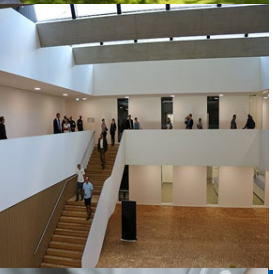

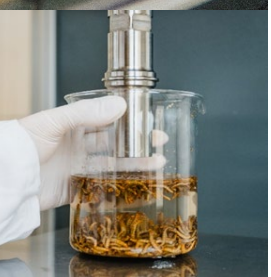

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2024 EFFoST / IFT-NPD WORKSHOP ON NONTHERMAL PROCESSING OF FOODS

Book of Abstracts

7h – 9th October 2024
Potsdam, Germany

Bornimer Agrartechnische Berichte
Heft 109
Potsdam 2024

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Preface

Food loss and waste, hunger and obesity are still of high importance as indicated by recent publications, e.g. Nature Food (https://doi.org/10.1038/s43016-024-01041-7) and The Lancet (https://doi.org/10.1016/S0140-6736(23)02750-2). From a holistic perspective, new nutritional concepts should include a physiologically balanced, mainly plant-based diet, novel alternative food resources and innovative technologies. In this context, nonthermal processing methods offer an opportunity to imagine new pathways for the processing of conventional and alternative food resources. Thus, the capabilities of already established processes such as high pressure processing (HPP), pulsed electric fields (PEF) treatment, the use of ultraviolet (UV) light and various radiation sources, along with less explored processes such as ultrasound (US) and cold atmospheric pressure plasma (CAPP), must all be taken into account. Additionally, the combination of electrical and thermal processes (e.g. ohmic heating and PEF-assisted drying) as well as nonthermal and thermal techniques (e.g. high pressure freezing, and high pressure thermal sterilization) can also bring benefits.

The “2024 EFFoST/IFT-NPD WORKSHOP ON NONTHERMAL PROCESSING OF FOODS” is organized for the first time by the Leibniz-Institut für Agrartechnik und Bioökonomie e.V. (ATB) in the Center for Research and Communication in a Circular BioEconomy (CIRCLE) between October 7-9, 2024. The workshop is organized through a collaboration between EFFoST, the European Federation of Food Science and Technology, and the Nonthermal Processing Division of IFT, the Institute of Food Technologists. The workshop provides an overview of the state-of-the-art developments in nonthermal processing of food materials and aims to emphasize both the diversity of the processes and the products to be treated, and also the resilience and sustainability of various applications that can deliver the best possible holistic food concepts. This is encompassed in the theme of the workshop, “Nonthermal processes to foster diversity, sustainability and resilience of future food systems”. This publication contains the abstracts of all oral and poster presentations at this event.

Within the workshop, we will offer a special platform for intensive and trustful professional exchange between newcomers and experts in the field, between academia and industry. We have compiled a broad scientific program consisting of five central workshop themes: i) Applications of high

pressure processing, ii) Applications of pulsed electric fields, iii) Applications of ultrasound and sonication processes, iv) Applications of cold plasma, v) Sustainability aspects, and vi) Success stories of innovations in food processing. In total, the workshop has attracted 55 presentations from 11 countries and 5 continents. During the three days of the workshop, 8 short course lectures and 33 oral presentations will be delivered in seven plenary sessions. Additionally, 14 posters and 3 company stands will be displayed for further discussion and scientific exchange. The COST Action (CA19110) on Plasma Applications for Smart and Sustainable Agriculture – PlAgri will also be considered during the workshop. Finally, as the chairpersons of the workshop, we would like to express our sincere gratitude to the authors, members of the scientific committee, sponsors and supporters for their valuable contribution.

Oliver Schlüter, Carmen I. Moraru, Marios Psarianos
Potsdam, October 2024

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About the venue

The Leibniz Institute of Agricultural Engineering and Bioeconomy e.V. (ATB) is a nationally and internationally networked research centre, working as world leader in the agricultural engineering and bio-economy research fields.

Founded in 1992 as Institute for Agriculture Engineering Bornim e.V., ATB immediately became part of the Blue List, later named Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz (WGL), today Leibniz Association. Following the increasing research outputs in the bio-economy and sustainable production fields, the institute was officially renamed on September 1, 2016, becoming “Leibniz Institute for Agriculture Engineering and Bio-economy”.

Today, ATB is an international recognized institution, which research is guided by the idea that a circular, diversified, innovative and sustainable bio-economy produces healthy food for all, operates on the basis of renewable raw materials and facilitates the realization of the One Health concept for humans, animals and the environment.

ATB has state-of-the-art infrastructures, including special laboratories, large-scale equipment (atmospheric boundary layer wind tunnel), pilot plants (pilot plant for lactic acid , pilot plant for natural fibre processing) and experimental equipment (e.g. the Field Lab for Digital Agriculture in Marquardt) as well as the model farm project *Innovationshof*, a real-lab for sustainable circular bio-economy, which is currently being established.

Since 2019, the latest ATB research building CIRCLE has been expanding the infrastructure. CIRCLE stands for 'Center for Research and Communication in a Circular BioEconomy'. With 25 laboratories and 23 offices, the research building offers workplaces for about 60 employees, especially in the fields of microbiology and IT

The peculiar interdisciplinary approach of the institute, covering a broad spectrum of methods from the natural, engineering and economic sciences, and the constant dialogue with society, enables ATB to effectively contribute on solving socially relevant issues and to continuously transfer knowledge into the modern economy. Through a 360-degree approach, spacing from basic research to final application, ATB aims to create a solid knowledge-based scientific foundation, with the goal of transforming the

agricultural, food, industrial and energy systems into a comprehensive bio-based circular economy.

The research carried out at ATB is structured in five well-integrated program areas:

- ❖ Diversified crop production
- ❖ Individualized livestock production
- ❖ Healthy foods
- ❖ Multifunctional biomaterials
- ❖ Integrated residue management

Aligning to the ATB main goal and focusing on the three main drivers of diversification, digitalisation and microbiota management, each program area works in strict connection aiming to create and promote a sustainable intensification of traditional and innovative production systems and improving the quality of life.

The capital region can also look back on a long history of German and European research in the field of innovative nonthermal techniques for food processing, as the first studies in this area were carried out more than three decades ago. The ATB has various systems for the nonthermal treatment of food, such as high pressure units, plasma generators, PEF systems and ultrasonic units. In the innovation laboratory (about 200 m^2), tailor-made process modules are assembled for the sustainable production of protein-rich food from alternative sources such as macroalgae and edible insects. Various nonthermal processes are used for extraction and modification of relevant food ingredients, sometimes combined with conventional processes.

Program overview

Monday 7. October 2024	
8:00	Shuttle Bus to ATB from Potsdam
8:30	Registration desk open
9:00-9:30	Opening remarks and initiation of the short course
9:30 – 17:45	Short course on nonthermal processing
17:45 - 18:00	Concluding remarks and discussion
18:00 – 20:00	Get together
20:00	Shuttle Bus to Potsdam city center from ATB
Tuesday 8. October 2024	
8:00	Shuttle Bus to ATB from Potsdam
8:30	Registration desk open
9:00 - 9:20	Opening ceremony and welcome remarks
9:20 – 11:00	Presentation session
11:00 – 11:40	Coffee break and poster session
11:40 – 13:00	Presentation session
13:20 – 14:00	Lunch break and poster session

14:00 – 15:40	Presentation session
15:40 – 16:10	Coffee break and poster session
16:10 – 18:10	Presentation session
18:20	Shuttle bus to Biosphere Potsdam from ATB for the Gala Dinner
19:00	Gala Diner
Wednesday 9. October 2024	
8:45	Shuttle Bus to ATB from Potsdam
9:15	Registration desk open
9:30 – 11:10	Presentation session
11:10 – 11:40	Coffee break and poster session
11:40 – 13:00	Presentation session
13:00 – 14:00	Lunch break and poster session
14:00 – 15:00	Presentation session
15:00 – 15:20	Closing remarks
16:00	ATB lab tour (optional)
16:00	Shuttle Bus from ATB to Potsdam central station

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2024 EFFoST / IFT-NPD Workshop on Nonthermal Processing of Foods

Oral presentations

Combining non-thermal plasma technology with hygienic design for food and water safety for fresh-cut lettuce

Uta Schnabel[1], Clemens Morath[2], Jörg Stachowiak[1], Andreas Ell[3]; Oliver Schlüter[4]

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2 GARTENFRISCH Jung GmbH, Jagsthausen, Germany
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4 Leibniz Institute for Agricultural Engineering and Bioeconomy, Potsdam, Germany

Bacteria, including human pathogens and zoonoses, are known for (persistent) biofilm growth. Especially in fresh food production this can be challenging, as high humidity and nutrient availability provide a perfect fundament for biofilm growth. Equipment with hygienic design, antimicrobial properties of the process water and CIP/SIP-processes offer avoidance of biofilm growth. The presentation will focus on plasma-processed-air treated water (PTW) application which was combined with hygienic design within a commercial lettuce washing line to investigate its industrial applicability and antimicrobial effectiveness. PTW was applied within a lettuce washing line to investigate total viable count (TVC), microbial viability and vitality of the fresh-cut lettuce itself and the process water with/without storage respecting the food quality and toxicology. In dependency of the PTW concentration TVC reductions of 2 lg-steps on the lettuce and 3 lg-steps in the process water were detected. Viability and vitality were decreased additionally. Food quality like color was not affected and no toxicological effects have been seen. The implementation of PTW at different washing steps was realized under industrial conditions. The promising results of this project, the strong industrial need and the realistic implementation possibilities offer new non-thermal plasma-based tools for the challenging defense against biofilm growth in food industry.

The innovative application of ultra-high pressure in the processing of fermented chili peppers

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2 National Engineering Research Centre for Fruit and Vegetable Processing, China
3 Key Lab of Fruit and Vegetable Processing, Ministry of Agriculture and Rural Affairs, China
4 Beijing Key Laboratory for Food Nonthermal Processing, Beijing, China

Fermented chili pepper is a prominent traditional Chinese fermented food renowned for its distinctive flavor and purported health benefits. However, challenges such as high salt content during natural fermentation, susceptibility to stray bacterial contamination, and variability in fermentation quality necessitate innovative approaches for enhancement. In this study, we developed three novel methods integrating inoculated fermentation with ultra-high pressure processing (HPP). Initially, we identified a strain of *Lactiplantibacillus plantarum* (LP1) exhibiting robust resistance at pH 3 and demonstrating exceptional fermentation capabilities. Subsequently, we introduced a novel processing technique for low-salt inoculated pickled chili peppers utilizing LP1 for fermentation, followed by HPP sterilization of the final products (LP1 fermentation + HPP sterilization). Additionally, we cultivated a strain of *Lactiplantibacillus plantarum* (LP2) resilient to pressures up to 400 MPa, and devised two distinct inoculation strategies for processing low-salt inoculated chopped chili peppers. One strategy involved HPP treatment to mitigate bacterial presence in raw chili materials prior to LP2 fermentation (HPP for bacterial reduction in raw chili peppers + LP2 fermentation), while the other method employed HPP to minimize bacteria in inoculated chili peppers post-inoculation (HPP for bacterial reduction in inoculated chili peppers + LP2 fermentation). This research offers theoretical insights and innovative pathways to enhance the stability and value of fermented chili products, thereby fostering advancements in the fermented chili products industry toward healthier product development.

