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6. Application of novel technology to foods.

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Acidified Thermal Processing of Low Acid Foods

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Abstract:

There has been interest in food industry to move the "low acid foods" into "high acid food category" so that a pasteurization process can be used instead of commercial sterilization as normally required for low acid foods. This transformation helps to achieve significant energy savings and better quality retention because of using lower processing temperatures and times. Generally this process works well for vegetables. Meat products pose greater challenge for this approach due to their sensitivity to low pH, but can be extended to white meat and some seafood. It can provide a good alternative when the acid taste is tolerated. In combination, acidification and use of agitation processing could offer powerful tools for energy efficient quality enhanced thermal processing applications.

Charlotte Jacobsen

Technical University of Denmark, Denmark.

Abstract:

Long chain omega-3 polyunsaturated fatty acids (PUFA), particularly EPA and DHA, are crucial for heart and brain health. However, many people consume too little seafood, the main source of these lipids. Alternatives include supplements or enriched foods, but these face challenges. Fish oil production can't meet the rising demand sustainably, and EPA and DHA are prone to oxidation, causing off-flavors. This presentation will explore these issues, showcasing the author's work on sustainable marine lipid sources and strategies to prevent lipid oxidation, including optimizing antioxidant use and improving prediction methods for antioxidant efficacy in complex foods.

New Food Processing Technologies: Modulating Protein Properties Using Electric Fields

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Abstract:

There has been a significant shift in the consumers' preferences, acceptance and needs in the last ten years, which has been particularly strong in the last five years. The "top trends" are: Clean claims (e.g. preservatives free); Clean labels; Lifestyle enhancers (e.g. high energetic foods); Functional foods (e.g. with nutraceutical function); Minimally processed foods (e.g. using natural ingredients as much as possible) and the so-called "Green foods" (making use of the benefits of plants - e.g. replacement of animal protein by other protein sources). Along with this shift, there are two major problems related with the food we eat: I) ensuring people's food, health and wellbeing, and II) ensuring the health of our planet. When answering to problem I), the future food needs to tackle malnutrition, reduce calorie density, reduce food digestibility, increase micronutrient bioavailability, control gut health, allow personalized nutrition and

provide appropriate food for the elderly. In order to answer to problem II), we need to make use a set of tools for the future: molecular biology, nanotechnology, artificial intelligence, robots & sensors, the so-called "Cellular agriculture" and search for alternative protein sources. This keynote will address the latest developments made by our research group towards tackling some of these challenges, in particular focusing on the very versatile nature of proteins and how is it possible to change their behaviour and properties using electric fields processing.

Design of Composite Gels from Fermented Protein Emulsions and Starch for Plant-Based Cheese Alternatives

Poul Erik Jensen

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Abstract:

Plant-based foods are gaining attention due to their sustainability and health benefits. Current commercial cheese alternatives may offer sustainable options compared to dairy cheeses, but they often have low protein content and are associated with inferior taste and texture. In this study, we investigated the effects of incorporating lipids (rapeseed oil or shea butter) and proteins (pea protein isolate) on the properties of starch-based gels relevant for plant-based cheese alternatives. The gels were prepared by first fermenting protein-based emulsions to create primary gels. The water from these primary gels was then used as the starch hydration medium to produce secondary starch-based, pea protein-rich composite emulsion gels. Fermentation appeared to increase gel hardness compared to non-fermented protein addition. Acid-hydrolysed/acetylated starch produced firmer gels and was selected for further experimentation. While the gels appeared macroscopically homogeneous, microscopic analysis showed lipid coalescence with increasing lipid content (>8%), which was mitigated by ultrasonicating the emulsion prior to fermentation. The dry matter content significantly influenced the textural and rheological properties of the gels, with starch/protein gels containing 36% dry matter exhibiting hardness and viscoelastic properties similar to those of dairy cheese. However, the composite gels did not melt when heated to temperatures up to 80 °C (Δ below 20°). Proton dynamics were found to be influenced by gel properties and lipid addition. Overall, this study presents a novel approach to producing cheese-like gels with tuneable characteristics through fermentation and syneresis.

Dynamic Processes Occurring During Food Production Microfluidic Techniques Used to Create Unique Insights

Karin Schroen

Wageningen University and Research, The Netherlands.

Abstract:

Humanity faces the huge challenge to supply a growing world population with sufficient and healthy food. To make this a reality we need to rethink how we produce food at large scale. This implies understanding ingredient functionality under conditions as they occur during the production of food, as well as under digestive conditions, to thus make the connection to health effects that can be created by smart food design. Today's presentation will focus on investigation of processes that take place at micrometre scale, and even smaller scales, and often within very short time scales (sub-milli seconds). These dynamics are very difficult to capture due to time and size challenges. Most examples that I will discuss use microfluidic tools to visualize these processes. For example, for formation of two-phase systems such as emulsions and foams, and their dynamic formation for which we monitor interfacial tension

at very short time scales. I hope to discuss with you how these techniques can contribute to more flexible use of ingredients. For example, replacement of animal-based products with their plant-based counterparts, as well as design of food structures with health benefits. I am convinced that the techniques developed can ultimately be used to do fast screening, will allow comparison of ingredients, link with digestion, and can be connected to the typical times scales as would occur using classic processing technologies (e.g., high pressure homogenization), and look forward to discussing this with you.

Plant Phenols as Multifunctional Food Constituents: From Sources to Reactions and Applications

Andreas Schieber

Institute of Nutritional and Food Sciences, Molecular Food Technology, University of Bonn, Germany.

Abstract:

The food sector is characterized by a strong trend towards sustainability and naturalness. These factors require, among others, an efficient use of resources and the avoidance of synthetic additives such as preservatives and colorants in favor of natural ingredients, preferably of plant origin. Phenolic compounds are secondary metabolites that protect plants against biotic and abiotic stress and have a role in communication of plants with their environment. Therefore, they are found in large quantities in the outer layers of plant foods. Because these are often removed during processing, side streams represent a rich, cost-effective and sustainable source of phenolic compounds (Schieber et al., 2017). However, the qualitative profile varies from plant to plant, and there are also large differences in quantitative terms. Chemotaxonomic considerations can be of great help in the selection of suitable sources (Schulze-Kaysers et al., 2015). Furthermore, plant phenols are characterized by a pronounced chemical heterogeneity, which causes strong differences in bioactivity. Studies on phenolic acids have shown that their antibacterial activity against lactic acid bacteria depends, among others, on the substitution pattern and pH value. The metabolism by lactobacilli of phenolic acids through reduction and decarboxylation leads to detoxification (Sánchez-Maldonado et al., 2011). Gallotannins from mango seeds show activity against Gram-positive bacteria except lactic acid bacteria, which is partly due to their iron-complexing effect (Engels et al., 2009). In contrast, there is no correlation between the antibacterial activity and the iron-binding properties of biflavonoids (Linden et al., 2020). Exposure of bacteria to biflavonoids results in adaptive mechanisms, as shown by changes in carotenoids, fatty acids and menaquinones in the membrane (Linden et al., 2023). Interestingly, the metabolism of hydroxycinnamic acids can be exploited also for accelerated generation of pyranoanthocyanins (Schieber and Weber, 2023). Red and green colorants can be produced from chlorogenic acid by oxidative coupling with amino acids. While the green reaction products are based on a substituted benzacridine core, several structures have been described for the red dyes. The latter arise exclusively from the reaction of chlorogenic acid with tryptophan (Bongartz et al., 2016; Santarcangelo et al., 2023). Initial studies on the red and green compounds demonstrate satisfactory stability against food-relevant processes, from which promising application potentials for their use as colorants can be derived (Iacomino et al., 2017; Santarcangelo et al., 2024). The results presented confirm that plant phenols, or their reaction products, can potentially be used as natural preservatives or colorants. However, numerous aspects still need to be clarified, especially since additives are subject to approval. Extensive studies are therefore required, particularly with regard to their toxicity. In the case of preservatives, it should be noted that their efficiency can significantly be impaired by the food matrix. Last but not least, success will also depend to a large extent on economic aspects.

Numerical Simulation and Optimization of Heat Transfer in Solar Box Cookers: A Pathway to Sustainable Cooking

Ana C. Araújo, Cristina L. M. Silva*

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Abstract:

Solar box cookers offer a sustainable and eco-friendly alternative to conventional cooking methods, harnessing solar energy to generate heat for food preparation. A solar box cooker consists of an insulated box with a transparent cover that allows sunlight to enter, where it is then trapped and converted into heat, similar to the greenhouse effect. This simple yet effective design can reach sufficient temperatures to cook meals without the need for fossil fuels or electricity. Box solar cookers are especially beneficial in regions with abundant sunlight, as they provide a cost-effective, renewable way to cook food while reducing greenhouse gas emissions and dependence on non-renewable energy sources. In this study, a comprehensive mathematical model was developed for a solar box cooker equipped with multi-step inner reflectors, aimed at simulating its thermal performance. The model incorporates various heat transfer mechanisms, including conduction, convection, and radiation, across key components such as the double-glazed cover and reflectors positioned at specific angles (30º, 45º, and 75º). By solving a system of nonlinear differential equations, the temperature distribution across the cooker's components was predicted over time. A statistical surface design was also applied to assess and optimize critical factors, including reflector angles, material properties, and ambient conditions, revealing key variables that enhance the cooker's overall performance. The findings highlight the potential of this design to improve the efficiency of solar cooking systems and promote their use as a viable solution for sustainable food preparation, particularly in sun-rich regions.

Development of Cultivated Meat: Drawing Lessons from Tissue Engineering and Polymer Processing

Tan Lay Poh

Nanyang Technological University, Singapore.

Abstract:

Cultivated meat also known as cultured meat or lab-grown meat has garnered a lot of interest in recent years as an alternative protein source. While it is not the answer to all problems faced in animal agriculture, it has the potential to alleviate its drawbacks, and provide an alternative to the growing meat demand. In general, cultivated meat is produced by first taking a biopsy of the targeted animal, so that these starter cells are fed with culture medium for proliferation. Once there are sufficient cells, biochemical substances are added to differentiate stem cells towards skeletal muscle cells, which makes up most of a meat product. To produce cultivated meat with texture, scaffolds can be utilized such that higher order of muscle tissue structure can be achieved. Scaffolds are usually used in conjunction during the differentiation of stem cells. This aids in bridging the difference in structural and textural properties between cultured meat and traditional meat products. The high cost of cultivated meat is still a key challenge. One of the cost-drivers is the cell culture and differentiation media. In our laboratory we try to circumvent the use of the costly differentiation media by using biophysical induction methods for differentiation. In departure from tradition, our lab introduced an innovative single-step process that integrates scaffold fabrication and stem cell seeding, effectively eliminating the cumbersome multi-stage process of the current status of producing cultivated meat.

Desirability-based Modeling - Integrating non-traditional Proteins in Food Products

Clara Talens

AZTI, Food Research, Basque Research and Technology Alliance (BRTA), Derio, Spain.

Abstract:

The transition to sustainable food systems necessitates the creation of products that balance environmental responsibility with consumer satisfaction. Across four separate studies, the use of non-traditional proteins and hybrid formulations to develop innovative food products, such as meat analogues and dairy-free yogurts will be investigated. The primary objective was to utilize advanced predictive modeling techniques to optimize the sensory and nutritional attributes of various food products. The research emphasizes incorporating novel protein sources like pea, hemp, insect flours, broccoli, upcycled brewer's spent grain, faba bean, chickpea, oat, and hydrolyzed insect proteins. These ingredients are applied in diverse formulations, including dairy- and egg-free sponge cakes, hybrid sausages, and cheese- and yogurt-like products. The studies utilized a desirability-based mixture design model to optimize food formulations with non-traditional proteins. Regression models predicted the impact of protein combinations on product attributes, followed by optimization using desirability functions to balance sensory and nutritional qualities. Validation through Quantitative Descriptive Analysis confirmed consumer acceptance. Key parameters analyzed included protein content, textural properties (firmness, consistency, cohesiveness, viscosity), nutritional value (caloric content from proteins), and sensory properties (flavor, texture, appearance). The findings demonstrated that alternative proteins can effectively replace traditional animal proteins without compromising quality, supporting sustainable food production. The findings indicate that alternative protein sources can successfully replace traditional animal proteins in various food products without sacrificing sensory and nutritional quality. The use of desirability-based mixture designs facilitated systematic optimization of product formulations, demonstrating that these proteins can not only meet but enhance desired food properties. This supports the sustainability of food production and highlights the potential of alternative proteins and hybrid approaches in food industry innovation, emphasizing the importance of methodological rigor in product development.

Antonio Derossi

University of Foggia, Italy.

Abstract:

Anne Louise Dannesboe Nielsen

Danish Technological Institute, Denmark.

Abstract:

The IMAGINE Project: Creating Fully Personalized Nutrition by Means of 3D Printing

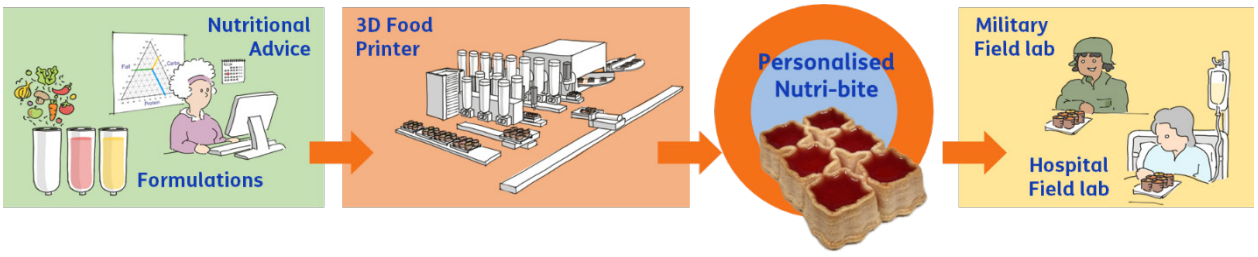
Kjeld Van Bommel

TNO, Netherlands.

Abstract:

Within the IMAGINE project, a public private partnership project, research was carried out by a

consortium of partners on the creation and effects of Personalized Nutrition (PN) food products. The main objective of IMAGINE was to deliver such personalized food products into consumers' daily lives by connecting personal data and digital food manufacturing technology, thus allowing consumers to be and/or perform at their best.



Within IMAGINE the following research topics were addressed:

- Creation of PN food advice based on individual consumer data, expert input, and consumer preferences.
- Development of software that can turn a PN advice into a recipe, and subsequently into printing and dosing instructions.
- Development of a range of base food formulations, the combination of which can be used for the creation of PN food products.
- Development of a complex 3D Food Printer that can print and bake a PN food product, comprising a casing, fillings, additional micronutrients, and toppings, altogether resulting in a products with personalized types and amounts of macro- and micronutrients.

This 3 year project has resulted in the most complex 3D Food Printer ever developed, which has been integrated into a so-called Mobile Satellite Kitchen (MSK) container, allowing it to be placed and used in nearly any location. Using the IMAGINE MSK, together with the dedicated software and food formulations, field lab trials have been carried out in a hospital as well as a military setting to look at the effects of PN food products on respectively recovery and performance of the test panels.

Extraction and Purification of Bioactive Compounds from Micro/Macroalgae and Hairy Root Cultures

KSMS Raghavarao

Department of Chemical Engineering, Indian Institute of Technology Tirupati, Andhra Pradesh, 517619, India.

Abstract:

Health and wellness have been on high in the priority of individuals as well as Nations, especially after the recent pandemic-COVID 19. In fact, it is one of the important Sustainable Development Goals (SDGs) identified by the United Nations. Bioactive compounds by virtue of their medicinal and nutritional properties are finding increased applications in functional and healthfoods. Our group has been working in downstream processing of several biomolecules such as enzymes, phycobiliproteins (phycocyanin), natural pigment (betalains) from natural sources, crude extract of solid-state fermentation, microalgae (wet and dry) and macroalgae. Currently, we are working on the extraction of bioactive compounds from alternate sources such as Amaranthus hairy root cultures (betalains), and macroalgae Gracilaria corticata (phycoerythrin). Also, on the design and development of acoustic mist bioreactor and the strategy for using the same bioreactor as extractor. Green extraction methodologies are

being developed employing aqueous two-phase systems (ATPSs), and natural deep eutectic solvents (NADES). Further, applications of nanoparticles (again produced by green methods) and external fields (MW and acoustic) for achieving process intensification in terms of increased extraction efficiency. The concept of process integration (extraction plus membrane processing) for inter-integration and differential partitioning in aqueous two-phase extraction for intra-integration is also employed to increase overall productivity. The talk highlights the importance of downstream processing, current problems, and possible solutions.

Plant Protein Functionality in a Nutshell

Vibeke Orlien

University of Copenhagen, Denmark.

Abstract:

In the increasing global market for plant-based foods, both the raw materials and ingredient processing technologies is crucial for technical functions in the quality and stability of food products and at the same time ensure sustainability, supply, and demand. To advance the quality of plant-based food, we need to understand the important relationship between protein structure and functional requirements. However, this is not straightforward as proteins differ considerably. This presentation gives an overview of the processing-molecular-function relationship of three different plant-based protein types: the well-known pea and faba bean proteins and the emerging myco-proteins and grass proteins. Ten different genotypes of pea and faba bean were processed into concentrates and isolates, which were characterized, and the physicochemical and foam properties were evaluated at different pHs relevant for food products. Solid-state fermentation of brewer's spent grain has high potential to produce highly functional myco-protein ingredients suitable for food application. Leafy proteins are the most abundant protein source available, but extraction is challenging. A food-compatible filtration process to produce functional proteins from legume grasses has been developed and the protein-ingredients have functionalities comparable to animal-based proteins and surpass the plant-based ingredients. For optimal functionality the ingredient processing needs to be controlled and fine-tuned, which in turn can be done best if the relationship between structure and the physico-chemical and functional properties are understood. The overall objective is to significantly enhance the understanding of the complex process by which various raw plant-based materials are transformed into functionalised protein ingredients.

Stability of Individual Anthocyanins from Black Carrots Towards pH and Light – Impact of Acylation

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Abstract:

Anthocyanins from black carrots are getting more attention due to their high degree of acylation compared to e.g. anthocyanins from berries and the degree of acylation has been correlated with higher color stability. Four different varieties, Night Bird, Deep Purple, and two non-commercial varieties, were tested with respect to stability towards pH (pH 1.0, 3.0, 4.5, and 6.0) and light exposure (pH 4.5). Deep Purple retained more color at higher pH values, which correlated with highest degree of acylation. All varieties change their visual appearance by

being red at pH 1.0, and 3.0, pink at pH 4.5, and purple at pH 6.0. After fractionating the five dominant anthocyanins by reverse phase preparative HPLC, the two non-acylated; cya-xyl-gal and cya-xyl-glu-gal appeared with a more orange-red shade than the three acylated; cya-xyl-glu-gal sinapoyl, cya-xyl-glu-gal feryloyl, and cya-xyl-glu-gal p-coumaroyl being pink to purple. The most purple one was cya-xyl-glu-gal sinapoyl. The specific molar absorption coefficients were calculated for all five purified anthocyanins at pH 1, cya-xyl-glu-gal < cya-xyl-glu-gal sinapoyl < cya-xyl-gal < cya-xyl-glu-gal p-coumaroyl < cya-xyl-glu-gal feryloyl. When stored at pH 4.5 in light and darkness to investigate how acylation affected the stability, both absorbance spectroscopy and mass spectrometry analysis showed a clear effect of acylation, but surprisingly the two non-acylated anthocyanins, showed higher stability than the three acylated ones.

Revolutionizing Food Structure Through 3D Printing for Enhanced Nutritional and Sensory Benefits

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[2]Centre of Biological Engineering, University of Minho, Braga, 4710-057, Portugal.

Abstract:

3D food printing (3DFP) is an innovative technology that creates edible foods by adding layers of materials according to a digital model. It can utilize a variety of ingredients, including dough, chocolate, sugar, cheese, or even proteins derived from plant or animal sources. 3D food printing has the potential to revolutionize food production, consumption, and customer's experience, offering advantages such as improved health, sustainability, on-demand manufacturing, and product innovation. Moreover, 3DFP opens up new possibilities for tailoring sensory experiences, enabling customization of texture, flavor, appearance, to enhance consumer engagement and satisfaction. Some specific aspects related to the ability of 3DFP to customize sensory and nutritional properties of food will be discussed. Particularly, it has been investigated the ability of precisely designing 4 virtual models using a new slicing software, FullControl Gcode, for realizing 3D objects with different textures, impacting the perceived satiety and food consumption. Snacks printed at 80% of infill level induced a higher fullness and a low energy intake, about 125 Kcal, during the three hours after the test, probably due to the high hardness and masticatory work associated with the oral processing of the snack. Additionally, inhomogeneous three-dimensional structures have been created to regulate the release of riboflavin in a model food spreading the potential of the 3DFP technology to contribute to personalized nutrition. After 3h, riboflavin release decreased from 55.21% in the control sample to 27.46% in the complex printed structure. Also, composite foods have been realized with a dual-extruder printer. The deposition of rice and chickpea flours in different positions of the three-dimensional space can significantly affect the textural and sensorial attributes of printed food products. These strategies will help facilitate the adoption of a more sustainable and healthy diet by designing 3D printed foods highly appreciated by consumers, thus motivating people to improve their eating behaviour, with potential societal and environmental benefits.

Synergistic Effect of Phytocannabinoids and Terpenes from Hemp Inflorescences in Preventing Lipid Oxidation

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Abstract:

The inflorescences of the hemp (*Cannabis sativa* L.) contain bioactive chemicals, in particular phytocannabinoids and terpenes, that may be able to inhibit lipid oxidation in vegetable oils. In the present work, two extracts with (E) and without (wE) phytocannabinoids, obtained from hemp inflorescences, were added at different concentrations (0.02 - 2.0 g/100 g) to high-oleic sunflower oil (HOSO) and subjected to thermo-oxidative conditions (90 °C; pO_2, 600 KPa). The oxidative stability index (OSI) was used to determine the induction time; in addition, the peroxide value, phytosterols and their oxidation products (POPs), and volatile organic compounds were all measured. The results showed a synergistic effect between phytocannabinoids and terpenes, as the E extract was more effective than the terpenes-rich extract (wE), increasing the OSI by about 30% compared to the control. Again, when both phytocannabinoids and terpenes were present together, the oil had the lowest peroxide value ($p < 0.01$) and POPs level ($p < 0.05$). In addition, principal component analysis (PCA) showed that the antioxidant activity varied according to the type and amount of extract. In conclusion, this study demonstrated how hemp inflorescence extract can prevent the formation of chemicals that are hazardous to human health, such as POPs, even under high oxidative stress conditions. This is a significant benefit for the food industry as hemp would provide a natural source of antioxidants that could extend the shelf life of vegetable oils even in high-temperature cooking processes.

Characterization and Use of Wild Edible Plants for the Realization of Functional Foods

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[2]*Grupo de Investigación Calidad y Seguridad Alimentaria, Instituto de Investigación e Innovación Agroalimentaria y Agroambiental (CIAGRO-UMH), Miguel Hernández University, Spain.*

Abstract:

Wild Edible Plants (WEPs) are plants that grow without the help of humans, suffering undervaluation over years. However, in many developing countries, due to food shortages, these plants have become a fundamental support to meet the daily food needs of many families, providing not only nutrients but also bioactive compounds, such as flavonoids, proanthocyanidins, flavonols, vitamin C, tocols (vitamin E), carotenes (vitamin A) and xanthophylls that play a key role in reducing the risk to develop several degenerative diseases in humans. In this context, we report the results of the nutritional and the quali/quantitative characterization of some liposoluble and water-soluble bioactives in different WEPs of the Mediterranean area. Considering the significant quantities of the investigated bioactive compounds, the most promising WEPs were used as ingredients for the realization of functional foods like pasta and bread. Leafy vegetables products proved to be a good alternative food, with high nutritional, healthy, technological and sensorial properties.

Development and Evaluation of Salt Microcapsules: Oral Release and Sensory Perception

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[1]*Instituto Universitario de Carne y Productos Cárnicos (IProCar), Universidad de Extremadura, Avda. de las Ciencias s/n, 10003, Cáceres, Spain.*

Abstract:

This study is encouraged by the need of the food industry to reduce the salt (NaCl) content in processed products and founded by the hypothesis of the capability of salt microcapsules to prevent its solubilization in food matrices and to release in the oral cavity, to reduce the quantity of salt added but having an acceptable salty perception. Therefore, the present study aims to evaluate different wall materials and coating techniques to develop sodium salt microcapsules to get a stable encapsulated salt system with poor water solubilization and high salt release in the oral cavity. For that, a sodium chloride dissolution was prepared and subjected to six different preparations: i) without wall material, as control batch (CON), ii) mixing with maltodextrin solution (MD), iii) mixing with chitosan solution (CH), iv) mixing with alginate solution (AG), v) adding into a double emulsion (DE), and vi) adding into liposomes (LP). These preparations were finally spray-dried to obtain the corresponding microcapsule powder. In general, the developed microcapsules were stable and showed appropriate structure characteristics, demonstrating the feasibility of wall materials and coating techniques. Significant differences were found in solubility and oral release, which may be explained by the quantity of salt in the surface and related to an insufficient coating of NaCl, and in the savor and flavor perception, which may be influenced by the wall material. These findings seem to point out the need of selecting that type of salt microcapsule that best fit with each type of food matrix.

Allergens from Rosaceae Fruits: Challenges in Protein Extraction and IgE-reactivity Assessment

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Abstract:

Rosaceae allergy is connected with pollen-food allergy syndrome and lipid transfer protein allergies, requiring extreme management measures [1]. As Rosaceae fruits are used as ingredients, it is crucial to monitor their allergens in foods. Herein, different protein extraction strategies are proposed to retrieve allergens with IgE-reactivity from Rosaceae species. For this purpose, pulp of 11 Rosaceae fruits (apple/pear/raspberry/strawberry/blackberry/cherry/plum /apricot/nectarine/yellow/red peach) was peeled, lyophilized, and grounded. Almond seeds were also ground/defatted with acetone (overnight, 4ºC). Each fruit (150 mg) was extracted with 11 extraction buffers: 1) H2O pH 9.0; 2) H2O pH 12.0; 3) Tris-HCl 0.1M (pH 8.0); 4) NaN3 0.02%; 5) PBS 0.2M (pH 7.4); 6) acetate buffer 0.1M (pH 3.6); 7) Glycine-HCl 0.1M (pH 2.5); 8) Tris 20 mM+urea 8M+thiourea 2M; 9) Tris-HCl-SDS 4% (pH 7.6); and 10/11) SDS buffer (sucrose 30%+SDS 2%+Tris-HCl 0.1M+mercaptoethanol 5%+PVPP 1%) without/with pre-cleaning step, following 2 protocols (4ºC overnight vs 60ºC, 2h). Protein was quantified by UV/Vis spectrophotometry. SDS-PAGE/immunoblotting with anti-almond IgG/pooled sera of Rosaceae-allergic patients was performed to assess protein profile and respective IgG/IgE-reactivity. Generally, fruit extracts showed low protein concentration for buffers (#1-#7) (5.31-19.98mg/mL), except #8, for which extracts exhibited 63.5±2.1mg/mL of total protein. SDS-PAGE indicates that buffers (#1-#7) were inefficient in extracting Rosaceae proteins. Buffers #8-#11 extracted proteins from most fruit species although with variable amounts/profiles (<75 kDa), with Tris-SDS 4% often allowing the best compromise of protein quantity/resolution. Contrarily, almonds exhibited high protein content, using buffers #1-#5, with molecular weights of 15-75 kDa. The anti-almond IgG was used to assess other Rosaceae fruits, but no cross-reactivity was observed. The IgE-binding

profile of Rosaceae allergens is currently being assessed with pooled sera from Rosaceae allergic patients. Herein, it is presented for the first time, the efficiency of multiple buffers exhibiting different pH and ionic forces to extract proteins from numerous Rosaceae species.
Funding: Project HYPOALLERGEN (PTDC/BAA-AGR/4005/2021) with national funds by FCT.

Modulation of Carotenoid Content in Sweet Potato through Cooking and Lactic Acid Fermentation

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Abstract:

Sweet potatoes are cultivated across a wide range of subtropical and tropical regions due to their resilience to diverse environmental conditions. As a starch-rich crop, they serve as a staple food in many countries, typically consumed in forms such as purée or baked goods. Orange-fleshed sweet potato varieties are particularly valued for their high carotenoid content, which plays a crucial role in vitamin A supply. In this study, the roots of six yellow and orange-fleshed sweet potato cultivars were analyzed, revealing a broad spectrum of carotenoid levels, ranging from 1.0 to 62.2 mg β-carotene equivalents per 100g dry weight. The carotenoids were primarily composed of β-carotene, with smaller amounts of α-carotene, lutein, and β-carotene 5,8-epoxide. The impact of various cooking methods, both alone and in combination with lactic acid fermentation (LAF), on carotenoid content was investigated. Baking significantly reduced carotenoid levels, whereas boiling, frying, microwave cooking, and especially steaming preserved or even enhanced carotenoid content. The observed effects are likely due to plant cell lysis and enzyme inactivation during these cooking processes. LAF was applied either before or after cooking, using two different lactic acid bacterial strains. Unexpectedly, pre-cooking LAF led to a reduction in carotenoid levels, particularly after baking, with α-carotene being the most affected. In contrast, performing LAF post-cooking generally preserved carotenoid content. Steaming followed by LAF emerged as the most effective method for retaining carotenoids, especially β-carotene. All processing methods modified sweet potato flesh color, reducing L* (lightness) and a* (red component) values. Conversely, b* (yellow component) decreased with baking, both alone and in combination with LAF, as well as with steaming. However, b* increased when LAF was applied prior to cooking. This study provides insights into how processing techniques influence the retention of bioactive compounds in sweet potatoes.

Insect Proteins to Create Innovative Emulsifiers with Enhanced Antioxidant Capacity

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Abstract:

Using sustainable sources, such as edible insects, to create novel surface-active structures in advanced emulsions can be key to design a new generation of foods. While emulsion stabilizers are ubiquitous and comprise a multi-billion-dollar global industry, these stabilizers often include chemical surfactants that have detrimental health and environmental consequences and are becoming increasingly regulated – motivating the development of greener, bio-based alternatives. We have applied several strategies to obtain surface active proteins from insects aiming to increase the physical stability and/or to protect against oil oxidation when formulating emulsions. Conjugating lesser mealworm protein concentrate (LMPC) to polyphenols, such as chlorogenic acid or tannic acid (TA) enabled to obtain antioxidant emulsifiers, which can successfully stabilize O/W emulsions containing highly oxidable oils, like that from linseed, with a notable reduction of secondary oxidation products. Besides, double $W_1/O/W_2$ emulsions stabilized with LMPC-polyphenol conjugates were used to co-encapsulate hydrophilic polyphenols with a polyunsaturated oil. Double $W_1/O/W_2$ emulsions, stabilized with LMPC-TA conjugate, containing a concentrated beet residue extract rich in polyphenols (W_1) and linseed oil (O) showed a higher physical stability than those stabilized with the native protein, while the formation of oil oxidation products was inhibited. Moreover, we analyzed the enzymatic hydrolysis of LMPC, performed with several commercial enzymes (e.g. Alcalase, trypsin), to establish the impact of the type of enzyme and degree of hydrolysis on the emulsifying activity and antioxidant capacity. The mechanisms underpinning the impact of LMPC-polyphenol conjugation and protein hydrolysis on their properties at the interface were investigated from the interfacial (surface hydrophobicity,) and structural properties (secondary and tertiary structure) of the resulting conjugates and hydrolysates. Although LMPC-polyphenol conjugation and enzymatic hydrolysis of LMPC not always led to a clear improvement on their properties as interfacial stabilizers, they did show to be promising strategies to enhance stability against oil oxidation.

