processes

MDPI

Editorial

Special Issue on "Current Trends in Food and Food Byproducts Processing"

Dariusz Dziki

Department of Thermal Technology and Food Process Engineering, University of Life Sciences in Lublin, Głęboka 31, 20612 Lublin, Poland; dariusz.dziki@up.lublin.pl

check for updates

Citation: Dziki, D. Special Issue on "Current Trends in Food and Food Byproducts Processing". *Processes* **2024**, *12*, 704. https://doi.org/10.3390/pr12040704

Received: 26 March 2024
Accepted: 27 March 2024
Published: 30 March 2024

The growing interest in healthy lifestyles has contributed to an increased demand for nutrient-rich foods, such as plant-based proteins, vitamins, and minerals [1]. Furthermore, there is a rising popularity of products with additional health functions, such as functional foods containing probiotics, prebiotics, and antioxidants [2]. Additionally, an increasing number of individuals are opting for plant-based alternatives to meat products due to a heightened awareness of health, animal ethics, and the environmental impact of meat production [3]. Progress in food drying has brought forth a plethora of innovations and process optimizations aimed at improving its quality, efficiency, and safety [4]. Modern drying technologies, such as microwave drying, circulating drying, and vacuum drying, enable more controlled drying conditions, preserving a higher amount of nutrients and flavors in food products [5]. Moreover, new packaging materials, such as modified atmosphere packaging, aid in maintaining freshness and the longer shelf life of dried products [6]. The automation and monitoring of the drying process using advanced quality control systems and production management systems contribute to enhancing the efficiency and effectiveness of food drying processes. Additionally, research into novel pre- and post-drying processing methods may further enhance the nutritional and sensory value of dried products. All these advancements lead to the creation of dried products with improved quality, a longer shelf life, and greater nutritional value, thereby increasing the attractiveness and competitiveness of food products in the market. Consumers are increasingly seeking products procured from sustainable, ecological, and local sources. Another trend is the utilization of byproducts in food processing [7]. Byproducts are materials generated during food production processes but are not directly used for consumption. Instead, they can be transformed and utilized in various ways, contributing to a reduction in food waste and an increase in production efficiency [8]. Food processing focuses on reducing greenhouse gas emissions, minimizing water consumption, and promoting sustainable agriculture practices. Technological advancements, including 3D food printing technologies, artificial intelligence for process optimization and data analysis, and new food preservation methods, allow for the creation of innovative products and improvement of production efficiency [9]. Food processing increasingly considers individual consumer preferences and needs. Technological advancements enable the customization of food products for the specific dietary requirements, food allergies, and taste preferences of customers [10].

This Special Issue of *Processes* on "Current Trends in Food and Food Byproducts Processing" is a collection of studies related to recent advances in food processing, with a focus on experimental, theoretical, and computational research on current trends in this area's development and improvement. Sixteen manuscripts were published in this Special Issue (fifteen articles and one review). The contributions are listed below.

The In the contributions 1 and 6 are focused on encapsulation process of seed extracts. In the Contribution 1 the researchers extracted valuable components from sweet corn byproducts (SCB). The SCB extract contained a total carotenoid content of 1.19 mg/100 g DW, with zeaxanthin, β-cryptoxanthin, and lutein identified as the primary carotenoids using HPLC analysis. Freeze-drying and spray-drying methods were employed to encapsulate the SCB extract, utilizing four different wall materials: two proteins (soy and pea) and two carbohydrates (maltodextrin and inulin). The physicochemical properties of eight encapsulated samples were analyzed to evaluate their stability. Results indicated that freeze-drying yielded superior water activity, moisture content, and encapsulation efficiency, while spray-drying resulted in improved flow characteristics. The objective of Contribution 6 was to encapsulate papaya seed extracts at different stages of maturation. Extracts from unripe and ripe papaya seeds were subjected to spray-drying using varying concentrations of maltodextrin and inlet air temperatures of 130 and 150 °C. Powders formulated with maltodextrin exhibited superior characteristics in terms of particle diameter, hygroscopicity, dispersibility, and phenolic stability during storage. The impact of drying temperatures on powder attributes was found to be minimal. Encapsulated phenolic compounds were predominantly released during the intestinal phase (86.6–100%). Among the conditions tested, powders produced from unripe seeds, with 15% maltodextrin and an inlet air temperature of 130 °C, yielded the most favorable outcomes.