Decontamination of almond-based milk alternative by pulsed electric fields: Comparison of microbial resistance and chamber design

Arisa Thamsuaidee[1,3], Matteo Stefanelli[2], Claudia Siemer[1], Vasilis P. Valdramidis[3]

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To explore pulsed electric fields (PEF) as an alternative to thermal pasteurization of almond-based beverage. Two different designs of treatment chamber were compared with regards to decontamination performance and contribution of thermal vs. electroporation effects on spoilage microorganisms. The microbiota of almonds and almond beverage was identified via MALDI-TOF MS and/or 16S rRNA sequencing. Microbial challenge tests were performed in a continuous PEF system equipped with treatment chamber in either co-linear or parallel-plate configuration. To differentiate between heat and electroporation, work was performed to obtain the thermal inactivation kinetic parameters and the PEF temperature-time profiles for each type of treatment chamber. *Pediococcus pentosaceus* was the most frequently identified vegetative non-spore forming microorganism in almonds and the unprocessed beverage. In comparison to *Lactiplantibacillus plantarum* WCFS1, *P. pentosaceus* exhibited higher resistance against PEF and thermal inactivation. As the PEF process intensity increased (as exemplified by the electric field strength and specific energy input), it was possible to achieve ≥5 $\log_{10}$ reductions of vegetative microorganisms in almond beverage, resulting in a product with extended storage life at refrigeration temperatures. The parallel-plate design was found to have an overall lower temperature impact in comparison to the standard co-linear design. The study offers insights into the type of microbial contaminants found in almond-based beverages. While PEF proved to be a promising technology for gentle preservation, it will be crucial to define the target pertinent microorganisms during process optimization, as there could be variability in resistance between different spoilage species. Furthermore, utilizing a different chamber design could form part of the optimization strategy to overcome the heat sensitivity of valuable food components.

Impact of electrolyte water treatment and storage conditions on polyphenol content and antioxidant capacity of whole apple fruit

Oluwafemi J. Caleb[1,2], Nandi E. Nyamende[1,2], Zinash A. Belay[3], Buhle Mpahleni[4], Ayodeji B. Oyenihi[4]

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The benefits of whole fresh apple fruit are often attributed to their high antioxidant content and other secondary plant metabolites. Extensive research supports the role of secondary plant metabolites such as polyphenols in the prevention of degenerative diseases. This study was undertaken to investigate the impact of electrolyte water treatment (200 mg L^{-1} and 300 mg L^{-1}) on total phenolics and antioxidant properties of 'Granny Smith' apples during storage. Apples were stored at 0.5°C for 3 months prior to treatments and storage at 5 °C for 21 days to simulate the average conditions at retail shelf life. Antioxidant capacity differed between the treated and non-treated (control) apples. Cold storage for 3 months increased the antioxidant capacity and maintained polyphenol content in 'Granny Smith' apples. Shelf life storage at 5 °C and electrolyte water treatment led to an increase in polyphenol content and in antioxidant capacity compared to the control. Correlation analysis showed a positive correlation between total phenols and antioxidant capacity. Lipophilic antioxidants (via ORAC) declined across all treatments at the end of storage, while hydrophilic antioxidant activity using the FRAP assay and TEAC assay increased during storage. Storage experiments indicated that the high content of polyphenols and antioxidants of 'Granny Smith' can be sustained by the treatment with electrolyte water.

Potential for mild microwave treatment on biochemical qualities, secondary metabolites, and microbial load of 'Sunectwentyone 'nectarine fruit

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Nectarines are prone to rapid quality loss and deterioration during postharvest handling, resulting in a notably short shelf-life. To address this challenge, exploring non-thermal chemical free methods for extending shelf life in a safer, health-conscious manner is essential. This study assesses the effectiveness of microwave treatment in preserving the physicochemical quality, microbial load, and secondary metabolites of 'Sunectwentyone' nectarines stored at 2°C for 21 days. The experimental design involved three groups: nectarines subjected to mild microwave (MW) treatment at 100 W for 55 seconds, those dipped in a sodium hypochlorite (SH) solution (200 mg/L) for 5 minutes, and untreated controls. The results indicated that MW treatment significantly ($p < 0.05$) improved texture and color (Chroma, C^*), thereby enhancing overall fruit quality compared to untreated controls. Both MW and SH treatments effectively inhibited the growth of aerobic mesophilic bacteria, yeast, and mold throughout the storage period. Notably, MW treatment preserved key *Prunus* genus metabolites, including 2-Hexenal, 1-Hexanol, 2-Hexen-1-ol, oxalic acid dimorpholide, and benzaldehyde, which are vital for the fruit's quality and aroma. Additionally, MW treatment successfully removed agrochemical residues such as Isopropyl myristate and 4-intro-1H pyrazole. In summary, this study demonstrates that microwave treatment is an effective non-chemical method for extending the shelf life of 'Sunectwentyone' nectarines. It offers a viable alternative to thermal and chemical based postharvest treatments by preserving key quality attributes, reducing microbial contamination, and eliminating harmful residues.

Production of HPP natural hydrogels from conventional and non-conventional starch sources

Katerina Koshenaj[1], Giovanna Ferrari[1,2*]

1 Department of Industrial Engineering, University of Salerno, Fisciano (SA), Italy
2 ProdAl Scarl, Fisciano (SA), Italy

Starch-based hydrogels are complex networks known for their ability to absorb and retain substantial amounts of water, attracting significant interest in recent years. Conventional starch sources such as cereal crops, pulses, and tubers have been utilized in the production of these biomaterials. This study aimed to produce starch-based hydrogels using high-pressure processing (HPP) with conventional and non-conventional starches isolated from pea flour, lentil flour, unripe apples, and banana peels. The starch powders isolated through traditional methods showed high starch content (76.91-86.56%) with minimal starch damage. The amylose content of these starches ranged from 18.74% to 22.42%, classifying them as normal starches. The recovered starches suspended in distilled water (25% w/w) were then treated at 600 MPa for 15 minutes at room temperature to enable starch gelatinization. Gel formation was assessed by analyzing the samples' gelatinization extent, structuring level, and swelling power. Further characterizations of the obtained hydrogels were performed, evaluating their physical appearance and flow profile. The results indicated that the starch-based hydrogels produced under these processing conditions exhibited variations in gel formation, physical appearance, and flow behavior. These differences were attributed to the distinct properties of the recovered starches. However, the mechanical properties and physical stability of these structured materials during shelf life should be assessed in future studies.

Assessing electroporation of different plant tissue structures: Influence of method of analysis on quantification

Madita Kirchner[1,2], Claudia Siemer[1], Damijan Miklavčič[3], Stefan Toepfl[1,4], Samo Mahnič-Kalamiza[3]

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2 Institute of Food Technology, University of Natural Resources and Life Sciences, Vienna, Austria
3 University of Ljubljana, Faculty of Electrical Engineering, Ljubljana, Slovenia
4 Osnabrueck University of Applied Sciences, Osnabrueck, Germany

The use of Pulsed Electric Fields (PEF) has been successfully implemented in the potato industry, but its application in the vegetable industry remains limited due to the lack of knowledge on the behavior of various plant tissue types in subsequent processing steps. Our work aimed to investigate the non-uniform effects of PEF treatment due to the structural diversity of plant tissues commonly used in industrial applications. These include mostly homogeneous tissues (red beet, sweet potato), tissues with lignified parts (broccoli), and tissues with varying characteristics (inhomogeneities) within the same raw material (parsnip, carrot). The applied PEF treatment ranges from a field strength of 0.4 to 3 kV/cm with specific energy inputs up to 6.5 kJ/kg. Electrical impedance measurements were conducted before and immediately after the PEF treatment as well as after a holding time of 10 minutes to monitor effects of water redistribution. Texture analysis was performed using compression and cutting force measurements to determine the responsiveness of PEF treated tissue to different force applications by comparing thresholds. The results show that the more complex the tissue structure, the less homogeneous the PEF treatment. This can be attributed to factors such as air pockets, low-conductivity structures (e.g. lignin), and variations in water content and distribution. Due to these, the orientation of the tissue in the electric field also plays a crucial role when treating inhomogeneous materials. Varying temporal changes in the average impedance ratio (after-to-before the treatment) were observed for different treatment protocols and need to be considered for industrial processes when holding times are part of the production line. Based on the findings, appropriate PEF assessments and treatment conditions can be defined for different groups of plant raw materials, ensuring a gentler and more efficient production process.

Sustainable valorization of cherry pomace: A novel cascade approach using pulse electric fields and ultrasound-assisted extraction

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The sustainable valorization of biomass residues, particularly in the context of food science, is gaining significant attention. Sweet cherry pomace, a by-product of sweet cherry processing, is a rich source of bioactive phenolic compounds such as flavonols, flavan-3-ols, anthocyanins, and hydroxycinnamic acids are known for their antioxidant, anticarcinogenic, and antihypertensive properties. To efficiently extract these valuable compounds, a biorefinery approach known as the Bio-cascade is being adopted, aiming to transform biowaste into high-value products. This study fills a critical research gap by investigating the combined impact of Pulsed Electric Fields (PEF) and Ultrasound (US) on the recovery of phenolic compounds while emphasizing the importance of a tailored, progressive permeabilization strategy in the efficient and sustainable biorefinery process for cherry pomace. In this frame, a cascaded cell disintegration process, based on pulsed electric fields (PEF - 3 kV/cm, 20 kJ/kg.) and ultrasound-assisted extraction (P - 200 W, 20 min, f – 24kHz, T - 25°C ± 1°C) was designed for the efficient and selective release of intracellular compounds (total polyphenol content (TPC), flavonoid content (FC), total anthocyanins content (TAC), and antioxidant activity (FRAP). This extraction process is conducted in ethanol-water (50%, 50°C, 60 min, pH 2.5, solid-to-liquid ratio 1/5 g/ml). The resulting extracts will undergo comprehensive analysis using advanced techniques such as HPLC-DAD and Scanning Electron Microscopy (SEM). This innovative approach holds promise for boosting the efficiency of cherry pomace compound extraction, benefiting sustainable waste use and high-value food and pharmaceutical production.