Multiobjective Optimization of Lactic Acid Fermentation of Murta Juice

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Abstract:

Maximize total polyphenols content (TPC), lactic acid (LA), and lactic acid bacteria (LAB) count after lactic acid fermentation of murta juice with *Lactobacillus acidophilus* La-5. *L. acidophilus* La-5 fermentations were performed following a Box-Behnken design. The effects of fermentation temperature, pH, and initial bacterial concentration on TPC, LA, and LAB were modeled using quadratic models. The NSGA-II algorithm was applied to solve the multiobjective optimization (MO) problem. Several multi-criteria decision-making (MCDM) methods were used to find solutions prioritizing total polyphenol content. The desirability function approach and the single objective optimization method with a weighted cost function (WM) were also applied. The fitted models showed adjusted coefficients of determination (Ra^2) ranging from 0.982 to 0.882. For TPC and LAB, all terms were significant, while for LAC, the temperature terms were non-significant. The solutions chosen by the WM and the MCDM algorithms, TOPSIS and SAW, were deemed the most appropriate. The WM solution projected a TPC of 713 mg/L, an LC content of 0.46 g/L, and an LAB count of 6.20 log CFU/mL. The SAW solution projected a TPC of 720 mg/L, an LA of 0.45 g/L, and a BA of 6.32 log CFU/mL. The TOPSIS solution projected a TPC of 710 mg/L, an LA of 0.47 g/L, and a BAL of 6.34 log CFU/mL. The error between the experimental validation values and the projected optimal solutions varied between 2% and 11%. The NSGA-II MO algorithm, in tandem with MCDM techniques, was effective for the optimal design of a lactic fermentation process, considering multiple responses simultaneously. The selected optimal

solutions were experimentally validated with reasonably small errors. In particular, the SAW solution yielded a higher TPC at the expense of slightly lower values of LAC and LAB.

The Mineral Oil Hydrocarbon Paradox in Olive Pomace Oils

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Abstract:

This work focuses on the presence, content and nature of mineral oil hydrocarbons (MOH) in olive pomace oil. The request made by the European Food Safety Authority (EFSA) regarding the monitoring of the food groups making a relevant impact on human background exposure to MOH made us study such matrix since edible vegetable oils are among them. Such information will complement both the knowledge inferred from the limits established by the EU and the interpretation of the next toxicological risk assessment. As pointed out, also the origin of such a group of compounds is discussed. From the raw material to the final marketed product, olive pomace oils were sampled and analyzed at different points and/or under different conditions. Through the ultimate online HPLC-GC-FID system, we gathered information on the MOH presence and molecular mass profiles (C-fractions), and through GCxGC-TOF/MS, we identified the key structures that prove the innocuousness of the mineral oil aromatic hydrocarbon (MOAH) fraction. Our results showed chromatographic signals on the C10-C50 range, rendering 33–205 mg/kg mineral oil saturated hydrocarbon (MOSH) and 2–55 mg/kg MOAH in the commercial product. The data confirmed that the C25-C35 cut is the main fraction to which humans are exposed via olive pomace oil, at concentrations highly dependent on the extraction process, e. g. physical or through the use of solvents. Furthermore, the identification of certain MOAH groups demonstrated that in olive pomace oil, mainly 1- and 2-ring species were present, being virtually free of the carcinogenic 3–7 ring aromatics.

Spray Drying Microencapsulation is an Efficient Strategy to Produce Sustainable Insect Protein-Derived Food Ingredientss

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Abstract:

Edible insects are an alternative protein source with balanced nutritional profile produced through more sustainable practices than traditional animal husbandry. However, the incorporation of edible insects into the Western diet is challenging because of sensory (low sensory acceptance linked to reported disgust feelings) and technological (poorly documented techno-functionality) drawbacks. Here we describe a green strategy to produce value-added ingredients using insect protein and polyphenols recovered from muscadine grape pomace, a by-product of the food industry. Spray drying (SD) microencapsulation of insect protein (crickets, IP) or insect/pea protein blend (IPP) with muscadine grape pomace extract (MG) was conducted to produce protein-polyphenol (PP) particles (IP-MG and IPP-MG). The SD yield, physicochemical attributes, phenolic content, and techno-functional attributes of particles were determined and compared to IP alone. The SD yield was improved by 20% when using IP/pea blend (IP-MG 43.8% *vs* IPP-MG 53.3%). All PP particles had high total phenolic content (> 70 mg GAE/g sample), protein (>30%), besides acid pH (4.3-4.4), water activity within microbiologically safe levels (0.27-0.32) and attractive reddish color compared to IP alone. The solubility of PP particles was increased by more than 2-fold (IP 21.6%, IP-MG 52.9%, IPP-MG

45.4%), but similar emulsifying activity and stability were observed for both IP alone and PP particles. The microencapsulation efficiently protected polyphenols from thermal degradation (up to 100 °C). Overall, PP microencapsulation using IP is a rational technique to create versatile fruit-derived ingredients for multiple dietary applications such as snacks, bakery and other products using an environmentally friendly approach.

Polyphenol-Based Protein Modification: Reactivity of Amino Acids and Evaluation of the Biological Activity of Modified Products

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Abstract:

Plant polyphenols possess well-known antioxidant and anti-inflammatory properties. However, oxidized forms of polyphenols, known as *ortho*-quinones, can form polyphenol-protein adducts by reacting with protein nucleophilic groups in food products, like coffee with milk. β-Lactoglobulin (β-LG), a predominant milk whey protein, is not extensively studied for its reactivity with quinones and the impact of resulting adducts on antioxidant and anti-inflammatory functions. The study comprehensively investigated the reaction between 4-methylbenzoquinone (4MBQ) and various amino acids/β-LG using kinetics and site modification quantification. High-resolution mass spectrometry identified reaction products and quantified modified sites in 4MBQ-modified β-LG. Antioxidant and anti-inflammatory properties of *in vitro* digested 4MBQ-modified β-LG were assessed in LPS-activated RAW 264.7 cells. The LC-MS-based proteomics analysis revealed that cysteine in β-LG was the most modified residue. Kinetic data also confirmed that cysteine residues were the most reactive residues followed by lysine and histidine residues. Michael addition products and Schiff bases were formed due to the reaction between 4MBQ and amino acids/β-LG. Assessment of LPS-induced reactive oxygen species (ROS) and pro-inflammatory cytokines (IL-6 and TNF-α) revealed that the antioxidant and anti-inflammatory activities of β-LG digests (> 3 kDa) were enhanced by the 4MBQ modification. Furthermore, low-molecular-weight digests (< 3 kDa) of 4MBQ-modified β-LG had significantly lower cellular antioxidant activity, but higher anti-inflammatory activity than those of β-LG. 4MBQ-modified β-LG had more abundant bioactive peptides after digestion than non-modified β-LG. In summary, this study systematically demonstrated how 4MBQ interacts with protein residues and 4MBQ-based modification can enhance the antioxidant and anti-inflammatory activities of β-LG digests.

Assessing the Quality of Honey from Natural Park of Montesinho: Antioxidant Properties, Phenolic Composition, and Environmental Contaminant Safety

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Abstract:

Honey, a natural sweetener produced by honeybees from plant secretions, has been valued for its nutritional and medicinal properties since prehistoric times [1]. Its unique composition,

including sugars, vitamins, phenolic compounds, and minerals, provides various health benefits. However, the chemical composition and health properties of honey vary significantly based on botanical and geographical origins, climate, and handling practices [2]. Additionally, honey can be contaminated with environmental pollutants, such as pesticides and antibiotics used to control bee pests and pathogens, making safety a critical concern. This study aimed to differentiate honey samples collected from the Natural Park of Montesinho (NPM) in Portugal across two seasons (2021 and 2023) based on their antioxidant activity, bioactive chemical composition, and pesticide residues, using spectrophotometric and chromatographic methods (LC-DAD, GC-ECD and GC-FPD). Manuka honey served as a control. The results revealed significant differences in total phenolic content among the examined samples and between harvest seasons, with values ranging from 556 to 900 mg gallic acid equivalents per kg of honey (mg GAE/kg), compared to 586 mg GAE/kg for Manuka honey. In terms of antioxidant activity, honey samples from NPM exhibited higher values (494 and 740 mg ascorbic acid equivalents (AAE)/kg honey for FRAP and ABTS assays, respectively) than Manuka honey (240 and 287 mg AAE/kg honey, respectively), except for the DPPH-RSA assay which showed an opposite trend. HPLC-DAD analysis identified gallic acid, catechin, phloridzin, and ellagic acid as the main phenolic compounds responsible for the antioxidant properties. Ongoing GC-ECD and GC-FPD analysis aims to determine pesticide residues to ensure honey safety. These findings suggest that honey samples from NPM can offer promising health benefits, presenting a significant economic opportunity for honey producers to expand into international markets.
Funding: This work received financial support from PT national funds (FCT/MCTES, Fundação para a Ciência e Tecnologia and Ministério da Ciência, Tecnologia e Ensino Superior) through the project MTS/SAS/0077/2020 DOI 10.54499/MTS/SAS/0077/2020- Honey+ - New reasons to care honey from the Natural Park of Montesinho: A bioindicator of environmental quality & its therapeutic potential. **Acknowledgments:** This work was also financially supported by FCT/MCTES through the projects: LA/P/0008/2020 DOI 10.54499/LA/P/0008/2020, UIDP/ 50006/2020 DOI 10.54499/UIDP/50006/2020 and UIDB/ 50006/2020 DOI 10.54499/UIDB/50006/2020. Olena Dorosh (2021.05322.BD) is thankful for her Ph.D. grant financed by FCT/MCTES. Manuela M. Moreira (CEECIND/02702/2017, DOI 10.54499/CEEC IND/02702/2017/CP1427/CT0004), Sónia Soares (CEECIND/00588/2022, DOI 10.54499/2022.00588.CEECIND/CP1724/CT0009) and Francisca Rodrigues (CEECIND/01886/2020, DOI 10.54499/2020.01886.CEECIND/CP1596/CT0001) are thankful for their contracts financed by FCT/MCTES-CEEC Individual Program Contract and to REQUIMTE/LAQV.

Green Extraction of Olive By-products from 2 Different Greek Varieties: Valorization of their Phenolic and Antioxidant Content for Food Grade Additive Production

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Abstract:

The aim of this study was the valorization of phenolic compounds obtained from industrial olive by-products, as functional food-grade addititives, through optimization of a green extraction method. To date, the Folin-Ciocalteu assay has determined a maximum theoretical yield of total polyphenol content to be 250.2 mg gallic acid equivalents (GAE) per 100 g of olive leaf extract dry weight. However, the phenolic composition can differ based on the extraction protocol and the extracts origin. For the purpose of this study, 2 major Greek varieties (Koroneiki, Megaritiki) from 3 different regions (Aeghion, Herakleion, Megara) were analyzed. An ultrasound-assisted extraction protocol was developed, based on 4 solvents of water/ ethanol in different ratios (100/0, 70/30, 50/50, 30/70) and extraction time (45 and 90 min) Spectrophotometric analyses were performed for the evaluation of total phenolic content (TPC), antioxidant activity (DPPH,

FRAP), and color (L*, a*, b*, DE) of the samples. Their individual phenolic compounds were also assessed using HPLC-DAD analysis. Significant differences in phenolic content were established for all samples, as a function of variety and solvent composition, while extraction time did not seem to impair significant changes. Similar results were demonstrated for antioxidant activity and individual phenolic compounds. For higher ethanol content parameter a* presented lower values and lightness was increased regardless of samples origin. In conclusion, a green extraction protocol was optimized for the production of extracts, rich in antioxidant content from 2 greek varieties of olive leaves by-products, that has potential as a functional food grade additive.

Nanostructured Lipid Carriers for Enhanced Cannabidiol Bioaccessibility: *In vitro* Digestion Study and Cytotoxicity Assessment

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Abstract:

Cannabidiol (CBD) stands out as one of the major active constituents of Cannabis and it has been explored for food and medical applications. CBD presents very poor bioaccessibility mainly ascribed to its lipophilic character and marked liver first pass metabolism. The development of advanced delivery systems, such as nanostructured lipid carriers (NLCs) can provide a potential solution to increase the CBD bioaccessibility. This work aims to evaluate the behavior of NLCs loaded with isolate CBD (CBD_{iso}) and CBD-rich extract (CBD_{ext}) during *in vitro* digestion, and to access their potential cytotoxicity. The nanostructures were submitted to harmonized static *in vitro* digestion and their cytotoxicity was evaluated using Caco-2 cells. For comparison purposes, the bioaccessibility of CBD_{iso} and CBD_{ext} (dispersed in hemp seed oil) was also evaluated and presented values of 76.2 ± 4.6% and 77.3 ± 3.7%, respectively. After incorporation into the NLC, the CBD bioaccessibility was improved to 94.3 ± 3.7% for CBDiso and to 86.3 ± 0.9% for CBDext. The cytotoxicity results demonstrated that the free CBDiso and CBDext components reduced the cell viability to values lower than 85% at concentrations above 5 µg/mL, while the CBD-loaded NLCs presented no effect on the cell viability for the CBD concentration range evaluated (5 - 25 µg/mL). This work demonstrated that different forms of CBD (isolate or extract) affected the behavior of CBD-loaded NLCs during *in vitro* digestion. In addition, the incorporation of CBD into the nanostructures reduced its cytotoxicity.

Natural Deep Eutectic Solvents (NADES) for Sustainable Extraction of Bioactives from Food By-products

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Abstract:

Many plant-based by-products are generated during food processing which contain valuable bioactives such as polyphenols with nutritional and functional value. Typically, these are extracted using organic solvents such as, ethanol that although suitable for food applications it can be problematic due to its high flammability. Natural deep eutectic solvents (NADES) emerge as an attractive green and nontoxic alternative to other green solvents that have high flammability and/or require energy intensive operation. NADES are composed of natural compounds such as, sugar, amino acids and organic acids. One key feature of NADES is their

fine-tunability for specific purposes by changing NADES components which modifies their physicochemical properties such as, polarity, pH, and viscosity. Here the application of NADES to the extraction of polyphenols from plant-based side streams namely, grape seed and spent coffee ground is presented. In particular, the effect of NADES composition on recovery and selectivity of the separation is evaluated to obtain a better insight into the mechanism of the separation. In addition, the impact of NADES on the bioactivity of the extract is assessed.

Novel Bioanalytical Approach for Facilitated Discovery Bioactive Peptides and Optimization of Enzymatic Protein Hydrolysis

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Abstract:

Enzymatic protein hydrolysis (EPH), a proteolytic digestion of dietary proteins using food-grade proteases, is an attractive biotechnological process for valorization of underutilized food processing by-products. This technology has recently gained significant attention as a sustainable source of bioactive peptides against several important therapeutic targets. However, due to the complexity of protein hydrolysate composition, discovery and optimization of bioactive peptide fractions is a laborious and time-consuming task, usually comprising multiple cycles of chromatographic fractionation and bioactivity measurements. Here we are presenting a novel methodology combing: (1) chromatography fingerprint-based interval partial least squares (iPLS) for facilitated identification of bioactive peptide fractions, and (2) response surface modeling (RSM) using the identified chromatographic fractions as a response for a robust optimization of the hydrolysis process.

A library of 108 hydrolysates were produced from mechanical deboning chicken residue (MDCR) using three different temperatures, four enzyme concentrations and nine hydrolysis times, in a full factorial manner. Hydrolysates were characterized by size-exclusion chromatography (SEC) and in vitro ACE-I inhibition assay. To identify a bioactive fraction, iPLS regression based on a chromatographic fingerprint of crude samples was used, which eliminated the need for time-consuming bioassay-guided fractionation. After the bioactive fraction was identified, RSM was employed to develop a predictive model for the optimization of hydrolysate properties by adjusting the production parameters. The novel combination of iPLS and RSM utilizing chromatographic fingerprints was demonstrated as a promising analytical approach that can facilitate discovery of bioactive peptides of interest in complex hydrolysates and further enable optimization of production conditions.

Tailored Carbohydrate Materials and Their Application in the Food Industry

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Abstract:

Carbohydrates are a main component of human diet representing, on average, half of total calories according to nutritional guidelines. Carbohydrate-based materials presenting a balanced nutritional profile are of high interest for consumers. Nonetheless, carbohydrates also play a key role from a technological standpoint in many food products as they can be plasticizing, thickening and gelling agents, among others. In order to design materials that

are both techno-functional and nutritionally balanced, tailored modifications are key. How the structural modification of carbohydrate materials impact their nutritional and technical functionality has been extensively explored. As an example, the use of enzyme-driven technologies to modify both the backbone and back-bone substituents of carbohydrates such sugars and polysaccharides is commonly used in the food industry. In this research, we explored tailored designed carbohydrate materials derived from plants and their potential as functional ingredients. The use of chemical, mechanical and enzymatic modifications were evaluated to alter the fine structure of polysaccharides like pectic polysaccharides, glucomannans, or the synthesis of new carbohydrate structures starting from building blocks such sucrose. The techno-functional and/or health-promoting properties were evaluated showing these strategies as a promising approach to design novel functional food products.

Characterization of Molecular Structure, Physicochemical and Nutritional Properties of Starch and Flour from Lentil with Different Treatments using Pulse Electrical Field (PEF), Microwave (MW), Ohmic Heating (OH), and Ultrasound Technologies

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Abstract:

Characterization of molecular structure, physicochemical and nutritional properties of starch and flour from lentil with different treatments using pulse electrical field (PEF), Microwave (MW), Ohmic heating (OH), and ultrasound technologies was conducted in this study. Using wet milling extraction method, lentil starch was extracted from lentil residue flour treated with above advanced technologies. The structure and physicochemical properties of lentil starch including granular morphology, particle size and size distribution, crystalline and amorphous region, amylose and amylopectin content, gelatinization, retrogradation, rheological (pasting) properties and digestibility *in vitro* were characterized using various analytical techniques, such as differential scanning calorimetry (DSC), rapid visco-analyzer (RVA), Fourier transfer infrared spectroscopy (FTIR), optical microscopy and particle size analyzer. Low quantities of starch were extracted from the following sample treatments: control 3, wet heating, 85 °C; microwave, 300 W, 85 °C, microwave, 700 W, 85 °C, ohmic heating, 270 V, 50 Hz. This is likely due to the increased voltage causing an increase in temperature, resulting in starch gelatinization during the treatment of lentil flour. Samples which were treated at 85 °C and ohmic heating in high voltage (200V to 270V) changed the thermal behavior of starch gelatinization and retrogradation. This is due to starch gelatinization occurred during those advanced technologies applied in the lentil flour. For digestibility *in vitro* of lentil starches, samples treated at 85 °C and with ohmic heating, 270 V, 50 Hz, had much higher RDS – with majority of the starch being digested within 20 minutes. From FTIR, lentil starches have an increased 1047/1022 cm^{-1} ratio (the amount of ordered crystalline domains to amorphous domains in starches) and decreased 995/1022 cm^{-1} ratio for samples treated at 85 °C compared to the samples treated below 85 °C, indicating a change in the ordering of the crystalline domains due to the treatment of lentil flour.

The Second Life of Food By-products: Technological and Chemical Characteristics of Enriched Fresh Pasta with No-waste

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Abstract:

The application of a patented, innovative, non-thermal and non-invasive physical technology allowed to obtain ingredients from food by-products (i.e artichoke bracts and grape pomace) and without making further waste (i.e the whole berry of tomato) to produce enriched fresh pasta. In the case of artichoke bracts and tomato, the novel technology was applied obtaining two kinds of ingredients: a treated mush (TM), a kind of wet paste and a lio-powder (LP), obtained by the application of the freeze-drying process on the TM. In the case of grape pomace, two different percentages (5% and 10%) of lio-powder were tested. The evaluation of pasta features before and after the addition of the new ingredients was obtained on raw and cooked pasta samples, to have an idea of the technological and chemical potential of these newly-formulated fresh pasta samples. Electrophoretic (SDS-PAGE) and chromatographic analysis (SE-HPLC) were carried out to assess the arrangement of the gluten network, estimating the percentage of the unextractable polymeric proteins and the disulfide bond formation. The polyphenolic content (through Folin-Ciocalteau assay and chromatographic determination) and the antioxidant activity (through DPPH Radical Scavenging Activity) were assessed to evaluate the chemical characteristics of the ingredients and how the pasta samples were influenced by their addition, before and after the cooking process. The sensory characteristics were evaluated, too. Results showed how the addition of the by-products enhanced the chemical characteristics of the fresh pasta samples, highlighting a high content of polyphenols and a good antioxidant activity, without affecting the technological performance and the consumers evaluation. Moreover, a preservation of the nutritional properties, even after the cooking process was observed. Further studies are ongoing to assess if it is possible to increase the level of fortification and if these outcomes change if tested on dry pasta.

Biodisponibility of Sacha Inchi (*Plukenetia volubilis*) Antioxidant Peptides Released during Simulated Gastrointestinal Digestion

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Abstract:

Sacha Inchi oil press cake (SIPC) is an important source of proteins, and it is the main by-product generated during the Sacha Inchi oil processing. In order to adding value to this by-product, a Sacha Inchi protein concentrate (SPC) was obtained by extraction with alkaline water. The SPC was subjected to a simulated gastro-intestinal digestion following the INFOGEST protocol. The obtained hydrolysates were fractionated by a sequential ultrafiltration process using membranes of different cut-off values (>10 kDa, 3<kDa<10, and <3 kDa), and six peptide fractions were obtained. *In vitro* and *Ex vivo* antioxidant activity were evaluated. The gastric hydrolysates with nominal molecular weights of 3<kDa<10 showed the highest TEAC and ORAC values (577.84±20.69 and 719.47±59.69 µmol Trolox-Eq/g, respectively), followed by the intestinal fractions of molecular weights of 3<kDa<10 and <3 kDa, which presented TEAC and ORAC values ranging between 325-188 and 669-490 µmol Trolox-Eq/g, respectively. The ROS scavenging ability in RAW 264.7 mouse macrophages of the gastric digest peptide fractions >10kDa, 3<kDa<10, and <3kDa, at concentrations between 0.016 and 1.0 mg/mL was superior under basal and stimulated (bacterial lipopolysaccharide) conditions, in comparison to the same fractions of the intestinal digest. Furthermore, the *de novo* peptidome was fully determined for the first time for SPC digests, and 416 peptides were selected based on their resistance to complete digestion. Through *in silico* tools, 18 resistant peptides were identified

as antioxidants, and 12 of these were predicted to be bioavailable. These results offer new perspectives on the use of SIPC as a sustainable source of proteins and bioactive peptides, as well as a nutraceutical component for the human diet.

Bread Improvement with Nutraceutical Ingredients Obtained from Food By-products: Effect on Quality and Technological Aspects

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Abstract:

The use of by-products as functional ingredients for bread recipes may open up new horizons in terms of product innovation to increase nutraceutical characteristics and/or shelf-life. In this research, the ability of residual products from important food chains (*Citrus* and wine) to influence the water binding capacity of dough and bread was investigated in order to create industrial breads of high quality with prolonged shelf-life in the absence of any chemical additives (e.g., ethanol, sorbic acid, and propionic acid). The product under study is the 'Pan Bauletto bianco con olio EVO', an 'industrial bread' type usually treated with ethanol before being marketed, aiming to prolong its short shelf-life. The effect of the addition of different amounts of pectin (*Citrus* supply chain) and grape pomace (wine supply chain), in combination or not, has shown promising results from both a technological point of view and the increasing shelf-life, allowing to obtain products with high nutraceutical value and interesting properties. The study not only deals with the obtainment of a higher technological quality of bakery products but also with the improvement of the nutraceutical value of these products, which represent one of the main sources of carbohydrates. The integration Citrus peel and grape pomace in the bread recipe allows for the valorization of food by-products, which otherwise could become waste material and thus a cost for the industry and for the planet. The results underscore the positive impact of pectin on both leavening volume and bread density, which represent important attributes in breadmaking. In turn, grape pomace constitutes a high-value by-product of the wine industry due to its relevant content of phenolic compounds. Interestingly, the formulation of bread with the addition of both pectin and grape pomace leads to the best outcomes, as they allow to obtain a product with a homogeneous structure and an increased volume, with positive technological aspects if compared to the control.

Utilisation of Agri-Food By-Products with Antioxidant Properties for Beef Burgers Production

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Abstract:

The agri-food industry generates significant amounts of by-products, many of which are rich in bioactive compounds and with nutritional interest. These by-products have potential

future applications in food due to their antioxidant properties, which can be used to enhance food quality. This study evaluates and compares the nutritional composition and bioactive properties of several agri-food by-products and commonly consumed parts: leaves and florets from broccoli (Brassica oleracea var. italica) and cauliflower (Brassica oleracea var. botrytis) and leaves, heart, and external bracts from artichoke plant (Cynara scolymus). Proximate composition, total polyphenols and antiradical capacity (measured by ABTS), were analyzed. The different parts of the Brassica genus were characterised by the highest protein content (21.7-34.7% d.m.) with broccoli florets having the highest protein (34.7% d.m.). Artichoke leaves showed the highest total polyphenol content (13.04 mg GAE/g d.m.) followed by broccoli and cauliflower leaves (11.26 and 11.12 mg GAE/g d.m., respectively). The antiradical capacity was highest in artichoke leaves (34.2 µmolTE/g d.m.). Given the high antiradical properties of artichoke leaves, they were tested in beef burgers to assess its efficacy in preventing lipid oxidation, reducing microbial load and maintaining meat colour during storage. Beef burgers were prepared with 0.5 and 1% artichoke leaf powder (ALP) and stored at 4ºC for 8 days. They were compared to a negative control (only beef meat) and positive control (with meat + meat-industry antioxidant). Lipid oxidation, measured by TBARS, showed a reduction of 53 and 60% in the burgers with 0.5 and 1% ALP, compared to negative control and similarly to positive control. The microbial load significantly decreased in the burgers with artichoke leaves, especially with 1% ALP. Moreover, burgers with ALP exhibited lower metmyoglobin formation, retaining a more attractive red colour for a longer period. This study demonstrates the potential of agri-food by-products, especially artichoke leaves, as antioxidant ingredients to the production of beef burgers.

Fractionation, Characterization, and Assessment of Nutritional and Immunostimulatory Protein-Rich Polysaccharide-Protein Complexes Isolated from *Lentinula edodes* Mushroom

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Abstract:

This study aimed to fractionate and characterize the protein-rich polysaccharide-protein (PSP) complexes from a well-known edible mushroom, *Lentinula edodes*, and assess their nutritional and immunostimulatory functions. Crude PSP isolated from the mushroom water extract was purified by anion exchange chromatography, yielding fractions PSP-F1 and PSP-F2 containing 66.1% and 74.0% protein, respectively. Both fractions exhibited primarily β-sheet and random-coil protein structures, though the crude PSP fraction exhibited an additional α-helix structure. On SDS-PAGE, PSP-F1 showed two molecular weight bands, one below 10 kDa and another at 34 kDa, and PSP-F2 showed several bands, one below 10 kDa and others between 34 and 95 kDa. The nutritional value of essential and non-essential amino acid profiles was in the order of PSP-F2 > PSP-F1 > crude PSP; the amino acid ratio coefficient values of the crude PSP, PSP-F1, and PSP-F2 were 63%, 67%, and 72%, respectively. The combination of PS and PSP fractions exhibited stronger immunoactivity than PSP-F1 or PSP-F2 alone. PSP-F2 showed a higher immunostimulatory activity than PSP-F1 in RAW264.7 cell culture. PSP-F2 was also more abundant of easily absorbed high-quality proteins. The results provide useful references for dietary and medicinal uses of PSP fractions in *L. edodes* and other edible mushrooms.

Cordyceps Cs-HK1 Exopolysaccharide Protects Intestinal Barrier Integrity and Mitigates Oxidative Stress in H2O2 -exposed Caco-2 Cells

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Abstract:

Exopolysaccharide (EPS) derived from the mycelial fermentation of the medicinal fungus *Cordyceps sinensis* strain HK1 has demonstrated significant potential in anti-inflammation, suggesting its suitability as a functional ingredient in health foods. This study investigated the intestinal barrier integrity and oxidative stress of a low molecular weight fraction of exopolysaccharide, EPS-LM, in Caco-2 cells exposed to 550 μM hydrogen peroxide (H_2O_2). Treatment with hydrogen peroxide for 24 hours notably reduced cell viability and elevated reactive oxygen species (ROS) levels. Conversely, administration of EPS-LM at concentrations of 50 and 200 μg/mL ameliorated these effects by enhancing cell viability, decreasing ROS levels, and increasing the activities of antioxidative enzymes (superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), and catalase (CAT)). Western blot analysis revealed that EPS-LM treatment led to the stabilization and functional enhancement of the nuclear factor erythroid 2-related factor 2 (NRF2) pathway, as evidenced by increased expression of the NRF2 target protein NAD(P)H quinone dehydrogenase 1 (NQO1). Moreover, EPS-LM significantly improved intestinal barrier function, demonstrated by a decrease in sodium fluorescein permeability and an increase in transepithelial electrical resistance (TEER). This was further supported by the upregulation of tight junction proteins Occludin, Zonula Occludens-1 (ZO-1), and Claudin-1. Additionally, EPS-LM was found to activate the extracellular signal-regulated kinase (ERK) signaling pathway, further contributing to the reinforcement of tight junction integrity. Collectively, these findings emphasize the significant therapeutic potential of EPS-LM in not only mitigating oxidative stress but also strengthening and protecting the integrity of the intestinal barrier, making it a promising candidate for promoting gut health and preventing intestinal epithelial damage. **Keywords:** Cs-HK1 exopolysaccharide; antioxidative effect; H_2O_2; transepithelial resistance (TEER); Caco-2 cells

Identification of a New Marker for Musty Off-flavor in Apple Products: 1-hydroxyoctan-3-one

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Abstract:

Over the last 20 years, an organoleptic spoilage was reported about Golden Delicious apples. Descriptors of this spoilage were essentially cellar-like, musty, dusty, mushroom or metallic. In this context, control and spoiled cooked apple products (apple purees and applesauces) were characterized using GC-Olfactometry. In addition of GC-O profiling of the different products, several C8 compounds including 1-hydroxyoctan-3-one, 3-octanol, 1-octen-3-one and 1-octen-3-ol were defined as putative compounds responsible for this spoilage. These C8 compounds were quantified by either GC-MS/MS and or LC-MS/MS methods, using Stable Isotope Dilution Assay (SIDA). On one hand, the results obtained showed that 3-octanol, 1-octen3-one and 1-octen-3-ol, which are often presented in literature as good markers

of mushroom off flavor in fruit, were not discriminatory in our samples. On the other hand, GC-O identification, and MS/MS quantitation both confirmed for the first time the presence of 1-hydroxyoctan-3-one in apple derived foods. A significantly higher concentration was determined in spoiled applesauces compared to control ones, and an absence-presence phenomenon between control and spoiled apple purees was observed. A similar observation regarding 1-hydroxyoctan-3-one concentration was recently reported in spoiled and controlled wines. All together these data make this compound a good marker of spoilage. Moreover, some putative compounds were assigned to olfactory signals for which no specific C8 target was identified, using Linear Retention Index (LRI), mass spectrum and GC-O descriptors. For those signals, 2-pentylfuran and octanoic acid were proposed as markers of spoilage. Our work highlights the discovery of 1-hydroxyoctan-3-one in apple constituted products. This marker is relevant for quality segmentation at an early stage in food industry production and opens avenue to a better understanding of fruit quality decline.