Contribution 2 seeks to explore the toxic and protective impacts of sapota-do-Solimões juice, both in its raw form and after undergoing ultrasound processing, on A. salina nauplii. The ultrasound-processed sapota-do-Solimões juice did not exhibit any toxic effects on A. salina. Conversely, particles present in the juice induced morphological alterations in the organisms, such as surface wrinkling and formation of cavities. In terms of stress biomarkers, the unprocessed juice displayed higher activity levels of the antioxidant enzymes catalase and superoxide dismutase, while Lipoperoxidation exhibited similar outcomes across different processing methods.

In contribution 3, the authors examined the antimicrobial characteristics of nanocomposite coatings containing nanoscale particles of zinc oxide (ZnO), titanium dioxide (TiO_2), and silicon dioxide (SiO_2). The findings indicate that the application of nanocomposites results in an elevation of the total surface free energy of the packaging surface, while concurrently diminishing the polar component of the surface free energy, consequently reducing its hydrophilic properties. Both types of nanocomposites demonstrated that an increase in the weight ratio of nanoparticles leads to enhanced protective effects. It was observed that nanocomposites containing ZnO exhibited superior antimicrobial efficacy compared to those containing TiO_2.

In Contribution 4, the potential application of FT-NIR technique for the quick and non-invasive assessment of ripeness in sweet cherries and sour cherries is demonstrated. Titratable acidity, water-soluble total solids, total anthocyanin content, and calculated maturity index served as reference parameters. The study illustrates that this approach enables swift identification of fruit ripeness, facilitating rapid quality control measures for fruit consumption.

Contribution 5 aims to assess the impact of incorporating date press cake (DPC) on the quality characteristics, total phenolics, and antioxidant capacity of date jam. The findings demonstrate that higher levels of DPC led to notable increases in the hardness, cohesiveness, adhesiveness, and chewiness attributes of date jam. Additionally, the inclusion of DPC resulted in a significant enhancement in phenolics content and antioxidant capacity, with the effects being dose-dependent. Sensory evaluation indicated that date jam formulated with 9% DPC received the highest overall acceptability rating.

In Contribution 7, the authors investigated the impact of various thermal treatments on reducing soy immunoreactivity (IR) in a 5% slurry using a sandwich ELISA technique. By comparing IR with an internal soy allergen standard, the allergen concentration in the untreated soy sample was determined to be equivalent to 333 mg/kg (ppm). Cooking conditions only marginally reduced the IR sensitivity to about 10 mg/kg (~1.5 log reductions), whereas the thermal processing treatments significantly lowered the allergen IR to as low as 23×10^{-3} mg/kg (or 23 ppb) (>4 log reductions). Furthermore, FTIR analysis revealed notable alterations in protein structure resulting from the thermal processing treatments, with a higher degree of allergen reduction correlating with an increased percentage of random coil formations.

Contribution 8 aimed to assess how the strawberry variety affects the efficacy of ozone application in preserving harvested fruit over a 12-day storage period. Experimental kinetics were acquired and modeled using a first-order kinetic model. Regardless of the strawberry variety, treatment with 0.3 ppm ozone generally yielded the most favorable outcomes across most quality parameters examined. Conversely, exposure to 1.0 ppm ozone resulted in some adverse effects on fruit preservation, particularly concerning their physicochemical properties.