Ultrasonic Extraction of Nutrients from Plant - From Feasibility to Production

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The extraction of proteins and bioactive compounds from plants is crucial for the development of functional foods and nutraceuticals. Traditional extraction methods often lack efficiency, speed, and the ability to preserve compound integrity. Probe-type sonication is a well-established technology offering numerous advantages for the extraction of proteins and bioactive compounds from plants. The linear scalability of ultrasonic extraction from batch to inline processing facilitates the scale-up to high-throughput production. Probe-type sonication employs high-intensity, low-frequency ultrasound waves to disrupt plant cell walls, effectively releasing intracellular compounds. This method is known for producing high extract yields and superior quality compounds, significantly outperforming traditional techniques. One of the primary benefits of sonication is its ability to accelerate the extraction process, reducing the time required from hours to minutes without compromising the integrity of the extracted compounds. This rapid processing capability enhances productivity and reduces operational costs. A key advantage of probe-type sonication is its non-thermal nature, which is particularly beneficial for extracting heat-sensitive bioactive compounds. Unlike conventional thermal extraction methods, which risk degrading sensitive compounds, sonication preserves the functional and nutritional properties of the extracts. This is especially important in the food industry, where maintaining the bioactivity of compounds such as polyphenols, flavonoids, and vitamins is critical for product efficacy and consumer health. Here we present exemplary extraction results from various plant sources, demonstrating the broad applicability and effectiveness of probe-type sonication. These case studies highlight the high yield and quality of proteins and bioactive compounds extracted using sonication, underscoring the method's versatility and robustness. Furthermore, a comprehensive overview of the successful scale-up of probe-type sonication from laboratory settings to full-scale production is provided. This includes insights into the technical challenges and solutions encountered during scale-up, such as equipment selection, process optimization, and integration into existing production lines. Practical examples illustrate how sonication technology can be effectively scaled to meet industrial demands while maintaining consistency and quality.

Optimisation of manothermosonication in the liquid whole egg pasteurisation: food safety and quality assessments

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Manothermosonication (MTS) offers a promising alternative to traditional thermal pasteurisation of liquid whole egg (LWE), aiming to reduce thermal impact while preserving quality. This study explored MTS's effectiveness in inactivating *Salmonella* Enteritidis DSM 17420 in LWE by modeling inactivation kinetics under dynamic thermal conditions and evaluating its effects on LWE's techno-functional properties. Using an own-designed MTS prototype, a central composite face-cantered design was applied, with wave amplitude (66-132 µm) and pressure (100-300 kPa) as variables. Kinetic parameters (D_{ref}-, z_T-, and z_{UI}-values) were determined under reference conditions (57°C, 166.91 W/cm^2). Optimal MTS parameters were identified at the highest amplitude (132 µm) and pressure (300 kPa), resulting in an ultrasound intensity of 277 W/cm^2. This configuration allowed rapid temperature increases, enhancing microbial inactivation in shorter time. In terms of techno-functional properties, MTS treatment significantly improved LWE's foaming capacity, increasing it by 3.2 times compared to thermal treatment. It also enhanced emulsion stability, producing smaller emulsion droplets (2.62 ± 0.05 µm) and a broader droplet size distribution, without notably altering the coagulation temperature (78.61 ± 0.33°C) compared to untreated LWE (78.71 ± 0.44°C). As a result, MTS emerges as a viable alternative to traditional pasteurisation, achieving equal food safety standards with the same processing time (3.5 min) but requiring lower thermal exposure. This reduction in thermal load resulted in improved foaming and emulsifying properties, offering better preservation of LWE ingredients and potentially enhancing the quality of end products.

Life cycle assessment of the manothermosonication of liquid whole egg: a comparative assessment with conventional thermal pasteurisation

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Manothermosonication (MTS) offers a promising alternative to traditional thermal pasteurisation, known for its high energy demand in the food industry. While previous studies on MTS in liquid whole egg (LWE) demonstrated improved food quality and safety, a comprehensive sustainability assessment of MTS as a preservation technology is currently lacking. This study aimed to compare the energy balance and life cycle assessment (LCA) of LWE processing using traditional thermal and MTS treatments at pilot scale. The analysis considered equal microbial decontamination levels of *Salmonella* spp. and the same production capacity (100 kg/h). Energy requirements for MTS were experimentally measured, while those for thermal treatment were empirically calculated. For the LCA, the "gate to gate" approach in the LWE processing was followed, focusing on a functional unit (FU) of 1 kg of pasteurised LWE. The analysis utilised SimaPro 9.5.0.2 software and the IMPACT WORLD+ methodology. Results indicated that MTS processing required 15.25% less energy (2.00 kWh/kg of LWE) compared to thermal processing (2.36 kWh/kg of LWE), due to the cavitation phenomenon in MTS, which eliminates the need for pre-homogenisation and reduces water usage. The LCA revealed lower environmental impact scores for MTS across all indicators, primarily due to reduced electricity and water consumption. For instance, the carbon footprint from LWE processing stages was 57.3% in MTS compared to 61.8% in thermal processing, with the environmental impact of thermal pasteurisation being 4.1 times higher than that of MTS. In conclusion, replacing traditional thermal methods with MTS in LWE processing is expected to significantly reduce energy and water consumption, offering a more sustainable alternative with a lower overall environmental impact.

Nonthermal plasma air treatment technology improving the safety of food by eliminating Escherichia coli 0157:H7, Listeria monocytogenes, and Salmonella enteritidis phage type 30 on surface inoculated spinach

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Escherichia coli, Listeria, and Salmonella cause most foodborne illnesses and are often harbored on ready-to-eat. Conventional post-harvest sanitizing and washing protocols are minimally effective to control microbial contamination of leafy greens. These pathogens were chosen for several reasons. Enhancements to existing sanitation methods may result in fresh produce that is safer to consume, more profitable; while facilitating improvements in sustainable practice. Nonthermal plasma generates reactive oxygen species in ambient air. Growing numbers of evaluations demonstrate ROS is highly effective in reducing bacteria and mold in refrigerated and non-refrigerated environments. Growers, shippers, wholesalers, and retailers of perishable commodities may significantly expand their market window, reduce losses due to decay and disease, and reduce operational risk and costs using this technology. We evaluated the effects of a modulated dielectric barrier discharge air treatment system generating reactive oxygen species concentration (0.04-ppm) using O3 as an indicator of reactive oxygen species production, relative humidity 60%, and treatment time (0.5 to 48-hours) to inactivate Escherichia coli, Listeria monocytogenes and Salmonella enteritidis inoculations on spinach leaf surfaces using response surface methodology. 5 cm x 5 cm spinach leaf surfaces were inoculated with the mentioned pathogens and were treated with 0.04-ppm ROS for periods from 30-minutes to 48-hours at 60% RH and at 36°F. After the treatment, the samples were subjected to enumeration by surface plating. The log reduction of the pathogens was evaluated with and without the consideration of resuscitation of injured cells after ROS treatment. Three different controls were prepared in each ROS treatment. For a positive control, 5 cm x 5 cm area of the spinach leaves were inoculated with the surrogate's cells and dried for 1-hour but not exposed to the ROS treatment. There were three negative controls, in which 5 cm x 5 cm spinach samples were inoculated with 100-µl droplets of sterile water and dried for 1-hour. One negative control was treated with ROS and the other was not subjected to the ROS treatment. Each treatment sample and the 3 controls were prepared in triplicate. The destructive effects of a modulated dielectric barrier discharge treatment system on the above pathogens were enumerated and displayed significant reductions in E coli 0157:H7, Listeria monocytogenes, and Salmonella enteritidis phage type 30 on Surface Inoculated Spinach. Additionally, our predictions were confirmed that treatment time significantly ($P<0.01$) increased the rate of log reduction. This evaluation shows a potential benefit to fresh and ready to eat produce growers and suppliers looking for disinfection enhancements that will increase product safety and reduce the cost of product recalls.

High pressure improves enzymatic proteolysis and the release of oligopeptides with α-amylase inhibitory from sea cucumber proteins

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Anti-diabetic peptides are a new class of anti-diabetic therapeutic agents. The effects of high hydrostatic pressure on proteolysis and the release of bioactive oligopeptides from sea cucumber (Stichopus horrens) proteins were evaluated at 100-600 MPa for 10 min. Their sulphated polysaccharides, structural proteins and in vitro α-amylase inhibitory activity were compared with control (0.1 MPa). Biochemical analyses revealed that HPP treatment significantly increased peptide formation (~20 kDa) and sulphated polysaccharides release at pressure above 400 MPa. 2D SDS-PAGE analysis revealed that protein expression is strongly influenced by increase in pressure levels with formation of low molecular weight peptides (~20 kDa) were identified as non-acidic proteins. HPP treatments also activated protease enzymes significantly above 400 MPa. The α-amylase inhibitory activity significantly increased above 400 MPa with the highest inhibition at 500 MPa (42.1% inhibition at 10 mg/mL) for both S. horrens soluble extract and hydrolysates. In summary, high pressure treatment facilitates protein conformational changes and proteolysis activity in collagenous sea cucumber proteins that enhances their anti-diabetic properties from the release of sulphated polysaccharides and low molecular weight collagen peptides.

Process simulation and LCA to assess novel solutions based on nonthermal technologies to increase the sustainability of tomato processing industries

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The agri-food sector has been identified as one of the most significant contributors to environmental degradation and emissions. Thus, to respond to today's societal demand for cleaner and greener production, the food industry has been striving to identify and apply more sustainable practices than current ones to minimize its negative impact on the environment. Among the strategic measures to increase the sustainability of the food industry, the efficient utilization of the resources and the adoption of innovative technologies in the processing lines to substitute or complement the traditional ones have been proposed. Within the framework of the H2020 European Project 'Accelwater', this work presents the results of a process simulation approach used to evaluate the overall system performance when different alternatives are applied for an Italian tomato processing company as sustainability solution. The implementation of different nonthermal technologies in the processing lines is considered through process simulation and the advantages obtained are evaluated by applying LCA considering the improved scenarios. The potential for reducing the environmental impact of the tomato processing industry through the implementation of conservation measures is discussed and the advantages deriving from the adoption of more sustainable processing practices are highlighted considering the reduction of the environmental impact and the economic benefits derived to the company.