Identification of *Chlorella vulgaris* Proteins – Functional and Structural Characterisation

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Abstract:

With the constant growth of the world population in the last years, the search for new protein sources has increased. Recently, microalgae have become an interesting alternative protein source, being sold in different forms. Despite their wide commercialization, the knowledge on microalgae proteins' functionality is still scarce. In this work, the production, extraction, and purification of proteins from the microalga *Chlorella vulgaris* was conducted to access their structural and functional properties. After cellular rupture, the soluble fraction was recovered by centrifugation and the protein content isolated though membrane fractioning. Through SDS-Page, one was able to identify protein fractions at 50 kDa, which corroborated the presence of the subunits of Ribulose-1,5-bisphosphate carboxylase, commonly known as Rubisco. This is an important protein in the carbon fixation during photosynthesis. The obtained protein isolate was further characterized in terms of intrinsic fluorescence and surface hydrophobicity, both related with protein's conformational aspects. Circular dichroism determinations allowed to evaluate the protein's secondary structure and its thermal stability, showing a transition at around 55 ºC. Rheological determinations demonstrated its gelation capacity, with a sol-gel transition consistent with the protein's denaturation profile. The isolate produced showed additional functionality, being able to create a stable emulsion, with more than 60% of emulsification capacity and capable to maintain stability above 50% during 24h. This characterisation builds a strong base of knowledge on how these proteins can be functionalized and be used as ingredients in the development of food products.

Valorisation of Brewer's Spent Grain Flour as a Functional Ingredient to Improve Nutritional and Health Quality in Dry Pasta Formulation

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Abstract:

The aim of this study is to valorize Brewer's Spent Grain (BSG), the most abundant by-product of beer brewing process. Fresh BSG was dried to produce flour (BSGF), followed by a comprehensive analysis of its physical-chemical, nutritional, and technological properties. Three formulations of semolina pasta, enriched with different percentages of BSGF 25% (PBSG25) 40% (PBSG40), 50% (PBSG50), were produced and compared with a positive control comprising semolina (PC) and a negative control comprising wholemeal semolina (PI). Pasta samples were dried at 40°C for 2 hours, samples taken after 60, 105 and 120 minutes. A chemical-physical, nutritional and technological characterization were conducted. After 105 minutes of drying, PBSG50 had a moisture of 12% and an Aw of 0.612, comparable to the PI and lower than the Italian legal limit. PBSG50 exhibited high protein (20.11±0.13%) and fiber (36.5±0.21%) content, along with favourable technological attributes such as a 5-minute Optimum Cooking Time and specific cooking loss and water absorption rates. Color parameters of PBSG50 do not differ greatly compared to PI, especially in the b* value (Yellow index) of 15.37±0.23 for PBSG50 and 14.83±0.50 for PI, and a* values respectively for 2.76±0.08 for PBSG50 and 2.61±0.61 for PI. Furthermore, an effect on metabolic syndrome was evaluated throught inhibitory effects on α-glucosidase and prebiotic 'in vitro' activity against *Lactobacillus* strains *L. casei* and *L. rhamnosus.* Future research could be conducted to evaluate 'in vivo' functionality of enriched pasta formulations with a view to upcycling aimed at minimizing environmental impact and food waste. **Keywords:** brewers' spent grain, formulation, functional pasta, quality, prebiotic activity, α-glucosidase inhibition.

Exploitation of Microwave-assisted Extraction to Produce High-Valuable Pomegranate Juice

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Abstract:

The public awareness of the benefits linked to the intake of fruits rich in phytonutrients has increased the popularity of pomegranate (*Punica granatum* L.) worldwide. In fact, it has been classified as a 'super fruit', being an important source of health-promoting compounds (Hegazi et al., 2021). Pomegranate juice (PJ) is also particularly appreciated for its unique flavor, taste, and beneficial proprieties. It is currently obtained with many industrial practices which can alter its composition and organoleptic features. In this framework, the development of novel extraction techniques which guarantee the production of minimal processed pomegranate juices is desirable. Green technologies based on microwaves hydrodiffusion and gravity (MHG) extraction has already been investigated to produce juices (Alam et al., 2023; Mazzara et al., 2023). However, they have never been experimented with pomegranate. Hence, this work aimed at evaluating MHG as a likely alternative of conventional squeezing to produce PJ. The best extractive conditions (microwave power and extraction time) have been selected through a central composite design study (CCD) to obtain the product with the highest yield, polyphenols content, and antioxidant activity. These responses were evaluated carrying out HPLC-DAD analysis and spectrophotometric assays. Worthy of note, the selected process did not alter the chemical-physical properties of the obtained products, i.e., total acidity, pH, density, and total soluble solid content. Thus, this technique can be considered a valid alternative to conventional squeezing to produce a PJ rich in beneficial phytonutrients (e.g., flavan-3-ols, ellagitannins, phenolic acids, and anthocyanins). Finally, the dry extracts obtained by freeze-drying the juice exerted considerable anti-glycation and anti-glucosidase activities. Interestingly, the market proposes microwave heating equipment in pilot scale. Thus, the scalability of the process together with the interesting results of this study could open the way for the exploitation of this procedure by the fruit juice and nutraceutical industries.

In vitro Digestion Study Comparing a Predigested Glycerolysis Product versus Long-chain Polyunsaturated Fatty Acid-rich Oils (LCPUFA) as A Strategy for Administering LCPUFA to Preterm Neonates

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Abstract:

A comparative study of the digestibility of two oils rich in polyunsaturated acids namely arachidonic (ARA) oil and docosahexaenoic (DHA) oil, and of a predigested product produced by enzymatic glycerolysis from these two oils has been carried out. The main hypothesis is whether the glycerolysis product will have a better digestibility than the separate starting oils, which could be attributed to the different lipid classes composition of the glycerolysis product and better emulsification properties with respect to the precursor oils. After carrying out an in vitro digestion of the three products, poorer digestibility was observed based on the oily phase found for the oils compared to the glycerolysis product. The highest micellar phase was found in the glycerolysis product (approx. 83%). On the other hand, the monoglyceride content is lower in ARA oil and DHA oil, 4.3% and 9.2%, respectively, compared to that observed in the glycerolysis product (15%). Considering the percentage of oily and micellar phases and the monoglyceride content, the glycerolysis product is more digestible than its precursor oils. For all these reasons we consider a very interesting strategy utilization of these predigested mixtures for oral and enteral administration of these bioactive fatty acids, especially in premature newborns.

Antioxidant Capacity of Pequi Oil (*Caryocar brasiliense Camb.)* in the Nutrition of Laying Hens Under Heat Stress: Investigation of Changes in the Plasma Proteome

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Abstract:

High temperatures in laying hen production cause physiological changes and hormonal shifts. Heat stress increases reactive oxygen species, leading to oxidative damage the macromolecules. Dietary adjustments, including antioxidant-rich vegetable oils, improve laying hens' performance amid these challenges. Therefore, this research proposal aims to evaluate the effects of Pequi Oil (PO) in the diet of laying hens under heat stress. 26 weeks old Lohmann White laying hens were housed in cages arranged in a climatic chamber, where they were kept under cyclic heat stress (31°C/32°C), for eight hours a day from the beginning to the end of the experiment. The birds were divided into two groups: one supplemented with 0.6% PO and a control group (CON) without PO. After an 84-day experimental period, blood samples were collected from one bird per experimental unit (6 per treatment) and processed for plasma separation with anticoagulant. Protein relative abundance variance analysis by

Shotgun-LC-MS/MS detected modulation of 60 plasma proteins in laying hens under cyclic heat stress. Among these, two proteins were upregulated in the 0.6% PO group in response to stress and inflammation, Alpha-2-Macroglobulin and Hemopexin, along with two unique proteins in the PO group, the Alpha-macroglobulin receptor-binding domain-containing protein and Serpin1. Proteins with antioxidant properties such as Hemopexin and Ovotransferrin, as well as the expression of the protein Proteasome activator subunit 4, involved in protein degradation during oxidative stress, help prevent oxidative damage, especially under stressful conditions. The exclusive presence of specific proteins indicates an adaptive response to mitigate the damage caused by cyclic heat stress. During heat stress, various changes affect tissue integrity, and proteins with indirect roles can aid in responding to such stress. For instance, the protein expressed in PO, vWFD domain-containing protein can help maintaining functional coagulation and cellular adhesion under heat stress, crucial for survival in high-temperature environments.

Mathematical Modeling of Bioactive Extraction from Cashew Apple: Maxwell-Stefan Approach to Resolve Effect of Internal Diffusivity and External Mass Transfer

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Abstract:

Every year 2.2 giga-tons of cashew apples are produced and 80% (unutilized fruit) of them are wasted and contain useful bioactives such as polyphenols and tannins (high molecular weight polyphenols). These bioactives can be separated using extraction: the nutraceutical value of which is of the order of 1 billion USD/year. However, extraction kinetics are normally fitted to simple phenomenological models. These models fail to establish the effect of shrinkage, temperature, thermodynamic parameters, and internal resistances on diffusion of solute. Hence, the objective of this study was to develop a Maxwell-Stefan model that can overcome the above shortcomings and optimize the extraction process of bioactives from cashew apples. The optimized parameters for the extraction process obtained were - solid:solvent ratio- 1:6, particle size (of solid) 125-250□m, and the extraction temperature as 30oC. The non-random two liquid (NRTL) activity coefficient model was first used to capture the thermodynamics of extraction effectively, followed by its utilization in the development of Maxwell-Stefan model to resolve the effect of internal diffusivity and external mass transfer coefficient. The model gave a good fit (R2>0.90) for all the parameters and could thus predict the extraction data greatly for all operating parameters including temperature, particle size, and solid:solvent ratio. This makes it eminently suitable for scale-up studies.

The Power of Bacteria and Enzymes: Texture and Aroma Improvement in Pea Protein Gels for Plant-based Cheese

Carmen Masiá

Novonesis, Denmark.

Abstract:

Plant-based cheese is one of the most challenging products within dairy alternatives due to the complexity of cheese's physicochemical and sensory properties. Currently, plant-based cheese production mainly relies on solid fats and starch to obtain firm textures,

and on flavouring agents to emulate cheese flavours, leading to products with low protein content that do not fulfil consumer sensory expectations. Bacteria and enzymes, particularly transglutaminase, have a great potential to fine-tune plant protein gelation and modification of aroma and flavour profiles, thus re-directing plant-based cheese production towards high-quality products. Through meticulous screening of bacterial blends and enzyme treatments, we identified promising bacterial combinations that accelerate fermentation, enhance texture, and elevate the dairy-like aroma profile of pea protein-based gels for plant-based cheeses. Improved hardness and elasticity, reduction of beany notes and increase of fermented dairy notes were observed. This presentation offers valuable insights into leveraging fermentation and enzymatic treatment to craft plant-based cheeses with satisfactory texture and aroma profiles.

Green Seaweed, Green Technologies: Towards Sustainable High-Value Compound Extraction and Biofilm Production

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Abstract:

Sea lettuce, classified as a green seaweed, represents a group of closely related multicellular marine species within the genus *Ulva* with diverse applications ranging from food supplements to biomedical uses due to its abundance in biologically active compounds. *Ulva* species offer rich sources of polysaccharides, proteins, minerals, vitamins, dietary fibers, and functional polyphenols (André et al., 2023; Flórez-Fernández et al., 2023). This project aimed to perform an integral valorization of *Ulva* within a biorefinery approach and bio-circular economy. For this purpose, the green seaweed was subjected to environmentally-friendly extraction technologies including hot pressurized water treatment at different temperatures ranging from 120 to 220 ºC operating in a non-isothermal mode. After hydrothermal processing, the chemical composition of the residue solid and the corresponding phytochemical features of the liquid phase was investigated. Following extraction, the residual seaweed biomass was used to produce bio-based films for food packaging applications. This innovative approach not only repurposes waste materials but also reduces reliance on traditional petroleum-based packaging, thereby decreasing carbon emissions and mitigating environmental pollution. Through minimal processing techniques like melt blending and compression molding, it was also our aim to investigate the influence of composition and cell wall structure on the film's final performance (Cebrián-Lloret et al., 2023). By repurposing waste biomass into eco-friendly packaging materials, this research work contributes to environmental sustainability while simultaneously transforming biomass into valuable marketable products.

Incorporating Stinging Nettles as a Sustainable Food Source?

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Abstract:

Sustainable food production requires resource-efficient food value chains with minimal impact on the environment, and stinging nettle has such promising potential as a sustainable food source. Compared to most leafy vegetables, stinging nettles (*Urtica dioica* L.) are nutritious perennial herbs that can grow in temperate and tropical climate conditions. However, they are currently not cultivated for food but are considered as tenacious weeds in many communities

around the world. In this study, we randomly harvested stinging nettle leaves from gardens and through freeze-drying, stinging nettle leaf flour was obtained. The flour was then incorporated at 5%, 10%, 15% and 20% into corn-based complementary foods and gluten-free cookies, and its effect on the nutritional, physical, in vitro digestibility, and shelf-life of the formulated food products was investigated. The results showed that increasing the incorporation of stinging nettle leaf flour enhanced the nutritional and health properties of the formulations. Specifically, for gluten-free cookies, total phenolic content and antioxidant activity increased approximately twenty-seven and seven times, respectively, and the estimated glycaemic index decreased ($p < 0.05$) from 48.60% (100% corn cookies) to 33.18% (20% stinging nettle leaf flour incorporated corn cookies). In addition, shelf-life characteristics, including water activity, peroxide value, and microbial count, were within acceptable limits for human consumption after storage for six months. Indeed, a significant decrease in metabolic glycaemic response indicated that 'low glycaemic index foods' could be formulated using stinging nettles, and, more importantly, sustainably combat malnutrition and/or celiac disease, especially in poorer countries where they grow abundantly as 'weed'.

Valorization of Lupin Seeds using Green Technologies: Extraction of Non-Polar and Polar Compounds for High-Protein Flour Production

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Abstract:

Interest in plant-based ingredients, particularly lupin seeds, is increasing due to their health benefits[1,2]. Although much research focuses on lupin's protein content, its oil fraction and phenolic compounds are overlooked. Even studies emphasizing the protein fraction stress the need to remove oil content for enhanced protein accessibility[2,3]. However, many studies use non-GRAS solvents, which may limit applications of the extracted lipids in food. This study aimed to enhance lupin seeds valorization by sequentially extracting non-polar lipid fractions using Supercritical Fluid Extraction (SFE) and polar fractions using gas-expanded liquid extraction with ethanol/CO2 to produce protein-rich flour. Yield was significantly influenced by temperature (40-60°C) and pressure (150–350bar). SFE extracts contained 50 times more α- and γ-tocopherols than Bligh and Dyer method, and lipids had a higher proportion of unsaturated fatty acids and a lower proportion of saturated fatty acids. Additionally, SFE extracts showed higher neutral lipid levels and lower phospholipid levels. For the ethanolic extraction process, there was a positive correlation between ethanol concentration and yield, and the extract exhibited a high proportion of phospholipids (53-69%). Five phenolic compounds were identified. Extracts exhibited high free radical scavenging activity for DPPH with EC50 values ranging from 1.5-4.4mg/mL. After SFE, the protein content in lupin flour increased by 11%. Subsequent extraction with ethanol/CO2 resulted in a lower protein concentration, indicating some solubility of proteins alongside phenolics. The content of essential amino acids increased after extraction. SDS-PAGE and FTIR analyses revealed no structural changes in the extracted flours, confirming efficiency and sustainability of the employed method for producing bioactive compounds and protein-rich flour, free of non-GRAS solvents.

Simultaneous Recovery of Bioactive Compounds from Winemaking By-products by Green Subcritical Fluids

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Abstract:

The food industry generates large amounts of by-products. Most of these biomasses are disposed of in landfills, contributing to climate change through greenhouse gas emissions, water and soil contamination. Several strategies have been proposed to reduce their environmental impact and convert these biomasses into valuable economic resources. In this context, the extraction of valuable compounds with technological or healthful properties from food by-products has gained significant interest. Several extraction methods are available. Conventional methods have several drawbacks, and several innovative processes were proposed. Subcritical Fluids Extraction (SSE) may be considered one of the most promising and versatile. A compound is defined as being in the subcritical state when its temperature is increased between its boiling and critical points, and its pressure is high enough to maintain the liquid state. Increasing temperature and pressure improve extraction rates and process efficiency through several mechanisms. The present study aims to evaluate SSE for extracting bioactive compounds from grape marc, the most abundant solid by-product of winemaking, using different green solvents: water, ethanol, and a 50% water-ethanol mixture. The effect of temperature (120, 150, and 180 °C) was also evaluated. A technological comparison, based on the mathematical modelling of extraction curves, and a chemical comparison between SSE and conventional extraction (CSLE) were considered. The best extraction conditions were obtained with the ethanol-water mixture at subcritical conditions, allowing the simultaneous extraction of polyphenols, proteins, and polysaccharides. Increasing the SSE temperature resulted in a 3-fold increase in polyphenols, an 8-fold increase in proteins, and a 15-fold increase in polysaccharide content compared to CSLE. The mathematical modelling of the extraction curves revealed that SSE was, on average, eight times faster. Moreover, the subcritical conditions positively affected some chemical properties of the extracted solutes, which may be related to the increase in antioxidant activity of SSE extracts.

Use of Resonance Waves in Winemaking to Produce Sangiovese Red Wine Without Sulphites Addition in a Sustainable Way

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Abstract:

In recent years, wine without sulphite addition has grown increasingly popular. In this work, resonance waves were applied to Sangiovese must in fermentation to produce wine without sulphite addition, monitoring the fermentation kinetics and analyzing polyphenols and volatile organic compounds (VOCs) extraction. Resonance waves were created by injecting compressed air into a 10 hL stainless steel tank filled with Sangiovese must, without pumping-over or delestage, and no sulphites in all the process (AM). Control wine was produced using pumping-over or delestage and adding sulphur dioxide. After a 4-month maturation period in bottles, the AM wine exhibited significantly lower volatile acidity, while total anthocyanins and trans-resveratrol were notably higher compared to the Control. The AM wine also showed a significantly higher content of free quercetin (2.44 vs 1.60 mg/L). When considering free volatile organic compounds (VOCs), the Control wine had a higher concentration of terpenes, while the AM wine displayed higher levels in the classes of aldehydes, alcohols, volatile phenols, lactones, and pyrazine. In terms of glycosylated VOCs, terpenes were significantly more abundant in the AM wine, which was the opposite trend observed in free VOCs. In conclusion, resonance waves permit to speed up the fermentation increasing phenols extraction and producing wines

with excellent maintenance of VOCs, requiring less energy and labor, and thus being more economically and environmentally sustainable.

Microwave Assisted Extraction as a Sustainable Technology Approach to Recover Phenolic Compounds with Antioxidant Activity from Sacha Inchi Shell

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Abstract:

Sacha Inchi (SI) (*Plukenetia volubilis*) is endemic plant to the Amazonian region, whose fruits are rich in essential fatty acids omega-3 and omega-6. The agro-industrial potential of the SI, has resulted in a plantations' expansion in Southeast Asia, South Africa and Southwest China, and the SI oil industry has grown in various countries in the late years. An important by-products of the SI oil processing is the shell of the kernels (SIS), which may reach 35% of the processed material. Taking into account that any sustainable processing of the SI seeds should provide socio-economic benefits to local communities, and contribute to promote compliance with the Sustainable Development Goals, and that the interest in phenolic compounds has increased, due to their multiple health benefits, in this work microwave-assisted extraction (MAE) was applied as sustainable technology approach to recover phenolic compounds with antioxidant activity from SIS. A Box-Behnken design was employed to investigate the effects of the microwave power (400, 600, and 800 W), extraction time (60, 180, and 300 s), and solvent pH (5, 7, and 9), on the extraction yield, total phenolic content (TPC), antioxidant capacity (evaluated by means of the FRAP, ABTS, and DPPH assays), and chemical composition of the extracts. The extraction yields varied from 0.58 to 23.6%, and were significantly higher than those obtained under unassisted extraction processes. TPC varied between 0.82 and 59.86 mg GAE/g, while the antioxidant capacity displayed values up to 524.38 μmol Trolox/g. The predominant compounds found in the extracts were trehalose, caffeyl alcohol, gluconic acid, (Z)-5,8,11-trihydroxyoctadec-9-enoic acid, ellagic acid, 3',4',5,7-tetrahydroxyflavone, catechol, azelaic acid, caffeate, daphnetin, and benzoic acid. These results indicate that SIS is a promissory source of compounds with antioxidant activity, and that MAE could be applied for valorizing the SIS and contribute to the sustainability of the SI agro-industrial chain.

Low pH-Assisted Extraction of Date Seeds for the Preparation of Bioactive-Rich Emulsions

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Abstract:

Date seeds, constituting 10-15% of the date palm, are a significant byproduct of the date palm industry, presenting economic and environmental challenges. This study aimed to evaluate whether low-pH extraction of date seeds could produce extracts rich in bioactive compounds with effective emulsion stabilization properties. An I-optimal design was used to assess the effects of extraction time (30-150 min), temperature (30-50°C), pH (1-6), and date seed concentration (5-25%) on maximizing bioactive content, measured as total polyphenol content (TPC), and minimizing emulsion droplet size, measured as the Sauter mean diameter (D[3,2]). All extraction parameters had significant effects ($p > 0.05$) on both the TPC and D[3,2]. The increased extraction time and temperature favored both TPC and D[3,2], and a higher DSP (%) resulted in lower TPC and smaller D[3,2]. pH reduction enhanced TPC, but pH below 4.3 increased D[3,2]. A higher date seed concentration (%) resulted in lower TPC and smaller D[3,2].

Models predicting TPC and D[3,2] based on these parameters were generated and validated at optimized conditions. The optimized extract, yielding the maximum TPC and minimum D[3,2], exhibited good stability under neutral to mildly acidic conditions (pH 5-7) but was sensitive to salt concentrations during a 21-day study period. The study illustrates the potential of date seeds to be valorized as an emulsion stabilizer. However, further exploration for droplet size reduction and enhanced stability against salt concentrations is recommended.

Development of Sodium-Caseinate Packaging Films: Upcycling the Casein from Expired Pasteurized Milk in A Circular Economy Approach

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Abstract:

The worldwide growing demand for milk and its derivatives has promoted a parallel increase of waste throughout the supply chain. Pasteurized milk is highly appreciated in many countries but its shelf life is very short. Unsold pasteurized milk that reaches the expiration date is considered to be no longer suitable for human consumption and is downgraded to waste. However, it still contains around 25 g/L of casein which can be destined to high-value applications. This study focuses on upcycling expired pasteurized milk into sodium caseinate (NaCas) as a raw material suitable for producing packaging films. Three experimental NaCas samples were produced from pasteurized milk with three different fat contents. Commercial NaCas served as a control. Glycerol was used as a plasticizer, and two low-frequency sonication techniques were applied to degas the film forming solutions. The study examined how the content of fat retained from milk (ranging from 0.7 to 25%) and the sonication mode (bath or probe) affected microstructural, mechanical, thermal, optical and gas-barrier properties of neat NaCas films. Microstructure of films was investigated by confocal and scanning electron microscopy. Thermal behavior was assessed using differential scanning calorimetry and dynamo-mechanical thermal analysis. A permeability tester was used to assess the oxygen and water vapour barrier properties of films. Results indicated that fat content plays a crucial role in defining film properties. The probe sonication significantly increased the number of fat structures and decreased their diameter from 1.2 up to 0.9 μm. In turn, fat structures characteristics affected the thermal, mechanical, optical, and barrier properties of the films. This study highlights the potential of NaCas-based films as eco-friendly packaging material, though water vapor barrier properties need further improvement to reduce the gap with conventional plastic films.

Exploring the Extraction and Optimization of Bioactive Compounds from *Carica papaya L.* by-products for Eco-Friendly Food and Packaging Solutions

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Abstract:

This research aims to characterize and optimize the extraction of bioactive compounds from papaya by-products through eco-friendly methodologies. Papaya boasts numerous health advantages owing to its nutritional content, medicinal attributes, and rich reserves of antioxidants and minerals. Despite its benefits, worldwide papaya production yields approximately 3 million tones of agricultural waste each year. In this work, an optimization study on ultrasound-assisted extraction (UAE) to isolate phenolic compounds from papaya stems and leaves, employing a multivariate approach has been carried out. Utilizing a four-variable Box-Behnken experimental design, it has been assessed the impact of extraction time, amplitude, mass, cycles, and volume on total phenolic content (TPC) and antioxidant

activity (2,2-Diphenyl-1-picrylhydrazyl assay (DPPH), ferric reducing antioxidant power assay (FRAP), cupric ion reducing antioxidant capacity test (CUPRAC) and 2,2-azino-bis-3-ethylbenzothiazoline-6-sulphonic acid test (ABTS)). Under optimized extraction conditions, interesting values of TPC for stem and leaves were obtained (565 ± 19 and 2350 ± 40 mg GA/ dry matter, respectively) with high antioxidant capacity as the DPPH (237 ± 15 and 930 ± 30 mg Trolox/DM); FRAP (440 ± 6 and 2290 ± 30 mg Trolox/DM); CUPRAC (788 ± 14 and 5150 ± 80 mg Trolox/DM); and ABTS (587 ± 15 and 3630 ± 130 mg Trolox/DM) showed. In addition, TAPPI and AOAC standards were performed on seeds, skin, pulp, stem and leaves underlying the potential of stems in α-cellulose content (31.5 ± 0.2%). The obtained results underscore the potential of these extracts to extend the shelf life of food products, thereby reducing food waste and fostering a circular economy.

Valorization of Mushroom Biomass for Protein Extraction

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Abstract:

The production of mushrooms has shown a growing trend in the last years, being the most widely produced genus the *Agaricus* and *Pleurotus* ones. According to the "Asociación Profesional de Productores de Sustratos y Hongos de La Rioja", only in La Rioja region (Spain), the managing costs associated with the residues (stalks and mushrooms discards) generated by this industry ascend to 200.000€ annually; thus there is a great interest in their valorization. Nevertheless, despite the potential of mushrooms as a source of dietary proteins, only a few works report[1,2] on the extraction of proteins or protein-polysaccharide complexes and, specifically, the extraction of proteins from mushroom residues has been scarcely studied. Therefore, this research aims to optimize their protein-extraction yields using an environmentally-friendly methodology and to characterize the whole biomass residues to estimate an integrated use of industrial interest. A compositional characterization of *Agaricus bisporus* and *Pleorotus ostreatus* residues (both discarded biomass and their stipes) was done, and stipes of both species were selected to optimize the protein extraction conditions. A 2-level full factorial design was carried out to study the effect of temperature (30-95ºC) and time (2-7 h) on the protein yield. Protein extracts obtained from discared biomass and their stipes were deepdly characterized not only in terms of chemical composition but also on their technological and tecno-functional properties. The optimal protein extraction conditions were established for both mushroom biomasses. The determination coefficient (R^2) for the models generated was high, advocating a good adjustment for the prediction values. The results showed that both temperature and pH significantly affected the yield. The protein extraction efficiency, the structural as well as the functional properties of the recovered protein, depended on the extraction process and the mushroom species. The protein extracted from discarded mushroom biomass could have potential future use in the food industry. The 2-level full factorial design method used to optimize the protein extraction allowed not only to increase the extraction yields but also to fine-tune the functional protein properties.

Valorization of Cassava Peels via Hydrothermal Liquefaction as a Potential Co-emulsifier

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Abstract:

Cassava tubers, the third primary global carbohydrate source, generate at least 20% of waste during processing, primarily peels. These peels contribute to environmental pollution due to underutilization. Our study aims to valorize cassava peels (CP) by exploring their potential as a cost-effective, sustainable plant-based co-emulsifier when combined with Quillaja saponin (QS), a commercially available plant-based emulsifier. We subjected CP to hydrothermal liquefaction (HTL) at 2 MPa, 140°C for 15 min and blended the liquefied CP with QS at various ratios (100:0, 75:25, 50:50, 25:75, 0:100) in the aqueous phase. The liquid-liquid interfacial tension of HTL-liquefied CP blended in the same aqueous matrix with a 75:25 ratio, the least amount of QS against soybean oil, led to a synergistic reduction of the interfacial tension ($\gamma o/w$ = 5 mN/m) when compared with pure water ($\gamma o/w$ = 25 mN/m), HTL-liquefied CP ($\gamma o/w$ = 13 mN/m), or QS-solution ($\gamma o/w$ = 7 mN/m) in the water matrix. CP displayed a surfactant-like structure owing to its amphiphilic structure and hydrophobic chains (non-polar region) attached to the -OH functional group (polar region). Combining a second surface-active compound or co-emulsifier results in an additive effect, reducing the interfacial tension ($\gamma o/w$). Our findings demonstrate that utilizing HTL-liquefied CP presents a promising solution for producing a sustainable, cost-effective, plant-based co-emulsifier. This innovative approach offers an alternative to synthetic emulsifiers and addresses the environmental pollution caused by cassava tuber production, promoting sustainability in the emulsifier industry. Further research is needed to optimize the HTL process, explore the application of this novel co-emulsifier in various sectors, and assess its environmental impact and economic viability on a larger scale.

Novel and Sustainable Food-Grade O/W Pickering Emulsions Valorizing Complexes of Bacterial Nanocellulose and Chitosan

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Abstract:

This study evaluated the potential of chitosan/bacterial nanocellulose (BNC) complexes (0.5% w/v) as novel emulsifiers to stabilize o/w Pickering emulsions with food applications. The emulsions were prepared with 20% v/v sunflower oil while the emulsifying capacity of chitosan, bacterial cellulose (BC), BNCs derived after acid-assisted hydrolysis (with H_2SO_4 and mixture of H_2SO_4-HCl), and different mixing ratios of chitosan/BNCs complexes (75:25, 50:50, 25:75) was investigated. Notably, emulsions produced with chitosan/BNC-treated with H_2SO_4 complexes exhibited exceptional emulsion stability index (ESI) (ESI up to 100% after 3 days of storage), while limited creaming and phase separation were observed during 7-day storage. Moreover, their droplet size (R_h~8.5-8.8 μm) and zeta potential values (ζ= 15.1-29.8 mV) did not exhibit remarkable fluctuations over time as detected from DLS/ELS studies whilst the absence of coalescence phenomena was verified through polarized light microscopy indicating stability. FTIR spectroscopy and rheological studies were also used to further characterize the produced emulsions. At a final step, selected emulsions were tested as protein carriers using renewable protein matrices that were extracted from sunflower meal via alkaline extraction followed by isoelectric precipitation. This research underscores the potential of chitosan/BC complexes as effective stabilizers for food-grade Pickering emulsions, offering a pathway for eco-friendly food products within the circular bioeconomy era.

