tested formulations, biscuits enriched with 5% fresh pollen (5%) emerged as the optimal formulation, offering a balanced combination of improved chemical composition and favorable sensory qualities. The addition of bee pollen notably increased the antioxidant content, enhancing the presence of phenolic compounds and carotenoids. This suggests that fortified biscuits could serve as an effective vehicle for bioactive compounds, offering both nutritional and sensory benefits. As a future goal, it would be valuable to implement a more targeted drying treatment for pollen to better understand its impact on fortified biscuits and, ultimately, to extend this approach to gluten-free products. Moreover, the unique flavor and texture imparted by bee pollen could provide a distinctive market appeal, making these biscuits not only a healthier option but also a product with a unique taste profile.

Multilayered Encapsulation of Betalains by Ionic Gelation

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Abstract

Betalain, a vibrant red-violet pigment sourced from Caryophyllales, finds attractive applications in the food and beverage industries due to their proven nutraceutical and therapeutic benefits. However, the betalains suffers from fast degradation rates due to their higher sensitivity to the change in temperature, and pH. Thus, despite the wide range of solvents explored for the extraction of betalains, the encapsulation and stabilization of betalains remain a challenge for enhanced application of betalains. This work focuses on the millifluidic based ionic gelation for the encapsulation of betalains. The water-in-oil emulsion of aqueous betalains in oil is obtained by employing lipophilic emulsifiers. The crossflow geometry channels with 1.2 mm inner diameter are employed for the multilayered encapsulation. The resultant water-oil-water emulsions formed in the millichannel

are carefully collected into calcium chloride solution (3%). The electrostatic interactions between the alginate and the divalent calcium ions results in the cross-linking and thus the efficient encapsulation of betalains. The interplay of the competing stress at the junction of the channel determines the resultant droplet size. The influence of flowrate ratio (QR) and continuous phase fluid properties (due to the change in sodium alginate concentration) on the droplet size and encapsulation efficiency are studied. The mechanical strength and the thermal properties of the multilayered milli-capsules are studied using texture analyzer and differential scanning colorimeter.

Application of Pulsed Electric Field to Promote Peelability on Peponids and Drupes: Understanding the Effects on Cells and the Physical Properties of Fruits

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Abstract

Pulsed Electric Field (PEF) is an emerging non-thermal technology with the potential to improve peeling processes in the fruit and vegetable industry. This study investigated the impact of thermal (blanching) and non-thermal PEF treatments on the peeling ability and structural integrity of mangoes *(Mangifera indica)* and red bell peppers *(Capsicum annuum)*. PEF treatments were applied at 1 kV/cm using two specific energy levels for each product: 1.1 and 4.6 kJ/kg for mangoes, and 3.4 and 10.3 kJ/kg for bell peppers. Conventional blanching (94 °C for 1 and 3 min for mangoes, and 1 and 2 min for red bell pepper) served as the reference method. Key parameters evaluated peeling force and losses, firmness, color, and microstructure. In mangoes, PEF at 4.6 kJ/kg effectively reduced peeling force by 50% and minimized losses by 40%, performing better than 3 min blanching, which reduced peeling losses by 30%. Microstructure analysis confirmed structural changes in parenchyma and collenchyma tissues, facilitating easier peel removal. Additionally, PEF treatments resulted in better color retention than blanching; in contrast, red bell pepper samples didn't show any improvement in peeling ability after PEF treatment, due to their waxy nature skin that created a significant barrier. Although blanching for 2 min reduced firmness by up to 50%, microstructure analysis showed cell shrinkage and thickened cell walls, with no significant impact from PEF on peel detachment. These results demonstrate that PEF shows promising potential for improving mango peeling while preserving quality, but its effectiveness on red bell peppers appears limited, likely due to variations in tissue structure and morphological characteristics.

Nitro-fatty Acids: Novel Virgin Olive Oil Quality Markers Responsible for Health Benefits

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Abstract

Virgin olive oil (VOO) consumption exerts beneficial health effects reducing the risk of infectious, cardiovascular, liver, and neurodegenerative diseases, among others. Nitro-fatty acids (NO2-FA) are endogenously present in VOO and olives and formed after VOO consumption in gastric conditions, exhibiting pleiotropic anti-inflammatory responses. Herein, we analyzed the conditions which favor the formation of VOO-derived NO2-FA. Firstly, we analyzed the formation of NO2-FA in contrasting varieties of VOO, finding a strong correlation between the formation of NO2-FA and the type of cultivar. In addition, the variation of NO2-FA levels with the stage of maturation was evidenced, observing maximum levels of NO2-FA in intermediate stages. Other bioactive constituents of VOO such as polyphenols protect VOO from lipid oxidation favoring fatty acid nitration, while their absence switches nitration to oxidation. Moreover, we find polyphenols in VOO act synergistically with NO2-FA to exert anti-inflammatory actions. Of relevance, VOO supplementation prevented inflammation in murine models of non-alcoholic fatty liver disease and metabolic syndrome. There was a positive correlation between NO2-FA formation from VOO and an improvement of mitochondrial function as well as decreased body weight, fat accumulation and pro-inflammatory cytokines in these inflammatory disease models. Thus, the increase of NO2-FA formation in VOO enhances their lipid electrophile pleiotropic protective actions in human health. All this evidence supports that NO2-FA represent novel markers of quality associated with the health benefits offered by VOO. The information reported here can be useful to make recommendations about which cultivars to use and at what stages of maturation the oil should be extracted to maximize the concentration of these compounds that are so beneficial to human health. We conclude that stimulating NO2-FA formation represents a novel mechanism to explain the beneficial effects of consuming VOO.

Probing the Staling Process in Chickpea Composite Bread Through Dynamic Mechanical Analysis

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Abstract

The inclusion of chickpea flour in bread formulation could be a great opportunity for enhancing nutritional quality. However, significant effort is required to study the technological effects, both on fresh bread and throughout storage. Dynamic mechanical analysis (DMA) is a relatively underexplored technique for this purpose, but it could offer great potential as an analytical tool. In our study, composite bread loaves were produced by the inclusion of chickpea flour at 0, 10, 20, and 30% (flour based) in bread formulation. Bread staling was assessed over 7 days of storage, following moisture content, texture, and mechanical properties by DMA with frequency sweep and temperature scan tests. Principal component analysis and orthogonal – partial least squares (OPLS) techniques were used to assess the overall effect of formulation and storage time. The presence of chickpea flour resulted in significantly harder crumbs and reduced springiness due to the dilution of the gluten proteins, while no differences in terms of cohesiveness were found. Hardness, and viscoelastic parameters evaluated by DMA frequency sweep test, were grouped together in the OPLS biplot. The temperature scan test (-50 - 120 °C) with DMA revealed the drop of moduli around 0 °C associated with the frozen water melting transition. Both chickpea flour and storage time significantly decreased the moduli drop temperature. Furthermore, during storage, the frozen water melting transition was characterized by a significant decrease of the ranges of moduli in which the transition occurred. In conclusion, DMA has proven to be a valuable tool for the analysis of stalling chickpea composite bread highlighting different thermal parameters changes due to the effect of formulation and storage time and able to describe water-solids interactions at mesoscopic level.

Characterization of Ahl-mediated Quorum Sensing in *Pseudomonas Gessardii* from Raw Milk and Application of Polyphenols for Controlling Proteolytic Activity

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Abstract

Quorum sensing (QS) is a bacterial signaling mechanism regulating the expression of genes associated with spoilage and virulence. In dairy products, psychrotrophic *Pseudomonas* spp. can proliferate during cold storage and produce thermostable proteases that compromise milk quality and processing. This study aimed to characterize the acyl-homoserine lactone (AHL)-mediated QS system in *Pseudomonas gessardii* isolated from raw milk and to investigate the potential of polyphenols, a class of bioactive compounds with recognized nutritional and health-promoting properties, to mitigate proteolytic spoilage activity. Raw milk samples were screened for highly proteolytic bacteria, which were identified by MALDI-TOF mass spectrometry and 16S rRNA sequencing. The AHL profile of the isolates was characterized using biosensor strains, thin layer chromatography-overlay assay, and liquid chromatography-mass spectrometry analysis. Whole-genome sequencing provided insights into the presence of LuxRI-type QS systems, and the AHL-degrading enzyme lactonase was heterologously expressed in the strains to investigate the contribution of AHL signals to spoilage phenotypes in comparison with wild-type strains. Selected polyphenols (salicylic acid, cinnamaldehyde, and tannic acid) were tested for their inhibitory effect on proteolytic activity at 4 °C and 25 °C, while silico docking was applied to study their interactions with the LuxR receptor protein. Six highly proteolytic isolates were identified as *P. gessardii*. They were found to produce short chain AHL, mainly C4-HSL. Genetically modified strains with lactonase expression confirmed the regulatory role of AHLs in proteolytic activity. Polyphenols showed significant inhibition of spoilage phenotypes without antibacterial effects, with docking analysis supporting their function as QS inhibitors by bind with the LuxR receptors. This work provides new insights into QS-regulated spoilage mechanisms in dairy-associated *Pseudomonas* and demonstrates the potential of polyphenols to stabilize raw milk by restricting proteolytic activity. These results highlight a sustainable strategy to preserve food quality and nutritional value.