The effects of nonionic kosmotropes under high pressure: implications for protein-flavonoid non-covalent Interactions

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Kosmotropic co-solutes, known for enhancing the structural order of water, stabilize proteins against external forces such as temperature and hydrostatic pressure (HP). Carbohydrates, alongside salts, exhibit kosmotropic properties. Pressure-induced protein unfolding differs from thermal unfolding, but most studies on the kosmotropic effect have been in the context of thermal unfolding. Proteins can interact non-covalently with flavonoids, influencing the properties of both. However, the impact of pressure on these interactions, especially in the presence of kosmotropes, remains underexplored. This study investigates protein-flavonoid interactions under pressure, with and without sugar as a nonionic kosmotrope, to better understand HP's impact on protein structure and interactions. We examined the effect of sucrose on the interactions between ovalbumin (a model protein) and flavonoids differing in structural features under HP and heating. CD spectroscopy revealed changes in protein secondary structure upon heating (65°C-90°C) and HP (300-500MPa). The addition of 1M sucrose significantly preserved the α-helical content in the protein structure after both treatments. This kosmotropic effect was also evidenced by a smaller increase in particle size due to aggregation, being more pronounced under HP than due to heating. Surface hydrophobicity increased significantly due to heating and HP but was also mitigated by sucrose. Flavonoids interacted non-covalently with ovalbumin in a structure-dependent manner, with glycoside presence and flavonoid planarity reducing binding. Both HP and heating enhanced flavonoid-ovalbumin interactions (up to a 2-fold increase in relative binding), likely due to exposure of hydrophobic domains, with heating having a greater impact. The kosmotropic effect of sucrose mitigated the processing-induced increase in interaction, and under HP, the interaction in the presence of sucrose was similar to that without HP. A correlation was observed between flavonoid structure-dependent hydrophobicity and the effects of sucrose and HP. Our findings emphasize the influence of kosmotropic effects on protein stability and functionality at HP, with potential applications in nutraceutical formulations and osmolyte utilization.

Nonthermal concentration of fluid foods using a hybrid membrane processing approach

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Concentration of liquid foods and beverages is traditionally achieved by thermal evaporation, an energy-intensive operation that also causes undesirable sensory and nutritional changes to the product. An alternative to thermal evaporation is Reverse Osmosis (RO), in which water is removed through selective semipermeable membranes, using high transmembrane pressures. Unfortunately, RO is negatively affected by concentration polarization and membrane fouling, which limits the achievable concentration of the final product. Forward Osmosis (FO), in which water is removed with help of a draw solution, allows much higher concentration levels to be achieved. This presentation will showcase how RO and FO can be combined into an efficient nonthermal process for the concentration of juices and beverages of high sensory and nutritional quality. The hybrid process, in which RO is followed by FO, takes advantage of the good performance of RO at low concentrations and of FO at high concentrations. For FO, product temperatures of 25 – 30 °C and high draw solution flow rates resulted in high water fluxes. The type of draw solution was also a key factor for FO efficiency. Of the four draw solutes tested (potassium lactate, dipotassium malate, fructose, and xylitol), dipotassium malate showed the highest water flux and the lowest reverse solute flux, due to its molecular weight and low viscosity. Tested at pilot-scale, the RO-FO hybrid process was able to concentrate dairy fluids (acid whey and skim milk) to ~ 45°Brix, and fruit juices (including strawberry, cranberry, and grape juice) up to ~50 °Brix, which is comparable to thermal concentration. Physico-chemical and sensory analyses demonstrated that the final products, upon reconstitution, had similar color, flavor, and appearance to the fresh, unprocessed single strength fluids. Overall, this study offers useful theoretical and practical insights for developing efficient FO and hybrid RO-FO processes for the concentration of liquid foods and beverages.

High pressure homogenization as a pre-processing technology to tackle techno-functional challenges of alternative protein sources in aqueous solutions

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Recent studies have shown the potential of High-pressure Homogenization, HPH, to address some of the techno-functional challenges in the utilization of alternative proteins (AP). Yet there are gaps in our understanding of HPH's impact. To provide a deeper understanding of how HPH affects techno-functionality and protein interaction with other components in aqueous solutions, we examined commercial protein sources from peas (differing in their composition) and potato, as well as self-extracted algae protein concentrate. We assessed the impact of HPH on various techno-functionalities and additionally, we studied the interaction of polyphenolic compounds with the proteins and the effect of HPH on forming a protein 3D network by thermal gelation or fermentation. As anticipated, HPH (≤200 MPa) led to a decrease in the particle size of all concentrates and an improvement in solubility for most. However, the extent of this effect varied significantly, from a 99% reduction in Dv50 for one of the pea isolates to ~35% reduction in a different one, attributed to a different composition of proteins and their ratio as quantified by proteomics, and solution pH of the unmodified aqueous solution. An increase in surface hydrophobicity (H0) due to HPH was observed for all tested AP sources, yet, unexpectedly, this was not correlated with increased interactions with polyphenols. This was contrary to our observations for hydrostatic high-pressure-induced H0 increase for animal-sourced proteins (tested with more hydrophobic polyphenols). Finally, for several tested protein sources, an improvement in forming a 3D protein network by fermentation or thermal gelation was observed, correlated with the increase in H0. HPH holds promise as part of the toolbox for improving AP techno-functionality, yet it's important to note that this conclusion may not apply universally to all sources, likely due to compositional variation between production processes and sources.

Cold plasma for the inactivation of emerging bacterial pathogens on fresh cut fruit and vegetables

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Foodborne diseases represent a considerable burden to public health and continue to challenge health systems worldwide. Besides traditional food borne hazards, safety of the food chain is facing new challenges, for emerging pathogens that have been underdiagnosed and underreported so far. Among bacterial pathogens, some Arcobacter species are emerging as food hazard, causing illness related to the consumption of fresh produce. The objective of this research was to test the inactivation effect of cold plasma (CP) on Arcobacter in fresh cut products. CP was generated by a Surface Dielectric Barrier Discharge (SDBD) placed at the top of a closed chamber and connected to a high voltage generator (peak voltage: 6 kV, repetition frequency: 23 kHz, power density: 425.35 ± 25.79 W, surface power density: 2.6 W/cm2). The inactivation effect was tested on a variety of Arcobacter butzleri strains, and compared to E. coli. Selected strains were then inoculated on fresh cut carrots and apples, treated with CP up to 30 min. Quality of the fresh product was also tested after plasma exposure. Results showed that inactivation was strain dependent. CP showed a promising inactivation effect, higher to the one obtained on E. coli, but dependent on the food matrix. Quality parameters (pH, color, bioactive compounds content ad enzymatic activity) were only slightly affected.

Mechanisms of accelerated inactivation of bacterial spores by ohmic heating

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Ohmic heating has been shown to accelerate the inactivation of the most thermally resistant sporeforming bacteria. Herein we investigated the influence of process parameters, such as electric field strength and frequency, and sought explanations for the effects of various spore components to determine which components within bacterial spores (*Clostridium sporogenes* and *Bacillus subtilis*) were affected by the field. In all cases, increasing field strength significantly increased the rate of inactivation; indeed, the temperature sensitivity of inactivation was greatly enhanced when field strength was increased, suggesting the possibility of a heat-cool process with no holding period. Among various components that were found to interact with the field were Small Acid Soluble Proteins (SASPs), 2Duf membrane proteins, SpoVA ion channel proteins, and Dipicolinic Acid (DPA). Components such as SpoVA that related to ion channels were strongly affected by electric fields. Components that strengthened the spore inner membrane (2Duf) resulted in a great increase in spore resistance to heat, and although electric field accelerated its inactivation, the increase was far less than for other variants. As expected, the loss of DPA caused a major decline in heat (and electric field) resistance of spores. Studies were conducted to test whether the accelerated inactivation could improve quality of heat sensitive products. Samples of green bean puree (baby food) were processed to equivalent sterilization levels using an ohmically heated pouch, and compared to conventional retort processing, Quality indicators, tested by a sensory panel showed significant improvement in the ohmically sterilized product.

Enhancing protein functionality in animal and plant-based foods by high pressure processing

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High pressure processing (HPP) is primarily used in the food industry to enhance safety and extend shelf life. However, HPP can also modify biopolymer structures, which can enhance their functional properties like water solubility, gel formation, water-holding capacity, or emulsification. This makes HPP a promising, additive-free method for structuring animal and plant-based food products to improve their sensory and health attributes. This paper explores the effects of HPP on myofibrillar and soy proteins, emphasising its commercial potential for fish, meat, and plant-based meat products. Specifically, our results have shown that application of high pressure at 200-400 MPa (2 min, 25°C) can effectively produce high quality textural properties of fish and meat sausages with reduced salt content having similar, if not better, texture and cooked yields compared to non-HPP sausages with normal (2%) salt equivalents. Sensory analysis also suggested that HPP can partially replace fat by water in sausage-type products due to improved textural and water-holding capacities during cooking. Soy-based sausages treated at up to 600 MPa (2 min, 25°C) showed increased protein solubility and water-binding. Low-field nuclear magnetic resonance indicated that water became significantly more bound with increasing pressure. Results for expressible moisture supported this, although the trend was statistically insignificant. There was no significant effect of treatment on colour or texture. This indicates that HPP can improve protein solubility and water-binding, with myoproteins being more easily modified by HPP than soy proteins. As protein demand increases, HPP has potential for the manufacture of reduced sodium, cleaner labelled, tastier and healthier animal and plant-based food products.

Designing and 3D printing of food snacks based on apple pomace and lemon albedo through the application of ultrasound technology

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Using natural sources, like agrifood residues, to create high-value products can meet the growing consumer demand for eco-friendly products. Exploring 3D-printed foods and their role as nutraceutical carriers may lead to customized nutrition and the develop of "green" products tailored to specific dietary needs. This study aimed at developing 3D-printed snacks based on the combined use of apple pomace (95-80%) and lemon albedo (5-20%) flours by integrating the Ultrasound (US) technology in the production process. The effect of US on the techno-functional properties of the binary blends as well as on the final product was assessed in terms of color, granulometry, hydration, texture and rheological properties, spectral characteristics (FTIR), reducing sugars, total phenolic content and antioxidant activity. In vitro digestion studies were also carried out to evaluate the bioaccessibility of bioactives during gastrointestinal digestion. The application of US showed the potential to increase the extraction yield of bioactive compounds (up to 40%) from the formulated mixtures. US treatment also induced significant improvements in the techno-functional properties, elastic and viscous moduli, printability, extrusion force and superficial smoothness of the mixtures. Higher amounts of lemon albedo flour led to increased lightness values, phenolic and carbohydrate contents, as corroborated by the FTIR spectra, detected when lemon albedo flour was added to the formulation up to 10% (w/w). The post-processing of the 3D-printed snack, consisting of microwave drying, did not lead to any degradation phenomena of the bioactive compounds. These promising results have highlighted the possibility of using US to produce 3D-printed snacks with improved printability, techno-functional properties, and potential health-promoting properties, based on the valorisation of low-cost and natural ingredients.