Coupling *in vitro* Food Digestion Process to Caco-2 Cells Bioassays for a Lipid-Enriched Supercritical CO_2 Extract from Coffee Pulp

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Abstract:

Coupling *in vitro* gastrointestinal digestion (*i.e.*, INFOGEST method) with *in vitro* epithelial cells (*i.e.*, Caco-2 cells) is commonly used to mimic the digestion, absorption and bioactivity of food components [1]. The lipid-enriched food digesta obtained following the INFOGEST contains digestive enzymes, and bile salts at physiologically relevant concentrations, which can compromise the viability of Caco-2 cells [2]. Thus, developing a cytosafe protocol for preparing food digesta using *in vitro* digestion for subsequent Caco-2 studies is essential. In this study, the INFOGEST protocol was firstly performed by varying the pancreatin digestion load, based on lipase activity (500, 1000, 1500, and 2000 U/mL of digesta) and bile salt concentration (2.5 mM and 5 mM in digesta) without extracts. Subsequently, the cytotoxicity of the resulting digesta was studied in Caco-2 cells by diluting the digestion pool in 10% FBS complete DMEM medium from 1:3 to 1:69 ratio. Moreover, the Caco-2 cell viability of the coffee pulp supercritical CO_2 (sc-CO_2) extract digesta (1.2, 3.1, 6.2 and 20 mg /mL) at the obtained potentially safe lipase activity, bile salt concentration and dilution ratio were verified. The results showed that pancreatin and extract concentration might contribute to the cytotoxicity of the digesta in Caco-2 cells. The digesta obtained with 3.1 mg/mL sc-CO_2 extract at 1000 U/mL pancreatic lipase and 2.5 mM bile salts was recommended to be diluted at a ratio of 1: 14 with complete DMEM medium to ensure cytosafety (viability > 85%) in Caco-2 cells, while modifying such conditions diverse cytosafe dilutions were found. This study reinforces the evidence that *in vitro* digestion process must be customized for Caco-2 cell bioassays according to the extract digesta composition. These results might provide a potential framework for *in vitro* studies focused on the digestion, absorption and bioactivity of lipid-enriched foods using Caco-2 cells as a model.

Ultra-High-Temperature Effects on Whey Protein Isolate via Ohmic Heating

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Abstract:

Food proteins are recognized for their substantial nutritional and technological significance, offering immense potential within diverse biotechnological applications. Whey, a dairy co-product, stands out due to its versatility in adding functionality to various food products. The use of electric field processing and the resulting ohmic heating effect have revealed new structures and functionalities in whey protein over recent decades. However, there is a considerable knowledge gap regarding the impact of electric field processing on the functional aspects of these proteins when applied at the ultra-high-temperature range (UHT). The objective of this study is to systematically investigate the effects of ohmic heating at UHT on structural properties of whey protein isolate. Ohmic heating treatments were performed at temperatures up to 165 °C. This approach allowed understanding of structural changes through a multivariate analysis of parameters such as intrinsic fluorescence, surface hydrophobicity, secondary structures distribution, hydrolysis rate and fibrillar aggregates formation. Results highlight several structural assignments: i) hydrophobic patches were exposed between 90

and 120 ºC; ii) there was an observed increase in hydrolysis rate and the formation of coil structures between 130 and 165 ºC; and iii) fibrillar aggregates became apparent at 100 ºC. For the first time, structural transitions during ohmic heating at UHT were identified and correlated. This comprehensive mapping will help to enhance the functionality of whey protein ingredients by creating better structures and produce useful bioactive hydrolysates. This aids in understanding ohmic heating's impact on whey allergens, helping develop hypoallergenic foods.

Enzymatic Pretreatment for Enhanced Ohmic Heating Effect on *Nannochloropsis gaditana* Cells Disruption/Permeabilization

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Abstract:

Microalgae have proven to be a promising source in food industry in recent years, because of their high contents on proteins, lipids, carbohydrates, antioxidants, dyes, vitamins and minerals (Pedro Santos et al., 2021). Nevertheless, the extraction of biochemical compounds from microalgae is confronted with several challenges. The complex nature of microalgae cell walls often requires the implementation of energy-intensive disruption methods (Sierra et al., 2017). It is imperative to employ disruption techniques targeting microalgae cell walls, such as enzymatic pretreatment of biomass to promote the release of specific biomolecules. *Nannochloropsis gaditana* cell wall is composed by an internal cellulosic layer and an outer layer of hydrophobic algaenan (Roncaglia et al., 2021). In this study, an aqueous enzymatic extraction treatment was performed. Two lytic enzymes (pectinase and cellulase) and a cellulolytic enzyme complex (Viscozyme®) were tested for their ability to permeate *N. gaditana* cell walls. Next, an ohmic heating (OH) treatment was applied with a sinusoidal wave at 20 kHz. The integrity of treated cells was evaluated by flow cytometry and the intracellular organic matter release (IOMR) was quantified. After a 48-hour pretreatment with pectinase, cellulase, and Viscozyme®(40 $mg_{enzyme}.g_{dw}^{-1}$), an IOMR factor of 0.566±0.062, 0.726±0.073, and 0.842±0.058, respectively, was achieved. It was also demonstrated that the cellular integrity of 57.1±1.8%, 31.9±1.3%, and 36.8±0.9% of *Nannochloropsis* cells was compromised by the pretreatment with pectinase, cellulase, and Viscozyme®, respectively. The same pretreatments, when subjected to OH at a temperature of 60 ºC, did not appear to have a negative effect on cellular integrity, however OH increase by 28.9±2.1%, 32.4±6.8%, and 18.9±1.0% the IOMR factor, ascribed to an increase in the extraction yield.

Use of *Wickerhamomyces anomalus* BS91 Glucanases to Improve Stability of Anthocyanins in Free Sulfur Dioxide Frappato Wine

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Abstract:

The color of young red wine is extremely unstable both during fermentation and aging, due to the steady decline of monomeric anthocyanins 3-O-monoglucosides, even called free anthocyanins. The instability of anthocyanins determined the formation of anthocyanin-

derived new pigments and the progressive shift from the red-purple color, of young red wines, to the more red-orange color of aged red wines. Furthermore, a decrease in free anthocyanins is even associated with a decrease in the antioxidant capacity of wine and therefore in its healthy properties. In the present study we investigated the use of exo-glucanases, produced by the yeast *Wickerhamomyces anomalus* BS91, as potential tool for improving the stability of free anthocyanins in Frappato wine. Polyphenol amount, anthocyanin content, color and antioxidant activity of wine, treated with *W. anomalus* glucanases, were evaluated immediately after fermentation and up to six months of storage in comparison to untreated wine (control). Results evidenced as free anthocyanins, after 6 months of storage, were equal to 66.41±5.6 mg/L in wine treated with *W. anomalus* glucanases, while the control wine registered a value of 15.05±6.7 mg/L. Moreover, in comparison to the control, antioxidant activity and Folin Chocolateau Index of wine treated with *W. anomalus* glucanases was higher at all evaluated time points. The findings obtained suggest a protective effect of free anthocyanins, probably attributable to the release of glucans by the glucanases and therefore to an improvement of color, bioactive compounds and antioxidant activity of Frappato wine during its aging.

Wine with Alcohol or Low Alcohol? An Alternative to Produce A New Low Alcohol Wine that Resemble A Classic Wine: Preliminary Results

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Abstract:

In recent years, we have been witnessing an unexpected phenomenon regarding oenology. Global warming created two turning points for this sector: (i) planting grapes even in regions where they traditionally did not grow; (ii) a sugar content in grape so high to achieve significant alcohol levels, which often exceed 14% (v/v), which in turn caused: (a) the production of too much wine, unmanageable by the market; (b) the impossibility for the consumer to recognize the features of a product, because the high alcohol content changes its sensory features. Therefore, there is a demand for a product linked to the aim of regulating alcohol consumption by those consumers who do not regularly consume it or by those that do not consume it on some occasions: for example when driving, playing sports or during pregnancy. Due to the increase in these needs, European legislation well defined what alcohol-free wines are and how they can be produced (PAC 2023-2027). Dealcoholization techniques have high performance, but with a heavy impact on the composition of the wine, especially on the concentration of the fixed constituents and aromatic profile. Consumers, due to these changes, do not often recognize dealcoholized products as wines, increasing prejudice towards them. In the light of these considerations, this research was focused on the optimization of a new process to obtain a low-alcohol wine that tastes like a classic wine. The objective was to work on the must with enzymes in order to carry out the classic alcoholic fermentation, but with minimal efficiency. At operational level, the operating temperatures and above all the acidic composition of the must were the greatest challenges. The preliminary results demonstrated that the optimization of the deacidification, oxygenation and shaking processes allowed to obtain a wine with a low alcohol content with a strong acid print.

Flavonoid-Induced Activation of MAPK and PI3K/AKT/mTOR Pathways Enhances Fish Muscle Stem Cell Growth for Cultured Meat Innovation

Xiaojuan Xu*, Pei Xuan Lim, Rosalie Elvira, Benjamin Vinod, Woon Khiong Chan

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Abstract:

Cultured meat represents a cutting-edge technology revolutionizing meat production by cultivating meat cells in controlled laboratory environments rather than relying on traditional animal rearing practices. However, the inadequate preservation of stemness in muscle stem cells (MuSCs) cultivated *in vitro* diminishes their capacity for both cell expansion and myogenic differentiation, significantly constraining the scalability of cultured meat production. The advancement of cost-effective and food-safe components that effectively promote *in vitro* proliferation and maintain stemness of MuSCs is imperative for the industrial-scale production of cultured meat. Flavonoids, renowned for their diverse biological activities, their effects on fish MuSCs behaviors remain understudied. Herein, we investigated the effects of 20 flavonoids from various classes on the proliferation of Golden Tank Goby (GTG) MuSCs. The results indicated that different classes of flavonoids exhibited general proliferation effects on GTG MuSCs at lower concentrations (0-4.8 μM). Notably, kaempferol, chrysin, 6-hydroxyflavone, and silibinin demonstrated superior proliferation effects, with peak proliferation rates of 21%, 24%, 27%, and 23%, respectively. Several flavonoids, including isohamnetin, apigenin, luteolin, and genistein, presented cytotoxic effects on GTG MuSCs at higher concentration (9.6 μM), indicating a concentration-dependent response. Further mechanistic study revealed that flavonoids reduce cell cellular reactive oxygen species and upregulate the MAPK and PI3K/AKT/mTOR pathways, thereby enhancing cell proliferation. Additionally, qPCR and Western blot analyses demonstrated that flavonoids markedly upregulate PAX7 expression, suggesting their role in maintaining stemness. Overall, these findings underscore the untapped potential of flavonoids as valuable components in developing innovative strategies for cultured meat production, opening new avenues for sustainable and ethical meat manufacturing.

A Comprehensive Approach to Ensure the Food Safety and Quality of In-Shell Eggs

Daniela Bermudez-Aguirre[1]*, Joseph Sites[1], Joshua Carter[1,2], Brendan A. Niemira[1]

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Abstract:

The egg industry is one of the most important worldwide, with an estimated 87 million metric tons of annual production. However, foodborne outbreaks linked to the consumption of eggs have been widely reported in several countries, mainly because of *Salmonella* spp. inside the eggs. No regulations exist about the pasteurization of eggs before they reach the market, regardless of the country; only 3% of eggs are pasteurized in the USA in a lengthy and costly process. The USDA ARS has developed a comprehensive approach to pasteurizing in-shell eggs and providing consumers with safe and high-quality eggs. A radio frequency (RF) pasteurizer (40.68 MHz, 35 W) processes in-shell eggs placed on silicone rollers and holds them using 3D-printed nylon paddles with stainless steel electrodes. The internal temperature of eggs is monitored using fiber optic sensors inserted in the albumen and yolk. The energy from the RF source volumetrically heats the internal components of the egg for 4.5 min. Then, a hot water spray (HWS) process at 56.7°C for 20 min inactivates *S.* Typhimurium inside the eggs. A required pasteurization standard of 5–log reduction is achieved after 24.5 min. The quality of eggs is like that of raw eggs with similar quality attributes (Haugh unit, yolk index, pH, albumen turbidity, yolk color, eggshell strength, and mineral composition). A Cleaning-In-Place (CIP)

system was also tested in the RF – pasteurizer to ensure the safety of eggs if any breaks during processing. Combining an enzymatic treatment with peracetic acid (120 ppm, 1 min) could remove any egg residue and inactivate *Salmonella* cells in the main materials of the RF pasteurizer (silicone, nylon, and stainless steel). This comprehensive approach represents an affordable and environmentally friendly option for egg processors to reduce the incidence of pathogens in eggs and provide safe and high-quality products.

Effect of Concentration and Charge of Maltodextrin, and Packing Factor on the Electrospinning Processing Performance

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Presenter author 1*: *Juan de Dios Figueroa-Cárdenas. Centro de Investigación y de Estudios Avanzados Unidad Querétaro (Cinvestav-Unidad Querétaro). Mexico; 2Instituto Tecnológico de Veracruz. Mexico; 3.Instituto Politécnico Nacional. CICATA Unidad Querétaro. Mexico.*

Abstract:

The power law $\eta_{rel} \sim C^a$ of maltodextrins with higher entanglement concentrations (C_e) of dextrose equivalent (DE) 4, 10, and 18 exhibits an unusually high exponent *a,* ranging from 10.34 to 14.38 in congested solutions where particles occupy significant space. This contrasts with the dilute exponents (a~2) typically observed in polymer–solvent systems. **Methodology.** To address this issue, several viscosity factors such as volume fraction (ϕ), crowding (k) and packing ($1/k$) factors and cell type were evaluated using the Einstein–Roscoe and Mooney equations. **Results.** Those factors demonstrated viscosity dependence due to (ϕ) > 0.35, shape, crowding (k), packing ($1/k$~0.5) of centered cubic cell (CC) for larger chain sizes (>20 glucoses) in DE-4. Chain electrical charges significantly stiffen the chain and increase its length which seems to be responsible for the exponential increase in viscosity. In addition to concentration, electrospinning processing is influenced by strong particle-charge interactions, (ϕ), packing factor ($1/k$), cell type, and chain sizes. The Maxwell model demonstrated poor interaction for DE-4 (modulus ~286 Pa due to loosen packing of CC), in contrast to DE-18, which exhibited a modulus of 994 Pa for ϕ>0.5 and a congested solution of 52% w/v, packing factor of 0.68 and body-centered cubic cell, favoring electrospun fiber formation. **Discussion.** This information delineates two mechanisms: (1) particle–particle interactions and entanglement in dilute and semidilute systems, explained by the power law $\eta_{rel} \sim C^a$ and, (2) mechanism, with log–log slope from 2.0-3.5, attributed to entangled polymers, (ϕ), (k) and free volume occupied by particles into cell type, along with particle shape (exponent n) in the Einstein-Roscoe equation. **Conclusion.** The volume fraction, packing factor, and cell type, are highly sensitive and have potential applications for detecting adulterations in food systems, 3D-printing quality, bio-printing of living cells, 3D-scaffolds among many other scientific domains.

Mangosteen (*Garcinia mangostana* L.) Peels: A Novel Antibrowning Agent with Inhibition Effect of on Potato Polyphenol Oxidase

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Abstract:

Enzymatic browning, caused mainly by the enzyme polyphenol oxidase (PPO), strongly affects the quality of vegetables. Mangosteen (*Garcinia mangostana* L.) peel is a natural source of bioactive compounds with high antioxidant and anti-inflammatory properties. In the present study, water mangosteen peel extract was identified a novel and safe anti-browning agent,

which can prevent fresh-cut potatoes from browning. The effect of water mangosteen peel extract as potential inhibitor of polyphenol oxidase was studied. Different water extracts obtained at different conditions from the mangosteen peel were characterized and evaluated for the content of total polyphenols, total flavonoids, and antioxidant activity. Potato slices were dipped in different mangosteen peel extracts for different times (0, 5, 10 and 30 minutes). Browning of potato slices was monitored through color evaluation respect to a no treated potato slices. The water mangosteen extract evidenced the highest bioactive compounds content and was then applied as polyphenol oxidase (PPO) inhibitor both 'in vitro' and 'in vivo' on sliced potatoes. The results obtained not only provided a novel and safe anti-browning agent candidate to efficiently solve the browning issue for fresh-cut food products, but also preliminarily revealed its mechanism in browning inhibition. **Keywords:** fresh-cut potatoes, polyphenol oxidase, mangosteen extracts, anti-browning

Investigation of the Usability of Natural Deep Eutectic Solvents as Co-solvents for Supercritical CO_2 Extraction of Curcumin Using COSMO-RS

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Abstract:

Although supercritical CO_2 has high extraction power, a co-solvent is needed for higher efficiency. Generally used co-solvents are organic and fall short of fulfilling the requirements of being green solvents. Their sustainability, biodegradability, acceptable toxicity profiles, and high solvation power could make NaDESs a good potential co-solvent. In this study, the molar mixing ratios of NaDESs, solubility of CO_2 and curcumin in the examined NaDESs were investigated by COSMO-RS. We evaluated mixtures of choline chloride (CC) with sugar (fructose (Fru), sucrose (Suc), dextrose (Dex)), sugar alcohol (sorbitol (Sor), glycerol (Gly), xylitol (Xyl)), and carboxylic acid (glutamic acid (GA), lactic acid (LA), malic acid (MA), succinic acid (SA), tartaric acid (TA)) molecules. To increase the solubility of CO_2 and decrease the viscosity of NaDES, isothermic temperature was selected as 50°C. At this temperature, molar mixing ratio of CC:sugar and CC:sugar alcohol was approximately found to be 1:1, CC:GA and CC:LA 1:2, CC:MA 2:1, CC:SA 2:1, CC:TA 2:1. The highest curcumin solubility (mass fraction) (0.2445) predicted by COSMO-RS was obtained with CC-Gly (1:1), followed by CC-Sor (1:1) (0.1661) while the lowest solubility (0.0796) was obtained with CC-GA. CO_2 solubility in NaDES was investigated at conditions up to 200 bar at 50°C. For most solvents, solubility at conditions higher than 100 bar is given as high and not calculated. At 100 bar, the highest solubilities (mass fraction) were obtained with CC-Suc (2:1) (0.4946) and CC-Gly (1:1) (0.4808) while the lowest solubilities were obtained with CC-Suc (1:1) (0.2370). The results of the study show the high solubility of CO_2 in NaDES and that they can be used concomitantly in the extraction. Furthermore, since the high diversity of NaDES may cause a high load in experimental studies, it was shown that it is possible to decide which NaDES could be studied as co-solvent in supercritical extraction by utilizing COSMO-RS.

Heterogeneous Structures of Starch-Based Materials using NIR Post-Processing in 3D Food Printing

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Abstract:

The 3D printing technology gained significant interest in the food industry due to its potential to create highly defined and structured products with unique compositions. Therefore, in combination with the printing process and additional post-processing, the technology has the potential to elucidate the interplay of structure, texture, and sensory perception of complex foods, e.g., starch-base products. However, knowledge of the contribution of starch gelatinization to texture properties and, thus, its influence on sensory perception is essential for developing individual products. Therefore, it is necessary to change the degree of gelatinization by adjusting the process settings and keeping the water content at a certain level to investigate the individual contribution of starch to the texture properties. The question is whether it is possible to create distinguishable textures by changing the structure of the printed product. A promising technology for precise and fast heating during the post-processing of a 3D printing process is near-infrared radiation heating (NIR). Integrating the post-processing into the printing process by attaching the NIR heater to the print head makes it possible to heat the material after each layer. In the case of a mixture containing wheat starch and soy protein, it was possible to reach targeted degrees of gelatinization between 0-100% abs. and thus, changing the hardness significantly by a constant water content. In addition to that, it was possible to implement these changes within a sample size of 25x15x15 mm in two different texture profiles. These results show that by using 3D printing technology, it is possible to create defined textures. This knowledge can be used to elucidate the influence of heterogeneous and unique textures on the sensory perception of starch-based food.

From Waste to Taste: Characterization and Investigation of the Prebiotic Effect of Sunflower Meal Extract on Gut Microbiota Residents

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Abstract:

Sunflower meal, a by-product of sunflower oil production, contains various bioactive compounds that can be extracted to yield high-value fractions with significant market potential. Among these plant-based active compounds are polyphenols, which are regarded as novel prebiotics due to their biological activities, including anti-inflammatory, antimicrobial, and antioxidant properties, as well as their ability to modify gut microbiota. In order to utilize the potential of the sunflower meal, a three-stage extraction with 70% ethanol (v/v) was performed, and a polyphenolic extract yield of 17.0±0.75% was obtained. After that, a detailed characterization of the extract was carried out in terms of total sugars, polyphenols, flavonoids, flavonols, tannins and phenolic acids content determination, furthermore, the antioxidant properties were also tested. In addition to significant amounts of structurally different total polyphenols (125.0 mg GAE/g DM), the presence of phenolic acids prevails in the extract of which chlorogenic acid is dominant. The antioxidant capacity was quantified by different methods (DPPH, CUPRAC, ABTS and FRAP), and the obtained data lead to the conclusion that the sunflower meal extract represents a significant source of antioxidants. Taking into account that agri-food waste represents exceptional sources of valuable compounds, for potential application in the development of functional food, its prebiotic effect on individual gut members was also investigated. A wide range of concentrations of polyphenolic extract was tested on the growth of probiotic cultures *Lactobacillus plantarum*, *Lactobacillus rhamnosus* and *Saccharomyces boulardii* as well as pathogenic culture *Escherichia coli*. The obtained results indicate the exceptional ability of the extract in the manipulation of intestinal microbiota which is reflected through the proliferation of probiotic and suppression of the pathogen one. Overall, transforming

sunflower meal into a polyphenolic extract not only adds value to this agricultural by-product but also provides a natural source of antioxidants and prebiotics, which can be leveraged in the food industry to enhance health benefits of consumers.

Comparative Analysis of Cold Plasma Effects on Pearl and Finger Millet Starch: Role of Molecular Weight and Functional Differences

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Abstract:

Interest in alternative starch sources, such as millets, is increasing due to their diverse applications. However, native starches often fall short of desired qualities, necessitating modification for specific uses. This study investigated the effects of atmospheric cold plasma (CP) on pearl millet starch (PMS) and finger millet starch (FMS) at 170, 200, and 230V for 10, 20, and 30 minutes. Significant reductions in zeta potential, and pH were observed, alongside increased carbonyl and carboxyl groups due to oxidation at the C6 position, as confirmed by NMR. The modification improved paste clarity and stability by breaking down starch into smaller, soluble chains and hindering amylose reassociation owing to functional groups, which also enhanced whiteness (L* values). CP treatment caused surge in reducing sugar and decreased amylose without altering starch crystallinity much, indicating selective depolymerization in amorphous regions. Rheological analysis revealed improved gel strength owing to carbonyl-carbonyl interactions, though gels were weak and showed decreased frequency sweep and static shear with increased strain. Distinct differences between PMS and FMS were noted via XRD, FTIR, intrinsic viscosity, etc: PMS exhibited crosslinking at lower voltages and depolymerization at higher voltages, whereas FMS showed continuous depolymerization with some crosslinking at intermediate voltages, attributed to its higher molecular weight (5.3 × 107 versus 3.68 × 107 g/mol for PMS). The study hence concluded new interesting findings about the expected changed induced by cold plasma. Although the modification tool is regarded as a physical one, the incorporation of carbonyl and carboxyl functional group into the starch suggests that modification occurred at chemical level. Hence, cold plasma offers a sustainable approach for starch modification, enhancing functionality for various applications, however the exact changes induced would depend on many factors as molecular weight, sample weight, etc. discussed in the study with detailed mechanisms.

Crafting Guilt-Free Indulgence: Exploring Dietary Fibers as Fat Replacers in Low-Fat Ice Cream

Roberta Tolve[1*], Matteo Zanoni[1], Giovanna Ferrentino[2], Lucia Sportiello[1], Matteo Scampicchio[2], Fabio Favati[1]

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[2]Faculty of Agriculture, Environmental and Food Sciences, Free University of Bolzano-Bozen, Piazza Università 5, Bolzano, Italy.

Abstract:

Ice cream is a widely consumed dairy product, with Italy leading European production at over 80 million kilograms annually and a per capita consumption of 8 litres. Physically, ice cream is a complex colloidal system of fat droplets, air bubbles, ice crystals, and an aqueous phase. As consumers shift toward low-fat options, the challenge is maintaining texture, flavour, and structural stability. Fat significantly influences creaminess, flavour, and melt resistance,

making innovative fat replacers like plant fibres essential for low-fat ice cream production. This study evaluated the use of four dietary fibres—acacia, apple, oat, and inulin—as fat substitutes in vanilla-flavoured ice cream. By replacing 3% of fat with these fibres, the physical (pH, viscosity), thermal properties, and sensory characteristics were analyzed and compared to a 9% fat control. The results showed a significant increase in viscosity with the addition of fibres. Inulin performed comparably to the control in nearly all sensory attributes, evaluated using Quantitative Descriptive Analysis with 12 judges, confirming its suitability as a fat replacer. Acacia fibre improved thermodynamic stability, minimized melt rate, and reduced the cold sensation, making it a promising fat substitute, though its cost is currently high. Apple and oat fibres, however, reduced the crystallization and melting temperatures ($p < 0.05$), altered the vanilla flavour, and affected the ice cream's colour, limiting their use in light-coloured varieties. These findings suggest that inulin and acacia fibres offer the potential for producing high-quality, reduced-fat ice cream with minimal sensory compromise.

Nutrients and Antinutrients in Legume Seeds

Svend Dam[1]*, Juliana T. Martins[2], Jim Rasmussen[2], Linda Kærgaard Nielsen[3], Andrea Schiemann[4], Marcin Nadzieja[5], Stig U. Andersen[5], Anders L Kjeldbjerg[1]

[1] Business Academy Aarhus, Denmark, Department of Applied Sciences and Technology [2] Aarhus University, Department of Agroecology [3] Sejet Plant Breeding, Denmark [4] Nordic Seed, Denmark, [5] Aarhus University, Denmark, Department of Molecular Biology and Genetics.

Abstract:

In the Nordic European countries, dietary guidelines prioritize both human health and climate-friendly food choices. The official Danish guidelines advocate for reduced meat consumption and increased intake of plant-based foods, including a recommended daily portion of 100 grams of legumes. However, these guidelines overlook the potential impact of antinutrients. Our research focuses on quantifying both nutrients and antinutrients in locally grown legume seeds, but also include lupin and soy, which may see increased cultivation in Denmark in the future. We specifically examine total protein content using the Kjeldahl method and the ratio of different storage proteins using gel filtration and SDS PAGE. These parameters are crucial for the nutritional value and processing functionality of legume flour. We observe immense variation within (approximately 200 faba bean lines) and between legume species for protein content and the composition of storage proteins. Additionally, we analyze the levels of antinutrients, which can impede nutrient absorption when consuming legumes. The following step will be combining our laboratory data with the increasing genetic information from, for example faba bean, to identify markers important for the measured parameters. By providing insight into these factors, our research aims to support breeders in developing new legume cultivars tailored to the Danish climate, with enhanced nutrient profiles and improved functional properties.

Black Persimmon (*Diospyros digyna* Jacq.) Extracts: IL-1β induced Inflammation Mitigation & Barrier Function Preservation in Intestinal Epithelial Cells

Graziella Serio[1]*, Roberto Chiarelli[1], Fabiana Geraci[1], Giuseppe Mannino[2], Lorenza La Rosa[1], Cinzia Margherita Bertea [2], Carla Gentile[1]

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[2]Department of Life Sciences and System Biology, University of Turin, Via Quarello 15/A, 10135 Turin (Italy).

Abstract:

Diospyros digyna Jacq., a tropical fruit tree unfamiliar in Europe, is renowned for its soft, dark chocolate pulp and is commonly referred to as black persimmon or 'chocolate pudding fruit'. Previous investigations have revealed the abundance of bioactive compounds uniquely distributed across its various parts. These compounds demonstrate significant radical scavenging and metal-reducing activities, along with the capacity to counteract oxidative damage in cells (Mannino et al., 2022). To further our understanding of black persimmon's functional properties, our study explores the potential anti-inflammatory effects of extracts from the pulp, peel, and seed in a model of intestinal inflammation. The collected results demonstrate that black persimmon extracts significantly alleviate the inflammatory response induced by IL-1β in differentiated Caco-2 cell monolayers. Notably, the seed extract exhibited significant anti-inflammatory effects, highlighting the potential value of typically discarded fruit parts. Specifically, exposure of cells to the extracts prior to the proinflammatory stimulus reduces gene expression and protein levels of proinflammatory mediators, including cytokines such as IL-6, IL-8, IL-12, and INF-g, as well as enzymes such as COX-2 and iNOS. Moreover, black persimmon extracts preserve the barrier functions of epithelial cells, preventing ZO-1 redistribution and influencing the expression levels of MMPs affected by the proinflammatory stimulus. These protective actions are linked to reduced activation of NF-κB, as well as positive modulation of the Nrf2-dependent pathway, resulting in increased expression of genes associated with antioxidant response. These findings elucidate a clear correlation between the anti-inflammatory and antioxidant actions of bioactive compounds in black persimmon, suggesting its potential as a natural therapeutic agent in intestinal inflammatory disorders.

Exploring the Impact of Gastrointestinal Digestion on Phlorotannin Bioaccessibility and Antioxidant Capacity in Brown Algae-based Orally Consumed Products throughout the Life Cycle

Maria Salome Mariotti Celis

Finis Terrae University, Chile.

Abstract:

Assess the impact of aging and microstructure on the bioaccessibility of polyphenols, phlorotannin, and antioxidant capacity within different brown algae-based orally consumed products. Three brown algae-based orally consumed products —powder extract reconstituted in tap water at sub cytotoxic concentration (E40), micronized capsule (MC), and cooked salad (CS)—underwent *in vitro* digestion using the static models for adults and older adults of INFOGEST in order to evaluate the impact of aging and matrix microstructure on the bioaccessibility of polyphenols (TPC), phlorotannin (PhT), and antioxidant capacity (AOC) within these nutritional matrices. To achieve this, the TPC content (Folin assay), PhT content (DMBA assay), and antioxidant capacity (DPPH and ORAC assays) were measured before and after *in vitro* digestion.

Phenolic compounds present in the three brown algae-based oral vehicles exhibited high bioaccessibility. Both the phenolic contents (TPC and PhT) and antioxidant capacity (DPPH and ORAC) of these matrices, significantly increased after gastrointestinal digestion. This increase was greater (≥ 50%) for the adult gastrointestinal conditions compared to those of older adults, suggesting that the physiological changes that occur with aging could difficult the biological activity of these compounds. Interestingly, the extent of the increase in the phenolic compounds (TPC and PhT) and antioxidant capacity (measured by DPPH and ORAC) was highly dependent on the microstructure of the oral vehicles. TPC and PhT increased from 1.5-fold for cooked salad to 20-fold for powder extract, and from 1.2-fold for powder extract to 20-fold for cooked salad, respectively. As for antioxidant capacity (AOC), both DPPH and ORAC values also increased after gastrointestinal digestion, ranging from 4.6% for cooked

salad to 25-fold for powder extract, and from 3-fold for cooked salad to 29-fold for micronized capsule, respectively. This study offers valuable insights into the digestibility of various brown algae-based oral vehicles throughout the life cycle. While brown algae extracts may not have shown the highest bioaccessibility for all antioxidant properties responses, they seem to present a promising alternative for incorporation into commonly consumed healthy foods and beverages as a functional ingredient. Future research should prioritize evaluating the sensory acceptability of these algae-based products. Furthermore, it is crucial to conduct phenolic characterization of brown-algae extract and assess its stability after gastrointestinal digestion to draw definitive conclusions about its biological potential.