Poster Presentations

Reaction-based Optical Fingerprinting Strategy vs. Existing Techniques for the Discrimination of Food Samples

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Abstract

Colorimetric and fluorescence-based methods have gained popularity in food control due to their simplicity, short analysis time, inexpensive instruments, and easy protocols. Such important problems as adulteration detection, freshness evaluation, or estimation of dose after irradiation can be solved by using those techniques combined with machine learning data processing. We proposed a reaction-based fingerprinting strategy that involves redox indicator reactions of carbocyanines conducted in the presence of a sample. The technique is based on the optical signal measurement in several spectral ranges photographically over a certain period of time followed by chemometric analysis of the data. We used supervised classification methods: linear discriminant analysis, SoftMax regression, and k-nearest neighbors' algorithm to process the data, performed using a Python script written by the authors. We applied the proposed strategy to distinguish between apple juices and to estimate the radiation dose in chicken breast, turkey liver, and potato tubers. To show the efficiency of the proposed approach, it should be compared with existing techniques. As alternative methods, we examined absorbance and intrinsic fluorescence spectra, fluorescence with an added fluorophore, measured the ferric reducing antioxidant power, and conducted the oxidation of 3,3′,5,5′-tetramethylbenzidine with hypochlorite and peroxide. Since a key feature of the proposed strategy is measurement of the signal vs. time, we demonstrated the necessity of the kinetic factor by processing only one image captured in the intermediate timepoint of the kinetic curve. In most cases the discrimination accuracy by alternative methods did not exceed 85%, while the suggested approach allowed nearly 100% accuracy. Despite limitations, such as the necessity to run the control sample parallel with the unknowns and to choose a new indicator reaction for every new type of sample, the reaction-based optical fingerprinting strategy promises a powerful alternative to existing techniques for food discrimination.

Zero Waste Processing of Legumes: Pea Starch Valorization

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Abstract

Processing peas (*Pisum sativum*) into protein and starch, is a complex process that requires the use of various extraction and processing technologies. The main steps include grinding, extraction, separation, drying, and purification. This allows us to obtain protein and starch in forms ready for use in food and industrial applications. Zero waste technologies allow for full utilization of raw material, which is beneficial both from an ecological and economic point of view. Therefore, the aim of the work was to develop a method of pea processing, which will allow for full utilization of the raw material and the creation of high value-added products. The scope of the research was focused on obtainment of high-quality starch as many processing plants produce pea protein, while the resulting starch which can be equally valuable product, is often of inferior quality. The obtained starch was afterwards evaluated in terms of crucial parameters that determine impurities i.e. microconstituents contents such as protein, fiber and ash. Moreover, the quality of obtained product was further evaluated by investigation of rheological properties including pasting characteristics, flow behavior, and gelling properties. The presented research provides insights into possible techniques for improving quality of isolated pea starch and contributes to more sustainable practices in the pea processing industry towards zero waste production.

Valorization of Pea Husks in No Waste Processing of Legumes

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Abstract

Pea (*Pisum sativum*) is an important crop that is a valuable protein source providing numerous nutritional benefits and contrib-

uting to sustainable agriculture. The increasing popularity of vegan diets has led to a greater demand for plant-based protein sources including peas. The growing demand for peas is challenging in context of pea husk valorization, but important due to global goals of sustainable development and circular economy. Pea pods, being a by-product of pea processing, are often treated as waste, while in fact they are an abundant source of many valuable ingredients. Therefore, the aim of the work was to utilize pea husk as a valuable food ingredient. The experimental material consisted of wheat bread fortified with addition of different levels of pea husk. The obtained products were afterwards evaluated in terms of their nutritional value and quality; both employing instrumental methods (Texture profile analysis and color parameters) and quantitative sensory analysis. Moreover, the influence of pea husks on properties of bread dough was evaluated by light scattering techniques, static multiple light scattering and diffusing wave spectroscopy. It was found that pea husk, apart from being a valuable nutritional ingredient, may also have a positive effect on sensory properties of wheat bread. Therefore, processed pea husks can be recommended as a sustainable way improve to quality and nutritional value of bakery products.

Bioaccessibility of Omega-3 Fatty Acids in Fish Oil Microcapsules as Affected by Protein-based Wall Material and Homogenization Procedure

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Abstract

Microencapsulation of fish oil is an appropriate strategy to obtain stables vehicles of omega-3 polyunsaturated fatty acids to enrich food. The process involves preparing a fish oil emulsion followed by a desiccation stage. Current trends in fish oil microencapsulation are the use of less experienced materials, such as animals and vegetable proteins; the application of an additional homogenization stage; and evaluating bioaccessibility, (amount of bioactive compounds reaching intestinal level for absorption). This study aims to evaluate bioaccessibility of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in fish oil microcapsules affected by protein-based wall material (calcium caseinate (CAS)) vs soy protein (SP)), and homogenization procedure (high-pressure (HP) vs ultrasounds (US)). Fish oil emulsions were prepared by mixing oil with wall materials (CAS and SP) and homogenized by US or HP. Emulsions were then spray-dried to obtain the microcapsules batches (CAS-HP, CAS-US, SP-HP, SP-US). The quantity of EPA and DHA was analyzed by gas chromatography equipped with a flame ionization detector in the microcapsules before and after an *in vitro* digestion assay, determining their bioaccessibility. Major release of EPA and DHA took place at the oral phase in SP microcapsules and at intestinal level in CAS ones. Furthermore, both wall material and homogenization procedure significantly influenced on the release of EPA and DHA at intestinal level, with the highest values found in CAS-US, followed in decreasing order by CAS-HP, while SP-HP and SP-US showed the lowest quantities. Consequently, CAS microcapsules obtained higher bioaccessibility than SP ones. These differences may be related to the high solubility of SP and indicate the major suitability of CAS to be used as wall material to microencapsulate fish oil; both HP and US may be used.

Mineral Profile of Citrus Fruits from Volcanoes Etna and Stromboli

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Abstract

In Italy citrus fruits are widely produced and national production is primarily concentrated in Sicily (87%). Citrus fruits are rich in minerals, vitamins A, C, E, and B, and phenolic compounds, helping to prevent cardiovascular diseases and supporting digestive and immune functions. In this study lemon, mandarin and grapefruit samples from different areas surrounding the Etna and Stromboli volcanoes (Sicily, Italy) were analyzed, to characterize them and assess their nutritional benefits and risk to the consumer. The unique geographical location, volcanic soil, and climate conditions define citrus fruits production in these areas. In fact, Etna citrus fruits are influenced by tempering effect of the Ionian Sea, while Stromboli citrus fruits are influenced by the Tyrrhenian Sea. These factors are rarely found together elsewhere. Total phenolics compounds by Folin-Ciocalteau colorimetric method, titratable acidity by the conventional method, ascorbic acid by high-performance liquid chromatography method and mineral elements by inductively coupled plasma-mass spectrometry method in juice, pulp and peel of citrus fruits under analysis were detected. In addition, the same control samples from non-volcanic Sicilian area were evaluated. The results obtained were estimated by statistical analysis also. It was found that volcanic areas mainly influenced the mineral profile by affecting the nutritional value of citrus fruit from these areas.

