

Editorial

Closing Editorial: Emerging Processing Techniques and Their Impact on Physicochemical, Sensory, and Nutritional Properties of Foods

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1. Introduction

The food industry is currently undergoing a profound transformation driven by the need to provide safe, nutritious, high-quality, and sustainable food products to a growing global population. Traditional processing technologies are increasingly being complemented by innovative approaches designed to preserve nutritional quality, improve sensory characteristics, enhance food safety, and reduce environmental impacts. Against this background, the Special Issue “Emerging Processing Techniques and Their Impact on Physicochemical, Sensory, and Nutritional Properties of Foods” was launched to provide a platform for research on processing strategies, analytical tools, and food-quality outcomes relevant to modern food systems [1–4].

This Special Issue contains nine published contributions. Together, they do not provide a comprehensive resolution of all challenges associated with emerging food-processing technologies; rather, they offer targeted evidence from specific food matrices and processing contexts. The collection covers freeze-drying and edible coatings, extrusion processing, beer clarification, UV-C post-harvest treatment, ultrasonic processing, high-pressure processing, sous vide processing combined with packaging, fluorescence fingerprinting combined with machine learning, and the characterization of essential oils [5–13].

2. Synthesis of the Published Contributions

Freeze-drying and edible coatings were addressed by Wrzodak et al. (contribution 1), who evaluated zein- and carboxymethylcellulose-based coatings and citric acid treatment applied before freeze-drying Jerusalem artichoke slices. The study showed that freeze-drying increased inulin extraction efficiency, while carboxymethylcellulose and citric acid supported better retention of selected bioactive compounds and improved sensory-related attributes compared with some alternative treatments. The authors also used image texture analysis and machine-learning classification to differentiate sample characteristics, illustrating how conventional quality assessment can be complemented by digital analytical tools.

Extrusion processing was represented by Biernacka et al. (contribution 2), who developed extruded snack pellets enriched with fresh lucerne sprouts. Their results indicated that screw speed, feed moisture, and lucerne content strongly influenced process efficiency and product quality. Although higher lucerne contents and moisture increased energy demand and reduced extrusion-cooking efficiency, moderate enrichment improved phenolic content and antioxidant activity, supporting the potential of plant-based ingredients in functional extruded products.



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In the area of beer clarification, Sterczyńska et al. (contribution 3) examined chitosan- and collagen-based fining agents in laboratory beers. The study found that both types of agents improved clarity, with effects also observed for colour, surface tension, foam volume, and short-term stability indicators, while pH was largely unchanged. Because the work was explicitly presented as a pi-lot study with limited replication, its findings are best interpreted as preliminary evidence for selecting clarifying agents rather than as definitive industrial guidance.

Post-harvest UV-C treatment was investigated by Menga et al. (contribution 4) in fresh green asparagus. Different UV-C doses affected nutraceutical and hedonic quality parameters during storage: lower doses better preserved phenolic and flavonoid compounds and antioxidant activity, whereas higher doses were more relevant for texture and colour stabilization. This contribution therefore highlights the importance of dose optimization according to the quality attribute that is prioritized.

Ultrasonic processing was studied by Alfaro-Rodríguez et al. (contribution 5) using aqueous flaxseed fibre dispersions. Short ultrasonic treatments had limited effects on viscoelastic parameters and viscosity, whereas longer treatments markedly reduced these properties, suggesting microstructural degradation. The study demonstrates that ultrasound can be a useful structuring or homogenization tool, but it also emphasizes that amplitude and treatment time must be carefully controlled to preserve desirable rheological behaviour and physical stability.

High-pressure processing was addressed by Inácio et al. (contribution 6) in raw ewe's Serra da Estrela cheese. Processing at selected pressure-time combinations slowed proteolysis during refrigerated storage and had limited immediate effects on texture. Some treatments maintained texture and sensory attributes closer to those of earlier-stage control cheeses, indicating that HPP may help modulate ripening and storage behaviour in traditional cheese matrices.

