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*Editorial*

# Impact of Novel Nonthermal Processing on Food Quality: Sustainability, Modelling, and Negative Aspects

**Anet Režek Jambrak**,[1] **Francesco Donsì**,[2] **Larysa Paniwnyk**,[3] **and Ilija Djekic**[4]

[1]*Faculty of Food Technology and Biotechnology, University of Zagreb, Zagreb, Croatia*
[2]*Department of Industrial Engineering, University of Salerno, Fisciano, Italy*
[3]*Coventry University, Coventry, UK*
[4]*Faculty of Agriculture, University of Belgrade, Belgrade, Serbia*

Correspondence should be addressed to Anet Režek Jambrak; anet.rezek.jambrak@pbf.hr

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Novel food processing technologies, including nonthermal processing techniques, such as electro-technologies (pulsed light, pulsed electric field, cold plasma, e-beam processing, etc.), mechanical processing (ultrasound and hydrodynamic cavitation), pressure-based technologies (high-pressure processing, high-pressure homogenization, supercritical fluid extraction, subcritical water extraction, etc.), and novel thermal processing techniques, such as ohmic heating and dielectric heating (radio frequency and microwave heating), have attracted increasing attention in the recent years. The implementation of novel nonthermal and thermal technologies in food processes is driven by the growing demand for fresh-like, more natural food products, which, however, ensure the convenience of large-scale commercial distribution and long shelf life. Therefore, food researchers are currently addressing the exploration and development of alternatives to conventional food processing technologies, not only to improve food preservation but also to product quality and sustainability, without jeopardizing food safety.

Food and Drug Administration (FDA) was among the first regulatory agencies to request from the Institute of Food Technologists (IFT) to report on the effectiveness of microbial inactivation by alternative food processing technologies. The idea was to develop applications of novel nonthermal technologies, eventually in combination with advanced thermal technologies, to ensure food safety by satisfying the requirement of a minimum 5-log reduction of the endogenous flora. In support to this trend, the latest UN Sustainable Development Goals also promote the development of sustainable technologies.

The researchers in food processing have to pursue food safety, bearing in mind food security and the reduction of the impact on the environment. The aim of processing by using alternative food processing technologies is to achieve the desired inactivation of microorganisms (food safety), and concurrently to reduce energy consumption, optimize time-consuming processes, and satisfy the consumers' requests. Nowadays, one of the biggest challenges is to scale up the readiness level of these novel technologies to an industrial level.

Thermal techniques have been used for decades, with the results in terms of inactivation of microorganisms, which are not debatable; however, high-temperature processing is often responsible for the deterioration of nutritive, functional, and organoleptic properties. Therefore, several nonthermal techniques had been evaluated for their potential in food preservation. So far, only high-pressure processing satisfied the requirements in terms of microbial inactivation, when used alone in food preservation, whilst the use of other nonthermal processing techniques is industrially viable only in combination with moderate heating, to ensure the required food preservation effect. In addition, the mechanisms underlying the inactivation of microorganism by novel technologies have not been fully elucidated and are still under study, with several proposed action plans still ongoing for each technique. Finally, more

reliable shelf life studies on nonthermally processed products are necessary, because of the risks associated with sublethal injuries, which lead to the revitalization and possible "stress" effect on microorganisms, where they are not killed but are "under stress." This phenomenon can be detected and is called viable but nonculturable state. Such microorganisms can revitalize and organize to set a biofilm formation, considered as a very strong network formed of microorganisms' cell and carbohydrates, whose formation is very hard to break.

These techniques have been extensively investigated in terms of their impact on food quality, the nutritional value of food, microbiological safety, drying, extraction, enzyme inactivation rate, and sensory properties and other advantages on product technological properties or functionality. However, there are still major unresearched gaps, especially concerning the evaluation of negative aspects of application of novel nonthermal processing on food quality, stability of food during shelf life upon nonthermal processing, negative sensory properties of food treated by novel nonthermal and thermal techniques, life cycle assessment and sustainability of novel nonthermal and thermal processing techniques, advantages of novel nonthermal and thermal processing in terms of energy consumption and quality, usage of green techniques, "green" solvents, "green" extraction processes, and impact on food quality. The scope for this special issue is to promote articles, which describe the current state of the art in the mentioned areas and to attract and "especially welcome" research papers dealing with proposed unresearched topics.

This special issue provides an overview of the focused usage of novel technologies for assuring food safety, quality, and low impact on the environment. In particular, it aims at emphasizing the usage of alternative nonthermal processing as sustainable processing technologies. In addition, this special issue also tries to address the optimization and combination of advanced processing technologies by promoting advantages of each nonthermal and advanced thermal ones, by avoiding negative factors and negative influence on food products. The special issue also emphasizes the negative effects of application of novel technologies in terms of radical formation. Production of free radicals is a negative side effect in using specific technologies (such as ozonization, radiation, ultrasound processing, plasma processing, and advanced oxidative processes), so it is necessary to optimize processing conditions in order to reduce processing time, and possibility for free radical formation, thereby reducing negative effect on products.

Special focus is given to determine the required lethality effect on microorganisms (without the possibility for revitalization) and induce biofilm deterioration and/or prevention. It also focuses on ensuring the safety of packaging materials of products that were treated by nonthermal processing, as well as efficient surface decontamination techniques, to ensure microbial inactivation and avoid contamination of container or packaging. Finally, this issue also treats the quality aspects of novel food processing technologies, especially for what concerns the observation and control of final product quality using various analytical methods, such as the analysis of chemical composition, and of physical and sensory properties of food, in terms of color, texture, taste, odor, flavor, etc.

Two future challenges in developing novel food processing technologies, which clearly emerged from the articles collected in this issue, are (i) the development of a compact tool for evaluating hygienic design of novel nonthermal or thermal food-processing equipment, when scaled up to industrial level, due to the redundancy of the several requirements outlined in different standards and regulations related to hygienic design and (ii) the improvement of the overall environmental performance of these novel technologies, compared to conventional technologies, with improved nutritional and quality characteristics.

## Conflicts of Interest

The editors declare that they have no conflicts of interest regarding the publication of this special issue.

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*Anet Režek Jambrak*
*Francesco Donsì*
*Larysa Paniwnyk*
*Ilija Djekic*