Avocado Fruit Defensin (Padef) Bioactive Peptides Promote Trypsin and Chymotrypsin Digestive Enzymes Activity

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Abstract

The fruit ripening process affects the nutritional content and quality of fruits. Fruits become more acceptable and increase nutritional value for animal consumption. Avocado is a climacteric fruit and produces several important compounds of human nutritional importance during fruit ripening. Plants produce peptides during their life cycle and are very important for the control of plant development and are an essential part of the innate immunity of plants. Avocado defensin (PaDef) is an antimicrobial peptide expressed abundantly during fruit ripening. Defensins have been reported with antimicrobial activity and as protease inhibitors. In this work we reported that PaDef is expressed in avocado pulp of three kinds of avocado fruits and enhances activity of digestive serin proteases trypsin and chymotrypsin. Using docking and computational modeling we show that the PaDef binds principally to the active site of the trypsin and chymotrypsin digestive proteases and by molecular dynamics technic we determine the stability and behavior of the peptides generated by PaDef chymotrypsin protease digestion against chymotrypsin at pHs 3 and 8 of digestive tract. Our results suggest an allosteric effect of PaDef bioactive peptides. This is one more property to classify avocado as a functional food.

Processing and Valorization of Agri-food By-products and Their Use as Elicitors in Agriculture

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Abstract

The rapid industrialization of the food and agricultural sectors has significantly increased waste generation, posing environmental and economic challenges. The conventional linear economy, based on a "take-make-use-dispose" model, leads to resource depletion and waste accumulation. In contrast, a circular economy emphasizes resource reuse and valorization, offering a sustainable solution by transforming agri-food by-products into high-value added applications. The primary aim of this study is to identify and characterize bioactive compounds from agri-food by-products. It then explores the synergistic potential of advanced processing technologies, particularly pulsed electric fields (PEF) as PEF enhances cell membrane permeability, improving the accessibility of bioactive compounds. By applying standard parameters, this research evaluates PEF-resistant plant growth-promoting lactic acid bacteria (LAB) strains to optimize fermentation. Fermentation further modifies bioactive compounds, increasing their bioavailability and functionality. Selecting resistant LAB strains enhances their metabolic activity, improving fermentation efficiency. The combination of PEF and fermentation creates a synergistic effect, enhancing extraction efficiency, stability, and the bioactivity of plant elicitors. This, in turn, boosts the production of plant elicitors, which promotes plant growth and resilience. By focusing on PEF-resistant, LAB strains, fermentation processes can be refined to achieve higher yields and improved outcomes. This research contributes to sustainable waste valorization, agricultural innovation, and environmental conservation. By integrating circular economy principles, it promotes eco-friendly solutions that enhance food security while reducing waste and resource inefficiency.

Impact Degradation of Antibiotics in Aqueous Solutions by Electron Beam Irradiation

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Abstract

Currently, the world produces, consumes, and uses large quantities of antibiotics to treat a wide range of diseases, but this has led to their widespread distribution in the environment. Antibiotic residues released into wastewater can contribute to the development of drug-resistant bacteria, which poses a serious threat to human health. Antibiotics are poorly biodegradable, so the development of methods for cleaning various matrices from them seems to be an urgent task. The aim of this work is to study the effect of electron beam irradiation on tetracycline, doxycycline, ampicillin, amoxicillin, benzylpenicillin, streptomycin, and chloramphenicol in aqueous solutions and to identify the degradation pathways of these antibiotics. The most promising method for determining antibiotics in various matrices and identifying degradation products seems to be liquid chromatography combined with mass spectrometry. For chromatograph mass spectrometric analysis, an analytical system consisting of an Ultimate 3000 RSLC liquid chromatograph (Dionex, Germany) equipped with an automatic sample injection system and an Orbitrap Fusion Lumos high-resolution mass spectrometer (Thermo Fisher Scientific, USA) was used. It was found that with an increase in the irradiation dose, the relative content of antibiotics in the solution exponentially decreased. Quantitative indicators of the degradation rate of antibiotics were established. The maximum is for amoxicillin; the minimum is for chloramphenicol. At the same time, with an increase in the dose from 0 to 1 kGy, the content of most degradation products increases, and with an increase in the dose to 7 kGy, they themselves also begin to degrade. Almost 100% removal from solutions was achieved under the influence of a dose of 7 kGy in the case of benzylpenicillin and streptomycin; other antibiotics were also close to this figure. Based on the data obtained using high-resolution mass spectra, conclusions can be made about the structures of antibiotic degradation products. However, specific reaction processes have not yet been identified. To obtain an idea of the reaction mechanisms and the pathways of conversion of antibiotics into their degradation products, the density functional theory was used.

Impact of Irradiation on Germination, Yield and Phytopathogenic Status of Seeds and Potatoes

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Abstract

Pre-sowing radiation treatment of crops can both reduce and increase their germination and yield. Also, irradiation leads to changes in the growth of bacterial and fungal infections associated with soil. Studies were conducted on wheat, flax, sunflower, soybean, rape seeds and potato tubers of different varieties naturally infected with Alternaria, Fusarium and Rhizoctonia. After irradiation with low-energy accelerated electrons and X-rays, seeds and tubers were planted in the open ground in Western Siberia, characterized by continental climate, or observed in laboratory conditions. The effect of treatment with low-energy accelerated electrons on different strains of pure cultures of phytopathogenic fungi was also investigated. Dose control during radiation exposure was carried out using ferrous sulfate (Fricke) dosimeter. Dose uniformity and linear energy transfer in irradiated seeds and potatoes were evaluated by computer modeling method GEANT 4. The work shows that irradiation in the dose range from 5 Gy to 15 Gy increases crop yields, while reducing the level of phytopathogens in the harvested crop. Different radiosensitivity of phytopathogenic fungi strains were revealed under irradiation. Data of phytosanitary condition of crops and their germination varied with combined irradiation with fungicide-etching agent and growth stimulant.

Catalase Inhibition under Electron Beam Irradiation: Spectrophotometry и Oxygen Bubble Method Study

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Abstract

Currently, in order to reduce the microbiological load and to extend the food product shelf life, there is a growing interest in using radiation. Low-energy electron beams (e-beam) irradiation are proposed for antimicrobial treatment of food products. High processing efficiency can be achieved only with optimal decontamination parameters: targets (pathogenic and opportunistic microorganisms) must be maximally suppressed, while non-target molecular components (proteins, particular enzymes etc.) are damaged minimally. When exposed to ionizing radiation, the antioxidant system can be suppressed, in particular, the enzyme catalase activity can be decreased. The aim of our work was to study the change in catalase activity under e-beam irradiation of model catalase solutions with electrons E = 1 MeV in doses of 100 Gy and 1000 Gy. Experimental studies of absorption spectra of hydrogen peroxide and catalase, oxygen bubble parameters, and also the construction of calibration curves, allowed us to identify a change in catalase activity after e-beam irradiation. At a dose of 100 Gy, catalase activity decreased in relation to the initial by ~ 1.5 times, and at a dose of 1000 Gy by ~ 40 times. These results may indicate conformational and functional changes in the molecules of the catalase after irradiation with low-energy accelerated electrons. This study has shown the potential of the oxygen bubbles method for express diagnostics of the catalase enzyme state after various physical and chemical influences on food products. This research can be productive for creating biodosimeters that allow the express assessment of food irradiation dose value. The experimental data we obtained are useful and necessary for establishing the optimal dose range for food product decontamination in radiation technologies.

Oil Spill on the Brazilian Coast: Development of Analytical Methods for Polycyclic Aromatic Hydrocarbons Control and Risk-Based Fish Monitoring

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Abstract

For the first time, a method based on pressurized liquid extraction using an espresso capsule coffee machine, followed by quantification of polycyclic aromatic hydrocarbons (PAHs) via liquid chromatography coupled with tandem mass spectrometry, was applied to fish samples. This method supported regulatory agencies in ensuring the sanitary safety of seafood. Initial results were included in the first official report on PAH contamination in seafood following the oil spill on the Brazilian coast. As the investigation progressed, the need for increased analytical frequency and method reproducibility emerged. To address this, an advanced energized dispersive guided extraction method was developed, providing chemical innovation of the study. This method was applied to various biological samples, contributing to the analysis of forensic evidence related to the spill and consolidating data from the first official Brazilian monitoring of PAHs in seafood. The risk of consumer exposure to PAHs was assessed using a deterministic chronic dietary exposure model and the margin of exposure approach. Over 400 samples were analyzed with the methods developed. Although the rate of non-compliant samples was low (<1%), PAHs were detected in 23% of the fish samples (n = 85), with concentrations reaching up to 156 μg kg^{-1} for the 8 PAHs marker group. The carcinogenic compound benzo[a]pyrene was found in 7.7% (n = 29) of the samples. The risk assessment indicated a low concern for consumer health. However, PAH exposure through seafood should be kept as low as reasonably achievable (ALARA), reinforcing the importance of continuous monitoring and the development of reliable analytical methods in the event of environmental disasters.