Analytical authentication and digital quality control were represented by Suzuki et al. (contribution 7), who combined fluorescence fingerprinting with convolutional neural networks for origin and variety identification of dried kelp. The approach achieved high classification accuracy even for genetically close varieties, indicating the potential of spectroscopic fingerprints and machine learning for food authenticity, traceability, and fraud prevention.

Sous vide processing and packaging were examined by Hanus et al. (contribution 8) in red peppers. The authors combined sous vide heat treatments with vacuum, unaltered atmosphere, and modified atmosphere packaging and reported reductions in total viable counts, Enterobacteriaceae, and filamentous fungi compared with raw controls. Depending on treatment and packaging conditions, the refrigerated shelf life was extended, showing how mild heat treatment and packaging strategy can act together to improve microbiological quality.

Finally, Dobрева et al. (contribution 9) characterized three Bulgarian garden thyme essential oils by GC-MS and antioxidant assays. The oils were dominated by thymol chemotypes and showed antioxidant activity in DPPH and ABTS assays. This contribution broadens the Special Issue beyond processing operations alone by addressing natural bioactive ingredients that may support food preservation, functional-food development, or nutraceutical applications.

3. Main Themes and Future Directions

Viewed as a collection, the nine papers show that emerging and optimized processing approaches can influence quality through multiple routes: preservation of bioactive compounds, modification of texture and rheology, improvement of microbiological stability,

enhancement of clarity or appearance, and strengthening of authenticity control [5–12]. They also show that the effects of a processing technology are matrix-dependent. For example, the beneficial role of a given treatment depends on the product structure, target quality attribute, storage conditions, and process intensity.

At the same time, the achievements of this Special Issue should be framed carefully. The published contributions provide valuable case studies and experimental evidence, but they do not comprehensively address molecular mechanisms, consumer acceptance, sustainability assessment, or industrial scalability across all technologies. Some papers include sensory or storage observations, and some report process-efficiency or energy-related parameters; however, systematic consumer studies, life-cycle assessments, techno-economic analyses, and scale-up validation remain important directions for future research.

Future work should therefore build on these contributions by integrating mechanistic studies with longer storage trials, standardized sensory evaluation, and broader validation across food matrices. Advanced analytical tools, including omics approaches, imaging methods, spectroscopy, and predictive modelling, may help clarify how processing parameters affect food components and quality attributes. The use of artificial intelligence and machine learning, already illustrated in this Special Issue through image-based and fluorescence-fingerprint classification [5,11], should be further explored for process monitoring, authenticity assessment, and data-driven quality control.

Industrial implementation also requires attention to feasibility, reproducibility, regulatory constraints, and environmental performance. Future studies should include pilot-scale and industrial-scale trials, cost and energy analysis, packaging compatibility, and safety validation. Consumer-centered research remains essential as well, because the adoption of innovative technologies depends not only on technical performance but also on trust, perceived naturalness, sensory quality, and communication of benefits [14–17].

In conclusion, this Special Issue provides a focused snapshot of current progress in innovative food processing and quality evaluation. Its nine contributions collectively demonstrate how specific technologies and analytical approaches can affect physicochemical, sensory, microbiological, nutritional, and authenticity-related properties in selected food systems. We hope that the findings presented in this collection will stimulate further interdisciplinary collaboration and inspire future research aimed at developing food systems that are technologically robust, nutritionally beneficial, environmentally responsible, and responsive to consumer needs.

As Guest Editors, we would like to express our sincere gratitude to all authors for their valuable contributions, to the reviewers for their expertise and constructive feedback, and to the editorial team of Applied Sciences for their continuous support throughout the development of this Special Issue. We believe that the work presented here represents a meaningful contribution to ongoing research on emerging food-processing technologies and their effects on food quality.

Conflicts of Interest: The authors declare no conflicts of interest.

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