Crafting Guilt-Free Indulgence: Exploring Dietary Fibers as Fat Replacers in Low-Fat Ice Cream

Roberta Tolve[1*], Matteo Zanoni[1], Giovanna Ferrentino[2], Lucia Sportiello[1], Matteo Scampicchio[2], Fabio Favati[1]

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[2]Faculty of Agriculture, Environmental and Food Sciences, Free University of Bolzano-Bozen, Piazza Università 5, Bolzano, Italy.

Abstract:

Ice cream is a widely consumed dairy product, with Italy leading European production at over 80 million kilograms annually and a per capita consumption of 8 litres. Physically, ice cream is a complex colloidal system of fat droplets, air bubbles, ice crystals, and an aqueous phase. As consumers shift toward low-fat options, the challenge is maintaining texture, flavour, and structural stability. Fat significantly influences creaminess, flavour, and melt resistance, making innovative fat replacers like plant fibres essential for low-fat ice cream production. This study evaluated the use of four dietary fibres—acacia, apple, oat, and inulin—as fat substitutes in vanilla-flavoured ice cream. By replacing 3% of fat with these fibres, the physical (pH, viscosity), thermal properties, and sensory characteristics were analyzed and compared to a 9% fat control. The results showed a significant increase in viscosity with the addition of fibres. Inulin performed comparably to the control in nearly all sensory attributes, evaluated using Quantitative Descriptive Analysis with 12 judges, confirming its suitability as a fat replacer. Acacia fibre improved thermodynamic stability, minimized melt rate, and reduced the cold sensation, making it a promising fat substitute, though its cost is currently high. Apple and oat fibres, however, reduced the crystallization and melting temperatures ($p < 0.05$), altered the vanilla flavour, and affected the ice cream's colour, limiting their use in light-coloured varieties. These findings suggest that inulin and acacia fibres offer the potential for producing high-quality, reduced-fat ice cream with minimal sensory compromise.

Towards Sulphite-Free Winemaking: A New Horizon of Vinification and Maturation

Nicola Mercanti[1*], Monica Macaluso[1], Ylenia Pieracci[2], Giulio Scappaticci[1], Guido Flamini[2,3] Andrea Marianelli[1] and Angela Zinnai [1,3]

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Abstract:

The complex dynamics between oxygen exposure, sulphur dioxide (SO_2) utilization, and wine quality are of the utmost importance in wine sector, and this study aims to explore their fine

balance in winemaking. As a common additive, SO_2 works as an antiseptic and antioxidant. However, its excessive use has raised health concerns. Regulatory guidelines, including Council Regulation (EC) N◦ 1493/1999 and Commission Regulation (EC) No 1622/2000, dictate SO_2 concentrations in wines. The increasing demand for natural preservatives is driving the search for alternatives, with natural plant extracts, rich in phenolic compounds, emerging as promising substitutes. In this context, Bioma Company has proposed alternative additives deriving from vineyard waste to replace SO_2 during winemaking. Thus, the aim of the present work was to compare the compositional characteristics between the product obtained with the alternative vinification and the traditional one during the winemaking, as well as the aroma compositions of the final wines. After a year of experimentation, the wines produced with Bioma products showed compositional characteristics comparable to their traditional counterparts. Notably, these wines comply with current legislation, with significantly reduced total sulphur content, allowing their designation as "without added sulphites". Bioma products emerge as potential catalysts for sustainable and health-conscious winemaking practices, reshaping the landscape of the industry.

Nutritional and Functional Benefits of Chickpea Protein Hydrolysates

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Abstract:

Chickpeas are a versatile and nutritious food, essential in the Mediterranean diet since ancient civilizations. The chickpea seed is rich in vitamins, minerals, and is a source of carbohydrates (49.2%), proteins (19.3%), and dietary fiber (14.9%), with a low-fat content (6.3%). Additionally, as one of the world's most important legume crops, it generates numerous by-products. In this context, enzymatic protein hydrolysis presents a solution for the reutilization of broken, dehulled, or undersized seeds that are no longer optimal for human consumption, improving not only their technological properties but also their nutritional value and bioactivity. The existing literature has demonstrated that the development of chickpea protein hydrolysates hold potential as antioxidant and immunomodulatory food supplements. The evaluation of different chickpea protein hydrolysates at laboratory scale using food-grade enzymes allowed for identifying the best conditions for scaling up at pilot plant. The analysis of various parameters (yields, protein content, degree of hydrolysis, and antioxidant activity) enabled the selection of the best hydrolysate through principal component analysis. The selected hydrolysate (H30BIO) exhibited remarkable characteristics in terms of protein content (67.71%), production yields, solubility (> 80%), high digestibility (89.50%), and antioxidant activity. All these characteristics were maintained when the hydrolysate was scaled up to the pilot plant level. Given the high antioxidant capacity of H30BIO, its effect was studied in human monocyte cell cultures (THP-1). Reactive oxygen species (ROS) and nitric oxide (NO) levels, intracellular enzyme activity, and cytokine expression and release were evaluated. The main findings highlighted an increase in ROS and NO metabolism, in a concentration-dependent manner, coupled with significant anti-inflammatory effects through the NLRP3 inflammasome and NF-κB components. Notably, exposure to the hydrolysate exerted an inhibitory effect on mitochondrial superoxide dismutase and decreasing the expression of pro-inflammatory genes, except for TNF-α. Derived chickpea protein hydrolysates could be used for innovative foods applications, maintaining prevention of chronic disease related to oxidative and inflammatory processes.

Simulated Digestion and Gut Microbial Fermentation of *Cordyceps sinensis* Polysaccharides and Effects on Intestinal Barrier

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Abstract:

Cs-HK1 is a medicinal fungus species isolated from Chinese famous medicinal fungus *Cordyceps sinensis* and exopolysaccharides (EPS) are its major constituents with many special bioactivities and health benefits. This study aimed to investigate the prebiotic effect of EPS fractions with different molecular weights on the metabolic characteristics and subsequent impacts on intestinal barrier function. EPS fractions, EPS-HM (high molecular weight) and EPS-LM (low molecular weight) was extracted and precipitated with 40% and 80% (v/v) ethanol from Cs-HK1 mycelial culture. The results showed that the EPS fractions demonstrated high resistance to digestive enzymes and gastric acid in a simulated human gastrointestinal tract, but were highly fermentable during in vitro human fecal fermentation. Over 48 hours of fecal fermentation, EPS fractions were consumed as a carbon source, significantly degraded and utilized by the intestinal microbiota, resulting in notable increases in short-chain fatty acids (SCFAs) production. The consumption rate and production levels of SCFAs varied slightly among the different EPS fractions. The fermentation of EPS fractions promoted the increase of *Actinobacteria*, *Bacteroidetes* and *Faecalibacterium*. Additionally, the fecal fermentation products of the EPS fractions exhibited a potential protective effect on intestinal barrier function against inflammatory damage in a Caco-2/Raw264.7 co-culture model. These findings suggest the potential of EPS fractions to improve gut health through the modulation of gut microbiota.

Application of Computer Vision for Predicting the Formation Content of Acrylamide and 5-Hydroxymethylfurfural in Crackers

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Abstract:

Crackers are a widely consumed food due to their taste, long shelf life, and low cost. However, their thermal treatment induces chemical changes through the Maillard reaction and caramelization, facilitating the formation of potentially toxic compounds such as acrylamide (AA) and 5-hydroxymethylfurfural (5-HMF). However, these reactions can simultaneously promote the development of attractive sensory attributes. Traditional laboratory methods for detecting AA and 5-HMF in food include gas chromatography coupled with mass spectrometry (GC-MS) and liquid chromatography coupled with a diode array detector (HPLC-DAD), respectively. The objective of this study was to apply computer vision (CV) techniques to estimate the formation of AA and 5-HMF in crackers, based on digital image processing. The predictive models obtained by CV to estimate the contents of AA and 5-HMF in crackers were built based on the concentrations of these two neo-contaminants measured through traditional analytical methods. These predictive models underwent statistical evaluation through the mean error of estimation using the "leave-one-out" procedure, involving cross-validation with 25 treatments. AA and 5-HMF contents were determined in crackers baked under different temperature-time conditions: (i) temperature (160, 170, 180, 190, and 200 °C); (ii) time (15, 20, 25, 30, and 35 min). The generated models demonstrated a low estimation error (3.10% and 3.28% for AA and 5-HMF, respectively) and performed excellently when evaluated

through 'leave-one-out' cross-validation (98.09% for AA and 96.78% for 5-HMF). These results support the feasibility of employing CV techniques for a faster, more cost-effective, and non-destructive estimation of AA and 5-HMF content in crackers through digital image processing.

Primary and Secondary Shelf-life of Bread as a Function of Formulation and MAP Conditions: Focus on Physical-chemical and Sensory Markers

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Abstract:

Bread is one of the most widely consumed foods worldwide, and extending its shelf-life is a key concern for reducing waste, especially in light of the expected increase in the world population. This study aimed to assess how the bread formulation (flour, leavening agent) or storage conditions (modified atmosphere packaging (Air or Ar)) could influence its primary shelf-life (PSL) and secondary shelf-life (SSL), also determining possible physical, chemical and sensory markers. The results revealed that the choice of leavening agent had a significant effect on the PSL of bread, especially when combined with the gas used in the packaging. Compared to Air, Ar combined with sourdough slowed down weight loss and the staling process and allows bread to have a longer shelf-life, preserving its initial characteristics. The same synergistic effect was not observed for bread made with baker's yeast, suggesting the potential need of employing a different storage gas in the packaging. Indeed, for the SSL, the only effects detected are related to the leavening agents, where the sourdough exhibits a longer shelf-life compared to the baker's yeast. These findings lead us to conclude that easily and quickly measurable parameters such as weight loss and water activity decrease, together with sensory analysis, can be used as markers to assess the PSL and SSL of bread.

Modelling Dynamics of Proving and Baking Process

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Abstract:

The baking process involves intricate dynamics, encompassing gas generation and retention during proving, as well as the subsequent complexities of heat and mass transfer during baking in convection oven. Despite extensive research, still not yet completely understood, particularly when incorporating new ingredients. The objective of this study is to enhance our understanding of the baking process, particularly focusing on the dynamics of gas generation, retention during proving, and the complexities of heat and mass transfer during baking, especially when incorporating new ingredients. A mechanistic model of heat and mass transfer during the baking process was developed based on first principles and solved using COMSOL Multiphysics®6.1. This model was augmented with a kinetic model of gas generation, retention, and expansion during proving, incorporating the effects of ingredient incorporation and proving conditions. Validation against experimental data collected during proving and baking processes revealed good agreement between model predictions and experimental values. Further, the model developed was utilized to predict temperature distribution, moisture content, and changes in gas generation and retention, with the aim of controlling and optimizing the baking process.

Normal Force Rheology as a Novel Method for Food Characterization

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Abstract:

Complex fluids often exhibit normal stresses perpendicular to the shear, induced by shear deformation which has been studied extensively in polymer physics. However, it is often ignored in food systems. Despite conventional rheological measurements being widely used to investigate food hydrocolloids, normal force induced by shear is a completely new subject in food science. This could provide information about the nonlinear rheological properties of food materials. We know that the normal force response of foods contributes to the mouthfeel, therefore, understanding the normal response induced by shear in edible materials is a new factor, important for understanding the sensory perception better. In this talk, I introduce several examples that normal stress rheology can be used to characterize the nonlinear response of complex food systems from highly anisotropic soft solids (meat and fibrous meat analogs) to structured multiphase systems such as liquid foams, and emulsions. Shear-induced normal force rheology reveals differences in these highly anisotropic systems that can not be clearly observed based on the results of conventional shear rheology. This new characterization method could provide a deeper understanding of the structure-function relation in complex anisotropic food materials. Normal force induced by shear also provides valuable information about the onset of yielding and flow of foams and emulsions. For the meat samples, this approach shows that fiber orientation, fiber strength and fiber micro rearrangement govern the normal response. Understanding the normal force behavior is also essential to predict their die-swell after extrusion with diverse applications from food 3D printing to food processing.

Novel Tools for the Botanical Authentication of Ayurveda Herbal Products: *Bacopa monnieri* and *Centella asiatica* as Case Studies

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Abstract:

Ayurveda is a traditional medicine from India, whose philosophy is to live a healthy life, avoiding the appearance of imbalance and unnecessary pain. *Bacopa monnieri*, commonly known as bacopa and brahmi, and *Centella asiatica*, known as gotu kola, bua bok, and brahmi, are two important plant species used in Ayurvedic medicine. Both botanicals have several biological activities at the neurological level, being very popular in Asian countries, with increasing consumption in Europe and USA, as health tonics, teas, herbal supplements, and juices. Their growing interest can lead to adulteration practices that may undergo plant substitution or simply mislabelling since in India both species can be sold under the name brahmi. Therefore, this work intends to propose novel real-time PCR approaches for the botanical authentication of *B. monnieri* and *C. asiatica* in herbal products. Two sets of model mixtures containing 25-0.1% (w/w) of *B. monnieri* in *Ginkgo biloba* or *C. asiatica* in *Camellia sinensis* dry/grounded leaves were prepared for method development. Species-specific real-time PCR assays and targeting the genes encoding photosystem I assembly protein and the UDP-glucosyltransferase for *B. monnieri* and *C. asiatica*, respectively, were developed. Real-time PCR assays showed optimal performance parameters (PCR efficiency 102.6% and 101.2%, *B. monnieri* and *C. asiatica*, respectively), R^2 (0.999) and high sensitivity (1 pg of DNA). Afterwards, quantitative real-time PCR calibration curves were proposed using the model mixtures, showing

acceptable performance parameters for both species (PCR efficiency 91.3% and 90.7%; R^2 0.993) and limits of detection/quantification of 0.1% and 0.5%, for *B. monnieri* and *C. asiatica*, respectively. Both calibration models were validated with blind mixtures (20-0.2% and 20-0.3%), exhibiting acceptable parameters of trueness and precision. The applicability of the assays suggested adulterations by the reduction or full substitution of both species in several herbal products and plant food supplements. Herein, the first quantitative real-time PCR approaches to detect *B. monnieri* and *C. asiatica* were successfully developed and validated, proving to be useful tools for the botanical authentication of herbal products. **Funding:** Project POIROT (PTDC/SAU-PUB/3803/2021) and the strategic funding from FCT/MCTES (UIDB/50006/2020| UIDP/50006/2020).

Investigating Nitrosamine Formation in Meat: Effects of Cooking, Digestion, and Preservatives

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Abstract:

The carcinogenicity of nitrosamines and their presence in many food products, including meat, has been demonstrated in several scientific studies [1,2]. The objectives of this research were to develop a new method for the determination and quantification of 15 nitrosamines, evaluating both APCI and HESI ionization coupled with liquid chromatography and high-resolution mass spectrometry (HPLC-HQOMS). The developed method was then used to investigate the formation of nitrosamines in commercially available meat, as well as during the cooking and digestion processes. In this regard, four samples of meat treated with different preservatives (no preservatives, mixture of nitrates and nitrites, ascorbic acid, and ascorbic acid with nitrites) were analyzed. The samples were then processed in different ways (raw, cooked, cooked combined with spinach, and digested) to assess the real consumption situation in the daily diet and the further natural development during digestion. The analysis revealed that the formation of nitrosamines already occurs in raw meat. Both cooking and digestion alter the composition of nitrosamines present by degrading some and favoring the formation of others. Cooking has a more destructive effect on the total quantity of nitrosamines, reducing their concentration. Digestion, on the other hand, leads to an overall increase in nitrosamine concentrations if nitrites or nitrates are present. The combination of cooking and digestion has a synergistic effect, significantly increasing the quantity of nitrosamines present in the meat. Finally, when combined with spinach, they have an inhibitory effect on the formation, contrary to expectations, significantly reducing the total content.

Green Bean Coffee Controlled Fermentation in Guatemala

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Abstract:

Coffee cultivation plays an important role in the Guatemalan economy. There are around 125,000 producers, mostly micro-producers, and they represent 7.32% of the national exports (2019) and 24.62 % of all agricultural exports. Guatemala accounts for 2.72% of the world coffee market and ranks second in high-grade coffee production. The problem that producers face

is the lack of profit on this crop, due to several factors, like low international prices, diseases (coffee leaf rust), labor costs, labor shortages, and climate change. [1] During in farm wet processing, the fermentation step is carried out to eliminate mucilage still stuck to the beans [2]. Naturally occurring microorganisms drive the fermentation process, during which uncontrolled alcoholic, lactic fermentations, and oxidation occur, affecting the quality of the coffee. [3]. A controlled fermentation can improve beverage flavor by producing microbial metabolites, which are precursors of volatile compounds formed during roasting. In the international collaboration project between Rafael Landívar University (Guatemala) and Institut Químic de Sarrià, controlled fermentations using various microorganism starters have been developed with coffee beans from different plantations. Additionally, an analytical method using HS-SPME-GC-MS was developed to analyze the volatile composition of green coffee bean samples. A total of 66 samples, from different plantations and types of fermentations, were analyzed to answer the following question: Can the quality of coffee be correlated to its composition of volatile compounds? All samples were tested by a professional cupper giving an indication of the perceived quality of each sample. Various ANOVA tests revealed a statistically significant increase in cupping scores for samples that underwent the specific fermentation process. In addition, different volatile compounds were found as biomarkers that positively or negatively affect cupping score.

Development of Bioactive Edible Starch Films Incorporated with Lignin Extracted from the Ozonation of *Miscanthus giganteus*

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Abstract:

Nowadays, the food lost during transport and storage is considerable, highlighting the urgent need for better methods to enhance the safety and shelf life of perishable fruits and vegetables. Active food packaging which prevents oxidation and bacterial growth during transport and storage offers a promising solution. Natural biopolymers, such as edible films with bioactive properties can potentially be used as active packaging. This study explores the use of bioactive and hydrophilic lignin extracted from the ozonation of *Miscanthus giganteus* in starch-based edible films. The impact of lignin on mechanical, antioxidant, antimicrobial, and UV-blocking properties of these starch films was examined. Starch-lignin films were prepared with varying lignin concentrations (0%, 5%, 10%, and 20%) using the casting method. Increasing the lignin content from 0% to 10% decreased the Young's modulus of the films, although a 20% lignin content led to an increase. The addition of lignin enhanced the elasticity of the films, with elongation rising from 35% to 166% as lignin content increased from 0% to 10%, but this elasticity diminished at 20% lignin. The phenolic structure of lignin improved the contact angle of the films from 50% to 110% for lignin contents of 0% to 10%. X-ray diffraction analysis revealed a reduction in the crystallinity of lignin-containing films. Lignin addition did not significantly affect the water vapor permeability of the starch films, but it reduced their internal transmittance. All starch-lignin films exhibited UV-blocking properties. The β-carotene antioxidant assay demonstrated a significant enhancement in the antioxidant capacity of the films, increasing from 0% to 93% with lignin content from 0% to 20%. Moreover, all the films containing lignin demonstrated bactericidal activity (99.9% viability reduction) against *Escherichia coli* and *Staphylococcus aureus*. These starch-lignin edible biofilms show great potential as environmentally friendly materials for active food packaging applications.

Metagenomics of Goat Coalho Cheese using the Autochthonous Cultures *Limosillactobacilus mucosae* and *Lactiplantibacillus plantarum*

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Abstract:

Artisan goat cheese made from raw milk requires strict processing and quality control since there is a risk of microbial contamination. In this study, potentially probiotic autochthonous cultures (*Lactiplantibacillus plantarum CNPC003*; *Limosilactobacillus mucosae CNPC007*), were added in the preparation of raw goat cheese, aiming to make the product safer from a microbiological point of view. Four treatments were prepared, using not only raw but pasteurized milk, with and without the addition of autochthonous cultures and left to mature for 60 days. The changes were monitored through microbiological and metataxonomic analysis (at 1 and 60 days of maturation) by sequencing the 16S rRNA gene. Cheese obtained from pasteurized milk was processed in parallel to be used as a control sample. The raw cheese without maturation showed diversity of bacterial genera, contrasting with the others. However, the addition of cultures to the cheese (raw and pasteurized) showed similar bacterial profiles, with *Streptococcus* genus predominating. In those that underwent pasteurization, the predominant genera were *Bacillus* and *Enhydrobacter*. By comparing beta diversity analyses, *Lactococcus, Aerococcus* and *Pseudomonas* predominated in matured raw cheese. Mature samples of raw and pasteurized cheese were similar, denoting the effect of maturation on microbial ecology. There was abundance of *Leuconostoc* in the cheese produced with *L. mucosae* as an adjuvant culture, considering the cheese with *L. plantarum* as an adjuvant culture there was abundance of *Lactobacillus* (raw milk), and Streptococcus (pasteurized milk). Addition of *L. plantarum* and *L. mucosae,* in the matured raw cheese, indicated modulation in the microbiota, resembling the pasteurized cheese, demonstrating an important technological role and offering an alternative of quality guarantee for small producers, which strengthens the "Selo Arte" (a seal from Brazil, for certification of artisanal cheese producers).

Development of Low-cost Gluten-free Bread from Raw Rice: Comparing the Cost of Gluten-free and Traditional Bread

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Abstract:

The development of gluten-free breads is challenging in the food industry due to the unique structural and sensory properties that gluten imparts. Gluten-free breads available on the market are expensive compared to traditional breads. This study aimed to develop a low-cost, gluten-free loaf bread using raw rice as a base in the formulation and to compare the cost with traditional bread. Six loaf recipes with different bases were tested: three with raw rice, one

with a mix of gluten-free flours, and two with raw rice and a mix of gluten-free flours (rice flour, potato starch, sweet tapioca/cassava starch, and xanthan gum). The cost of the ingredients for the six recipes was calculated and compared to the same recipe with wheat flour. Data were analyzed descriptively, and the cost was presented in Brazilian real (R$). The study was approved by the Brazilian ethics committee (6.306.990). The preparations varied in cost from R$6.92 to R$10.52. The recipes using exclusively raw rice had the following costs: R$7.39, R$6.92, and R$10.52. The recipe based on a gluten-free flour mix cost R$7.49. The recipes combining raw rice and a gluten-free flour mix cost R$7.90 and R$8.80. The recipe with the larger quantity of raw rice (350g) received the highest research team evaluations in all sensory criteria and purchase intention (>80%), with a production cost of R$10.52. When comparing these costs to a gluten-containing loaf bread, which is R$9.65, it can be seen that most gluten-free recipes are economically competitive. The higher cost of the successful recipe reflects the additional challenges in developing high-quality gluten-free alternatives. However, the successful receipt achieved the sensorial objective and showed a similar cost to traditional loaf bread.

Effect of pH in the Efficiency of Phenolic Antioxidants in Trapping Methylglyoxal

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Abstract:

Methylglyoxal (MGO) is a highly reactive α-dicarbonyl compound that may adversely impact food quality and human health by modifying proteins [1]. The efficiency of trapping of MGO by pyrogallol, gallic acid, ethyl and propyl gallate esters has been evaluated in the pH 6.5 – 8.0 range and at physiological temperature (37 °C). It was observed that pH affects the trapping efficiency of all compounds that were studied. Specifically, as the pH increases, from acidic to alkaline, the trapping efficiency is enhanced. Gallic acid and pyrogallol displayed similar trapping efficiency in the pH 6.5 – 8.0 range, reaching 70% and 87% MGO trapping at pH 7.4 and 8.0, respectively, within 5 h of reaction. Gallic acid esters demonstrated decreased trapping efficiency compared to pyrogallol and gallic acid, which was attributed to unstable coordination structures and steric hindrance. To identify the products of the reaction between MGO and pyrogallol, LC-MS was employed. Both the mono-MGO and di-MGO adducts of pyrogallol were detected as products of the reactions at all pH values. The formation of the di-MGO product is rapid at alkaline pH, since the deprotonation of the hydroxyl group of C1 of pyrogallol is faster compared to neutral and acidic pH, leading to the formation of the mono-MGO adduct that further reacts with MGO to form the di-MGO product. Finally, the reaction mechanism and the two pathways for the formation of the doubly conjugated di-MGO pyrogallol adducts were proposed.

Co-Assembled, Physically Cross-Linked Nanogels of Tannic Acid and Biocompatible Double Hydrophilic Random Copolymers Encapsulating Ovalbumin

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Abstract:

This study aimed to evaluate the efficacy of co-assembled physical cross-linked nanogels involving tannic acid (TA) and a P(DMAEMA-co-OEGMA) random copolymer for ovalbumin (OVA) encapsulation. The assemblies were prepared at different TA molar ratios (10% w/v and 20% w/v) in respect to amino groups of the copolymer. The formulations exhibited nano-gel

like aggregates, with 10% w/v TA yielding populations of 11 and 109 nm, while 20% w/v TA led to a single population of 75 nm size. Moreover, they displayed stability under various conditions, resilience to changes in ionic strength, but also disassembly phenomena at basic media. Subsequently, since the non-covalent cross-linking enhanced the co-assembly and stability over time, the produced nano-gels were utilized for ovalbumin loading through electrostatic interactions. Upon complexation of ovalbumin solution (0.1% w/v) into the polymer solution at 10% w/v and 20% w/v mass relative to the nanocarriers, all nanogels exhibited strong positive charges (~30 mV). Remarkably, nano-gels formed with 20% w/v TA and 10% w/v ovalbumin demonstrated size homogeneity (PDI=0.141) and sustained stability over a 20-days period. Insights into the secondary and tertiary structure of complexed ovalbumin molecules were obtained through fluorescence, UV–Vis, and ATR-FTIR spectroscopies, indicating no protein disordering. These findings underscore the potential of physical cross-linking as a viable strategy for effective ovalbumin encapsulation, with significant implications for food chemistry and technology applications.

Design and Development of an Acoustic Mist Bioreactor for the Cultivation of *Amaranthus* Hairy Roots

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Abstract:

Due to increasing consumer awareness, there is a growing demand for health foods by replacing synthetic colourants with natural counterparts. Amaranth is a sustainable rich source of one such natural colourant, namely, betalains. The cultivation of Amaranth hairy root culture in bioreactors will significantly reduce the load on natural resources such as water and land. However, the main problem with conventional bioreactor design is the limitation of oxygen mass transfer and high shear leading to poor growth and metabolic production. Hence, there is an unmet need for improved design of bioreactor. In the present study, an acoustic mist bioreactor is designed for the cultivation of hairy roots for the production of betalains. Hairy roots facilitate the direct extraction of secondary metabolites without the need to grow entire plants. Bioreactors can be utilised not only for the production but also for the extraction of high-value metabolites. The proof of concept of feasibility of cultivation of Amaranth hairy roots in an acoustic mist bioreactor is established. Natural deep eutectic solvents (NADES) are employed for the first time for the extraction of betalains from the hairy roots. Preliminary results are very encouraging for the cultivation of Amaranth hairy roots in an acoustic mist bioreactor followed by extraction. Optimisation of process parameters and scaling up the acoustic mist bioreactor cum extractor.

Extraction and Purification of R- Phycoerythrin from Macroalgae

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Abstract:

Macroalgae have been gaining importance as a valuable source of bioactive compounds, such as polysaccharides, polyphenols, and phycobiliproteins. Phycoerythrin (PE) is one of the phycobiliproteins present in macroalgae and received scant attention for its extraction and purification. Macroalgae have several advantages such as a diverse array of species along with high nutritional value, with the potential for sustainable cultivation in the mariculture systems. Further, macroalgae can be harvested from their natural habitat or cultivated in the shallow waters of the sea making them less prone to contamination. Freshly harvested wet biomass of macroalgae is highly perishable and drying helps in the extension of its shelf life. However, conventional wisdom indicates that mass transfer resistance being high, extraction of biomolecules from dry biomass is difficult. These mass transfer challenges of R-PE extraction from dry macroalgal biomass are overcome by different pretreatment methods employed. Accordingly, this study focuses on the extraction and purification of R-phycoerythrin (R-PE) from dry biomass of marine macroalgae *Gracilaria corticata.* Further, different primary extraction methods such as conventional (maceration, freezing, and thawing), mechanical (homogenization), and ultrasound-assisted extraction are carried out to develop the most suitable methodology for the primary extraction of R-PE. The Box-Behnken Design (BBD) is used to optimize the extraction process parameters. Aqueous two-phase extraction (ATPE) is employed for the purification and concentration of R-PE. To enhance the productivity of ATPE, microfluidics is employed. UV-visible spectrophotometry and HPLC analysis are carried out to estimate the R-PE content to confirm structural intactness even after processing, respectively.

Up-Cycling Food Waste for Bio-Based Functional Coatings in Food Packaging

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Abstract:

Every year, millions of tons of food waste are disposed of in the environment through illegal dumping or landfill sites, causing environmental damage. Recently, there has been a debate on how best to exploit agro-industrial waste for value-added products and up-cycling for environmental sustainable and circular bioeconomy. A solution would seem to be to use agro-industrial waste for the production of biomaterials into food packaging in promoting shelf life and food safety. In addition, the use of food waste for biomaterials is of great interest due to environmental concerns related to petroleum-based plastics. A huge amount of skins and peels from agricultural processes, including the coffee silver skin (CS) from the coffee roasting process as well as almonds, pine nuts and other nuts skins, have been identified as potential agrifood by-products suitable for creating value-added products. An added value of these skins is high lignocellulosic content that shows exciting potential for the production of biomaterials. In this work, a novel route for the up-cycling of these skins based on a sustainable mechano-chemical process has been developed used to realize thin bio-coatings deposited onto flexible polylactic acid films. The results show that skin-based coatings exhibit homogeneous morphology, excellent adhesion on polylactic acid substrates and good flexibility. Besides, the coatings display UV blocking properties, reducing the UV transmittance of polylactic acid and a significant improvement of the oxygen permeability. With these results, it is being considered to use this biofilm as food preservation and to try to up-cycle dried fruit waste, including pistachio, hazelnut, pine nut and almond skins.

Comparative effects of High-Pressure Processing on Colour, Anthocyanins, Phenolics, Vitamin C, and Browning Index of Raspberry Juice

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Abstract:

In this study, the impact of High-Pressure Processing (HPP) on quality attributes of raspberry juice was investigated. Freshly extracted raspberry juice was treated at different HPP conditions (400, 500, and 600 MPa, 2 and 6 min), with subsequent analysis for colour changes (ΔE*), anthocyanin content, total phenolic compounds concentration, vitamin C retention, and Browning index (BI). Results indicated noticeable colour changes (ΔE*: 1.5–3.0) after 6-minute-HPP treatments, whereas the 2-minute treatments yielded slightly noticeable changes (ΔE* < 1.5). Thermal treatment (75°C, 1 min) induced more pronounced colour changes (ΔE* = 4.08). Post-treatment, total phenolic compounds, and anthocyanin concentrations, compared with control, increased in HPP-processed samples, contrasting the decrease observed with thermal treatment. Particularly, HPP at 600 MPa led to a significant increase in these phytochemical compounds. BI remained stable in HPP-treated samples, whereas a substantial increase (> 22%) was observed in the thermally treated samples. Correlation analysis revealed a strong relationship between colour parameters (L*, a*, and b*) and vitamin C content. However, total phenolic compounds did not exhibit significant correlations with colour or vitamin C content. These findings offer important insights for optimising HPP processing techniques to preserve the quality and health benefits of raspberry juice and products.