Prediction and Mechanistic Elucidation of Texture in Noodles and Bread Based on Microstructure Using Artificial Intelligence

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Abstract

Food texture is a critical factor influencing palatability. In products such as noodles and bread, texture arises during mastication from the mechanical response of internal microstructures, which are composed primarily of gluten and starch. However, due to the complexity and heterogeneity of these microstructures, as well as their nonlinear deformation behavior, predicting texture from internal structures remains a major challenge. Although recent studies have explored the application of artificial

intelligence (AI), progress has been hindered by the lack of sufficient, high-quality training data. Thousands of structural images are typically required for robust AI training, but acquiring such datasets using traditional two-dimensional (2D) mechanical sectioning methods is impractical. In this study, we addressed this issue by extending conventional 2D imaging to three-dimensional (3D) microstructural imaging using our newly developed SoROCS-based optical clearing method for food samples. This method enables rapid and high-quality image acquisition of 3D structural data through optical, rather than mechanical, sectioning. As a result, it significantly increases both the quantity and quality of image data while reducing acquisition time. Using this approach, we collected 3D microstructural data from various types of noodles or bread with differing internal structures. We then trained AI models to learn the relationship between these microstructures and their textural properties (specifically, fracture strength) measured using a rheometer. Predictive performance was evaluated using independent image data from different regions of the same samples, achieving a prediction accuracy over 95%. Moreover, analysis of the trained AI models revealed key structural features that contribute to textural perception, which had previously been only hypothesized. These findings offer a scientific foundation for the rational design of food textures, opening new possibilities for quality control and product development in the food industry.

Development of Optimal Decolorization and Degreasing Reagents for Three-Dimensional Fluorescence Imaging of Food Microstructures

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Abstract

The internal microstructure of food plays a crucial role in determining quality attributes such as texture, taste, and aroma. We previously developed a reagent, SoROCS, that renders food samples optically transparent, enabling three-dimensional (3D) visualization of their microstructures through direct fluorescence imaging without the need for mechanical sectioning. However, this technique faces significant limitations when applied to foods with high levels of pigments and oils, due to light scattering and/or absorption that hinder accurate structural visualization and degrade image quality. Although chemical extraction methods for pigments and oils in foods exist, they typically involve homogenization before extraction, which completely disrupts the native microstructure and makes them unsuitable for structural analysis. Therefore, it is essential to develop decolorization and degreasing techniques that effectively remove these interfering components while preserving the food's microstructure throughout the optically clearing process. In this study, we aimed to develop optimal decolorization and degreasing reagents tailored to various foods through the establishment of a simple and effective high-throughput evaluation system. As test cases, we selected carotenoid pigments in durum wheat pasta, radish sprouts, and spinach, as well as chlorophylls in the latter two. For degreasing, we targeted the oils contained in deep-fried instant noodles. The newly developed decolorization reagents successfully removed lutein with high efficiency (98.5% from pasta, 95.9% from radish sprouts, and 97.3% from spinach). The degreasing reagent achieved a 99.6% removal rate of oils from instant noodles. These results demonstrate that substantial reductions in light scattering and/or absorption can be achieved through decolorization and degreasing, thereby enabling high-contrast imaging of internal microstructures using conventional fluorescence microscopy, even in deep regions of food samples. This approach significantly enhances the applicability of 3D fluorescence imaging in food science research and quality assessment.

Living Labs for Sustainable Agri-food Commercialization

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Abstract

Living Labs are real-world, multi-stakeholder innovation ecosystems that co-create and test solutions in practical settings. Within the EXCEL4MED project, a Horizon Europe initiative targeting Mediterranean fruit supply chains, living labs in Malta and Greece engaged farmers, processors, researchers, policymakers and businesses to jointly develop sustainable and climate-neutral food innovations. The living labs applied tools such as the triple layered business model canvas, which expands the traditional business model by incorporating environmental and social dimensions. This enabled participants to map economic, environmental and social value across supply chains in a structured and transparent way. Outcomes included concrete opportunities for waste valorization and the identification of systemic gaps requiring better stakeholder alignment. Critically, the inclusion of enterprises in the co-creation process enhanced their innovation capacity. Existing research confirms that living lab participation increases sustainable innovation output among small and medium-sized enterprises, improves knowledge flows and supports product refinement through real-world testing. Importantly, living labs help address common challenges

that prevent innovative solutions from advancing, such as limited access to real-world testing environments, weak value chain coordination, and insufficient investor readiness. They create the conditions needed for experimentation, validation, and successful commercialization. Early integration of governance and environmental, social, and governance (ESG) principles also proved essential. The involvement of food agencies and regional authorities helped ensure that innovations met both policy and sustainability standards early on. In the broader European context, the European green deal and farm to fork strategy call for a climate-neutral and resource-efficient food system. Living Labs offer a compelling approach to meet this goal by aligning new technologies and business models with sustainability requirements and policy objectives. The lessons learnt demonstrate the value of Living Labs as enablers of responsible commercialization. They offer a replicable framework for governance, stakeholder engagement and ESG integration that can accelerate sustainable innovation across Europe.

Consumer Acceptance of Bioactive-enriched Foods Derived from Citrus and Pomegranate Residues: Insights from the EXCEL4MED Project

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Abstract

The EXCEL4MED project, funded by the European Union under the Horizon Europe program, seeks to improve sustainability in Mediterranean food systems by valorizing fruit processing by-products, specifically citrus and pomegranate residues, into high-value bioactive compounds for use in food enrichment. This innovative approach addresses two pressing challenges: reducing food waste and enhancing the nutritional value of traditional Mediterranean foods. As part of the project, a comprehensive consumer survey was conducted in three representative Mediterranean countries; Malta, Greece, and France, to evaluate consumer acceptance and willingness to pay for traditional food products fortified with these bioactive. The findings reveal that consumers across the three countries generally show curiosity and openness toward trying bioactive-enriched food products. However, there remains a notable reluctance to pay a price premium exceeding 5% above the standard product cost. This hesitation is largely attributed to persistent skepticism surrounding food additives, including those of natural origin, and a strong cultural attachment to foods perceived as wholesome, minimally processed, and traditional. Key factors that positively influence consumer preferences include the natural origin of the ingredients, scientifically supported health benefits, and local or regional production, all of which align closely with values of authenticity and sustainability. These insights are crucial for guiding both the formulation and marketing strategies of functional foods derived from agricultural residues. The study emphasizes the need for clear and transparent communication about the natural origins and health-promoting properties of bioactive compounds in order to build consumer trust and encourage broader acceptance. By aligning product development with consumer expectations and cultural values, the EXCEL4MED project supports sustainable innovation, promotes circular economy practices, and contributes to reducing food processing waste in the Mediterranean agri-food sector.