Contributions 9 and 10 focus on the field of food drying. Advances in food drying techniques typically aim to decrease drying duration and enhance the overall characteristics of dried products. In Contribution 9, the impact of ultrasonic treatment on the drying kinetics of pumpkin pulp was examined, alongside the analysis and optimization of mathematical models for predicting drying kinetics. The findings indicate that ultrasonic pretreatment notably reduces drying time from 451 to 268 min, with optimal processing parameters identified at 90% of the maximum ultrasonic power and a processing time of 45 min. At these optimal parameters, the total color change of the samples was minimized. Evaluation of the mathematical drying models revealed that the Weibull model provided the best fit for the experimental data. In Contribution 10, the authors investigated the impact of freeze-drying and air-drying temperatures on the dehydration kinetics and selected physicochemical parameters of Mulberry fruits. Both temperature and dehydration methods were found to exert significant influence on the drying rate and fruit properties. The Midilli model demonstrated the best fit to the experimental data of the drying curves, exhibiting the lowest mean-square error values. Both drying methods led to a significant reduction in the content of phenolic compounds. Freeze-dried fruits exhibited the least reduction in L-ascorbic acid content. Additionally, fruits freeze-dried at 30 °C exhibited the highest content of phenolics and antioxidant capacity.

Contribution 11 concerns the development of two types of dietary supplements catering to individuals with celiac disease: energy-rich bars and fiber-rich bars. The aim is also to optimize the formulations of bars made from both puffed and non-puffed cereals. To achieve the optimal combination of ingredients, a mixture design approach was employed. The primary findings suggest that for energy bars with non-puffed cereals, the optimal combination comprises 37.5 g of cereals, 22.5 g of seeds, and 40 g of binder. Similarly, for fiber-rich bars with non-puffed cereals, the optimal recipe includes 54.57 g of cereals, 10.43 g of seeds, and 35 g of binder. In contrast, the optimal formulation for energy bars with puffed cereals consists of 35.42 g of cereals, 20.07 g of seeds, and 44.51 g of binder, while for fiber-rich bars with puffed cereals, it consists of 50 g of cereals, 15 g of seeds, and 35 g of binder.

Contribution 12 is a literature review paper that addresses the underexplored areas of utilizing brewing by-products, specifically focusing on the extraction of phytochemical compounds such as bitter acids and polyphenols, along with concentration techniques. It delves into emerging technologies and alternative solvents that have enhanced extraction efficiency. The paper emphasizes the significance of purification and concentration steps in non-destructive methods to enhance the value of products derived from by-product reuse strategies. Additionally, it highlights the importance of conducting scale-up and economic feasibility studies to promote the establishment of facilities capable of producing bitter acids and polyphenols from alternative sources like hot trub and spent hops.

Contribution 13 investigates the impact of high-intensity ultrasound (HIUS) on the increase in biomass of kefir grains and specific metabolites in cheese whey kefir. The findings indicate that the application of HIUS to fresh cheese whey kefir enhances the biosynthesis of total exopolysaccharides concentration in the kefir beverage and increases the biomass of kefir grains. Additionally, a negative correlation between the increase in kefir grains biomass and the concentration of soluble solids was observed.

In Contribution 14, the authors investigated earthworm protein hydrolysate and its peptide fractions as potential hypoglycemic agents by assessing their ability to inhibit α-amylase and α-glucosidase. The findings revealed that under optimal hydrolysis conditions, the hydrolysates demonstrated α-amylase inhibitory activity of 91.30 ± 2.51% and α-glucosidase inhibitory activity of 44.69 ± 0.47%. Notably, following in vitro digestion treatment, the hydrolysates and their fractions exhibited enhanced activity, maintaining over 40% inhibition after exposure to pH treatment across the range of 1 to 11, as well as heat treatment at 100 °C for 180 min.