Improvement of the Protein Quality of Hemp Press Cakes by Fermentation for Use in Plant-based Meat Alternatives

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Abstract:

Hemp press cakes (HPCs) are byproducts of the hemp oil production process. While HPCs are almost fully devoid of their initial fat content, they contain significant amounts of protein and fiber, which makes them an attractive protein source for plant-based meat alternatives. Previous research has primarily focused on producing protein concentrates and isolates, however the direct utilization of HPCs without previous extraction remains underexplored. A known limitation of plant materials as a protein source is their reduced digestibility and the presence of antinutritional factors. Therefore, it is crucial to develop efficient methods to enhance the protein quality of HPCs before their incorporation in meat alternatives. The study aims to determine the effect of lactic acid fermentation on the protein fraction of HPCs. Organic HPCs obtained through purification, pasteurization and cold pressing were separated into two fractions using a 500 µm sieve. The coarser fraction was subjected to fermentation applying a commercial lyophilized starter culture at 40 °C. The fermentation process was conducted with three final pH points (4.8, 5.2 and 6.5), and with or without a preceding autoclave sterilization step. The fermented HPCs were analyzed for protein oxidation using DNPH method, protein bond analysis, and phytic acid content determination. Fermentation influenced the protein bonds in HPCs by disrupting disulfide bonds and hydrophobic interactions, thereby enhancing

the significance of hydrogen bonds. While fermentation did not reduce the phytic acid content, it tended to lower the levels of protein oxidation products. These findings suggest that fermentation may improve the quality of HPCs and therefore be a sustainable part of meat alternatives production. Future research will focus on the impact of extrusion as an additional method to enhance protein quality and structure, and on the combined effects of fermentation and extrusion to develop an intermediate product for meat alternative applications.

Selection of Potential Cellulolytic Filamentous Fungal Strains for the Effective Degradation of Sugar Beet Processing By-products Lignocelluloses

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Abstract:

Due to growing concerns regarding the global food supply, second-generation bioethanol from lignocellulosic non-edible biomass is becoming increasingly attractive. One such agro-industrial by-product is spent sugar beet pulp (SBP) obtained in the sugar-processing industry after sucrose extraction, which represents a very attractive raw material for bioethanol. This research aims to develop a cost-effective process model of bioethanol production from SBP by direct application of extracellular enzyme activities produced by different fungi for the degradation of long-chain carbohydrates. Ten fungal species initially were tested for the carboxymethylcellulose (CMC) degrading activity. Four most active strains (*Aspergillus niger* CCF 3264, *Penicillium oxalicum* CCF 3438, *Fusarium solani* CCF 2967 and *Botrytis cinerea* CCF 2361) were characterized as effectively producing reducing sugars (25.13 - 21.06 g/100 g d.w.) and cellulase activity (7.35 – 3.17 U/g d.w.) during 120 h fermentation of SBP at a substrate-to-water (s/w) ratio of 1:15 and temperature of 25°C. Optimization of the RS and cellulase activity production through the semi-solid process conditions was evaluated under different s/w, incubation temperatures (20–30℃), and time (120–144 h). Data evaluation showed that the highest RS concentration (39.15 g/100 g d.w.) and cellulolytic activity (6.67 U/g d.w.) could be achieved by using *A. niger* CCF 3264 for the degradation of SBP at 26 ℃ temperature with 136 h of processing time and 1:15 solid/water ratio. The results obtained suggest that SBP could be a potential low-cost and abundant substrate for the production of the holocellulose degrading enzymes producing simple sugars for further applications.

Proteomic Insights into Stress Responses and Adhesion Markers of *Lactobacillus reuteri* DPC16

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Abstract:

This study explores the proteomic changes in *Lactobacillus reuteri* DPC16 when co-encapsulated with *Cyclocarya paliurus* (CP) leaf extracts and subjected to simulated gastrointestinal (GI) tract conditions. Novel formulated microcapsules containing *L. reuteri* DPC16 and CP leaf extracts were exposed to sequential simulated GI environments (gastric, duodenum, and ileum), with pH adjustments and digestive enzymes. Surface proteins of *L. reuteri* DPC16 were extracted at each stage, separated by SDS-PAGE, and analyzed via LC-ESI-MS/MS to identify and quantify the differential expression of proteins. Over 200 differentially expressed proteins were identified, highlighting the upregulation of stress-responsive proteins like heat shock proteins and cell wall synthesis enzymes. These proteins and those involved in metabolic pathways contribute to the probiotic's stability and activity under GI conditions. The presence

of CP extracts not only enhanced resistance to oxidative stress but also influenced protein expression to improve probiotic efficacy. Notably, proteins related to mucosal adhesion, such as mucus-binding and moonlighting-binding proteins, showed increased expression, suggesting an enhanced capability of *L. reuteri* DPC16 to colonize the gut. The integration of proteomics has provided a comprehensive view of the molecular dynamics of *L. reuteri* DPC16 into its adaptive mechanisms and functional potentials in varying environments. Therefore, these findings revealed the exploration and utilization of protein markers to substantiate the health-promoting properties of *L. reuteri* DPC16, which is essential for its application in functional foods and therapeutic supplements.

Pear Residue as a Functional Additive in Wheat Cookies

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Abstract:

Pear pomace, a significant byproduct generated during juice production and constituting as much as 40% of the pear's total mass, holds promise for advancing sustainability within the fruit industry and enhancing the nutritional composition of functional foods like cookies. This study was designed to evaluate the physical, chemical, and sensory characteristics of cookies incorporating 5-25% pear pomace powder as a partial substitute for wheat flour. The investigation encompassed analyses of basic chemical composition, including protein, ash, fat, soluble and insoluble fiber, and available carbohydrates. Furthermore, assessments were conducted on total phenolic compounds and antiradical activity against DPPH and ABTS radicals. Alongside these evaluations, the study also scrutinized the color attributes, texture (measured by cutting force), and sensory perceptions using a 9-point hedonic scale. Integrating pear pomace into wheat cookies significantly enriched their dietary fiber and ash content, while concurrently reducing levels of protein and available carbohydrates. Moreover, the incorporation of higher concentrations of pomace was found to correlate positively with increased levels of total phenolic compounds and enhanced antioxidant properties. The cookies containing added pomace exhibited distinct changes in color, manifesting darker and redder tones with diminished yellowness, coupled with softer textures as the proportion of pomace rose. In terms of sensory analysis, cookies formulated with 10% pear pomace powder demonstrated superior overall acceptability compared to those devoid of additives. However, perceptual attributes such as smell, taste, color, and texture showed minor declines only at the highest levels of pomace inclusion. These findings underscore the potential of pear pomace as a functional ingredient in enhancing both the nutritional value and sensory appeal of baked goods.

Innovative Hydrogel and Cryogel Applications of Pectin from Non-Conventional Sources: Grape Pomace, Sugar Beet Flakes, and *Malus domestica* 'Fălticeni' Pomace

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Abstract:

Recent advances in pectin research have led to a broader range of its applications. In recent years, there has been growing interest in the gelling properties of pectin, with numerous studies exploring its use in hydrogel preparation. Hydrogels are three-dimensional, hydrophilic polymer networks that can absorb and retain water. Depending on the preparation method and drying process, various gel types can be produced from pectin, such as cryogels (formed

through lyophilization or supercritical drying of hydrogels), aerogels (created by substituting the liquid in hydrogels with air), and xerogels (hydrogels oven- or air-dried). This study aimed to investigate the applications for hydrogel and cryogel preparation of pectin from three non-conventional sources, namely grape pomace of Rară Neagră variety, sugar beet flakes, and *Malus domestica* 'Fălticeni' pomace. Solutions containing 6% pectin were used to prepare hydrogels and cryogels, and these solutions were initially characterized by their rheological properties. The hydrogels and cryogels were tested to determine the porosity, specific pore volume, color, textural parameters (hardness, adhesiveness, springiness, stickiness, cohesiveness, chewiness and gumminess) and swelling behavior. Furthermore, the thermal behavior of the hydrogels and cryogels was analyzed by thermogravimetric analysis. Cryogels obtained using pectin extracted from grape pomace of Rară Neagră variety, sugar beet flakes, and *Malus domestica* 'Fălticeni' pomace demonstrated enhanced physicochemical properties, including improved texture and thermal stability, and therefore were considered suitable for applications in confectionery fillings or other food components that require structural integrity after production.

Isolation and Characterization of Stable Fish Cell Lines for Scalable Production of Cultured Fish Meat

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Abstract:

Isolated fish cell lines form the cornerstone for the development of cultured fish meat, offering a sustainable alternative to traditional aquaculture and wild harvesting. These cells, typically derived from muscle progenitors or stem cells, are cultured *in vitro* to produce the biomass necessary for creating fish fillets and other seafood products. A thorough understanding and optimization of the growth conditions for fish cell lines are critical for achieving scalability in cultured meat production. The successful isolation and cultivation of these cells are pivotal in enabling large-scale production, making cultured fish meat a commercially viable product. In this study, we successfully isolated six fish cell lines from both freshwater and saltwater species: red snapper, Asian seabass, Japanese eel, golden tank goby, hybrid grouper, and threadfin. These cell lines demonstrated stable morphology and were continuously passaged over 60 times without any significant changes. Pax 7 staining confirmed that all six cell lines maintained their stemness throughout serial passages. Furthermore, a comparative analysis of gene expression profiles between early and later passages using RNA sequencing revealed no significant differences, indicating the genetic stability of the cell lines over extended culture periods. This stability, combined with the ability to maintain stemness and differentiate under controlled conditions, underscores the potential of these cell lines for the large-scale production of cultured fish meat.

Microencapsulation of Vitamin D by Using Proteins as Wall Material: Quality Evaluation

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Abstract:

Vitamin D plays crucial roles in the body, and its deficiency can cause softening and demineralization of bones. Nevertheless, there is strong evidence of vitamin D deficiency globally, which can be met through fortification and/or supplementation of food. Vitamin D is also highly sensitive to light, oxygen, high temperature or low pH. Besides, photosensitivity of this vitamin

may result in flavor development in fortified foods. In this context, microencapsulation appears as a potentially successful strategy to protect sensitive biomaterials in hostile conditions and/or matrices. Thus, this study aimed the evaluation of different wall materials (maltodextrin-chitosan (MDCH), pea protein (PP) and caseinate with transglutaminase (TGASA)) to microencapsulate vitamin D. For that, commercial vitamin D was firstly dissolved in olive oil and emulsified with different wall materials dissolutions by using ultrasounds to homogenize. The obtained emulsions were finally spray-dried to get the powder of microcapsules, which were analysed by means of yield, moisture, water activity, instrumental color, efficiency and morphology. In general, PP and TGASA microcapsules showed most suitable quality characteristics in comparison to MDCH ones, especially efficiency (68.1, 81.9% and 82.9% in MDCH, PP and TGASA, respectively). Although, the use of MD as wall material has been extensively explored to microencapsulate different bioactive compounds, this study demonstrated the possibility of using other different material, such as vegetal or animal proteins in combinations with enzymes, to get improved quality characteristic microcapsules.

High Hydrostatic Pressure (HHP) Assisted Protein Extraction and Technofunctional Modification of Brewer's Spent Grain (BSG) Protein Rich Isolates

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Abstract:

Future food security depends on developing sustainable proteins from alternative sources. Brewer's spent grain (BSG) is the major byproduct of the brewing industry and has potential as an alternative protein resource (12-30% CP). However, low protein extraction efficiency and protein isolates' poor technological functionality are the major concerns when applying the pHshift method. High hydrostatic pressure (HHP) is an effective non-thermal processing that not only can increase protein recovery but also affect the techno-functional properties of protein isolates. Therefore, an experiment was designed to elucidate the effect of hydrostatic pressure levels (0, 300, 450 and 600 MPa for 6 minutes at 20 °C) during the alkaline extraction step on protein yield, nutritional quality, chemical and techno-functional properties of isolated BSG protein mass. Results showed increased protein yields (around 125 g/kg) in all treatments regardless of the applied pressure when compared to the non-pressurized treatment (104 ± 0.8 g/kg). The crude protein levels were also increased to around 55.5% when compared to the control (51.37 ± 2.21%) whereas amino acid compositions remained unaffected. Surface hydrophobicity, total and free thiols, disulphide bonds, and intrinsic fluorescence were unaffected by HHP. However, the protein solubility was increased only when comparing 600 MPa (33.31 ± 1.9%) with the control (26.78 ± 3.53%). Except for 450 MPa treatment, HHP assisted extraction lowered emulsion activity index, whereas emulsion stability index was unaffected. Conversely, foaming stability was higher in the 600 MPa treatment than in all the remaining treatments whereas foaming capacity was similar. Finally, the minimum gelling concentration of HHP assisted protein isolates was about 7% regardless of the pressure level, however, in the control it remained at 9%. To conclude, HHP assisted protein extraction at 600 MPa is optimal for improving extraction efficiency and techno-functional properties of BSG protein rich isolates.

Preliminary Study for the Development of Eco-sustainable Functional Beverages from Coffee Pulp

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Abstract:

Eco-sustainable functional beverages from by-products are attracting the interest of food industry. Coffee pulp (CP), one of the main by-products of coffee processing, is recognized by the EU as a novel and safe ingredient [1], is rich in phenolic compounds (PC) with antioxidant and anti-inflammatory properties. The aim of this work is to develop CP infusions with high content of PC and antioxidant capacity for the development of functional beverages. Infusions were prepared from CP with two different particle sizes (0.2-1 mm and 2-3 mm) and using three solid-liquid ratios (CP/water: 0.02; 0.05 and 0.08 g/mL). All of them were extracted for 6 min. Total phenolic compounds (TPC) were determined by the Folin-Ciocalteu method and antioxidant capacity by ABTS [2]. The PC and caffeine profile was quantified by UHPLC-UV-VIS-MS [3]. CP infusions presented high TPC content (54-166 mg GAE/100 mL) and high antioxidant capacity (97-298 mg TE/100 mL), presenting a similar content to other infusions [3]. The caffeine content (166-654 µg/mL) was superior than that of individual PCs. The main PCs detected were protocatechuic (50-165 µg/mL) and chlorogenic (43-172 µg/mL) acids. As the S/L ratio rose (0.02, 0.05, 0.08 g/mL), the total bioactive compounds increased for the two particle sizes (259, 516 and 601 µg/mL for 0.2-1 mm and 495, 551 and 992 µg/mL for 2-3 mm, respectively). Both S/L ratio and particle size significantly affect bioactive compound content in CP infusions, indicating strong potential for functional beverage applications. However, other parameters such as extraction time could also affect. Therefore, a multivariate optimization should be carried out to know the best conditions to obtain a CP infusion with the highest antioxidant capacity.

Drying Kinetics and Characteristics of Olive Oil and Chitosan Oleogels

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Abstract:

The current food industry aims to replace saturated fats with healthier options, minimizing textural and sensorial changes in the final products. One alternative is to stabilize healthy oils with a structuring agent to form an oleogel using the indirect method (emulsion-templated). In this work, olive oil was gelled using chitosan and vanillin as structuring agents, as both react according to Schiff's base reaction. The reaction is conducted during both the emulsion step and the drying stage, hence its study is also essential in the latter. These oleogels were generated using two chitosan concentrations (0.7 and 0.8 w/w) keeping the vanillin/chitosan ratio constant (1.3) and the ratio of dispersed phase (oil)/continuous phase (water) at 50/50 (w/w), with a fixed thickness emulsion of 0.15 10^{-3} m. Four air temperatures (50, 60, 70 and 80ºC) in a convective dryer were assessed. The drying kinetics results were fitted through empirical (Newton, Henderson-Pabis, and Page) and diffusional models (D_{eff} values from 0.75 10^{-10} up to 1.58 10^{-10} m^2/s) obtaining that the optimum drying temperature was 70ºC (drying time approximately 90 min). The concentration of chitosan and drying time influenced the textural properties (hardness, adhesiveness, cohesiveness and springiness) and the oil retention capacity. Specifically, oleogel hardness (from 1.2 to 2.2 N) increased with chitosan concentration and decreased with temperature during drying step, whereas oil retention capacity (higher in all cases than 91.8%) was increased with chitosan concentration. **Acknowledgements:** Grant CNS2022-135217 funded by MCIN/AEI/10.13039/501100011033 and, as appropriate, by the "European Union NextGenerationEU/PRTR".

Carbon Footprint of Avocado in *Comunitat Valenciana*, Influence of Management Practices

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Abstract:

Avocado, a widely traded tropical fruit, has gained attention due to its high concentration of vitamins, and its utilization by pharmaceutical and cosmetic industries. Its cultivation has been in notable expansion during the last decade in *Comunitat Valenciana.* Due to this growth, developing agricultural practices adapted to the growing conditions in the area, without compromising yield or quality and guaranteeing the sustainability of the crop is crucial. In that sense, this work aims to assess the carbon footprint of avocado cultivation in *Comunitat Valenciana* using different management practices. Specifically, two production areas were considered, *Puçol* and *La Vall d'Uixó*. In both areas, 12 scenarios with different management practices were implemented, with application of different doses of biostimulants. Two functional units were considered, 1 ha and 1 kg of avocado. The system boundaries were set at the farm gate, including the production of inputs (fertilizers and biostimulants), electricity, and diesel, together with machinery use and direct on-field emissions. The inventory data was built from primary data (yield, management practices and biostimulant production) and secondary data from Ecoinvent 3.8 (fertilizers, electricity and diesel production and machinery use). The greenhouse gas emissions from fertilizers and biostimulant application were assessed following the IPCC guidelines (2006, 2019). The production of fertilizers was the most impacting stage in all the scenarios considered. The yield obtained from the different management practices was crucial to determine the differences in the carbon footprint of the scenarios considering 1 ha or 1 kg of avocado as a functional unit. These results highlight the importance of the development of management practices adapted to the geographical area for the cultivation of avocado.

Arthrospira platensis Protein Hydrolysates as A Promising Alternatives to Serum in Animal-Cell Culture

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Abstract:

A big challenge nowadays is ensuring we can maintain the sustainable production of healthy, nutritious food. Cultured meat is a promising option for reducing land and water consumption and pollution, but it remains expensive due to fetal bovine serum (FBS) use. Phycobiliproteins (PBPs) are abundant algal proteins, and their enzymatic hydrolysis produces chromopeptides with potent biological activities, making them a precious FBS alternative in cell media. This study aimed to investigate the serum substitution potential of the trypsin and pancreatin *Arthrospira platensis* (Spirulina) hydrolysates. Spirulina hydrolysates were prepared and partially purified by size exclusion chromatography into several fractions to test the growth and viability of CHO-K1 and QM7 cells in the absence or reduced serum conditions. An MTT assay was performed after a 3-day incubation of cells with Spirulina hydrolysates to determine cell viability. CHO-K1 and QM7 cells showed increased viability at lower concentrations than non-treated cells in serum-reduced conditions. Obtained data indicate that trypsin and pancreatin Spirulina hydrolysates

have comparable favourable effects on CHO-K1 cell proliferation. QM7 cells exhibited a higher survival rate when exposed to pancreatin hydrolysates. CHO-K1 cell viability surpassed that of QM7 cells in both pancreatin and trypsin hydrolysates at higher concentrations. The most active fractions were also subjected to two additional viability tests: the resazurin and the neutral red uptake assay. In general, the results of this investigation demonstrated the potential benefits of Spirulina hydrolysates at lower doses on cell proliferation, health, and morphology in a serum-reduced environment. Conducting various viability assays and comparing their outcomes provided us with a deeper insight into the biological mechanisms of hydrolysates, thereby elucidating their impact on enhancing cell growth. **Acknowledgement:** Supported by the Science Fund of the Republic of Serbia, GRANT No 10302, "Exploring the potential of algal-derived (chromo)peptides as serum replacement components for meat cultivation", PEP4MEAT.

Bioaccessibility of Calcium and Phosphorus in Dairy and Plant-Based Products using the *in vitro* Digestion Model INFOGEST 2.0

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Abstract:

In the transition to a more sustainable and climate-friendly diet, plant-based products are increasingly becoming a focal point for conscious nutrition. This has led to the introduction of numerous new food products and food ingredients to the market. Nevertheless, dairy products represent a primary source of micronutrients, including vitamins and minerals, which have beneficial effects on consumers' health. For instance, calcium and phosphorous are minerals that are essential for numerous biological processes, including skeletal mineralization and bone health. The bioavailability of micronutrients following digestion in the gastrointestinal tract is significantly dependent on their ability to be efficiently extracted from the food matrix and made available for absorption in the gut. Previous studies have demonstrated significant differences in the bioaccessibility of micronutrients across different food matrices. However, there is a lack of available data comparing the bioaccessibility of different dairy and plant-based products. The objective of this study is to provide valuable data on the bioaccessibility of the micronutrients calcium and phosphorous, comparing different dairy and plant-based products using the standardized *in vitro* digestion model INFOGEST 2.0. The calcium and phosphorous content were determined using inductively coupled plasma optical emission spectroscopy (ICP-OES) following microwave-assisted digestion. The results demonstrate a high bioaccessibility of phosphorus in all tested products, with higher rates for dairy products (~90%) compared to the plant-based products (~55%). In contrast, the bioaccessibility of calcium is moderate (~50%), with only minor differences between the tested products.

The Impact of Differential Level of Antinutrients in Legume Seeds

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Abstract:

In Nordic European nations, dietary recommendations emphasize the importance of promoting both human health and environmentally sustainable food choices. The Danish national guidelines specifically encourage a reduction in meat consumption alongside an increased

intake of plant-based foods, with a daily suggestion of 100 grams of legumes. Despite these recommendations, the guidelines do not account for the possible effects of antinutrients, which can hinder nutrient absorption in legume consumption. This research aims to quantify the levels of antinutrients in locally cultivated legumes, as well as in lupin and soybeans, which are expected to become more widely grown in Denmark in the future. Our research focuses on enhancing the nutritional value of legumes by addressing their processing properties to reduce antinutrient levels. A key aspect involves analyzing phytate and lectin levels among other factors. Moreover, we will identify molecular markers/genes/SNP in the genome important for the level of a certain antinutrient by taking advantage of the genetic variation between approximately 200 faba bean lines. By providing insight into these factors, our research aims to support breeders and food producers in developing new legume cultivars and consumable food products with enhanced nutrient profiles and improved functional properties.

Unlocking Creaminess of Plant-based Yogurt Alternatives

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Abstract:

The characteristic flavor of yogurt encompasses several building blocks, including milky, buttery, fermented, vanilla, caramel, aldehydic, and fruity notes. In plant-based yogurt alternatives, some of these notes are not perceived due to low concentrations. Additionally, certain volatile compounds naturally present in plant-based sources can direct the flavor towards "beany", "green" or "vegetal". Although lactic acid fermentation (LAB) can produce aroma compounds related to fermented milk and buttery flavor, their concentrations are often below the threshold for detection, resulting in a weak contribution to the overall taste enhancement. In this study, the building blocks of yogurt flavor were compensated in a plant-based recipe with five ingredients (coded A, B, C, D, E), followed by LAB fermentation. A design of experiments with 5 factors at 2 levels and 6 central points was performed to maximize the response "creamy notes", measured by GC-MS and through a 5-point hedonic scale with a trained panel. The statistical analysis of the responses measured by GC-MS showed that factor A, B, and E were significant, with factor B at the high level contributing to an increase in the concentration of creamy notes. Conversely, the sensory test showed that the center point recipe, significantly enhanced the creamy note (up to 2 points) and decreased the plant taste. These findings indicate that aroma compounds that are not directly defined as creamy or buttery but are related to other building blocks of yogurt flavor, also contribute to the overall creaminess and could be acting as masking of the plant off-flavor.

Complexation of Copper(II) Ion by Camel Milk Caseins and Their Tryptic Hydrolysate

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Abstract:

Caseins (CN) from camel milk [Camelus dromedarius] are proteins with numerous biological properties. There are four components of casein, αs1-CN, αs2-CN, β-CN, and κ-CN, with β-CN being the predominant protein in camels, whereas in cows, it is αs1-CN. Among their multifunctionalities, caseins have the ability to bind metal ions, specially the divalent ions.

This ability enables them to act as vectors for these ions in the body. The objective of this work was to study the interaction between the Copper (II) ion with the camel milk caseins and their tryptic hydrolysate. First, we developed a chromatographic method for the separation of the camel casein components using Fast Protein Liquid Chromatography (FPLC), as in our knowledge, no efficient method for this species was reported (Badraghi et al. reported in 2009 the preparation of αs1- CN from whole camel casein by batch chromatography). Subsequently, two fractions predominantly containing β-CN and αs1-CN were prepared and hydrolyzed with the digestive enzyme trypsin. We investigated the ability of these caseins and their peptides to chelate copper ions using the innovative switchSENSE® technology, which allows real-time determination of biomolecular interactions. The results indicate that caseins and peptides are able to chelate copper ions. For further study, tryptic peptides will be purified and their affinity for metal ions determined to identify metal-chelating sequences. In this context, the caseinophosphopeptides β-CN-4P (8-28) and αs1-CN-4P (67-84) appear to be promising candidates. **KEY WORDS** Camel milk, casein tryptic hydrolysate, copper, metal chelating ACKNOWLEDGEMENTS Molecular interactions were investigated with the switchSENSE® technology available on the ASIA platform (University of Lorraine-INRAE; https://a2f.univ-lorraine.fr/en/asia-2/).

Comparative Analysis of Carotenoid and Fat-Soluble Vitamin Content in Dairy Products: A Comparison between Alpine and Industrial Products

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Abstract:

Carotenoids and fat-soluble vitamins are bioactive compounds essential for human beings and are involved in numerous processes necessary for maintaining health [1]. Except for vitamin D, which can be metabolized through exposure to UV rays, all other compounds must necessarily be obtained through the diet. Dairy products are an important source of micronutrients, including carotenoids and fat-soluble vitamins and the feeding of cows, based on grazing, strongly influences the content of these compounds [2], which could represent important markers in the traceability of mountain products. Carotenoids and fat-soluble vitamins have different polarity and solubility, which makes extracting and quantifying them simultaneously extremely difficult. In this work, a method was developed for the simultaneous analysis of these analytes in cheeses, butters, and creams, focusing on the extraction and analytical aspects. Subsequently, various products derived from mountain pastures (N=26) were compared with industrially produced ones (N=9). The developed method was able to analyze the contents of lutein, β-carotene, retinol, α-tocopherol, β/γ-tocopherol, δ-tocopherol, vitamin K1, and vitamins D2 and D3 using high-performance liquid chromatography coupled with high-resolution mass spectrometry (HPLC-HRMS) with APCI source. From the analysis conducted, the content of α-tocopherol, β/γ-tocopherol, retinol, lutein, vitamin K1, and vitamin D2 was found to be higher in mountain cheeses (KW test), while for butter samples, a higher content of lutein, β-carotene, vitamins D2 and D3, and δ-tocopherol was also observed in the alpine products. Overall, creams did not show significant differences except for the lutein content, although in general, concentrations tended to be higher in mountain products.

New Dynamic System to Investigate Food Compounds' Absorption

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Abstract:

Among emerging technologies, dynamic cell culture bioreactors represent a versatile tool to study the absorption mechanism of food components and drugs [1]. The aim of our research was to set-up the LiveFlow® bioreactor (IVTech Srl, Pisa, Italy) as a multi-organ system to reproduce the digestion process. The new model was firstly used to test a reactive toxic α-oxoaldehyde, methylglyoxal (MGO), generated both in food and endogenously. MGO is involved in the formation of advanced glycation end products (AGEs), which are responsible for aging-related chronic diseases from cardiovascular to neurological disorders [2]. Then, we used this multi-compartmental platform to investigate 5-caffeoylquinic acid (5-CQA) metabolic fate. 5-CQA is food-derived phenolic compound with antiglycative properties in *in vitro* biochemical assays and able to trap MGO, thus inhibiting AGEs formation. MGO and 5-CQA passed through GIST-882 and Caco-2 cells, and their concentrations were monitored over time by validated RP-HPLC-DAD methods, comparing their absorption/metabolization with data obtained by a static approach (InfoGest protocol combined with a colon step) [3-5]. Citotoxicity assays were also performed. The dynamic system highlights how dynamic conditions can affect molecules absorbance or bioactivity, representing a promising alternative to reduce animal testing at least in preliminary investigations.

Chemical Features of Ready-to-Eat Italian Omelettes Enriched with Vegetable By-products Obtained through Classic Drying and A Patented Process

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Abstract:

The use of two different techniques, classic dehydration and a novel patented, non-thermal and non-invasive physical technology were chosen to treat vegetable by-products, allowing to obtain fine powders. These powders were used to enrich Italian ready-to-eat omelettes, that were cooked comparing pan and oven. The evaluation of omelettes was obtained immediately after the cooking process and after 1 and 2 months of storage at -20 °C, to have an idea on the technological, chemical, and sensorial features of these ready to-eat products. Total polyphenolic compounds (through Folin-Ciocalteau assay), antioxidant activity (through DPPH Radical Scavenging Activity), moisture, pH and microbiological evaluation were assessed in order to assess how cooking procedures, the use of different vegetable by-products and storage period could influence the structure and properties of the omelettes. The sensorial analysis was also carried out immediately after cooking the omelettes and after a re-heat process in the microwave for the samples stored at -20°C, to understand the feasibility of the storage and how the use of by-products influenced the taste and quality of the samples. Results showed that the use of artichoke bracts and grape pomace as ingredients increased the content of total polyphenols and their antioxidant activity also during the storage period, especially for the omelettes cooked in the pan with the addition of vegetable powders from the patented technology. Moreover, a minor decrease of the moisture content in the samples enriched with both the type of powders was observed during the freezing storage, highlighting the better sensorial aspects. The microbial assessment showed that the use of vegetable by-products decreased microbial contamination during the storage. Further studies are ongoing to assess the feasibility of prolonged freezing storage under the microbial, chemical, and sensorial point of view.

Culture-dependent Methods and Flow Cytometry to Reveal the Effects of Ultrasound Attenuation on Probiotics

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Abstract:

As consumer preferences shift towards dairy alternatives as vehicle for probiotics, there is a growing interest in optimizing the performance of Lactic Acid Bacteria (LAB) probiotics to attenuate the off-flavor associated with rapid acidification. Attenuation induced by sublethal stress delays probiotic metabolism without affecting its viability. A model probiotic, Lacticaseibacillus casei ATCC 393, in a water suspension was subjected to ultrasound at 57 W, 50% duty cycle, and 20 kHz for both 6 (T) and 8 (ST) min. Optical microscopy, acidification test, spread plate count and spectroscopy were complemented with Flow Cytometry (FCM) to provide comprehensive insights into the performance of sonicated probiotics. A transition from streptobacilli to single-cell morphology was observed and confirmed by forward and side scatter parameters reduction and detected events increase. Intensity dependent effect was observed for both acidification attenuation and cultivability reduction. However, growth and metabolic recovery were observed in T and ST but in different time interval. FCM showed an increase in membrane permeability and a reduction in esterase activity, respectively as dependent and not dependent on treatment intensity. No statistical differences in cultivable, viable and esterase active populations were found in T. However, a differentiation was observed in ST with the induction of Viable But Not Cultivable state. These results suggested that ultrasound impair the cell membrane and that not all the bacterial enzymes are affected at the same degree. Finally, the high membrane damaged underlines the need of experimental design improvement to properly modulate the metabolic functions without affecting the probiotic viability.