Soluble and Insoluble Phenolic Compounds from Lupin Grains: Phenolic Profile and Antioxidant

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Abstract

Phenolic compounds occur in both soluble (free, esterified, and etherified forms) and insoluble-bound forms. As soluble conjugates, phenolic compounds can be bound to different molecules such as fatty acids, soluble carbohydrates, and soluble proteins. Meanwhile, insoluble macromolecules such as proteins, cellulose, and arabinoxylans can also be linked to phenolic compounds (insoluble-bound phenolics (IBPs)). However, a clear gap exists about insoluble-bound phenolic acids and flavonoids in legume grains, especially in lupin (*Lupinus albus* L.). Therefore, the objective of this study was to characterize the fractions containing soluble and IBPs in lupin grains in terms of their phenolics and antioxidant potential by focusing on cv. Rumbo, the most important in terms of commercial purposes in Chile. The fractions were characterized by their total phenolic content (TPC), ferric reducing antioxidant power (FRAP), oxygen radical absorbance capacity (ORAC-FL), and phenolic profile by high-performance liquid chromatography with diode-array detection. The TPC showed different levels of contributions of soluble and insoluble-bound compounds in the lupin grains. Free fraction had the highest TPC (182 mg gallic acid equivalents (GAE)/100 g sample), followed by IBPs (57 mg GAE/100 g), esterified (43 GAE/100 g), and etherified (7 mg GAE/100 g). The FRAP val-

ues showed the same trend: 81 µmol trolox equivalent (TE)/100 g, 57 µmol TE/100 g, 49 µmol TE/100 g, and 7 µmol TE/100 g, respectively. Likewise, the ORAC-FL showed the highest values for free fraction (354 µmol TE/100 g), followed by esterified (143 µmol TE/100 g), IBPs (94 µmol TE/100 g), and etherified (54 µmol TE/100 g). The main identified compounds in free fraction were p-coumaric acid, trans-ferulic acid, and catechin, in esterified forms trans-cinnamic and catequin, and in etherified and IBPs p-coumaric acid. These results are expected to significantly contribute to elucidating the total phenolic composition, which includes not only the soluble phenolics but also the IBPs of Chilean lupin grains.

Testing the Antimicrobial Properties of Various Beeswax Coating Formulations for Food Packaging Applications

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Abstract

The growing global concern for ensuring food preservation and safety has intensified efforts to develop new food packaging solutions, particularly active packaging with antimicrobial properties. The application of a coating formulation that incorporates an active antimicrobial agent over packaging materials represents one of the most recent and promising strategies to inhibit microbial growth on food, thereby extending shelf life and reducing food waste. Natural beeswax has recently gained attention in the food industry for its remarkable superhydrophobic properties and its ability to preserve the postharvest quality of perishable foods, extending their shelf life, when used in combination with other compounds in coating formulations. Despite these qualities and the antimicrobial potential of beeswax ethanolic and methanolic extracts previously demonstrated in a few studies, there is still no clear evidence of a direct inhibitory effect of beeswax on microbial proliferation. Therefore, this study aimed to assess the antimicrobial potential of beeswax when incorporated into six coating formulations and applied to an inert substrate. All the formulations included the use of a commercial brand of beeswax, which was dissolved in 95% ethanol at 80 °C. Three different beeswax concentrations (1%, 2%, and 4%) were tested, both individually and in combination with 1% lignin. The antimicrobial potential of each formulation and, specifically, its contact-killing mechanism of action was evaluated against four foodborne pathogenic bacteria (*Escherichia coli, Salmonella enterica, Listeria monocytogenes,* and *Bacillus cereus*) and three food spoilage fungi (*Botrytis cinerea, Rhizopus stolonifera* and *Saccharomyces cerevisiae*). The ASTM E2180 standard test method was chosen to assess the activity of the formulations due to the hydrophobic nature of the coating conferred by beeswax. The results revealed the antibacterial and antifungal activities of beeswax, when used isolated and in higher concentrations.

Development of a Hydrophobic Coating for Sustainable Food Packaging Derived from Wood Shaving Waste

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Abstract

In recent years, growing awareness of the increasing persistence of non-degradable plastics in natural habitats-and their impact on the environment and human health-has prompted greater efforts to replace plastics with more sustainable and biodegradable alternative materials. One of the most common uses of plastics is food packaging, particularly in single-use products, due to their high performance in protecting and preserving food items, as well as their resistance, lightweight nature, and low cost. The most common and widely explored solutions involve the use of biopolymers, either individually or in combination, to develop eco-friendly and cost-effective packaging with optimal physical and chemical properties. Following this line of research, this study specifically focused on a promising prototype packaging material developed within a circular economy framework, primarily utilizing wood shaving waste generated by the Portuguese company Freshwood. Despite the material's excellent characteristics, the main objective of this study was to develop a hydrophobic coating to apply to the material to enable its cleaning and further re-use. The methodology involved the application of different coating formulations in the prototype material by different methods, and assessment of the resistance of each coating to several washing procedures (water spray with different impact pressures, water immersion with different temperatures, chemical and mechanical brushing techniques). The results revealed that coating formulations based on natural waxes and applied in single or multiple layers were more effective and durable to different washing techniques.

Development of A Lab-on-chip for Detecting Polyphenolic Compounds in Olive and Its Derivatives

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Abstract

Polyphenols are plant-derived secondary metabolites that fulfill multiple metabolic functions. In agricultural products, polyphenol content is regarded as a key quality indicator, contributing to antioxidant capacity, physicochemical stability, coloration, flavor, and aroma. In olive cultivation, the quantification of polyphenols in olive fruits serves as a biomarker for plant physiological status, environmental interactions, and overall harvest quality. Determining the optimal ripening stage of olives is essential to achieve a balanced profile in terms of chemical composition, sensory attributes, and oxidative stability of extra virgin olive oil. The demand for a simple and cost-effective strategy to assess the phenolic content in olives has driven the development of numerous analytical methodologies over the years. In this context, the Quartz Crystal Microbalance technique represents a highly adaptable analytical tool, capable of detecting polyphenols within complex matrices such as olive-derived products. The aim of this study is the development of a lab-on-chip device consisting of commercial quartz crystal microbalance equipped with a dissipation monitoring system, intended for in-field application, to rapidly assess the phenolic content of olives and, consequently, their ripening stage-without the need for costly laboratory analyses, which often involve the use of organic solvents. Through a specifically developed predictive algorithm, the sensor response will be correlated with the phenolic characteristics of the olives and with the potential sensory profile of the resulting oil. This platform offers a promising tool for rapid, accurate polyphenol detection, enabling the development of a lab-on-chip for improved quality control and identification of the optimal harvest time based not only on oil yield, but also on market demands and consumer preferences.

Sustainable Approach Towards Value-added Lipids from Portuguese Hass Avocado by-products for Health-promoting Applications

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Abstract

As plant-based diets rise globally, avocado consumption, especially Hass variety, is booming due to its environmental adaptability and high nutritional value. This trend has generated increasing amounts of underutilized by-products, particularly seeds and peels, which are promising sources of bioactive lipids like polyunsaturated fatty acids, commonly esterified to polar lipids such as phospholipids and glycolipids. These lipids hold significant functional value for food, nutraceutical, and cosmetic industries, promoting a more sustainable use of this trend fruit. To promote sustainable reuse and valorization of avocado by-products, this study demonstrates the potential of ultrasound-assisted ethanol extraction (UAE), a green and food-grade method, to obtain bioactive extracts from Portuguese Hass by-products while evaluates their antioxidant, anti-inflammatory, and anti-diabetic properties through in chemico and cell-based assays. High-resolution C18 liquid chromatography coupled with tandem mass spectrometry (C18-HPLC-MS/MS) lipidomic analysis revealed over 250 lipid species belonging to 21 classes across 3 main lipid groups (polar lipids, sterol lipids, and neutral lipids). Notably, 6 of these classes (i.e., ceramides, hexosylceramides, N-acyl phosphatidylethanolamines,hemibismonoacylglycerophosphate, phosphatidylethanol, and phosphatidylmethanol) were identified for the first time in avocado by-products, highlighting their previously unrecognized lipid complexity. Peel extracts were richer in C18:3ω-3 lipid molecular species, while seed lipids were primarily esterified to C18:2ω-6. In chemico and cell-based assays confirmed the biological potential of UAE extracts. Both seed and peel lipids showed significant antioxidant (up to 80% ABTS●+ inhibition), anti-diabetic (up to 80% inhibition of α-glucosidase and α-amylase), and anti-inflammatory activities (over 65% COX-2 inhibition, reduced nitric oxide production, and downregulation of Il1β and Il6 in LPS-stimulated macrophages). Although UAE yields were slightly lower than the conventional Folch-like method, the green, solvent-free process preserved lipid bioactivity and aligned with circular bioeconomy strategies. These findings position avocado by-products as valuable sources of bioactive lipid ingredients for health-promoting applications, promoting sustainable waste valorization in the growing avocado sector.