In Contributions 15 and 16, the extraction process of bioactive compounds from plant raw materials was investigated. In Contribution 15, the impact of subcritical water extraction parameters, such as temperature, process duration, and extractor shape, on the composition of extracts and antioxidant activity of Norway maple (*Acer platanoides* L.) bark extracts was examined. The total polyphenol and flavonoid contents, along with antioxidant activity, were found to be significantly influenced by water temperature. The highest levels of polyphenols, flavonoids, and antioxidant activity were observed at a temperature of 170 °C, which represents the upper limit of the temperature range considered in these studies. In Contribution 16, ultrasound-assisted aqueous extraction was employed to enhance the extraction efficiency of bioactive compounds from *Levisticum officinale* root waste. Utilizing Pareto-optimal solution sets, it was determined that to optimize the extraction criteria, aqueous extraction should be conducted at a Levisticum officinale biomass/solvent ratio of 0.0643 g/mL for a duration of 8.1 to 9.0 min, with ultrasound assistance ranging from 162.8 to 201.4 W.

The presented studies encompass a broad spectrum of topics concerning food processing and the extraction of bioactive compounds. They entail various endeavors such as converting sweet corn by-products into carotenoid-rich encapsulates suitable for food applications, examining the protective efficacy of ultrasound-treated Amazonian Sapota-do-Solimões juice on Artemia salina nauplii, and exploring the antimicrobial attributes of nanocomposites for cardboard food packaging. Additionally, there are endeavors like developing a Fourier-transform near-infrared (FT-NIR) technique to gauge the ripeness of sweet and sour cherries, assessing the impact of incorporating date press cake on the texture, color, sensory properties, microstructure, and functional attributes of date jam, and investigating the encapsulation of Formosa papaya seed extract to elucidate its physicochemical characteristics, stability, and the release profile of encapsulated phenolic compounds. Furthermore, the research extends to endeavors such as mitigating soy allergen immunoreactivity via thermal processing utilizing enzyme-linked immunosorbent assay (ELISA), scrutinizing the effects of gaseous ozone treatment on the physicochemical, microbiological, and bioactive properties of strawberries, and employing mathematical modeling for optimizing ultrasonic pre-treatment in pumpkin drying processes. The analysis also encompasses investigations into the influences of air-drying and freeze-drying temperatures on the process kinetics and physicochemical attributes of white mulberry fruits, crafting energy-rich and fiber-rich bars utilizing both puffed and non-puffed cereals, and undertaking a comprehensive review on methodologies for extracting and concentrating bitter acids and polyphenols from brewing by-products. Furthermore, the research delves into the effects of high-intensity ultrasound pretreatment on exopolysaccharide concentration and biomass increase in cheese whey kefir, studying the hypoglycemic activity and stability of earthworm protein hydrolysate and its peptide fractions, investigating the influence of water extraction parameters and reactor shape on the quality of extracts obtained from Norway maple, and exploring multi-criteria optimization conditions for recovering bioactive compounds from *Levisticum officinale* roots using green and sustainable ultrasound-assisted extraction.

Conflicts of Interest: The author declares no conflicts of interest.

List of Contributions

1. Vulić, J.; Šeregelj, V.; Tumbas Šaponjac, V.; Karadžić Banjac, M.; Kovačević, S.; Šovljanski, O.; Ćetković, G.; Čanadanović-Brunet, J.; Jevrić, L.; Podunavac-Kuzmanović, S. From Sweet Corn By-Products to Carotenoid-Rich Encapsulates for Food Applications. *Processes* **2022**, *10*, 1616. https://doi.org/10.3390/pr10081616.