Developing New Formulations of Food Supplements using Functional Excipients Capable of Providing Technological and Health Advantages

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Abstract:

Food supplements' excipients are well-known and set, but the possible choices are limited, mainly due to the regulations. They are normally used as technological adjuvants to give the formula specific properties, to protect the active product ingredient (API), to deliver it to the desirable place of the gastrointestinal tract and/or to give the product certain organoleptic characteristics. With the exponential growth of the food supplements market, consumers have begun to be more aware of their own healthy, paying growing attention to the composition of the products they purchased, seeking for "clean" labels. Most of all, there is a particular interest on excipients for which there are reliable "alerts" or simple "rumors" regarding their safety and medium-long term effects. The purpose of this study is to identify alternative excipients and their mixtures, in specific weight ratios, which could be used in place of classic excipients to formulate food supplements. This would start with the identification of the API's most relevant characteristics that have an influence on product development as well as their use in specific dosage forms. Through the use of characterization techniques such as rheology, this project also aims to identify a predictive methodological approach for the development of new

products with alternative excipients and/or the restyling of those already on the market. This would be achieved by acting during the prototyping phase of tablets/capsules. The final step is to verify the physical-chemical stability of the new formulas, as well as their effectiveness, by carrying out *in vitro* tests.

Effect of Nixtamalization on Nutrimental, and Nutraceutical Characteristic of Wheat and Pigmented Corn (Gluten-free) Leavened Breads

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Abstract:

The increment of bread prices makes necessary to look for new grains such as corn (*Zea mays L.*) and sorghum for making leavened breads to reduce cost of gluten-free products of good quality. Traditional nixtamalization and a new corn breadmaking straight dough method reported by Canelo-Álvarez et al. (2023) was used. Proximal composition (water absorption, protein, fat, fiber, soluble fiber and resistant starch, contents was using AACC 2000). Minerals (calcium, iron and zinc with ICP) and phenolic content was evaluated by Folin-Ciocalteu, and the antioxidant capacity was assessed by ABTS (2,2'-azino-bis (3-ethylbenzthiazo-line-6-sulfonic acid)) and DPPH (1,1-diphenyl-2-picrylhydrazyl).), the aflatoxin-B1 with method 991.31 of the AOAC (2000). The new nixtamalization process performed in corn produces pseudo-gluten with viscoelastic properties like the wheat gluten that produces yeast leavened breads for celiac people. Besides the well-known advantages of nixtamalization related to improve nutritional (protein, calcium, iron, niacin, contents) and nutraceutical (significant decrease in the fat, phytate contents and increase in antioxidants), additional advantages of those gluten-free corn breads are the reduction aflatoxin-B1, and significantly increased the bread shelf live compared with control. The nutritional and nutraceutical characteristics of pigmented corn breads are absent in the wheat bread and in most of the gluten-free breads from other grains. Furthermore, nixtamalization increases the palatability of breads and, as other studies have demonstrated a positive impact on other nutritional parameters. The new bread making technology can be easily implemented due to low cost and simplicity in rural low-income communities as well as in commercial channels. Moreover, the loaf volume of whole corn breads was well acceptable and the sensory evaluation (texture, color taste and acceptability) of the 50 judges indicating an excellent potential for commercial applications of this new technology.
Keywords: Pigmented corn leavened bread; gluten-free; nutritional; nutraceutical**.**

Protein Hydrolysate and Peptide Fractions of Tarwi (*Lupinus mutabilis*) with Iron (Fe+2) Chelating and Antioxidant Properties

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Abstract:

Tarwi is a high Andean grain with a high protein content (41-51%) which can be used to obtain protein hydrolysates and/or peptides with functional properties. This research evaluated the iron chelation (Fe+2) and antioxidant (TEAC assay) properties of tarwi protein hydrolysates (TPH) and its fractions. Thus, a 2.5 % (w/v) protein solution was prepared from a tarwi protein concentrate (76.6 % protein) and hydrolyzed with Alcalase (pH 8.2, 50 °C for 180 min) followed by heat treatment at 100 °C for 5 min. The TPH was then passed through ultrafiltration (UF) using 10 and 2 kDa membranes sequentially. The 2 kDa permeate was then passed through Fe+2 metal ion affinity chromatography (Fe+2 -IMAC) to recover antioxidant peptide fractions with Fe+2 chelating capacity. From the exposed methodology, three UF fractions were obtained from TPH: fraction > 10 kDa (UF1), fraction 10 - 2 kDa (UF2) and fraction < 2 kDa (UF3). When evaluating the Fe+2 chelating capacity and the TEAC antioxidant activity of TPH, UF1, UF2 and UF3, the following values were found: 22.7, 26.2, 18.2 and 35.1 mg Fe+2/g protein and 1.72, 1.65, 1.80 and 1.12 µmol TE/g protein, respectively, highlighting the 2 kDa permeate (UF3) with the highest value to chelate Fe+2. Subsequently, three fractions (F1-3) were recovered from UF3 after Fe+2 -IMAC, of which F1 did not show activity to chelate Fe+2, contrary to F2 and F3 that showed values of 51.1 and 37.8 mg Fe+2/g protein, and TEAC values of 0.6 and 1.51 µmol TE/g protein, respectively, highlighting the peptide fraction F2. The results obtained highlight the potential of tarwi protein hydrolysates and their fractions in their capacity to chelate Fe+2, which could result in a potential future product as a source of bioavailable iron.

Tuning Protein Functionalities through Extraction Process

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Abstract:

Demand for proteins from alternative sources to replace or reduce animal products is surging globally due to sustainability, environmental, and consumer health factors. Despite significant advances in protein texturization and incorporation into various foods, the very first processing step, extraction, remains unmet needs for ingredient characteristics such as molecular structure, techno-functional and organoleptic properties, nutritional profile, etc. We aim to contribute to this area by development of a processing strategy that comprises sustainable and scalable methods for the isolation of proteins from protein-rich abundant regional material sources to advance their use as a basis ingredient for future foods of the plant origin from the structural, techno-functional, and nutritional perspectives. Furthermore, the methods used at each processing step need to produce a satisfactory yield to be economically feasible. Our approach incorporates novel emerging green and sustainable methods that apply supercritical carbon dioxide (SCCO2) treatment and enzymatic hydrolyses as well as chemical and mild/conventional wet fractionation processes. The proteins developed have functional properties tuned for food applications. For example, our protein ingredients with enhanced solubility from 15 to 80%, facilitate the behavior and sensory of food products while our protein ingredients with improved emulsifying properties from 0.4 to 2 times compared to commercial soy protein, form the basis of a huge range of food products. Our extraction strategies create quality plant protein ingredients with specific functional properties for particular needs in food product manufacturing.

Detection of Methanol in Wine Using Ion Mobility Spectrometry

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Abstract:

Methanol is a poisonous compound produced in trace level in wine, hence, its amount must be controlled during fermentation and consumption, strictly. Liquid chromatography (LC), gas chromatography (GC), and infrared (IR) spectroscopy are the main techniques are used for detection of methanol in wine. In this work, we developed an ion mobility spectrometry (IMS) method for measurement of methanol in the gas phase, aqueous solution and in wine in the presence of ethanol. As, the ion mobility peak of methanol overlaps the main reactant ion (RI) peak of IMS, we used 2-heptanone as a dopant to supress the RI peak. Two Tenax adsorbents (GR and TA) were used and compared for separation of ethanol and methanol, and it was found that the Tenax-GR exhibits a more efficient separation of ethanol and methanol. The measurement conditions including extraction temperature (60 °C), time extraction (15 min), flow rate of the carrier gas(70 ml min -1), desorption and separation temperature by Tenax (40 °C) were optimized to achieve the optimum methanol/ethanol separation as well as the maximum signal intensity. Using the optimum condition of the development method, the limit of detection (LOD) of methanol was obtained as 0.05% in wine and 10 µg in the gas phase.

Phytochemical Composition of *Garcinia huillensis* Pulp

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Abstract:

Garcinia huillensis is an evergreen tree mostly found in forest areas. The fruits of *G. huillensis* are consumed but little is known about their chemical composition. There is limited information on the phytochemical composition of the fruits and no studies have been done. The present study aimed at determining the phytochemical composition of the fruit pulp. Standard analytical methods were used to analyse vitamin C, total phenolic compounds, organic acids, anthocyanin, total carotenoids and total flavonoid content. The fruits contain significant amount of vitamin C (14.00 mg/100 g), carotenoids (53.80 µg/g), anthocyanin (0.49 mg/g), phenols (234 mg/g) and flavonoids (13.62 mg/g). Some of the organic acids present in the pulp are oxalic, tartaric, citric and hydroxycitric acids. The major acid detected in the samples was citric acid (789.07 mg/100 g) followed by hydroxycitric acid (25.32 mg/100 g). The presence of hydroxycitric acid in the pulp suggest that the fruits can help in managing weight. The results of this study can be a baseline database on the phytochemical profile of the fruits for the food industry and consumers regarding its value and in conserving the biodiversity. **Keywords:** *Garcinia huillensis*, Hydroxycitric acid, Vitamin C, Phytochemical, Forest food trees

Rheological Evaluation of Olive Oil Emulsions with Chitosan for Oleogels Production

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Abstract:

The search for healthy alternatives to saturated animal fats has led to research in the development of oleogels, defined as solid structures of vegetable oils trapped in a three-dimensional network. For the indirect method oleogels obtention is necessary, the formation of an emulsion. The influence of several variables on emulsion formation and further stability, such as agitation intensity, time of mixing, organogelator/s concentration, and addition of emulsifiers is essential to characterize it and predict its stability. This study was focused on characterizing the rheological properties and stability of olive oil/water (50/50 w/w) emulsions with chitosan and vanillin to produce oleogels. The mixing and homogenization stirring time was set for 8 minutes while operation variables such as stirring speed (6500-17500 min^{-1}), chitosan concentration (0.6 to 1 w/w) and vanillin/chitosan ratio (0.3 to 1.3) were evaluated. The rheological dynamic assays of tested emulsions revealed that the viscous modulus was predominant in comparison to the elastic modulus in the whole frequency range (0.01 to 10 s^{-1}). The steady flow curves showed strong shear-thinning behavior (not dependent on time) of emulsions with threshold stress. The apparent viscosity could be modeled successfully according to Herschel-Bulkley (R^2 > 0.998). The Cox-Merz rule that relates complex viscosity with apparent viscosity was only accomplished in the range of high shear rates (from 1 to 100 s^{-1}). From the three studied variables, stirring speed did not significantly affect the stability of the emulsion. On the contrary, the chitosan concentration and the vanillin/chitosan ratio had a significant impact on stability. **Acknowledgements:** Grant CNS2022-135217 funded by MCIN/AEI/10.13039/501100011033 and, as appropriate, by the "European Union NextGenerationEU/PRTR".

Antioxidant Composition of By-products from the Cider Industry: Apple Pomace

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Abstract:

The industry of cider-making generates around 10,000 tons of apple pomace each year in Asturias. This by-product, made up of peels, flesh and apple seeds, is a valuable material due to its antioxidant and dietary fiber content. Polyphenols such as dihydrochalcones and quercetin glycosides, and triterpenic acids, among which ursolic acid is a major compound, are the main antioxidant families described in apple pomace. The contents of those components depend on apple variety and harvests. The antioxidant composition of apple pomace from the cider industry has been analyzed in three consecutive harvests in order to evaluate the potential of this by-product as a source of bioactive compounds. The samples were dried, submitted to ultrasound-assisted extraction with ethanol:water and analyzed by HPLC. The extraction methods has been optimized by Response Surface Methodology to simultaneously extract polyphenols and triterpenic acids. On average, the cider apple pomace contains almost 1,060 mg/Kg dry matter of flavonols, hyperin, avicularin and quercitrin being the main components of this family. The group of dihydrochalcones, in which phloridzin represents between 59 and 87%, varies between 135 and 1,620 mg/Kg dm. With respect to triterpenic acids, corosolic, oleanolic and ursolic acids have been identified. The latter is the predominant compound, with an average concentration of 3,900 mg/Kg dm. These figures confirm the potential of industrial cider apple pomace as a source of high-value bioactive compounds.

Utilization of Cider By-products for Mannitol Bioproduction

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Abstract {Max words limit 250}

The biotechnological conversion of low-cost agri-food by-products into higher-value compounds represents a highly promising strategy for the industry. During the cider production, a percentage of apples (1-3%) are discarded due to their level of rot. This by-product maintains the properties of an apple juice; it is a fructose-rich feedstocks (74-82% total sugars) with an approximate fructose-to-glucose ratio of 3.6:1. On the other hand, the by-product called fermentation lees settles at the bottom of the tanks, constituting approximately 3-5% of the cider volume, and is characterized by its high protein content (16% of the dry matter). The suitability of both by-products in the production of mannitol was evaluated using the heterofermentative lactic acid bacteria *Fructobacillus fructosus* CECT 7088 *and Leuconostoc mesenteroides* CECT 8146. The objective was to develop a method for mannitol production applicable to biorefineries related to cider production. The rotten apple juice was fermented in a bioreactor at 30ºC and pH=5.0 with each strain in the presence of two nitrogen sources (yeast extract *vs.* lees extract). At 48 hours of fermentation, *L. mesenteroides* CECT 8146 showed the highest fructose consumption and mannitol concentration in all of the conditions tested. This strain produced 60.1 ± 1.0 g/L of mannitol in the presence of yeast extract, with a relationship between mannitol production and fructose consumption efficiency of 58.2±1.6g/L. A lower production of mannitol (34.8 ± 4.5 g/L) and a lower consumption of fructose (32.2 ± 0.8 g/L) were obtained when the cider lees extract was used as nitrogen source.

Assessing the Impact of Regulated Deficit Irrigation on Polyphenolic Profile in 'Mirlo Rojo' Apricots

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Abstract:

Within water-saving irrigation strategies employed in agriculture, Regulated Deficit Irrigation (RDI) emerges as an effective response to address water scarcity in stone fruit cultivation in semi-arid climates. This study focused on 'Mirlo Rojo' apricots from an experimental farm in Cieza (Murcia), testing four irrigation strategies: full irrigation (100% according to crop evapotranspiration, TA), 66% irrigation (TB), 33% irrigation (TC), and complete irrigation suspension (TD). These irrigation treatments were implemented during the late stage of the fruit's phenological cycle. Anthocyanins and phenolic compounds (non-anthocyanin) were analyzed by liquid chromatography – mass spectrometry (LC-MS). Eight phenolic compounds (non-anthocyanin) and six anthocyanins were identified, with rutin being the most abundant compound, followed by neochlorogenic acid. The most abundant anthocyanin was quercetin-3-galactoside, followed by quercetin-3-glucoside. Significant differences were observed between TA and TD treatments for these compounds, but not among the different irrigation reduction levels (TB, TC, and TD) except for neochlorogenic acid, which was significantly higher in all irrigation reduction treatments. Significant differences were observed in the total phenolic compounds (non-anthocyanin), total anthocyanins, and total polyphenols between TA and TD treatments. However, no significant differences were found among the various irrigation reduction levels (TB, TC, and TD), nor between TA, TB, and TC treatments. The findings of this study indicate that water restriction does not adversely affect the phenolic compounds and anthocyanin content in 'Mirlo Rojo' apricots. This suggests the potential to produce high-quality apricots while achieving significant water savings, thus aligning with the principles of sustainable production.

Response of Cabbage and Broccoli Powdered Ingredients to *in vitro* Digestion

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Abstract:

Obtaining powdered ingredients from fruit and vegetable wastes has gained interest in recent years, as a feasible way to integrally valorizing these residues. As functional food ingredients, physicochemical and technological properties acquire relevance, but it is also a key aspect to assess the availability of the beneficial compounds to be absorbed after digestion. In the present paper, response of selected air-dried and freeze-dried brassica waste powders to simulated *in vitro* digestion was evaluated in terms of antioxidant properties. Total phenols, total flavonoids, and antioxidant capacity (ABTS and DPPH) of selected powders, before and after each *in vitro* digestion phase, were measured in the supernatant (S) and the precipitate (P). Before digestion, broccoli waste powders exhibited better antioxidant properties than white cabbage ones, as occurred also with air-dried powders as compared to freeze-dried ones. Simulated *in vitro* digestion had a positive effect on antioxidant properties. Total phenols and flavonoids increased, but values were mostly maintained throughout digestion. In contrast, antioxidant activity after the intestinal phase, for both DPPH and ABTS, increased significantly as compared to results after the gastric phase. Recovery and bioaccessibility indexes indicated that antioxidant compounds became available for absorption after digestion. In conclusion, broccoli and white cabbage powders were evaluated as functional food ingredients, by assessing their response to simulated *in vitro* digestion. According to the results obtained, these innovative bio-ingredients could be proposed to increase the nutritional value of foods.

Impact of Thermophysical Pretreatments on *Lactiplantibacillus plantarum* Growth and Antioxidant Properties on Fermented IV-range Broccoli Wastes

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Abstract {Max words limit 250}

Food waste poses a significant challenge within the global food chain, crucially impacting sustainability and efficiency, as highlighted by the 2030 Agenda for Sustainable Development. In the case of broccoli, where only 15% of the total mass is edible, nearly 150 million tons of residues are generated annually worldwide. Despite stems not being the most nutrient-rich part of the plant, they offer valuable Compounds (fiber, fatty acids, organic acids, sugars, glucosinolates, etc.) which can be enhanced through fermentation. Various pre-treatments, including thermal, physical, and enzymatic methods, are commonly used to induce hydrolysis and acidogenesis in processing solid wastes. This study aims to assess the impact of four disruptive treatments -pasteurization (72 °C, 1 min), microwaving (4 W/g, 5 min), freezing/thawing, and autoclaving (121 °C, 5 min)- on the antioxidant properties and *Lactiplantibacillus plantarum* growth on ground broccoli stems over 96 hours of fermentation. Microbial growth was consistently observed after 24 hours in all cases, with minimal change until 48 hours, followed by a decline. However, all pretreatments resulted in a decrease in total phenolic content (TPC) and overall antioxidant activity compared to fresh samples, with no improvement during fermentation. Nonetheless, pretreated samples exhibited higher total flavonoids content (TFC) throughout fermentation, except for pasteurized samples at 0 and 24 hours. A significant increase in TFC was noted at 72 hours, except for frozen/thawed samples.

Enhancing *Lactiplantibacillus plantarum* Growth in Solid-State Fermentation of Broccoli Stems through Microwave Pretreatment

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Abstract:

The application of microwaves as a pretreatment to solid-state fermentation (SSF) has emerged as a promising tool to improve the accessibility of nutrients and substrates, facilitating enzymatic reactions and metabolic pathways essential for microbial proliferation. Furthermore, microwaves can modify the physicochemical properties of the substrate, such as moisture content and structure, creating an environment conducive to microbial growth. In this study, various combinations of microwaves power (2, 4, 6, 9 W/g) and time (4, 5, 6, 7 min) were applied to ground broccoli stems and changes in total soluble solids content (TSS), reducing sugars content (RSC) and total phenolic content (TPC) were evaluated. *Lactiplantibacillus plantarum* counts after fermenting the pre-treated broccoli stems for 24 h were also assessed. In terms of TSS, applying 4 W/g for 4 min resulted in a relatively high positive variation with the shortest treatment time. While all treatments led to a reduction in RSC, the combination of 2 W/g for 4 min resulted in a slightly smaller decrease. Microwave treatment also did not improve TPC, but combining 4 W/g for 5 min resulted in the highest value. Positive microbial growth (MG) was observed in all samples after 24 h of fermentation. MG was notably higher in the 9 W/g pre-treated samples. However, considering the high power involved in this treatment, the 4 W/g pre-treatment might be the most efficient one, showing the highest MG among all the other combinations. Therefore, it can be concluded that the optimal combination is 4 W/g for 5 min.

Temperature Effects on Texture Attributes of Dysphagia-Oriented Purees: Implications for Product Development and Evaluation

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Abstract:

Texture plays a pivotal role in the acceptance by consumers and the swallowing properties of food, a factor of particular significance for individuals with dysphagia. The objective of this study was to investigate the impact of temperature on the textural properties of pureed foods specifically formulated for individuals with swallowing impairments. Seven commercial purees were subjected to texture analysis using the back-extrusion test (BET) method as outlined by Ibañez et al. (2019), with slight adaptations. Samples were evaluated at two distinct temperatures: 40ºC and ambient room temperature. The evaluation of maximum force (Fmax) required for extrusion revealed notable disparities contingent upon temperature variations. At 40ºC, Fmax ranged between 0.97 and 5.90 N, whereas at room temperature, it exhibited a wider range of 1.14 to 21.22 N. Regarding the minimum force (Fmin), two distinct clusters were discerned based on the testing temperature. The observed results underscore the relationship between temperature and the mechanical properties of pureed foodstuffs. In conclusion, this study highlights the critical role of temperature in modulating the textural attributes of pureed foods intended for individuals experiencing dysphagia. These findings underline the importance of considering temperature in the development, consumption, and evaluation of puree products tailored to such individuals.

Characterization of Flour from Mango Seed Almonds

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Abstract:

The by-products generated from the industrialization of mango (*Mangífera indica L.*), such as seeds and peels, could represent an important environmental problem if no adequate policies for their management are followed. Several studies have highlighted that these contain bioactive compounds that are beneficial to human health and can be used as a potential source of functional food ingredients. The aim of this work was to address the production of flour from mango seed almonds (Haden var.) for food purposes. Thus, the seeds were washed with water to eliminate pulp residues, and then the almond was separated from the peel. The almonds were dried using hot air at 60 °C until to reach a moisture content lower than 8%. After that, they were ground in a commercial coffee grinder (particle size 0.20 ± 0.02 mm) and packaged in nylon ziplot packaging until their characterization. The flour obtained had 4.80 ± 0.30% of moisture, 83.73 ± 1.20% of carbohydrates, 6.10 ± 0.41% of protein and 2.40 ± 0.10% of ash. The results obtained are similar to those reported in the literature by different authors for similar products. In addition, the flour showed interesting functional properties for the food industry, such as water and lipid absorption index (8.67 ± 0.40 g gel/g sample) and water solubility index (23.66 ± 1.23%). Moreover, the phenolic content in the flour was 108 ± 0.78 mg of gallic acid equivalent/ g dry product. These results pointed out that the production of flour from mango seed almonds is a promising valorization of this by-product.

Effect of Protein Hydrolysis on Antinutrient Content of Black Bean Flour Hydrolysed with Pineapple By-product Extract

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Abstract:

Enzymatic hydrolysis is a method that can be used to enhance the nutritional and bioactive properties of legumes. For this purpose, purified enzymes, such as bromelain extracted from pineapple, are often used. However, several researches suggest that by-products of pineapple contain significant proteolytic activity, which can be a more sustainable and cost-effective alternative. This study aimed to obtain hydrolysed black bean flours using an aqueous pineapple crown extract, to compare its effectiveness with commercial bromelain and to evaluate how the degree of protein hydrolysis affected the content of phytic acid, trypsin inhibitors, total phenolic compounds, and tannins. For this purpose, flour samples were treated with either extract or bromelain solution and incubated at 37 °C for 2, 4, and 6 hours, while control samples were treated with water. After incubation, enzymes were deactivated, and flours were dried and ground. Subsequently, the degree of protein hydrolysis and antinutrient content (total phenolic compounds, tannins, trypsin inhibitors, and phytic acid) of black bean flours were determined. Results showed that hydrolysis rates of 5%, 8%, and 10% with extract and 8%, 14%, and 15% with commercial bromelain after 2, 4, and 6 hours, respectively, were achieved. In both cases, a higher degree of hydrolysis was correlated with higher levels of total phenolic compounds and tannins, while trypsin inhibitors and phytic acid did not show any clear trend. The authors acknowledge the Centro de Cooperación al Desarrollo of the Universitat Politècnica de València for the funding received through the ADSIDEO program.

Impact of Food Oral Processing and Digestive Conditions on Bolus Particle Size and Starch Digestibility of Red Lentil Pasta

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Abstract:

Over the last decades, an increase in the elderly population has been observed. With ageing, several masticatory deficiencies and digestive alterations occur, favouring the development of nutritional deficits. This work aims to study the effect of food oral processing and *in vitro* digestive conditions on bolus particle size and starch digestibility of red lentil pasta. To evaluate the oral processing of pasta, different *in vivo* boluses were prepared by simulating a normal (24 cycles) and a deficient (12 cycles) mastication. Furthermore, the time of masticatory sequence and saliva incorporated to the bolus were reported. The amount of saliva uptake was calculated by removing from each bolus the weight of the corresponding sample. Bolus particle size was determined by manual dry sieving using a tower of 11 sieves (pore sizes: 0.125-10 mm). To simulate the physiological conditions of healthy adults and seniors, four *in vitro* digestion models were used: Normal Mastication-Normal Digestion (NM-ND), Normal Mastication-Senior Digestion (NM-SD), Deficient Mastication-Normal Digestion (DM-ND) and Deficient Mastication-Senior Digestion (DM-SD). The concentration of total reducing sugars released from starch digestion was determined by the DNS method. Results showed that DM boluses exhibited lower amounts of saliva uptake and larger particle sizes. Moreover, the digestibility of sugars increased as digestion progressed. After the oral phase, DM samples exhibited the lowest digestibility, whereas a higher hydrolysis was observed in SD samples at the end of the gastric phase. Lastly, DM-ND samples showed the highest value of reducing sugars after the intestinal phase. The authors acknowledge *Primeros Proyectos de Investigación (PAID-06-23) del Vicerrectorado de Investigación de la Universitat Politècnica de València*.

Effect of Incorporating Encapsulated Omega-3 in 3D Food Printed Gels

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Abstract:

The incorporation of compounds in foods that are beneficial for the organism is one of the most frequently used methods in functional food development. The direct incorporation of these compounds into foods can lead to their loss due to sensitivities and degradation caused by environmental or external conditions (processing techniques). This is why, in many cases, these compounds are protected by encapsulation with hydrocolloids or proteins, such as pea protein. On the other hand, one of the most innovative techniques for food design is 3D food printing. This technique allows food customizations in shapes, textures, colors, incorporation of isolated ingredients, etc. To carry out these customizations, it is essential to know how to design and program segmentation software, as well as the correct formulation of food inks. This work will study the effect of incorporating encapsulated omega-3 with pea protein at different concentrations on the ink rheological behavior. For this proposal, three shapes were designed: checkerboard, concentric cylinder, and sandwich. Also, four inks were tested: a control ink (without encapsulates) formulated with iota-carrageenan at 2%, gelatine at 5% and water at 93% and three inks with the encapsulates of omega-3 with pea protein (PG) at different concentrations (3%, 3.75% and 6%). The formulations, depending on the amount of

encapsulants incorporated, were designed so that all the figures would have a 3% enrichment in omega-3 and could therefore be mentioned as a source of omega-3 fatty acids. All the designed figures were printed with control gel. Also, ink with omega-3 encapsulated with PG 3% was used for the checkerboard, ink with PG 6% for the concentric cylinder, and ink with PG 3.75% for the sandwich. The effect of encapsulated addition on the rheology of printed samples was evaluated by an oscillatory test and the quality of the printed samples using image analysis. The printed samples with different inks did not deviate significantly from the original designed figures. The rheological oscillatory test showed that all inks exhibited predominantly elastic behavior. The elastic modulus (highest value) increased significantly only in the samples printed with PG 6%. Incorporation of pea protein-encapsulated omega-3 increases the solid behavior of food inks for 3D food printing when their concentration is 6% or higher.

Gendered Perceptions of Food: A Cross-Cultural Study of Spain and Ecuador

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Abstract:

Eating is not merely a biological act but also carries symbolic and social meanings that reflect our identity and social relationships. This influences our food choices and associates certain foods with masculinity or femininity. This study aims to explore the existence of gender stereotypes in consumer perceptions from two different cultural contexts: Spain (n=161) and Ecuador (n=171), of six different foods (Fruit Bowl (FB), Caprese Salad (CS), Meat with Vegetables (MV), Cold Meat (CM), Salmon (S) and Chocolate Cake (CC)) and two control objects (Water (W) and Iron (I)) were analyzed. A projective technique based on the Product Personality Profile was used. Through an online survey, participants were asked to answer the question: "If this food/object were a person, it would be: (gender, age, education...)". The results were analyzed using Factor Correspondence Analysis. Findings reveal persistent gender stereotypes in food perception in both countries. In particular, foods such as fruits, vegetables, and sweets remain predominantly associated with the female gender, while meat maintains its link with the male gender. These gender stereotypes are especially pronounced in Ecuador, where associations of certain foods with the male gender are more marked. In contrast, Spain shows a slight trend towards associating some foods, such as water, with a non-binary gender, which could reflect progress towards gender equity. These findings provide evidence that that our food perceptions are intrinsically linked to specific genders, and how cultural contexts continue to influence our perception of food.

Clarified and Decolorized Black Carrot Colorant Process Liquid Waste as an Emerging Glycose Syrup Alternative: Potential in Gummy Confectionery Production

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Abstract:

This study aims to obtain an alternative material to corn syrup (glucose syrup) from the fluid waste (~12.0°Bx) released after pigment extraction from black carrot (BC) juice concentrate in the production of industrial BC extract powder and to determine its potential use as a model food in gummy formulations. After passing through several adsorbent resins (crosslinked polystyrene and modified styrene-DVB) at three different flow rates (1.00, 1.50, and 2.00 BV/h) and ion exchange resins (anion and cation), the samples were decolored and clarified (>65°Bx). All samples were analyzed to identify their composition (crude protein, TPC, total sugar, total ash content), sugar profiles (glucose, sucrose, and fructose), and visual characteristics (L*, a*, b*, clarity value (T625 nm), browning index (A420 nm). The material was prepared under the conditions where BCLW with the highest T625 value (88.7%) was obtained and used in the gummy composition for the model study. A study plan was prepared with an RSM custom mixture design where BCLW, glucose syrup, and gelatin were the independent variables (n=14). The physicochemical (TSS, pH value, moisture content, water activity value), color (L*, a*, b*, chroma, and hue angle), and texture (hardness, springiness, cohesiveness, gumminess, chewiness, resilience) properties of all samples were analyzed. Significant models related to the effects of independent variables were determined for all properties except TSS and water activity ($P<0.05$), and the R^2 values of these linear models were between 0.5254-0.9173. In addition, gummy samples were stored under accelerated shelf-life conditions (25°C/70% RH) for 8 weeks, and changes in texture properties, especially hardness, color difference (ΔE), moisture content, and water activity values were periodically (7 days) monitored. As a result of the study, it was determined that BCLW can be used as a substitute for glucose syrup in gummy candy after clarification and decolorization processes.