Species Specificity of Portuguese Avocados: Insights from Untargeted Lipidomic Approaches

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Abstract

Avocado is renowned for its nutritional value and health-promoting lipids, yet cultivar (cv.)-specific lipid profiles remain underexplored, particularly beyond the widely studied cv. *Hass*. This study presents the first in-depth comprehensive characterization of lipid molecular profiles in pulp, peel, and seed from three Portuguese-grown avocado cultivars (Hass, Bacon, and Zutano) using high-resolution C18 liquid chromatography coupled with tandem mass spectrometry (C18-RP-HPLC-MS/MS). A total of 117, 93, and 100 lipid molecular species were identified in the pulp of Hass, Bacon, and Zutano, respectively. In the by-products, 357, 394, and 430 lipid molecular species were identified in the peel, and 358, 432, and 413 in the seed. These lipid molecular species belong to phospholipids, glycolipids, sphingolipids, and neutral lipids. A group of 69 lipid molecular species were shared in pulp, while 307 and 323 were identified in common in peel and seed, respectively. Multivariate analysis confirmed cultivar-specific lipid signatures, with cv. Zutano displaying a notably higher abundance of lipids bearing polyunsaturated fatty acids like linoleic (FA 18:2 ω-6) and linolenic acids (FA 18:3 ω-3), across all avocado portions. Cultivar-specific lipid markers were identified, further supporting their biochemical individuality, namely TG 55:2 (TG 18:1_18:1_19:0), TG 63:2 (TG 18:2 18:0 27:0) and PC 38:6 (PC 18:3_20:3) in Zutano pulp, seed and peel, respectively; phosphatidylinositol 34:3 (PI 16:1_18:2) in Bacon peel; or PC 36:4 (PC 18:3_18:1) and PC 34:4 (PC 18:2/18:2) in Hass peel and pulp, respectively. Overall, our results reveal significant biochemical diversity among avocado cultivars, offering valuable biomarkers for food traceability and quality control. Lipidomics-based strategies could enhance cultivar selection targeting food, nutraceutical, and cosmetic industries and may help develop strategies to boost bioactive compound yield and promote sustainable avocado farming.

Analysis of Cupriavidus Necator Biomass by Gas Chromatography-Mass Spectrometry

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Abstract

The continuous development of biodegradable and environmentally safe alternatives for fossil-based materials has been supported by growing research into biopolymers, such as polyhydroxyalkanoates (PHA). PHA are a class of biopolymers naturally synthesized by various microorganisms, such as *Cupriavidus necator*, primarily through microbial fermentation processes - submerged fermentation or solid-state fermentation. These biopolymers have received growing attention due to their biodegradability and potential to replace conventional plastics. In this study, the focus is placed on the analysis of PHAs extracted from waste biomass, which represents a sustainable and low-cost raw material. The key steps in the production are extraction and purification, which involve solubilizing intracellular PHA, separating biomass, and isolating it from the solvent. Ensuring the purity and quality of the final biopolymer product requires precise analytical monitoring. To achieve this, gas chromatography coupled with mass spectrometry was used, providing an effective method for identifying and quantifying the polymer composition. In order to determine the type of polymer produced, acid hydrolysis was performed to break down the polymer into its monomeric components (methyl (R)-3-hydroxyvalerate). This study contributes to the improvement of analytical techniques for characterizing biopolymers and supports the continued development of sustainable biotechnological applications.

Green Approach for Polyphenolic Extraction and Valorization of *Mentha X piperita* L. Leaves Herbal Dust

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Abstract

Mentha is a medicinal plant due to its abundant bioactive compounds, particularly polyphenols, which are known for their

antioxidant, anti-inflammatory, and antimicrobial properties. Herbal dust of *Mentha x piperita* leaves is a by-product generated in considerable amounts during herbal tea production and is commonly discarded as waste. This research aimed to explore the valorization potential of herbal dust through the extraction of polyphenolic compounds using ultrasound-assisted extraction (UAE) with a sonotrode and subcritical fluid extraction (SBFE). Extractions were carried out using three different solvents (96% ethanol, ethanol-water (50:50, v/v) and pure water), at four defined temperatures for SBFE (120 °C, 140 °C, 160 °C, and 180 °C) and two extraction times for UAE (3 and 10 min). Total phenolic content (TPC) was determined by the Folin–Ciocalteu assay, whereas high-performance liquid chromatography with a photodiode array and high-resolution liquid chromatography-electrospray ionization-quadrupole time-of-flight-mass spectrometry were used for quantitative and qualitative analysis, respectively. The highest TPC was observed in SBFE extract at 180 °C with ethanol-water (50:50, v/v) as a solvent, yielding 4196.67 gallic acid equivalent (GAE) mg/L. For the UAE, the highest TPC value of 2235.71 mg GAE/L was achieved using the same solvent and a 10 min extraction time. The most abundant polyphenolic compounds were phenolic acids such as rosmarinic, caffeic, and protocatechuic acid, as well as flavonoids, namely naringin, hesperidin and apigenin. All compounds listed above were consistently quantified across all SBFE samples, with the exception of apigenin, which was absent in the water extract obtained at 120, 140 and 160 °C. Furthermore, rosmarinic acid, caffeic acid, as well as naringin and hesperidin were not detected in the UAE water extracts, likely due to their poor water solubility. These results indicate a rich and diverse polyphenolic content of *Mentha x piperita* leaves herbal dust extracts. The use of green extraction techniques facilitates their potential application in food, cosmetic, nutraceutical, and pharmaceutical industries.

Potential use of Brewery Solid Waste in Human and Animal Food

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Abstract

The craft beer industry in Mexico has grown steadily, increasing the generation of waste such as spent brewers' grain (SBG), a nutrient-rich subproduct. This material has a high content of protein, fiber, and functional compounds, making it a viable candidate for both human and animal feed. In the present study, two products were developed using SBG: an artisanal cookie and a balanced pig feed. Two batches of artisanal cookies were produced: one with 100% of wheat flour (GA00) and the other with 30% of SBG flour and 70% wheat flour (GA01). Acceptability was assessed using an affective sensory test with 40 untrained judges. In addition, a balanced feed was formulated using SBG, following the nutritional recommendations of the FEDNA (2019) table. The results indicated that the artisanal cookies were accepted similarly to commercial cookies and that the addition of 30% SBG did not affect its acceptability. On the other hand, SBG provided 9.7% protein and 33.8% sugars, allowing the formulation of balanced feed for pigs. Finally, it is concluded that the use of SBG is a sustainable and functional alternative for both human and animal feed. Its use contributes to the reduction of agro-industrial waste, improves the nutritional profile of processed products, and offers an economical option for the formulation of value-added feeds.

Microbial and Biochemical Impact of Starter Culture in Valtellina Casera Protected Designation of Origin Cheese Production

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Abstract

Valtellina casera protected designation of origin (PDO), a semi-hard cheese from Lombardy, is prone to late blowing defect caused by *Clostridium* spp. This study evaluates the impact of two starter cultures, a commercial (containing *Lactococcus lactis, L. cremoris, Streptococcus thermophilus, Lactobacillus delbrueckii* subsp. *bulgaricus*, and *L. helveticus*) and an experimental autochthonous culture (EAC) composed of *S. thermophilus* VC60 and *L. lactis* VC106, a bacteriocin producing strain effective against clostridia. Microbial populations and biochemical parameters were determined during cheese ripening at 8 °C and 12 °C. A total of 48 cheese samples, produced in three dairies in duplicate, were analyzed at 70 and 180 days. Analytical evaluations included microbiota profiling (16S rRNA sequencing on illumina MiSeq), lactic acid bacteria count, proteolysis (soluble nitrogen at

pH 4.4 by Kjeldahl and casein degradation by urea polyacrylamide gel electrophoresis), and lipolysis (free fatty acids by gas chromatography-flame ionization detector). Microbiota analysis revealed a dominant *Streptococcus* population (95%) in EAC cheeses, contrasting with 80% in commercial starter samples, which had a higher abundance of *Lactobacillus*. Microbial changes affected metabolic outputs, emphasizing EAC's ability to regulate enzymatic activity and modulate fermentation. The use of EAC resulted in a reduction of heterofermentative bacteria by 1 log CFU/g. Proteolytic activity increased with ripening time and temperature, with significant differences in soluble nitrogen observed between 70 and 180 days and between 8 °C and 12 °C. However, the two starter cultures exhibited similar index levels. Additionally, there was a notable decrease in propionic acid at 8 °C, indicating a decrease in *Propionibacterium* activity associated with cheese eyes. Moreover, EAC contributed to higher counts of rod-shaped lactic acid bacteria, particularly at 8 °C. This study emphasizes that selecting starter cultures influences microbial composition and biochemical traits, including fermentation processes, with potential and relevant effects for managing cheese defects and improving product quality during ripening.