2. Da Silva, R.; Miguel, T.; de Castro Miguel, E.; Campelo, P.; Fernandes, F.; Rodrigues, S. Protective Effect of Ultrasound-Processed Amazonian Sapota-do-Solimões (Quararibea cordata) Juice on Artemia salina Nauplii. *Processes* **2022**, *10*, 1880. https://doi.org/10.3390/pr10091880.
3. Hudika, T.; Zdolec, N.; Kiš, M.; Cigula, T. Providing Antimicrobial Properties to Cardboard Food Packaging by Coating with ZnO, TiO_2, and SiO_2—Water-Based Varnish Nanocomposites. *Processes* **2022**, *10*, 2285. https://doi.org/10.3390/pr10112285.
4. Fodor, M. Development of FT-NIR Technique to Determine the Ripeness of Sweet Cherries and Sour Cherries. *Processes* **2022**, *10*, 2423. https://doi.org/10.3390/pr10112423.
5. Alqahtani, N.; Alnemr, T.; Ahmed, A.; Ali, S. Effect of Inclusion of Date Press Cake on Texture, Color, Sensory, Microstructure, and Functional Properties of Date Jam. *Processes* **2022**, *10*, 2442. https://doi.org/10.3390/pr10112442.
6. Mesquita, M.; Santos, P.; Holkem, A.; Thomazini, M.; Favaro-Trindade, C. Encapsulation of Formosa Papaya (*Carica papaya* L.) Seed Extract: Physicochemical Characteristics of Particles, and Study of Stability and Release of Encapsulated Phenolic Compounds. *Processes* **2023**, *11*, 27. https://doi.org/10.3390/pr11010027.
7. Ravindran, A.; Ramaswamy, H. ELISA Based Immunoreactivity Reduction of Soy Allergens through Thermal Processing. *Processes* **2023**, *11*, 93. https://doi.org/10.3390/pr11010093.
8. Macías-Gallardo, F.; Barajas-Díaz, C.; Mireles-Arriaga, A.; Ozuna, C. Strawberry Variety Influences the Effectiveness of Postharvest Treatment with Gaseous Ozone: Impact on the Physicochemical, Microbiological, and Bioactive Properties of the Fruit. *Processes* **2023**, *11*, 346. https://doi.org/10.3390/pr11020346.
9. Karlović, S.; Dujmić, F.; Brnčić, S.; Sabolović, M.; Ninčević Grassino, A.; Škegro, M.; Šimić, M.; Brnčić, M. Mathematical Modeling and Optimization of Ultrasonic Pre-Treatment for Drying of Pumpkin (*Cucurbita moschata*). *Processes* **2023**, *11*, 469. https://doi.org/10.3390/pr11020469.
10. Krzykowski, A.; Dziki, D.; Rudy, S.; Polak, R.; Biernacka, B.; Gawlik-Dziki, U.; Janiszewska-Turak, E. Effect of Air-Drying and Freeze-Drying Temperature on the Process Kinetics and Physicochemical Characteristics of White Mulberry Fruits (*Morus alba* L.). *Processes* **2023**, *11*, 750. https://doi.org/10.3390/pr11030750.
11. Bourekoua, H.; Djeghim, F.; Ayad, R.; Benabdelkader, A.; Bouakkaz, A.; Dziki, D.; Różyło, R. Development of Energy-Rich and Fiber-Rich Bars Based on Puffed and Non-Puffed Cereals. *Processes* **2023**, *11*, 813. https://doi.org/10.3390/pr11030813.
12. Silva, K.; Strieder, M.; Pinto, M.; Rostagno, M.; Hubinger, M. Processing Strategies for Extraction and Concentration of Bitter Acids and Polyphenols from Brewing By-Products: A Comprehensive Review. *Processes* **2023**, *11*, 921. https://doi.org/10.3390/pr11030921.
13. Encinas-Vazquez, I.; Carrillo-Pérez, E.; Mártin-García, A.; Del-Toro-Sánchez, C.; Márquez-Ríos, E.; Bastarrachea, L.; Rodríguez-Figueroa, J. Effects of High-Intensity Ultrasound Pretreatment on the Exopolysaccharide Concentration and Biomass Increase in Cheese Whey Kefir. *Processes* **2023**, *11*, 1905. https://doi.org/10.3390/pr11071905.
14. Bui, P.; Pham, K.; Vo, T. Earthworm (*Perionyx excavatus*) Protein Hydrolysate: Hypoglycemic Activity and Its Stability for the Hydrolysate and Its Peptide Fractions. *Processes* **2023**, *11*, 2490. https://doi.org/10.3390/pr11082490.
15. Kamiński, P.; Gruba, M.; Fekner, Z.; Tyśkiewicz, K.; Kobus, Z. The Influence of Water Extraction Parameters in Subcritical Conditions and the Shape of the Reactor on the Quality of Extracts Obtained from Norway Maple (*Acer platanoides* L.). *Processes* **2023**, *11*, 3395. https://doi.org/10.3390/pr11123395.
16. Plawgo, M.; Kocira, S.; Bohata, A. Multi-Criteria Optimization Conditions for the Recovery of Bioactive Compounds from Levisticum officinale WDJ Koch Roots Using Green and Sustainable Ultrasound-Assisted Extraction. *Processes* **2024**, *12*, 275. https://doi.org/10.3390/pr12020275.