Evaluation of the Anti-bacterial and Anti-fungal Activity of Xanthones Obtained via Semi-synthetic Modification of α-mangostin

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Abstract:

The fruit of *Garcinia mangostana* Linn. (mangosteen), of the family Guttiferae, has been used in Asian traditional medicines for the treatment of various conditions including diarrhea, dysentery, suppuration, leucorrhea, chronic ulcers, gonorrhea, wounds, and skin infections. Xanthones are naturally-occurring compounds with a distinct chemical structure, known as tricyclic aromatic system, with known antibacterial properties. Mangosteen fruit extracts were shown to contain different xanthones, identified by HPLC analysis: α-mangostin, β-mangostin, γ-mangostin, 8-desoxygartanin and gartanin, two isoprenylated xanthones, and 9-hydroxycalabaxanthone. α-Mangostin (3,6,8-trihydroxy-2-methoxy-1,7-bis(3-methyl but-2-enyl)xanthen-9-one) is a compound purified as a yellow crystalline solid, with molecular mass 410.45 g/mol, having a xanthone core structure. The microbial contamination in food packaging has been a major concern that has paved the way to search for novel, natural anti-microbial agents, such as modified α-mangostin. In the present study, twelve synthetic analogs were obtained through semi-synthetic modification of α-mangostin (**I**) by Ritter reaction, reduction by palladium-carbon (Pd-C), alkylation, and acetylation. The evaluation of the anti-microbial potential of the synthetic analogs showed higher bactericidal activity than the parent molecule. The anti-microbial studies proved that **II** showed high anti-bacterial activity whereas **III** showed

the highest anti-fungal activity. Due to their microbicidal potential, modified α-mangostin derivatives could be utilized as active anti-microbial agents in materials for the biomedical and food industry.

Pilot Scale Production of Spray Dried American Elderberry (*Sambucus canadensis L.*) Protein-polyphenol Particles

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Abstract:

Elderberries have long been used in folk medicine to treat several diseases and flu symptoms. However, different from the European variety, American elderberries have not been fully explored regarding its technological uses and applications yet. As a contribution to increase the commercial expression of the American elderberry, our study investigated the production of protein-rich, value-added ingredients using scaled up spray drying microencapsulation. For this, elderberry pomace from juice pressing of eight American elderberry cultivars was used to prepare a concentrated pomace extract using 50% ethanol solution (1:3 extraction ratio w/v) at 80ºC for 2 h, followed by filtration and centrifugation for 20 min at 4000 rpm. Finally, the ethanol was removed using a rotary evaporator to yield a concentrated elderberry pomace extract. A pilot scale spray dryer GEA Mobile Minor was used to produce particles using the concentrated elderberry pomace extract and soy protein isolate. Preliminary lab-scale experiments were conducted to define the scaled up operational parameters: inlet temperature 150C, outlet temperature 73-74C, pump speed 1 L/h, carrier addition 10% (w/v). The elderberry particles showed an attractive reddish color and the process proved to be efficient as solids recovery were above 50%. The elderberry particles showed a significant concentration of phenolic compounds including acylated anthocyanins and proanthocyanidins. High antioxidant activity was detected, besides high solubility (>60%) and flowability. Overall, we showed that American elderberry pomace polyphenols can be efficiently recovered and processed using larger scale encapsulation techniques to produce food ingredients for the emerging health-oriented market.

Systematic Assessment of Algal Extracts as An Alternative to Fetal Bovine Serum in ZEM2S Fish Cell Culture

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Abstract:

Production of cell-based meat and seafood is one of the responses of the global community to ending hunger and providing a sustainable food alternative for the growing world population. The cultured meat technology is currently expensive and accounts for high ammonia and greenhouse emissions because it relies on utilizing fetal bovine serum (FBS) in cell culture media. To commercialize cell-cultured food successfully, addressing production costs and safety issues is crucial. Therefore, our ongoing research is dedicated to seeking cost-effective

and environmentally-friendly substitutes for FBS. In this study, we provide the results of screening 30 algal extracts in ZEM2S cell culture, which serves as a representative model of an aquatic cell line. Water-based extracts were prepared and characterized to determine their protein, sugar, and polyphenol content. During the initial screening, algal extracts were tested in a cell viability assay under reduced serum, 1% FBS, conditions. Ten extracts met the criteria for the second round of screening by demonstrating either protein tolerance at doses of 10 μg/ml or higher, or by enhancing cell proliferation at any concentration from 0.1 μg/ml. In the second stage of our screening process, we tested the impact of extracts on cell proliferation and doubling time. Five out of the 10 tested extracts supported normal cell cycle propagation at a concentration of 1 μg/ml, with some of them showing mitogenic activity as well. Extracts from two microalgae, *Arthrospira platensis* and *Dunaliella tertiolecta*, exhibited tolerance at doses of 10 μg/ml or higher. However, tolerance at a concentration of 100 μg/ml, was achieved only with a refined extract of *Arthrospira platensis*, commercially referred to as blue spirulina. This extract was selected for the final, third round of screening, in which its FBS substitution potency was evaluated in a multi-passage cell growth assay. This study is supported by the Good Food Institute Field Catalyst Grant: "Comprehensive platform for selecting and producing algal extracts as cell media components for meat cultivation", ALG2MEAT and Ministry of Science, Technological Development and Innovation, RS, Contract No: 451-03-66/2024-03/200168 and 451-03-66/2024-03/200288.

Ability of Lactic Acid Bacteria Strains to Improve the Safety and Functionality of Fermented Fruits Juices

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Abstract:

Fruits are an essential part of human nutrition, therefore, the fruit- based foods development promoting health is a research priority of the food industry. On the other hand, the growth and metabolism of lactic acid bacteria (LAB) affect the fermented foods quality. Thus, lactic acid or malolactic fermentations may be a natural technology for improving safety, nutritional, and/or sensorial properties of by-product fruits. In this context the behavior of *Oenococcus oeni* and *Lactilactobacillus plantarum* strains to ferment fruit juices in terms of growth, metabolic and antimicrobial activities, and health beneficial potentials was investigated. Two *O. oeni* strains (MS46 and MS9) isolated from a cellar from Cafayate, Argentina, were selected by exhibiting low diacetyl production and detectable glycosidase activities in laboratory media. When inoculated (~106 CFU/mL) in grape juice (GJ), prepared from Malbec grapes, both strains grew without lag period by 1.34±0.02 and 1.46±0.03 log CFU/mL at 12 days with maximum growth rates of 0.019 h -1 respectively, and adequate changes in the sugars and organic acids profiles from the sensorial viewpoint. At this time, initial pH decreased 0.45 units, however, it increased by 0.12 units during the first three days. In addition, both strains showed antibacterial properties against human pathogens, and ability to increase the antioxidant properties of fermented GJ, demonstrating their potential to ferment GJ with health benefits, which represents a novel alternative to its use in winemaking. In addition, the MS46 strain when inoculated in a commercial wine also increased its antioxidant activity at the end of MLF. On the other hand, selected L. plantarum strains isolated from regional oranges exhibited capacity to inhibit pathogenic bacteria, ability to grow in orange juice without pH-adjustment and probiotic potential. Thus, these studies show new insights on the *O. oeni* and *L. plantarum* strains behavior to ferment new, safe and functional fruit juices.

Fortification of Plant-Based Beverages of Almonds: Bioaccessibility Estimated with the Use of Microencapsulated Sodium Selenate

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Abstract:

Worldwide consumption of plant-based beverages (PBBs) has grown as an alternative to cow's milk, juices and other beverages. However, PBBs have low levels of selenium (Se), a trace element essential for human health. The fortification of vegetable beverages with Se can provide significant health benefits, since this nutrient performs several physiological functions, such as: protection against oxidative damage, strengthening the immune system and reducing the risk of chronic diseases. The aim of this study was to compare the *in vitro* bioaccessibility of Se in almond beverages fortified with sodium selenate, in its free or encapsulated version. Microparticles containing Se were obtained by combined methods (spray-drying and spray-chilling). Almonds beverages with low Se content (< 4.0 µg kg^{-1}) were acquired in the local market and fortified with Se at levels equivalent to the Recommended Daily Intake (RDI, 55 µg/day). The method of acid digestion assisted by ultrasound and ICP-MS was used to quantify the Se, while the *in vitro* digestion method proposed by INFOGEST was used to evaluate the percentage of bioaccessibility. The samples of almonds beverages fortified with sodium selenate salt showed a bioaccessibility percentage of 78%, being lower than the beverages fortified with the microparticles produced (83%). Thus, the use of sodium selenate microencapsulation stands out as an important tool for increasing the bioaccessibility of Se in vegetable beverages. **Keywords**: Microencapsulation, plant-based food, *in vitro* digestion, trace elements, nutrients. **Acknowledgements**: São Paulo Research Foundation (FAPESP) (grant numbers 2022/06111-8, 2022/07015-2 and 2017/50349-0); National Council for Scientific and Technological Development (CNPq) (grant numbers 465768/2014-8 and 407080/2021-0).

High-Pressure Technology Sterilization of Common Bean (*Phaseolus vulgaris L.*) and Cowpea [*Vigna unguiculata (L.)* Walp] Cultivars: *In vitro* Protein Quality and Bioactives Compounds

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Abstract:

The autoclaving process (AUT) is a conventional sterilization method considered efficient in preserving food products and has been mostly used on industrial scale for cooking beans. This study investigated five cultivars of beans (*Phaseolus vulgaris L*) in comparison to the cowpeas (*Vigna unguiculata* L), regarding: in vitro protein digestibility (ivPD), and Digestible Indispensable Amino Acid Scores (ivDIAA), resistant starch (RS), phenolic compounds (PC) and antioxidant capacity (DPPH method). Two processes were compared after bean soaking: 1) autoclave sterilization (AUT) for 15' at 121ºC, and 2) high pressure assisted sterilization (HPS) with a water bath pre-heated at 92ºC and subsequent application of 700 MPa for 3 min. Processed beans compared to raw samples, showed a significant reduction in protein concentration (about 14 %), but an increase in the ivPD levels (approximately 40%) for both treatments. The amino acids

(AA) profile showed a high content of branched-chain, lysine, conditionally essential AA, except for sulfurated (presented as limiting in all samples). Analyzing both processes, there was no significant difference in the protein contents, essential/non-essential AA, ivPD, and ivDigestible, ivDIAAS values. Maceration with water disposal promoted losses of soluble proteins and PC, which contributed to reducing the antioxidant capacity of the treated grains. The highest antioxidant activity values occurred in *BRS Esplendor* after the autoclave treatment (29.57 micromol Trolox/g) and in *BRS Ametista* after the HPS treatment (26.20 micromol Trolox/g). The bean protein quality was considered satisfactory in both sterilization processes, presenting meaningful data to the bean industry.

Proximate Composition and Volatile Profile of Pequi (*Caryocar brasiliense*) Pulp

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Universidade Federal de Goiás, Programa de Pós-graduação em Ciência e Tecnologia de Alimento, Goiás-Brasil.

Abstract:

Caryocar brasiliense, known as pequi, is a native fruit valued in local cuisine and traditional medicine. Its aromatic properties, due to ethyl esters, saturated fatty acids, and long-chain hydrocarbons, enhance the flavor of various culinary preparations, such as sauces and liqueurs. However, there are few detailed studies on the pulp's composition regarding aromatic compounds and proximate composition. This study aimed to analyze the proximate composition, mineral profile, and volatile organic compounds present in the pulp. The fruit underwent sanitization, peeling, selection, and pulp extraction, followed by cooking at 80°C for 1 hour and separation through a 1 mm sieve. Volatile aromatic compounds were analyzed using a Shimadzu Nexis GC2030 gas chromatograph coupled with a mass spectrometer and SH-Stabilwax-ms column. Samples of 3 g were incubated in headspace vials for analysis. Proximate composition analyses followed AOAC methodologies. Results indicated: proteins 2.89 g/100g, lipids 12.56 g/100g, carbohydrates 17.96 g/100g, total dietary fiber 7.54 g/100g, and moisture 58.65 g/100g. Minerals such as potassium (176.81 mg/100g), calcium (403 mg/kg), and magnesium (39.60 mg/100g) were found. In volatile compounds, ethyl hexanoate predominated in the pulp, followed by ethanol and butanoic acid, while in the peel, 3-penten-2-one and furfural were more abundant. Pequi pulp stands out for its high lipid and fiber content, as well as significant volatile compounds that enrich its nutritional and gastronomic value. These findings reinforce pequi's potential as a nutritious and flavorful food, promoting its conservation and sustainable use.

Antioxidant Potential of the Residue from the Extraction of Pigments from Jaboticaba (*Plinia cauliflora*)

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Abstract:

Jabuticaba (Plinia cauliflora) is a fruit originating from the central-southern region of Brazil, in the form of small fruits, with a diameter of 3 to 4 cm, black skin and white pulp attached to the seed. The fruit has a sweet and astringent flavor, due to its high content of sugars, acids

and polyphenols. During jabuticaba processing, the skin and seed are generally neglected, representing up to 50% of the fresh fruit (Miranda et al., 2023). A good alternative for using this waste is the recovery of its bioactive substances for industrial applications (Miranda et al., 2022). However, due to its high biological value, even after the extraction of these compounds, the extraction residue has great potential for technological use. In this sense, the objective of this work was to evaluate the antioxidant action of the residue from the extraction of pigments from jaboticaba peel. The antioxidant activity was determined following the DPPH method, using the Epoch Microplate Sperctrophotometer (Biotek Instumentes, VT, USA). Tests were performed with a calibration curve, using as reference antioxidant agent a 2 mM solution of Trolox (6-Hydroxy-2,5,7,8-tetramethylchroma-2-carboxylic acid) and the anthocyanin extract was used with concentrations from 0.1 to 0.5 mg mL^{-1}, and the IC50 values (mg/mL) were calculated based on a logarithmic regression curve. The jabuticaba extraction residue presented an IC50 of 0.067 mg/mL, demonstrating that the residue is still a substance rich in antioxidants and that it can be used for the re-extraction of bioactive compounds or directly in the incorporation of new products, contributing to a cleaner production system and with less waste.

Composition of Black Soldier Fly (*Hermetia illucens* L.) Larvae Flour, Raw and Defatted by Supercritical CO2 Extraction

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Abstract:

The continued increase in the global population and environmental concerns associated with conventional animal protein production are motivating the search for alternative protein sources. Thus, arises interest in antroentamophogy, the consumption of edible insects by humans, which has stood out for its economic, nutritional and sustainable advantages. Insect flours are recognized for their high nutritional value and have been incorporated into a wide range of bakery products as fortifiers or protein enrichers. Black soldier fly larva flour (Hermetia illucens L.) has high potential as an alternative source of proteins and amino acids, being advantageous for use in bakery products. The objective of this research was to evaluate the composition of raw and defatted Hermetia illucens L. larvae flour by extraction with supercritical CO2, including amino acids and also heavy metals. When comparing raw and defatted flour, an increase in the concentration of proteins (46.43 and 49.47%), fiber (9.07 and 12.54%) and all essential amino acids present in both was identified. The flours presented levels of heavy metals below those allowed by regulation, showing that the flours are free of these compounds, therefore, in this aspect, safe for the consumer's health. The results indicate that defatted flour from Hermetia illucens L. larvae offers valuable nutritional properties as a source of amino acids and fiber, being a promising alternative to enrich foods. The results of this research aim to promote health, encourage sustainable systems and environmental protection.

Development of Films with Antimicrobial Properties using Waste from *Solanum paniculatum* and *Dipteryx alata*

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Abstract:

The diversity of the Brazilian agro-industry and the availability of natural resources are excellent opportunities for development in a sustainable and integrated way, combining economic growth, and also the reality in the emergence of concerns about the sustainability of the agri-food system and chain. The agro-industrial residues of jurubeba (JU) (*S. paniculatum*) and baru (BA) (*Dipteryx alata*) fruits were collected from Brazilian agro-industrial plants. They were dried in a Tecnal® air circulation and renewal oven at 70°C until constant weight. After drying, a selection of particles adjusted to the particle size (0.500 mm and 0.250 mm respectively) was made. This material was vacuum-packed and kept at room temperature and protected from light to be incorporated into the films. The silver nanoparticles (AgNPs) were obtained following the methodology proposed by (LEE; OH, 2015). The starch-based films were prepared using a central composite design with three central points, where films were made using the casting method with JU or BA flours integrated with AgNPs, totaling 14 films. The results obtained are promising: All the films made with BA, even without AgNPs, have good antimicrobial activity on S. aureus, which could indicate good potential against Gram positives. The starch films combined with BA and JU baru have satisfactory antimicrobial properties for use in packaging. Baru films without AgNPs have the capacity to be edible, since the baru bark can be considered a probiotic, making it a functional and bactericidal film.

Study of a Local Productive Arrangement (LPA): Characterization of Aromatic Compounds Present in Cachaças from the Region of Orizona - Goiás - Brazil

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Abstract:

Cachaça is a traditionally Brazilian alcoholic drink obtained by fermenting and distilling sugar cane juice. Aromatic compounds are formed throughout the fermentation and distillation process of cachaça, and are influenced by the type of sugar cane used, the fermentation conditions, the type of still and the aging process in wooden barrels. This complex interaction of these compounds results in the wide variety of flavors and aromas found in different types of cachaça. The aim of this work was to characterize the aromatic compounds of four cachaças produced in the Orizona region. The methodology employed included the acquisition of cachaça samples from local businesses in the cities of Goiânia and Orizona. The cachaça samples were analyzed by gas chromatography using a Shimadzu Nexis GC2030 chromatograph coupled to a mass spectrometer to characterize the aromatic compounds. Compounds such as acetaldehyde, 1-propanol, 2-butanol, 1-butanol, 3-methyl, phenylethanol and ethyl acetate, acetic acid, which belong to various classes such as aldehydes, alcohols, esters and acids, were identified. There was a significant difference in the number of aromatic compounds identified as well as the percentage area of each compound, indicating that in some samples there was a greater predominance of 1-butanol, 3-methyl and in others 1-propanol, which may be associated with the different production and storage conditions.

Impact of Physical Treatments on Sorghum Flour Chemical Features

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Abstract:

The diversification of gluten free products market is an actual need in the context of a growing consumer demand for such products. Sorghum grains are a good alternative for people suffering from gluten intolerance. Sorghum processing could enhance its nutritional and functional value and reduce the content of antinutrients. This paper aimed to evaluate the effects of grinding and dry heat treatment on sorghum flour chemical composition in terms of amino acids, fatty acids and FT-IR molecular characteristics. Different particle sizes (L>300 μm, 200 μm<M<250 μm, and S<200 μm) of untreated (control) and dry heat-treated sample in optimal conditions (121°C for S, 132°C for M, and 140°C for L) were investigated. The amino acid profile of white sorghum flour fractions indicated the presence of essential amino acids, phenylalanine, lysine, isoleucine, leucine and histidine, as well as non-essential ones such as aspartic acid, tyrosine, phenylalanyl, glutamic acid. Dry heat treatment and grinding determined a different content in amino acids depending on the optimal temperature applied to white sorghum grains and their particle size. The particle size did not determine significant variations (p>0.05) in the content of fatty acids, and the content of PUFA, MUFA and SFA varied in the following order PUFA>MUFA>SFA in sorghum grains. A slight decrease of omega 6 PUFA content was observed with the reduction of the particle size, followed by a decrease in omega 3 acids content after the application of dry heat treatment. Thermal treatment favored the formation of β-helix protein structures, which could indicate protein aggregation. Regarding starch structure, crystalline areas were more abundant compared to amorphous ones in all samples and increased after dry heat treatment. These results could be helpful for processors interested in the development and optimization of novel gluten-free products based on sorghum flour.

Toxicity of Gadolinium on *Stevia rebaudiana*

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Abstract:

Gadolinium-based contrast agents are extensively used for diagnostic purposes in magnetic resonance imaging. Apart from their tremendous contribution in disease diagnostic, there are several issues related to their use. After administration, they are excreted unmetabolized and thus significant amounts are released in hospital effluents and, consequently, in wastewaters [1]. Gd presence in tap water and related beverages has been documented in Germany [2,3]. In this study, we have assessed the accumulation of gadobutrol on *Stevia rebaudiana* grown *in vitro* and in soil, and its impact on plant growth and plant metabolites (chlorophylls, carotenoids, ascorbic and dehydroascorbic acids). The plants were exposed to Gd in concentration ranges up to 3 mM.
We found that accumulation of Gd in the plants increases in a dose dependent manner. The plant metabolites were quantified by HPLC. For the *in vitro* treatments, the concentration variations of chlorophyll A and B, lutein, zeaxanthin, and beta-carotene showed similar trends.

Their concentrations increased up to 0.1 mM doses, while for the highest exposures of 1 and 3 mM, the concentrations of all investigated analytes were significantly lower compared to controls. The effects were milder for the soil grown plants. To conclude, we managed to establish a correlation between the Gd dose and the concentrations of stevia plant metabolites, and to compare the effects of similar treatments on *in vitro* and *in vivo* grown plants.

Accumulation of Metal Oxide Nanoparticles in Soybean Plants Grown *in vitro*

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Abstract:

Engineered nanomaterials (ENMs) are nowadays extensively used with significant technological advances, ranging from energy production and storage to agricultural and environmental applications, and to targeted drug delivery systems. Unfortunately, extended manufacturing and use of ENMs has become an environmental issue, due to their release in the environment.[1,2] In this study, we have assessed the accumulation of zinc oxide (ZnO-NPs) and titanium dioxide nanoparticles (TiO_2-NPs) into soybean (*Glycine max*) plants grown in soil and in vitro, and their impact on plant morphology and growth. Plant seeds were exposed to 10–1000 mg/L ZnO-NPs and TiO_2-NPs for 28 days. Accumulation in plants tissues was studied by ICP-OES and dark field hyperspectral imaging. A clear negative effect on plant morphology, with suppression of plant growth was observed for exposures to ZnO-NPs of 100 and 1000 mg/L. The root morphology was adversely affected, with almost complete inhibition observed at 1000 mg/L. The effects were much less pronounced for the soil grown plants. Contrarily, TiO_2-NPs showed no negative impact on the plant morphology. The NPs were accumulated in the soybean plant. The amounts of accumulated NPs were concentration dependent. For both ZnO and TiO_2 NPs, a preferential accumulation in the roots *vs* stems and leaves occurred. ZnO uptake was much higher compared to TiO_2 (2–10 times, depending on the plant organ). To conclude, we managed to quantify the uptake of ZnO-NPs and TiO_2-NPs in the soybean and to establish a connection between plant growth and morphology and nanoparticle type and concentration and to make a comparison between the *in vitro* and *in vivo* exposures to NPs.

Sensitive Organic Acids Detection by Surface-Enhanced Raman Spectroscopy

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Abstract:

Surface-enhanced Raman spectroscopy (SERS) offers the advantages of simplicity, low cost, and minimal sample preparation. However, the lack of standardization limits its broader applicability. In typical SERS applications, the analyte is mixed with a colloidal solution of silver nanoparticles. The plasmonic properties of these nanoparticles lead to a significant enhancement of Raman scattering, allowing detection primarily of the molecules adsorbed on the metal nanoparticle surface. The concentration of unadsorbed, free molecules is usually too low to significantly contribute to the spectrum. In our work, we optimized the SERS detection of organic acids, such as citric acid, fumaric acid, and salicylic acid, by selectively adsorbing these analytes onto the silver surface in the presence of cationic ions like Ca^{2+} or Mg^{2+}. This approach enabled selective SERS detection of organic acids at micromolar concentrations within complex mixtures.

Rapid and Non-Invasive Identification of Carotenoids in Food Samples using Thin-Layer Chromatography Combined with Raman Detection

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Abstract:

High-performance liquid chromatography (HPLC), combined with detectors such as UV/Vis spectroscopy or mass spectrometry, is considered the gold standard in food analysis due to its high sensitivity and reproducibility. However, HPLC is costly and time-consuming, limiting its use in routine analyses. Thin-layer chromatography (TLC) offers a faster and more economical alternative, but it requires reference substances to identify separated compounds. In this study, we demonstrate the use of Raman mapping to identify carotenoids directly on the TLC plate, providing a non-invasive and highly specific method without the need for external standards. Raman mapping, a function of Raman spectroscopy, enables spatial chemical analysis by scanning the sample with a laser and collecting spectra at predefined intervals. This technique provides both molecular and spatial distribution information for the compounds on the TLC plate. Unlike conventional Raman spectroscopy, which gives point-specific chemical data, Raman mapping creates a complete chemical image of the analyte distribution. When excited with a 532 nm laser, the resonance Raman spectrum of carotenoids is dominated by C-C and C=C stretching vibrations. Slight shifts in the C=C stretching vibration, such as at 1511 cm^{-1} for beta-carotene and 1518 cm^{-1} for zeaxanthin, allowed for their clear differentiation. Due to the intense Raman signal, the exposure time for each measurement was under one second, enabling mapping to be completed in a few minutes. By applying principal component analysis (PCA), we successfully discriminated between beta-carotene and zeaxanthin. This combined TLC-Raman method is rapid, cost-effective, and promises precise results for analyzing compounds in complex food matrices.

Fortified Edible Mushrooms with Vitamin D_2 and Evaluation of Their Biological Properties

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Abstract:

There is a vitamin D_2 deficiency worldwide due to low levels of sun exposure and dietary intake of this vitamin, because few foods naturally contain vitamin D and at low concentrations. Edible fungi emerge as a significant part of solution due to nutritional value and medicinal property with a broad spectrum of pharmacological activities and also, they serve as source to produce pharmacological active and beneficial compounds. The ergosterol, an essential component membrane-associated, is the biological precursor of vitamin D_2, which gets converted when exposed to ultraviolet light by photochemical reaction. The main objective was to determine the amount of ergosterol and vitamin D_2 in edible mushrooms. Edible mushroom known for their gastronomic value such as *Suillus luteus*, *Pleurotus ostreatus*, *Lactarius deliciosus*, *Grifola gargal* were exposed to different times of ultraviolet radiation to production of Vitamin D_2. The

content of ergosterol and vitamin D_2 were performed by LC-MS and detection of analytes within crude extracts were based on comparison of retention time and mass from high-resolution MS with reference compounds ($[M+H]^+$, $[M+H-H_2O]^+$). The extract fortified with higher amounts of vitamin D_2 was tested for its ability to inhibit reactive oxygen species (ROS) in endothelial cells (HEMEC) with the fluorescent probe CellROX Deep Red and intracellular ROS levels were analyzed using IncuCyte S3 live-cell imaging system. Data were expressed as RCU/mm^2/well (RCU as Red Calibrated Unit). The vitamin D_2 content was higher in the edible mushroom *Suillus luteus* with 43.61 µg/g after 90 minutes of exposure. The effect of *Suillus luteus* extract on oxidative stress showed that the incubation with *Suillus luteus* extract inhibits the ROS production induced by hydrogen peroxide (H_2O_2). These findings open new perspectives for future research on the therapeutic potential and application of this edible mushroom in the field of medicine and biotechnology.

Obtain the Best Blend between Maqui (*Aristotelia chilensis* (Mol.) Stuntz) and Murta ((*Ugni molinae*) Concentrated by Preparative HPLC, and Evaluate the Antioxidant and Anti-Inflammatory Effect in Cellular Model

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Abstract:

Maqui and murta (M&M) are berries with high antioxidant capacity. Maqui is native to South America and murta is an endemic shrub species that grows in southern Chile. They can provide beneficial health effects, such as being antidiabetic and cardioprotective, and can help prevent the harmful effects of oxidative stress in the body helping to prevent irritable bowel diseases. This research aimed to optimize mixtures between M&M by reverse phase preparative HPLC, to subsequently evaluate their anti-inflammatory, antioxidant and cytotoxic capacity with cellular models. Concentrated extracts were obtained by preparative HPLC (C-Prep). The maqui concentrate was lyophilized and reached 32% anthocyanin (delphinidin-3-glu), and the murta concentrate was lyophilized, achieving 11.8% quercetin (quercetin-3-glu). An optimization model was designed for a mixture of lyophilized M&M concentrate between 0 to 100% delphinidin-3-glu and 0 to 100% quercetin-3-glu. The antioxidant capacity ORAC (µmol TE/100 g) was used as a response variable. Regarding the results of the evaluated mixtures, the best ORAC result was achieved with a blend of 94.5% maqui extract rich in delphinidin-3-glu and 5.5% murta extract rich in quercetin-3-glu, a synergistic effect between both compounds, which achieved high ORAC values. Subsequently, studies were carried out on this optimal mixture of anti-inflammatory, antioxidant, and cytotoxic activity using the human intestinal cell lines CACO-2 and HT29-MTX-E12. The results indicate that the extracts inhibit the inflammatory response induced by TNFα and stimulate Nrf2 activity, respectively. On the other hand, the concentrated extracts did not show cytotoxicity for the CACO-2 and HT29-MTX-E12 cell lines. The 94.5% and 4.5% M&M mixture is very promising for the prevention of some chronic diseases.

Sacha Inchi Oil Press-cake: An Alternative Protein Source for Obtaining Red Tilapia Fillets with Enhanced Levels of Essential Omega-3 Fatty Acids under a Sustainable Approach

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Abstract:

Tilapia (*Oreochromis* spp.) is one of the most important species in fish production, because its fillets (TF) are highly appreciated by consumers, due to their sensorial attributes and lower costs in comparison to other omega-3 rich fishes such as tuna and salmon. Because TF contain relatively low amounts of omega-3 fatty acids (ω-3), the interest in increasing the concentration of these compounds in TF has pushed the research on alternative and sustainable ingredients to obtain TF with enhanced nutritional value, through feeding. Sacha Inchi oil press-cake (SIOPC), the main by-product of the Sacha Inchi (SI) oil processing industries, is characterized by its richness in proteins and ω-3. Due to important expansion of the Sacha Inchi plantations in Colombia, and because of the socio-economic importance that this culture represent for local communities, in order to reuse and valorize this by-product, in this work we investigated the effects of using SIOPC as partial replacer of soybean meal, on the productive parameters and meat quality of red tilapia. Seven groups of 16 tilapia each were fed with two SIOPC-based diets (5 and 24% fat content), with which soybean meal was replaced at 15, 30, and 50% levels. Experiments were carried out in earthen ponds in triplicate for a period of three months. No significant differences were found in the fishes' productive parameters in comparison to the control diet. However, the concentration of ω-3 was significantly enhanced in the animals fed with the SIOPC-based diets, without affecting neither their sensorial acceptability nor their oxidative stability. These results indicate that utilizing SIOPC as protein source for feeding red tilapia represents a promising approach to enhance the ω-3 content in TF, while contributing to the circular economy, and to the valorization of agro-industrial residues, which could provide a positive environmental impact in the SI chain value.

Modeling Multiscale Mass Transport within a Cocoa Bean during Polyphenol Extraction

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Abstract:

Plant-based foods are composed of cells that store various compounds, such as water, lipids, and secondary metabolites. These compounds can be released, reacted, or transported through porous spaces formed by cells and tissues. Consequently, the transport process is complex and necessitates a systematic understanding at multiple scales (cells and tissues). In this study, the Fick diffusion model was used to analyze the variation of polyphenols in cocoa beans during their transport from the interior to the exterior (liquid water) at a constant temperature. It is assumed that the solid is composed of cells, pores, and tissues. Therefore, an effective diffusion coefficient across different scales was used, taking into account an interscale resistance constant, Knudsen diffusion, and the molecular diffusion of polyphenols. The interscale resistance constant proposed in this work is a parameter to measures the difficulty of mass transport between the two scales. The model was successfully validated using experimental data on the variation of gallic acid, obtained from both solid and liquid phases by immersing the cocoa beans in water at a constant temperature.

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