In vitro starch digestibility and gastrointestinal release of bioactive compounds from tapioca starch-based HPP hydrogels

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Starch-based hydrogels have received a great interest in recent years due to their potential applications in different fields. The characteristic stable structure enables their functionalization allowing the use of hydrogels as smart carriers of bioactive compounds from natural extracts. This work aimed to evaluate the in vitro digestibility of tapioca starch hydrogels, obtained by high-pressure processing (HPP) at 600 MPa for 15 min and by conventional thermal treatment (TT) at 80 °C for 15 min to assess the influence of HPP on starch digestibility. The starch disintegration, total hydrolysed starch, and starch nutritional fractions were determined during in vitro gastrointestinal digestion, which included oral, gastric, and intestinal phases. The ability of starch-based HPP hydrogels to encapsulate bioactive compounds, preserving and conveying them through the gastrointestinal tract was also investigated. Tapioca starch (20% w/w) and natural extracts (2% w/w) were suspended in distilled water and processed by HPP and the in vitro gastrointestinal release of bioactive compounds encapsulated in hydrogels was studied. Results demonstrated that the hydrogels underwent a high disintegration extent and degree of starch hydrolysis, being this more evident in HPP hydrogels with 88% of hydrolysed starch at the end of the digestion phases. Results also highlighted that the addition of natural extracts to the formulation of starch suspensions did not hinder the gelation process under high pressure. The encapsulation of natural extracts in the hydrogel structure allowed their controlled and prolonged release, enhancing the stability and bioavailability of bioactive compounds. These findings indicated that HPP could represent a key technology to increase the digestibility of resistant starch fraction of tapioca starch hydrogels, which could be a promising basis for creating food products designed to deliver bioactive compounds to the intestinal tract. Nevertheless, further investigations should be performed to study the effect of bioactive compounds on starch digestibility, the physical and microbiological stability of these structures as well as their performance during shelf life.

Cocktails for non-barkeepers: Use of phages for natural biocontrol of MDR *S. aureus* CC398 strains

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The MRSA CC398 variant is prevalent in livestock, and individuals who are in contact with food-producing animals are at high risk of colonization and subsequent infection. The natural biocontrol of MRSA in livestock and derived food products may be achieved through the use of phages. Nevertheless, it is challenging to develop mixtures of phages with diverse and safe spectra that complement each other in terms of efficacy and host range, while avoiding the emergence of bacterial phage resistance. The present study evaluates the suitability of phages for the biocontrol of *S. aureus*. The efficacy of the phages was evaluated through spot assays on 20 strains derived from German pig farms. The phages were evaluated through in vitro biocontrol assays and genomic analysis. Furthermore, the viability of distinct *S. aureus* for phage propagation was evaluated to prevent cross-contamination of the preparations with spontaneously induced prophages. Despite the sample material's provenance from numerous German pig farms and slaughterhouses, the predominant identification was of closely related PSa-type podoviruses. These exhibited high efficiency with similar host ranges, covering approximately 70-75% of the 60 MDR LA-MRSA strains tested. WGS and bioinformatics analysis demonstrated that the recovered phages are safe for use and biocontrol of *S. aureus*. The majority of the phages demonstrated high efficacy in reducing *S. aureus* in vitro, but their reduction potential in/on food was found to be inferior. Safe polyvalent phages are pervasive in animal-associated sample materials, yet they are represented by a narrow spectrum of types. This presents a significant challenge in the preparation of compositions with broad bacterial receptor specificities, which are necessary to prevent the development of phage resistance in bacteria. Stress-induced prophage induction during propagation can result in cross-contamination of the composition with temperate phages carrying SEs, which also increases the likelihood of transduction of DNA from the bacterial host. While the potential applications of phages are promising, they must be carefully adapted to the matrix-specific properties.

Diversity of high-pressure processing units and applications

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The widespread adoption and progression of high-pressure techniques across numerous industries have been propelled by consumer preferences for transparent labeling, microbial safety requirements, and the pursuit of innovative product capabilities. Industrial-scale technologies using high isostatic or waterjet pressure and supercritical fluids are prevalent in the food, pharmaceutical, and material sectors. This presentation will emphasize high-pressure processing (HPP) units operating at ultra-high pressures (up to 600MPa) and highlight the novel applications across the food, feed, and cosmetic sectors. The HPP is a widely accepted nonthermal technique in the food industry for extending the shelf life and eliminating pathogens without impairing food's nutritional value, color, and flavor. It has been increasingly adopted in the seafood industry for the complete and efficient separation of meat from shells while providing superior overall product quality. Over the last few years, HPP has been progressively implemented as an antimicrobial intervention for raw pet food. Newly, HPP has been utilized as an intermediate processing step to meet GHP while preserving heat-sensitive bioactive ingredients in raw materials for supplements and cosmetics. Recent trends involve using HPP to stabilize the taste of fermented products or treat biomass rich in high-quality and thermosensitive nutrients such as edible seaweed or microalgae. The nonthermal structural alteration of hydrocolloids using high hydrostatic pressure has opened countless possibilities for developing and preserving novel food based on plant and insect proteins. The design of HPP units depends on factors like required output, pressure level, regional standards, and product-specific operational requirements. Industry demands include greater output, maximum safety, minimal investment, low operating costs, and minimal downtime. On the other side custom pilot plant design offers various process designs and data manipulation. Expanding application and outsourcing of HPP foster further development of automated and semi-automated solutions for more efficient product handling, quality management systems, digitalization, efficient water recycling, and cleaning programs to minimize operating costs, increase safety, and ensure product quality.

Impact of high-pressure processing on the textural and microbiological quality of food and feed based on alternative proteins

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The heightened awareness of climate change has fostered the use of alternative proteins in food and feed. High hydrostatic pressure processing (HPP) has traditionally been used in the food industry for nonthermal preservation without affecting flavor, color, or nutritional quality. Newer approaches explore the technology for improving consistency with fewer additives, fat, or salt to enhance the nutritional value of protein-based products. This work showcases the examples of the HPP effect on the texture, color, and emulsion stability of commercial soy-based yogurt and dessert. For the first time, the impact of HPP on the texture, microbiology, and nutritional content of raw dog food enriched with the protein from the Black Soldier Fly Larvae (BSFL) will be presented. The chosen soy-based products were optimally treated at 300 MPa for 3 min and kept at 4 °C to extend shelf time for up to 4 weeks while maintaining structural integrity and mouthfeel. In contrast to the soy dessert, soy yogurt had lower hardness and adhesiveness than the control samples. Up to 30 days of storage, no significant perceivable change in color ($\Delta E<5$) and oil droplet size was observed in HPP samples using spectrophotometry and static light scattering spectroscopy, respectively. The HPP showed great potential for improving microbiological quality and sensory attributes of tested soy-based milk substitutes. The raw chicken-based diet with up to 25% BSFL had favorable consistency and acceptable textural properties compared to the basic formulation (0% BSFL). However, adding BSFL increased the risk of higher initial counts of Enterobacteriaceae, E. coli, yeasts, and molds. The HPP at 500MPa for 5 min efficiently reduced spoilage and pathogenic microorganisms to a safe level and stabilized the color over 28 days at 4°C. The nutritional content (amino acid profile, minerals, and vitamins) of the BSFL formulation with BSFL suggests great potential of replacing a portion of up to animal with alternative proteins in Biologically Appropriate Raw Food (BARF) diets when combined with HPP treatment.

Application of non-thermal pretreatment methods (PEF, US) to produce apple snacks on a semi-industrial scale

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Drying is one of the most important food processing methods, aimed at reducing the water content in food products and extending their shelf life. However, it is an extremely energy-consuming process that can negatively affect product quality. Pulsed electric field (PEF) pre-treatments and ultrasound (US) applications are techniques previously used to enhance the drying process, not only by increasing drying kinetics but also by improving product quality.
The aim of this study was to investigate the impact of using unconventional processing methods, such as pulsed electric field and ultrasound, prior to the osmotic dehydration process, and to qualitatively assess the resulting dried apple snacks. Apple slices were subjected to PEF (1 kJ/kg) and US (30 min, 21 kHz, 180 W) before the osmodehydration process. Dehydration was carried out in unconventional solutions: wild rose and cherry juice with the addition of xylitol. The slices were then dried in a semi-industrial dryer (temperature of 70°C, air flow of 1.2 m/s). After the process, the quality of the obtained dried products was examined. Non-thermal treatments contributed to shortening the drying time and altering the physical and chemical properties of the apples. PEF caused a decrease in the content of total polyphenols, antioxidant activity, and the reduction power of iron ions. The effect of ultrasound depended on the osmotic medium used. SEM analysis showed a distribution of small, regular cells after PEF application and low porosity, irregular shapes, and cell density after sonication. The type of pretreatment did not affect the sensory characteristics of the snacks. The use of unconventional osmotic solutions in combination with pulsed electric field and ultrasound techniques offers many opportunities for introducing new products to the market.

Improving the Properties and Functionalities of Biopolymer-Based Materials Using High-Pressure Processing for Food Packaging Applications

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Petroleum-based materials are the most common food packaging materials, but they pose significant threats to the environment. Biopolymer-based materials have been proposed as promising alternatives to address these environmental concerns. However, their inferior properties limit their application in food packaging. High pressure processing (HPP) is an emerging non-thermal food processing technology that acts on the non-covalent bonds in biological macromolecules without affecting the covalent bonds of small molecules. As a green and efficient method for modifying biopolymer-based materials, HPP can alter the characteristics and application performance of the compressed material. In this presentation, we will showcase our recent work on using HPP to enhance the properties and functionalities of biopolymer-based materials. The performance changes of biopolymer packaging materials before and after undergoing HPP treatments were investigated, and the underlying mechanisms were explored. This will provide a better understanding of the effects of HPP on biopolymer-based materials, demonstrating the feasibility of HPP as a novel method to fabricate biopolymer films with substantially improved hydrophobicity, thermal stability, and mechanical properties. We will also present our attempt to combine HPP with antimicrobial films enriched with ethyl lauroyl arginate (LAE) to reduce the processing intensity of HPP while maintaining food safety. This combination could be a promising hurdle technology for energy-saving and cost-saving purposes, as it demonstrates the potential for a synergistic approach to food packaging material enhancement.