An Ethnobotanical, Sensorial and Chemical Characterization of *Prunus Brigantina* Vill.: A Traditional Plum of the Piedmont Occitan Valleys

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Abstract

Prunus brigantina Vill. (also called Briançon apricot or marmot plum) is a wild tree species native to a restricted Occitan Alpine area between France and Italy. Traditionally, kernels were used to extract oil and in the upper Susa Valley (Western Italian Alps), the fruit pulp has been used and is still used to prepare homemade jams. To the best of our knowledge, a systematic characterization of this fruit is lacking in literature. We aimed: 1. to obtain an ethnobotanical, chemical and sensorial characterization of the fruit; 2. to map possible innovative technological usage of the pulp in gastronomic preparations; 3. to valorize the fruit with a circular approach (by minimizing waste during transformation); and 4. to study the impact of human individual variability in the masticatory behavior on the liking for different *P. brigantina* preparations. A multidisciplinary approach was adopted including: an ethnobotanical characterization, a chemical characterization of the pulp and the oil, a systematic mapping of the possible technological pulp usage in gastronomic preparations, and a sensory test with consumers on three preparations representative of different textures (liquid: juice; gel: jelly candy; solid: chip). The sensory tests included a focus group to elicit sensory descriptors and a test with 80 people collecting socio-demographic data, hedonic response, a sensory characterization throughout Rate-All-That-Apply test, preferred masticatory behavior throughout the oral mouth behavior questionnaire, and the evaluation of perceived viscosity of three watery solutions with different viscosity. Part of results are still under elaboration. Preliminary results showed 1: that *P. brigantina* is a valuable fruit that can be successfully used in different gastronomic preparations; 2: the oil was mainly composed of unsaturated fatty acids (particularly oleic acid) with a great content of phytosterols; 3: this approach can contribute to valorize understudied products and expanding knowledge about plant biodiversity.

Practical Measurement Package for Antioxidant Capacity Determination

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Abstract

Under oxidative stress conditions, reactive oxygen species (ROS) and nitrogen species can damage essential biomacromolecules, leading to various health complications. One of the most effective strategies to counteract these species is through the intake of antioxidant-rich foods, which help balance ROS levels. While numerous methods exist for assessing the antioxidant capacity of food extracts, there is a growing demand for simple, rapid, and cost-effective analytical tools. This study aims to develop a practical, low-cost tablet-based analytical system for determining the antioxidant capacity of food extracts and biological samples. The well-established cupric reducing antioxidant capacity (CUPRAC) method has been adapted into a tablet form for enhanced field applicability. Initially, the CUPRAC reagent was lyophilized. A mixture containing Cu(II)-neocuproine reagent and phosphate buffer was compressed into tablet form using mechanical pressing. Each tablet was added to antioxidant solution and dissolved using vortex mixing (or manual shaking). After a 30 min incubation at room temperature, absorbance readings were recorded at 450 nm against a water blank. Calibration curves were constructed for selected standard antioxidants using the tablet-CUPRAC method. For trolox, the calibration equation was found to be A = 0.0139c + 0.0133 with a correlation

coefficient (r) of 0.9982, where A is the absorbance at 450 nm and c is the concentration in μM. The method's precision and accuracy were confirmed through repeatability tests. Furthermore, total antioxidant capacity values of various food extracts were successfully determined and compared with those obtained using the conventional CUPRAC method. The developed tablet-based CUPRAC system offers a user-friendly and portable alternative for antioxidant analysis, especially in field settings. It simplifies the analytical process by eliminating the need to prepare reagents and standard solutions individually, while also increasing throughput.

Extraction of Phenolic Compounds from Muña Leaves (*Minthostachys spicata*) using Pressurized Liquid Extraction in Intermittent Process

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Abstract

Muña (*Minthostachys spicata*) is a woody shrub with a distinctive menthol aroma that grows in the Andean region of Peru (2700 - 3400 m.a.s.l.). Muña leaves are traditionally used for their medicinal and antiseptic properties attributed to their wide variety of bioactive compounds. Pressurized liquid extraction (PLE) is a green technology for effectively extracting valuable bioactive compounds from natural sources. In this study, we aimed to optimize the PLE in an intermittent process to obtain phenolic-rich extracts from muña leaves. A central composite rotatable design was employed to evaluate the effects of process variables, including temperature (53 - 87 °C), rinse volume (66 - 134% of cell size), and number of cycles (1 - 5), on the yield and total phenolic content (TPC) of the extracts. The extracts were obtained using PLE equipment (Dionex ASE 150, Thermo Scientific, USA) with an extraction cell volume of 34 mL, a static time of 6 min, ethanol absolute pressurized at 10.35 MPa, and 7 g of triturated muña leaves. The PLE process completely modified the microstructure of leaves, inducing their rupture and the presence of filaments. The yield of extracts varied from 10.1 to 18.9 g dried extract solids/100 g dry mass of muña leaves, and the TPC from 169.9 ± 4.9 to 241.8 ± 4.4 mg gallic acid equivalent/g of extract. The statistical analysis of the main effects of process variables on the yield and TPC of extracts indicates that only temperature significantly influenced the PLE process for TPC. The extract obtained at 87 °C with a rinse volume of 100% and three cycles presented a higher yield (18.9%) and TPC concentration (226.5 ± 9.2 mg gallic acid equivalent/g of extract), which could be recommended for food applications. These findings highlight the potential of PLE as an efficient extraction process for producing muña leaf extracts with high TPC.

Chipilin Protein (*Crotalaria longirostrata*): Digestibility, Structure and Tecno-functional Properties

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Abstract

In recent years, plant proteins have gained prominence due to their multiple advantages. Among alternative sources, legumes stand out for their nutritionally complete composition and superior functional properties. Recent studies show that their proteins exhibit better techno-functional and nutritional qualities than most plant proteins. In this context, *Crotalaria longirostrata* (chipilín), a Mesoamerican legume traditionally consumed in southern Mexico, emerges as a novel and viable protein source. It is considered one of the 16 most important edible leafy species globally, with leaves containing 26 - 38% protein (region-dependent), surpassing conventional legumes. This study evaluated the nutritional, techno-functional, and structural properties of chipilín protein isolate to assess its potential as an alternative food ingredient. Chipilín leaves were collected from southern Mexico, dried, and milled into a fine powder. The protein was extracted via alkaline solubilization (pH 12.0, 1:15 w/v ratio) followed by isoelectric precipitation (pH 3.8). The hydrodynamic diameter of the protein was 0.96 ± 0.01 μm. Its digestibility (89.67 ± 1.12%) exceeded that of other legumes (e.g., pea: 74.59%; Zhou et al., 2025), indicating high nutritional value. Secondary structure analysis revealed β-sheets as the dominant conformation, suggesting structural stability and functional versatility. Techno-functional properties were ideal for food applications: water-holding capacity (2.34 ± 0.12 g/g) suits viscous foods like puddings and sauces; high emulsifying activity (99.37 ± 2.40 m^2/g) and stability (95.03 ± 3.09%) make it suitable for plant-based beverages or ice creams. At 0.5% concentration, its foaming capacity (203 ± 4.24%) matched egg white, with high stability

(86.26 ± 3.41%), ideal for baked goods. These results position chipilín protein as a versatile, novel ingredient for functional food development.