References

1. Melilli, M.G.; Buzzanca, C.; Di Stefano, V. Quality characteristics of cereal-based foods enriched with different degree of polymerization inulin: A review. *Carbohydr. Polym.* **2024**, *332*, 121918. [CrossRef] [PubMed]
2. Plawgo, M.; Kocira, S.; Bohata, A. Multi-Criteria Optimization Conditions for the Recovery of Bioactive Compounds from Levisticum officinale WDJ Koch Roots Using Green and Sustainable Ultrasound-Assisted Extraction. *Processes* **2024**, *12*, 275. [CrossRef]
3. Van der Sman, R.G.M.; van der Goot, A.J. Hypotheses concerning structuring of extruded meat analogs. *Curr. Res. Food Sci.* **2023**, *6*, 100510. [CrossRef] [PubMed]

4. Waghmare, R.; Kumar, M.; Yadav, R.; Mhatre, P.; Sonawane, S.; Sharma, S.; Gat, Y.; Chandran, D.; Radha; Hasan, M.; et al. Application of ultrasonication as pre-treatment for freeze drying: An innovative approach for the retention of nutraceutical quality in foods. *Food Chem.* **2023**, *404*, 134571. [CrossRef] [PubMed]
5. Madhankumar, S.; Viswanathan, K.; Taipabu, M.I.; Wu, W. A review on the latest developments in solar dryer technologies for food drying process. *Sustain. Energy Technol. Assess.* **2023**, *58*, 103298. [CrossRef]
6. Mahajan, P.V.; Lee, D.S. Modified atmosphere and moisture condensation in packaged fresh produce: Scientific efforts and commercial success. *Postharvest Biol. Technol.* **2023**, *198*, 112235. [CrossRef]
7. Krajewska, A.; Dziki, D. Enrichment of Cookies with Fruits and Their By-Products: Chemical Composition, Antioxidant Properties, and Sensory Changes. *Molecules* **2023**, *28*, 5. [CrossRef] [PubMed]
8. Ganeson, K.; Mouriya, G.K.; Bhubalan, K.; Razifah, M.R.; Jasmine, R.; Sowmiya, S.; Amirul, A.A.A.; Vigneswari, S.; Ramakrishna, S. Smart packaging—A pragmatic solution to approach sustainable food waste management. *Food Packag. Shelf Life* **2023**, *36*, 101044. [CrossRef]
9. Boateng, I.D. Application of Graphical Optimization, Desirability, and Multiple Response Functions in the Extraction of Food Bioactive Compounds. *Food Eng. Rev.* **2023**, *15*, 309–328. [CrossRef]
10. Shin, S.; Fu, J.; Shin, W.K.; Huang, D.; Min, S.; Kang, D. Association of food groups and dietary pattern with breast cancer risk: A systematic review and meta-analysis. *Clin. Nutr.* **2023**, *42*, 282–297. [CrossRef] [PubMed]