Transformation of agro-food by-products into high value-added ingredients through pulsed electric fields

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The agro-food sector generates substantial amounts of residues, such as peels, seeds, pomace, stems, barks, flowers and leaves, posing significant environmental and economic concerns. However, these by-products are rich sources of different compounds with well-established health benefits and techno-functional properties, such as phenolics, carotenoids, and dietary fiber. Hence, they hold great potential for use as functional ingredients in food and biotechnological applications. Non-thermal technologies, such as pulsed electric fields (PEF), could enhance the extraction of bioactive compounds from waste products, standing as a promising strategy for supporting environmental sustainability and reducing food waste. In this study, different PEF processing conditions were applied to two different matrices; peach pomace (PP) a as by-product from fruit juice extraction and a pecan nuts cake generated from an oil extraction process, in order to evaluate its impact on biocompounds extraction efficiency and bioactive compounds content. Compared to a conventional thermally assisted extraction (50ºC for 40 min), PEF processing significantly reduced extraction time (16 µs) of total phenolic compounds, total flavonoids and vitamin C from PP, while achieving similar extraction efficiencies with lower energy consumption (PEF: 0.02 – 0.06 kJ/kg; CTT: 89 kJ/kg). Furthermore, PEF treatment of pecan nuts at 0.8 kJ/kg for oil extraction purposes increased phenolic compounds and condensed tannins of the PNC in 9.5 and 30.1% in the resulting by-product, respectively, compared to the traditional pressing process, which led to a PNC with a higher antioxidant potential for being used as functional ingredient. These results provide evidence that PEF technology holds promise as environmentally friendly approach for improving the extraction and bioactive compounds content from agro-food by-products, thereby enhancing their functional properties and contributing to the reduction of food waste.

Unravelling the Molecular Response of *Escherichia coli* When Exposed to High Power Ultrasound Treatment

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Escherichia coli is an important microorganism implicated in several foodborne outbreaks especially in ready-to-eat foods. The microbial response of this microorganism to high power ultrasound (HPU) technology was evaluated. In this study, intra-species variability was first assessed by exposing ten wild-type strains of *E. coli* to 300s of HPU treatment under uncontrolled temperature conditions (200kHz, 200mL and 100% amplitude). Thereafter, RNA-seq analysis of the wild-type strain of *E. coli* K-12 and mutant screening (using the *E. coli* KEIO knockout collection) was performed, to assess the genes expression differences following HPU exposure and the identification of genes involved in HPU resistance. The findings indicated that there was significant intra-species variability ($p < 0.05$), with FAM21805, FAM21845 and FAM21843 emerging as the most resistant (<2 log CFU/mL) strains. Moreso, these US-resistant *E. coli* strains possess a transmissible locus of heat resistance which might have confer resistance. Mutant screening revealed that deletion of *soxS*, *oxyR*, *sdhC*, *rpoS*, and *clpB* genes decreased *E. coli* resistance to HPU treatment under uncontrolled temperature conditions when compared to the parental strain. The RNA-seq analysis showed that 596 genes were differentially expressed after HPU exposure of which 528 were upregulated, while 68 genes were downregulated. Furthermore, it was observed that genes relating to bacterial secretion system, propanoate metabolism and exopolysaccharide biosynthesis were upregulated while genes for biofilm formation and mismatch repair were downregulated. The result from this study suggests that ultrasound decontamination efficacy is strain-dependent and further elucidates the molecular response of *E. coli* to US-mediated cell injury.

High Pressure Processing (HPP): a technology for sustainable food preservation and waste reduction

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High Pressure Processing (HPP) is an innovative technology that uses high pressure, up to 600 MPa, to preserve a variety of foods. This nonthermal method processes food in its final packaging, reducing or eliminating the need for additives. The primary advantage of HPP is its minimal impact on the sensory and nutritional properties of food compared to conventional methods, resulting in higher quality products. By inactivating microorganisms and enzymes without compromising taste, texture, or nutritional value, HPP ensures the safety and quality of food, making it ideal for producing healthier products. HPP contributes to sustainable practices by extending the shelf life of foods through the effective elimination of spoilage microorganisms. Improved stock management not only reduces food waste but also lessens the reliance on frequent transportation, thereby lowering carbon emissions. Additionally, HPP facilitates upcycling by creating new products, such as fruit juices or bars, from by-products or “ugly fruit”. As a clean technology, HPP relies solely on electricity and water, with most of the water being reused. It does not generate effluents or residues, making it an environmentally friendly option. Companies that power their HPP operations with 100% renewable energy can achieve low CO_2 emissions. Compared to traditional thermal processes, HPP requires less energy per weight unit of food, resulting in substantial energy savings. This efficiency contributes to a reduction in the overall carbon footprint. Although HPP requires the use of flexible, waterproof packaging materials, typically plastic, which can raise environmental concerns, solutions are emerging. The incorporation of recycled materials and bioplastics is helping to mitigate the environmental impact. The use of kegs for larger volumes reduces the amount of plastic per volume unit. Advancements in HPP equipment enable bulk beverage processing, further addressing environmental issues. HPP not only assists in reducing food waste but also contributes to a more sustainable and efficient food system. HPP stands out as a revolutionary technology in the food industry by maintaining the sensory and nutritional properties of food, ensuring safety and quality, and promoting environmental sustainability.

Cold Plasma Intervention technologies for microbiological safety in fresh poultry processing

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Post-slaughter poultry processing surfaces provide ideal supports for microbial survival and proliferation. Poultry processing plant scales vary, but poultry is increasingly viewed as a healthy and sustainable source of animal protein. Despite intensive efforts, the principle food safety concerns of Salmonella and or Campylobacter spp remain important risks to be controlled. This talk focuses on post slaughter production and a range of cold plasma intervention technologies identified as acceptable and compatible through stakeholder engagement and how these may be integrated with current practice to support microbiological safety assurance. Cold plasma can be flexibly applied in gaseous or liquid mediated form. The Campydecon project identified production stages compatible for integrating non-thermal plasma processes within large-scale poultry processing, to understand the technical requirements for mitigating cross-contamination and maintaining food safety. Plasma functionalised liquids (PFL) in a range of delivery modes - mixing, dipping, and misting were investigated to mimic current stages in commercial poultry processing where water is currently used in unit processes. Other cold plasma mediated interventions compatible with packaging stages were also investigated namely in-package plasma treatment and plasma functionalized product coatings. Target pathogens included Campylobacter Jejuni NCTC 11168 and Salmonella Typhimurium ATCC 14028. The key plasma process parameters governing the antimicrobial efficacy of each mode of plasma application were identified against relevant bacterial phenotypes, using different food contact surfaces as well as a model poultry surface and fresh chicken. Developing the interventions aligned to key risks, stakeholder acceptability as well as industry process compatibility in sequence and scale focused the technology optimisation stages.

Scaling of continuous PEF processes by means of dimensionless numbers and computational fluid dynamics (CFD)

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The colinear arrangement of electrodes and insulators in continuous PEF treatment chambers is currently state of the art, enabling higher field strengths at relatively low power. This design is used in the industry for continuous liquid food treatment, such as microorganism inactivation. However, scaling remains difficult due to the electric field distribution's dependency on insulator geometry. Current models can't predict energy input or field distribution for different chamber geometries, limiting PEF's potential. Computational fluid dynamics (CFD) simulations can visualize local physical phenomena, but a mechanistic approach for scaling PEF via CFD is still missing. The presented work aims to fill this gap. Firstly, dimensionless numbers, based on the relevant balance equations were derived. These numbers include the Reynolds, the Prandtl numbers and a newly developed dimensionless factor which scales the electric energy source. Secondly, CFD-Simulations on five different scales with five different insulator geometries and a relevant process parameter space were performed. Thirdly, the dependency of relevant process parameters like the specific energy input and the average electric field strength on the derived dimensionless numbers was investigated. The results reveal that the specific energy input can be adequately described by the newly defined factor (R^2=0.983). Taking other factors into account, such as the volume of the insulators, the mean electric field strength and its inhomogeneity can also be described sufficiently well (R^2=0.9755 and 0.987 respectively). In conclusion, the study shows for the first time how the specific energy input, the electric field strength and the inhomogeneity of the electric field can be described independently of the treatment chamber geometry. This is an important contribution to simplify process design and enabling safe processes.

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Poster presentations

Insight into the effect and mechanism of high pressure processing on pectin methyl esterase activity and persimmon juice yield and quality

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High pressure processing (HPP) could improve the juice yield of persimmon (*Diospyros kaki* L.) pulp through a kinase effect on persimmon pectin methyl esterase (PME). Firstly, HPP at 300 MPa/8 min increased the juice yield by 60% through an increasing PME activity of 25.03%. Secondly, comparing pre-HPP (300 MPa/8 min) plus treatment processing (TP) at 95 °C/5 min, pre-HPP (300 MPa/8 min) plus HPP (550 Mpa/5 min) not only guaranteed microorganisms below 2.0 log CFU/mL, but also made the persimmon juice with more total phenol (16.07 mg GAE/100 g), ascorbic acid (17.92 mg/100 mL), better clarity (18.6%), less soluble tannin (55.64 μg/mL) and color change (ΔE=2.68). Additionally, we found that HPP at 500 MPa/5 min increased the purified PME activity to 11.3%, decreased the α-helix and β-folding to 10.8% and 6.1%, and the molecular dynamics (MD) showed that HPP decreased the PME volume, increased the number of hydrogen bonds between PME and pectin, changed the positions of Arg-225 and Gln-113 in the enzyme activity center, and changed the conformation of the substrate binding channel, ultimately altered PME activity.

Insight into the mechanism of high hydrostatic pressure effect on inhibitory efficiency of three natural inhibitors on polyphenol oxidase

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The development of natural inhibitors of polyphenol oxidase (PPO) is crucial in the prevention of enzymatic browning in fresh foods. At present, many natural phytochemicals have been reported to have PPO inhibitory activity. However, few studies have focused on the effect of subsequent sterilization on their inhibition efficiency. This study investigated the influence and mechanism of high hydrostatic pressure (HHP) on the inhibition of PPO by epigallocatechin gallate (EGCG), cyanidin-3-O-glucoside (C3G), and ferulic acid (FA). Results showed that under the conditions of 550 MPa/30 min, the activity of EGCG-PPO decreased to 55.92%, C3G-PPO decreased to 81.80%, whereas the activity of FA-PPO remained stable. Spectroscopic experiments displayed that HHP intensified the secondary structure transformation and fluorescence quenching of PPO. Molecular dynamics simulations revealed that at 550 MPa, the surface interaction between PPO with EGCG or C3G increased, potentially leading to a reduction in their activity. In contrast, FA-PPO demonstrated conformational stability. This study can provide a reference for the future industrial application of natural inhibitors.