Electrohydrodynamic Response of Clay-stabilized Pickering Droplets in Castor Oil

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Abstract

Pickering emulsions stabilized by clay particles exhibit unique interfacial mechanics that can be tuned using external electric fields. Such systems are relevant for developing stable, functional emulsions in food science and material engineering. In this study, we investigate the electrohydrodynamic behavior of water-in-castor-oil droplets stabilized with plate-like clay particles. Experiments were conducted using a custom-built chamber, where direct current electric fields were applied parallel to the droplet alignment. The work examines different configurations, including single clay-stabilized droplets, mixed droplet pairs (bare water and clay-coated), and pairs of particle-coated droplets. The observations reveal distinct deformation patterns, approach, and interaction dynamics under the applied field, influenced by both particle coverage and field strength. These results provide insights into tailoring droplet interactions and stability in particle-laden interfaces for advanced applications.

Rabbit Meat as a Traditional Ingredient: Culinary Uses and Perception in Local Cuisine

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Abstract

Rabbit meat is lean, rich in protein, low in cholesterol, and easy to digest. It provides B vitamins and essential minerals, is ideal for healthy diets, and has a low environmental impact. The current analysis explores the acceptance, preparation methods, and tactics to promote rabbit meat consumption in local cuisine, focusing particularly on restaurants in Salvatierra, Guanajuato, Mexico. Through a survey of a representative sample of businesses, it was discovered that approximately 15% already include rabbit meat on their menus. They primarily offer it in cuts such as loin and leg, and prepare it to use methods such as stewing, roasting, and barbecue. However, there is still not a wide variety of preparations. Low demand, supply difficulties, and a lack of awareness about its culinary and nutritional benefits are some of the barriers to expanding its presence. On the other hand, factors that could promote its inclusion include the perception of higher quality, the opportunity to expand culinary options, and providing consumers with more information about the product's health benefits. Participants agreed that promotional measures should focus on tastings and educational campaigns to educate consumers about this protein, as well as the development of innovative recipes that appeal to current customers. Promoting rabbit meat consumption through education, culinary creativity, and links to tourism and local gastronomy has the potential to strengthen the Agroindustrial sector.

Sesamum indicum (Sesame) Enhances Nk Anti-cancer Activity and Splenocyte Proliferation, Modulates Th1/th2 Balance, and Suppresses Macrophage Inflammatory Response

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Abstract

Sesame seeds, derived from *Sesamum indicum*, have traditionally been used for treating several inflammatory and metabolic conditions including various types of cancer. Our objective is to evaluate the potential immunomodulatory effects of an aqueous extract of *S. indicum* seeds with regard to splenocyte proliferation, Th1/Th2 balance, macrophage function, and NK cytotoxic activity. Splenocyte proliferation was measured by [^{3}H]-thymidine incorporation. Griess assay was performed to evaluate the production of NO by macrophages. The level of cytokines secreted by splenocytes and macrophages were measured by ELISA. JAM assay was performed to examine NK cytotoxic activity against YAC-1 tumor cells. *S. indicum* significantly enhanced splenocyte proliferation in a dose-dependent manner. *S. indicum* enhanced and suppressed the secretion of Th1 and Th2 cytokines, respectively, by splenocytes. The secretion of key pro-inflammatory mediators (IL-6, TNFa, and NO) by primary macrophages was significantly inhibited by *S. indicum*, indicative of its anti-inflammatory effects. Finally, *S. indicum* caused a significant enhancement of NK cytotoxic activity against YAC-1 tumor cells, suggesting that the documented anti-cancer effects of *S. indicum*

may be attributed, at least in part, to its ability to boost NK cytotoxic activity. Our findings present *S. indicum* as a traditionally used oilseed crop with potent immunomodulatory, anti-inflammatory, and anti-cancer effects. We anticipate that constituents of *S. indicum* may be used as effective therapeutic agents in regulating immune reactions implicated in various infectious and non-infectious conditions including cancer.

Toxic Aldehydes from High-temperature Cooking of Vegetable Oils: Could Enzymes Offer a Solution? Toward Innovative Bioremediation Tools

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Abstract

Olive oil plays a central role in the Mediterranean diet, largely due to its multifaceted functional properties, including anti-inflammatory and antioxidant effects. These health-promoting properties are mainly associated with the consumption of raw olive oil. However, when subjected to cooking - particularly at high temperatures, as in frying - its composition undergoes significant changes, leading to the formation of toxic aldehydes, a phenomenon also observed in other edible vegetable oils. A survey of the literature highlighted the critical role of frying-related aldehydes, including acrolein, acetaldehyde, formaldehyde, and trans,trans-2,4-decadienal. These highly reactive compounds represent a major public health concern, having been linked to respiratory irritation, oxidative stress, cardiovascular damage, mutagenicity, and carcinogenicity. However, they are also released into the environment from both natural and anthropogenic sources, resulting in widespread passive human exposure in outdoor and indoor settings, including workplaces. They are further detected in other food matrices, non-alcoholic beverages, cosmetics, hand sanitizers, and lifestyle-related sources such as tobacco smoke, e-cigarettes, and alcoholic beverages. Moreover, their persistence, low solubility, and resistance to degradation pathways further exacerbate their toxicological impact. Several strategies have been developed to limit aldehyde-related risks to human health and the environment, including air purification systems for volatile aldehydes. Nonetheless, their effectiveness is often limited. In this scenario, bioremediation represents a promising and sustainable alternative. Indeed, a number of enzymes utilize a broad spectrum of structurally diverse aldehydes as substrates, converting them into less toxic derivatives and thus representing valuable tools for bioremediation. Building on this, our project aims to design novel, versatile enzymes capable of degrading toxic aldehydes across multiple environmental contexts, through an integrated multidisciplinary approach combining biochemical and chemical assays with *in silico* modeling, with the ultimate goal of providing an innovative and sustainable tool for aldehyde detoxification.

Onion Peels from Waste to Resource: A Scientific Approach to an Environmentally Friendly Hair Dyeing

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Abstract

Among all fruits and vegetables, the onion (*Allium cepa* L.) in its various cultivars, is widely produced worldwide. Consequently, the related waste (i.e., peel, external fleshy leaves, top and bottom parts) is generated in considerable amounts. These waste products are rich in bioactive compounds owing to the presence of phenolics, flavonoids, flavanols, anthocyanins, tannins, vanillic acid, and ferulic acid. Many studies on phytoconstituents isolated from onion peels and their extract have been focused on their therapeutic potential and pharmacological activities. However, it is also known that the presence of flavonoid (quercetin, etc.) and anthocyanidin (pelargonidin, etc.) in the outermost part of the onion peel makes it useful as a natural dye. Onion peel is commonly used in some countries to dye Easter eggshells and, traditionally, to dye fabrics, primarily wool for carpets and rugs. Although there is some popular knowledge of the use of onion peel in hair dyes, to date no scientific data has been reported in this context. Here, we report the results of our study on dyeing blond human hair and white yak fur with aqueous, ethanolic, and methanolic onion peel extracts. After concentration, the methanolic extract was dissolved in a mixture of water:benzylic alcohol: *iso*-propylic alcohol, operating in acidic or basic medium and with different dyeing time. Red, yellow onion peel and a mixture of both, were used with different related results The addition of biocompatible mordants and, in one case of polydopamine, achieved excellent hair dyeing results, as confirmed by CieLAB colorimetric parameters.

Review on the pH Measurement on the Primary, Secondary and Working Levels

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Abstract

The traceability chain of pH measurement is realized through three hierarchical levels: primary, secondary and working. At the primary level, the conventional assignment of reference buffer standards, pH is established via Harned cell measurements. This method determines the acidity function p(aHγCl) for buffers with added chloride ions and extrapolates to zero chloride concentration, thereby providing conventional pH values traceable to fundamental constants. Uncertainties at this level arise mainly from deviations between theoretical dissociation constants and experimental results, particularly for polyprotic buffer systems. At the secondary level, traceability is disseminated through certified reference materials (CRMs) prepared and validated by national metrology institutes. These CRMs are linked to primary standards through high-precision characterization methods and ensure consistent international comparability of pH measurements. Finally, at the working level, pH traceability is transferred to routine analytical laboratories using glass-electrode pH meters calibrated with CRMs at multiple calibration points (pH 4, 7, and 10). Uncertainty evaluation is carried out following ISO GUM and EURACHEM/CITAC guidelines, considering contributions from the calibration slope, intercept, CRM uncertainty, temperature effects, resolution, drift and repeatability. This three-level framework ensures robust metrological traceability for pH, from primary realization to everyday laboratory practice.

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