Quality and Safety evaluation of *Tenebrio molitor* paste submitted to high hydrostatic pressure processing

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In order to promote the implementation of edible insects within the modern food system, high safety standards should be guaranteed. High Pressure Processing (HPP) is an emerging non-thermal technology capable of reducing microbial contamination of food while preserving its nutritional quality. The present study investigates the impact of HPP on quality and safety of Tenebrio molitor paste. Three different pressure levels (200, 400, 600 MPa) and six times were selected (0 min–control, 5, 15, 30, 45, 60 min) and applied on paste generated after milling fresh larvae. Microbial investigation of the studied pastes revealed a significant reduction in total viable count (TVC) at pressures of 600 MPa and 400 MPa (initial count = 8.49 cfu/g), with final counts ranged between 6.42 cfu/g (5 min) and 4.11 cfu/g (60 min) for the treatment at 600 MPa and between 7.61 cfu/g (5 min) and 6.26 cfu/g (60 min) when a pressure of 400 MPa was applied. No microbial reduction was observed at 200 MPa. Slight although significant increase of titratable acidity was detected at every pressure level, with the higher acidity measured for paste treated at 400MPa for 60 min (7.57 ± 0.34 mL NaOH/g sample). Complete absence of lipid oxidation was detected at the studied pressure levels, with the peroxide value going through a slight, although significant reduction regardless by the treatment time. Similar behaviour was also observed for TBARs at 600 MPa. Increasing of TBARs from short to long treatment time was instead observed at 400 and 200 MPa. Total phenol content and antioxidant activity, evaluated through DPPH and FRAP methods, increased notably after the HHP treatment, with the highest values recorded at 400 MPa, regardless by the treatment time. Reduction of lipase activity was also revealed at every pressure level, with an evident linear effect following the treatment time. Treatment at 600 MPa for 15 min was identified as the best combination for ensuring significant microbial reduction while keeping high nutritional quality of mealworm paste.

Unveiling the influence of high hydrostatic pressure and protein interactions on the color and chemical stability of cyanidin-3-O-glucoside

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This study explored how high hydrostatic pressure (HHP) and proteins (i.e., BSA and HSA) influence the color and chemical stability of cyanidin-3-O-glucoside (C3G) at neutral pH. HHP treatments (100-500 MPa, 0-20 min, 25°C) did not affect C3G content in phosphate buffer (PB) and MOPS buffer. However, significant color loss of C3G occurred in PB due to pressure-induced pH reduction (e.g., from 7 to 4.8 at 500 MPa), which accelerated the hydration of C3G, converting it from colored to colorless species. Consequently, MOPS buffer was employed for subsequent stability experiments to assess the impact of protein and HHP on the thermal, storage, and UV light stability of C3G. Initially, rapid color loss occurred during heating and storage, primarily due to the reversible hydration of C3G until equilibrium with colorless species was reached, followed by slower parallel degradation. HSA increased the fraction of colored species at equilibrium but accelerated thermal degradation, while BSA had minimal effects. UV light irradiation accelerated the degradation of C3G colored species, causing direct degradation without conversion to colorless species, a process further intensified by the presence of proteins. HHP exhibited a negligible effect on C3G stability regardless of protein addition. These findings provide insights into anthocyanin stability under HHP and protein interactions, contributing to the development of future formulation and processing strategies for improved stability and broader applications.

Exploring high hydrostatic pressure effects on anthocyanin binding to serum albumin and food-derived transferrins

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This study investigated the effects of high hydrostatic pressure (HHP) on the binding interactions of cyanindin-3-O-glucoside (C3G) to bovine serum albumin, human serum albumin (HSA), bovine lactoferrin, and ovotransferrin. Fluorescence quenching revealed that HHP reduced C3G-binding affinity to HSA, while having a largely unaffected role for the other proteins. Notably, pretreating HSA at 500 MPa significantly increased its dissociation constant with C3G from 24.7 to 34.3 μM. Spectroscopic techniques suggested that HSA underwent relatively pronounced tertiary structural alterations after HHP treatments. The C3G-HSA binding mechanisms under pressure were further analyzed through molecular dynamics simulation. The localized structural changes in HSA under pressure might weaken its interaction with C3G, particularly polar interactions such as hydrogen bonds and electrostatic forces, consequently leading to a decreased binding affinity. Overall, the importance of pressure-induced structural alterations in proteins influencing their binding with anthocyanins was highlighted, contributing to optimizing HHP processing for anthocyanin-based products.

Effect of pulsed electric fields processing on the protein properties of house crickets

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House crickets are among the edible insects that are most commonly consumed as food. Their use as an invisible food ingredient has been suggested in order to address low consumer acceptance of edible insects and produced nutritious foods with tailored properties. Pulsed electric fields (PEF) have been used as pretreatment in the production of cricket flour they have been shown to improve the drying rate, the extraction yield of proteins and lipids and some physicochemical properties of the flour. Since crickets are a protein source, the aim was to investigate the effect of PEF on the protein structure, oxidation and colloidal behaviour, while considering the applied drying method, as well. A PEF pretreatment (4.4 kV/cm, 500 pulses) was applied prior to oven drying at 60 ^{o}C or freeze drying for the production of house cricket flour. Proteins from oven dried crickets had larger molecular weight in compare to the freeze dried crickets, while being unaffected by PEF. Proteins from all samples had similar secondary structure; with PEF reducing the random coil of the proteins of the oven dried flours. Oven dried cricket flours had proteins with a 41.33% lower solubility, 31.92& higher disulfide content, 47.28% higher protein carbonyl content, 27.29% higher surface hydrophobicity, 31.59% higher zeta potential value and more than 10-times higher turbidity than the proteins from the freeze dried cricket flours. PEF affected more the characteristics of the freeze dried cricket flours in compare to the oven dried ones, increasing hydrophobicity and disulfide content by 39.94% and 34.185, respectively. It was concluded that there is a synergistic effect between PEF and drying method on the cricket proteins. The selection of processes to produce cricket flour should depend on the targeted properties of the generated product.

Influence of pulsed electric fields on the drying rate and cannabinoid content in hemp plants

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The drying of freshly harvested hemp plants needs to be done quickly and gently, because of the heat sensitivity of the cannabinoids (CBN). In this work, pulsed electric fields (PEF) technology was used as a pre-treatment for drying to potentially reduce the temperature and shorten the exposure time during drying process. This would allow for obtaining a high-quality, storage-stable hemp with satisfactory concentration of natural cannabinoids. Two PEF process intensities were compared with a non-pre-treated hemp sample. The drying process of hemp (variety Futura 75) was recorded at 40 °C in a climate chamber. For a comparison, hemp products with and without PEF pre-treatment were also dried on a large-scale belt dryer, also at 40 °C. The concentrations of the CBNs were determined in different plant parts (leaves and pods, large leaves, and whole plant), using HPLC-DAD, which enabled the individual cannabinoids CBD, CBDA and 9-THC to be differentiated. The application of PEF prior to drying successfully reduced the drying time for all hemp samples compared to control. A maximum reduction of drying time (about 30 %) was achieved, at the highest investigated energy input of 1 kJ/kg at 0.5 kV/cm. This suggests that the higher intensity leads to higher level of cell electroporation which in the end contributed to improved drying of the product. Results of chemical analysis of the belt-dried hemp samples indicated higher total amount of the cannabinoids CBD, CBD-A and 9-THC in the final product with increasing PEF pre-treatment intensity. When comparing the 1 kJ/kg PEF-pretreated samples to the non-PEF-pretreated references, the sum of CBN was 36% higher in the group of leaves and pods, and 158% higher in the group of dried large leaves, indicating that the gentle drying process better preserved the CBN content compared to the non-PEF-treated samples. PEF pre-treatment for fresh hemp drying showed to provide benefits in drying speed and appears to positively influence concentration of cannabinoids.

Ohmic heating assessment for the preservation of fresh-cut mango

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Fresh-cut mango with great market potential suffers significant quality losses during conventional processes extending its shelf-life. Ohmic Heating (OH) has surfaced as a thermal treatment alternative retaining the properties of fresh fruits. This study collected data for fresh-cut pieces of mango grown in Mexico (Tommy Atkins variety) subjected to OH (90°C/5 min), High Temperature Short Time (HTST, 90°C/5 min), and Low Temperature Long Time (LTLT, 75°C/12 min) treatments. Treated samples and untreated controls were stored at 2°C for 0, 3, 5, 10, 20, 30, and 60 days, up to 45 days at 5°C, and for up to 30 days at 10°C and 15°C. Determinations of enzymatic activity, antioxidant activity, total carotenoid content, total phenolic content and microbial counts (aerobic mesophiles, moulds/yeasts, and psychrophiles) were made considering 6 replicates. Experimental design considered a multi-level full factorial design, while significant differences among experimental treatments were determined via ANOVA and Tukey's HSD for an α=0.05. While, total phenolic content, antioxidant activity and total carotenoid content showed no significant differences within treatments and storage temperatures. OH treatment exhibited lower polyphenol oxidase (PPO) and pectin methyl esterase (PME) activity at day 30, with 8.44 U PPO/g and 17.39 U PME/g, compared to the control (15.93 U PPO/g and 62.19 U PME/g), HTST (11.56 U PPO/g and 43.51 U PME/g) and LTLT (10.22 U PPO/g and 56.29 U PME/g), this tendency of reduced enzymatic activity was consistent across all storage at the four different temperatures. Mean comparisons for psychrophiles and moulds/yeasts showed no significant differences between OH and HTST treatments (5.4 and 4.5 CFU/g for psychrophiles and 5.33 and 4.7 CFU/g for moulds/yeasts after 30 days), suggesting a similarity in effectiveness. Mesophilic counts exhibited no significant differences among OH, HTST, and LTLT treatments. Considering the storage temperature as the principal factor for statistical analysis for psychrophiles there is no significant differences for 10 and 15°C, and in the case of mesophilic bacteria between 5 and 10 °C. Overall, statistical analysis and kinetics for PPO activity, psychrophilic bacteria and moulds/yeasts showed time and temperature dependence, making them suitable for the development of predictive models to carry out these determinations in a more cost/resource/time efficient way. Findings indicate that OH is an efficient alternative to conventional treatments due to its effective control of enzymatic activity and no significant differences between treatments on the quality parameters. Furthermore, regarding microbial control performance, OH and HTST were similarly efficient and required 240% less time than the more efficient LTLT.

Novel Methods for the Preservation of Donor Human Milk

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Human milk banks are responsible for the safe and controlled distribution of donor milk. Holder pasteurization is the current pasteurization technique used by milk banks. Although effective in reducing microbial counts, holder pasteurization can have undesirable effects on the nutritional quality of milk. Current milk banking protocols require milk to be used within 24 hours of thawing, resulting in potential waste of a valuable fluid often in short supply. The aim of this study was to evaluate the efficacy of novel processing techniques and the microbial safety of donor milk over an extended storage period. Milk underwent holder pasteurization or high-pressure processing (HPP) at 200, 400 and 600 MPa. A series of biopreservation techniques were also tested, including nisin A, lactose oxidase and microfiltration. Bacterial screening on non-selective media demonstrated that holder pasteurized milk remained within acceptable growth limits (<1 CFU) when stored at 4 °C for 7 days, while HPP at 600 MPa reduced microbial counts to undetectable levels, which lasted for the 7 days of cold storage. Immediately following HPP at 400 mPa a 2.5-log reduction in microbial counts was observed, with undetectable growth at subsequent time-points. Additionally, HPP at 400 MPa demonstrated greater conservation of lactoperoxidase, lysozyme, plasmin and cathepsin D. Immediately following treatment, a 100% reduction in microbial growth on non-selective media was observed following microfiltration or nisin A combined with holder pasteurisation. Whilst a > 5-log reduction on media targeting *Pseudomonas* and *Enterobacteriaceae* was observed in both groups. However, a reduction in the lipid content following microfiltration occurred as milk was skimmed before treatment. Our findings show the microbial safety of holder pasteurised milk when stored at 4 °C for 7 days and that HPP is a potential non-thermal alternative to holder pasteurization. Additionally, a hybrid approach of holder pasteurisation and nisin A warrants further investigation due to the antimicrobial activity of nisin A against *Bacillus* spores, a major challenge currently facing the milk banking sector.

Optimising Non-Thermal Preservation of Macroalgae: A Preliminary Study on High-Pressure Processing for Enhanced Storage Stability and Quality

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As the global population continues to grow, the necessity for sustainable, high-protein food sources becomes increasingly urgent. The cultivation of land-based macroalgae represents a promising, resource-efficient solution for global food security. This preliminary study assesses the efficacy of high-pressure processing (HPP) at 400 MPa for 5 minutes in maintaining the nutritional and sensory attributes of two macroalgae species, the red algae *Palmaria palmata* and the brown algae *Laminaria digitata*. The preliminary experiments determined the optimal HPP intensity at 400 MPa based on quality and microbiological parameters, revealing an exponential decrease in photosynthetic performance with increasing pressure. Following the high-pressure treatment, the macroalgae were washed and stored at 4 °C and 15 °C to assess microbiological safety and quality keeping. Quality parameters, including colour and chlorophyll fluorescence, were monitored and evaluated. The findings indicate that HPP improves storage stability, particularly at 4 °C, although some colour alterations were observed. The microbiological safety of both species was confirmed. The observed inverse relationship between HPP pressure and chlorophyll fluorescence suggests that photosynthetic systems may be susceptible to non-thermal preservation. The microbiological risk potential of *Palmaria palmata* and *Laminaria digitata* was assessed after a high-pressure treatment, and both species were found to be generally harmless according to conventional microbiological analysis. However, *Palmaria palmata* is considered unsuitable for young children, pregnant women, the elderly, and immunocompromised individuals due to its higher total bacterial counts. This conclusion should be supported by further detailed analyses to validate the results, which emphasize the potential of HPP as an applicable preservation method for macroalgae and suggest that further research into its effects on other marine organisms may be promising.

Influencing Aroma and Texture: The Effect of Ultrasound on a Fiber-Enriched Plant-Based Yoghurt

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The intake of plant proteins and fibres is recommended for a healthy diet. However, their incorporation into foods is challenging due to techno-functional and sensorial limitations. Therefore, this study aimed at improving texture and aroma profile of a plant-based and fibre-enriched yoghurt alternative by using high-intensity ultrasound (US). A plant-based yoghurt was developed, consisting of 4 % pea protein, 3 % plant fibres, 3 % rice syrup, and 2.5 % rapeseed oil fermented by lactic acid bacteria. US treatment was used as an alternative to conventional high-pressure homogenisation (HPH). Off-flavour reducing potential, texture characteristics and quality parameters were determined. For this purpose, aroma analyses by HS-GC/MS were combined with techno-functional analyses, including rheology, syneresis, and scanning electron microscopy. US significantly reduced the concentrations of the off-flavours hexanal, 2-pentylfuran, and 2-methylpropanal. The concentrations of the yoghurt aromas diacetyl and acetoin were significantly increased. These effects were attributed to the cavitational forces of US. An increased availability of substrate might have increased the fermentation rate and yoghurt aromas. Further, conformational changes due to cavitation may have altered hydrophobic regions on the surface of the pea protein, resulting in the detaching of the hydrophobic, reversibly bound off-flavour-related compounds. The kind of homogenisation system might affect off-flavour reduction as well. The US treatment was an open system allowing detached aromas to evaporate, while HPH was a closed system. No significant differences on texture characteristics by US were detected compared to HPH.This study demonstrated the potential of US as an alternative homogenisation technique to reduce off-flavours in fibre-enriched, pea protein-based yoghurt alternatives. US presents a promising approach to enhance consumer acceptance of plant-based protein products, positioning them as a more sustainable alternative to animal-derived proteins. Further sensory analysis is recommended to assess the effects of US on consumer acceptance, as flavour perception is a multisensorial mechanism.

Environmentally Friendly and Sustainable Extraction of Bioactive Compounds Using Enzyme-Assisted Extraction (EAE) and High-Pressure Homogenization (HPH) as Nonthermal Techniques

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Nowadays, novel non-thermal approaches, including Enzyme-Assisted Extraction (EAE) and High-Pressure Homogenization (HPH), have been used in research as an innovative alternative to traditional methods for bioactive compound extraction. High mechanical stress and temperature are used in conventional extraction techniques to improve extraction yield; however, this might degrade final product quality and prevent the selective extraction of desirable chemicals. Therefore, green non-thermal techniques could provide a higher extraction yield of bioactive compounds compared to conventional procedures, through increasing mass transfer from different biomass matrices, as well as preserving thermosensitive bioactive compounds. This study analyzes the impact of EAE and HPH techniques and their parameters, including enzyme concentration, time, and temperature for EAE, pressure, temperature, and the number of passes for HPH, on enhancing bioactive compound extraction from agri-food residues. The effectiveness and the qualitative and quantitative impacts of each technique were analyzed using various methods, including total phenolic compounds (TPC) and total flavonoid compounds (TFC) to determine bioactive compound concentration and ferric-reducing antioxidant power (FRAP) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assays to evaluate extracts antioxidant capacity. The cellular damage rate of the treated biomass was assessed using particle size analysis and microscopy. Additionally, color and chlorophyll content were investigated to determine how these techniques affected pigment concentration and caused any color changes. This research shows the considerable potential of EAE and HPH techniques for extracting bioactive compounds from agri-food residues. The results indicated that both HPH and EAE techniques could significantly enhance the extraction yield of bioactive compounds and the antioxidant activity of the obtained extracts.

Comparative study: Thermal and non-thermal treatment on enzyme deactivation and selected quality attributes of fresh carrot juice

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The combined effect of emerging electro-technology high-voltage cold plasma (HVCP) and non-thermal ultra-high hydrostatic pressure (UHP) as bioprocess technologies on the quality and stability of carrot juice has been evaluated. Carrot juice was treated with HVCP (70 kV for 3 min), UHP (300, 400, and 500 MPa) at 25 °C for 5 min, and a blanched sample of 100 °C for 5 min (BS) was also prepared. As compared to control and single treatments, the combined treatment (HVCP-UHP500) has attained better results in terms of enzyme inactivation and electroporation extraction of coloring compounds, phytochemicals, and ascorbic acid. Wherein, the maximum of 25.87 ± 0.12^{a} μg/100 mL of β-Carotene, 11.89 ± 0.80^{a} GAE (μg g^{-1}) of total phenols, and 24.07 ± 0.12^{b} mg/100 mL of ascorbic acid content in carrot juice were also observed in the combined treatment at 500 MPa. In addition, phytochemical enhancement might be attributed to the disintegration of phenolic dimers into simple aglycones, predominantly because of the electro-kinetic phenomenon of HVCP, which is subsequently intensified by UHP treatment. Therefore, the current study suggests that the combination of two novel techniques is a highly efficient method in terms of energy, time, and cost, with low yield efficiency and bio-safety.

Enhancing Shelf Life of pumpkin pulp with natural-based preservative and High-Pressure Processing

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This study aimed to stimulate a value chain with innovative processes that goes throughout all developing stages of pumpkin fruit pulp formulation functionalised with a natural-based preservative extracted from pumpkin by-products. The overall process was aligned with sustainability principles and non-thermal process to improve pumpkin pulp fruit shelf life. Formulated pumpkin pulp fruit was incorporated with natural ingredient (NI) extracted from pumpkin waste, industrial mix (with and without potassium sorbate), processed by high pressure (600 MPa / 4 min) and stored at 5 °C for 45 days. The shelf life was evaluated by microbiological analysis (investigation of mesophilic aerobic, Enterobacteria and molds & yeasts), pH, color, texture (TPA) and oxidative stability via changes in β-Carotene, γ-Tocopherol, total phenolic content (TPC) and antioxidant potential (FRAP). No microbial growing was observed during 45 days of shelf life for all samples conditions, this can be attributed not only for the treatments, but also for the industrial mix and the NI (samples 4 and 5) added to the pulp. Besides that, samples added with NI retained the color, textural properties (firmness) and exhibited significantly higher TPC compared to other samples. In terms of quality attributes, samples processed by thermal treatment showed the most difference in terms of firmness, stickiness and chewiness as well as for changes in □-carotene, lutein and □-tocopherol. In conclusion, the combination of HPP with NI showed a great potential for the shelf life of pumpkin pulp, since no contamination was observed, the use of potassium sorbate in this product could be reduced by 50% or even completely replaced by NI.

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Heft 97	INSECTA. Conference 2017 07th–08th September 2017, Berlin, Germany	2017
Heft 98	Storability of broccoli – investigations of optical monitoring, chlorophyll degradation and predetermination in the field	2018
Heft 99	24. Workshop Computerbildanalyse in der Landwirtschaft 25. April 2018, Zürich	2018
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Heft 101	6th International Conference on Machine Control and Guidance 1–2 Oct 2018, Berlin, Germany	2018
Heft 102	25. Workshop Computerbildanalyse in der Landwirtschaft 17th 2019, Bonn, Germany	2019
Heft 103	INSECTA 2019. International Conference 05th–06th September 2019, Potsdam, Germany	2019
Heft 104	Transformation Strategies in Agriculture	2021
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Heft 106	INSECTA 2022. International Conference 14th – 16th September 2022, Gießen, Germany	2022
Heft 107	INSECTA 2023. International Conference 13th – 14th September 2023, Magdeburg, Germany	2023
Heft 108	INSECTA 2024. International Conference 14th – 16th May 2024, Potsdam, Germany	2024
Heft 109	2024 EFFoST / IFT-NPD WORKSHOP ON NONTHERMAL PROCESSING OF FOODS 7th – 9th October 2024, Potsdam, Germany	2024

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