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REVIEWER'S REPORT

Manuscript No.: IJAR51796 Date: 22-05-2025

Title: NON-THERMAL PROCESSING AND PACKAGING REQUIREMENTS: RECENT TRENDS AND APPLICATIONS

Recommendation:
Accept as it

Rating	Excel.	Good	Fair	Poor
Originality			√	
Techn. Quality			√	
Clarity			√	
Significance		√		

Reviewer Name: Dr. Manju M **Date:** 23-05-2025

Reviewer's Comment for Publication.

- HPP is beneficial but requires more scientific safety evidence and better regulations to expand industrial use.
- PEF improves energy efficiency and functional food production, with global research supporting its applications.
- Pulsed light shows promise in microbial inactivation but needs more study on resistant species for broader industrial adoption.
- Cold plasma extends shelf life and preserves quality with eco-friendly, energy-saving antimicrobial effects.
- Combining non-thermal technologies with conventional methods can enhance food safety and quality but faces scaling and acceptance challenges.

Detailed Reviewer's Report

High Pressure Processing (HPP) Benefits and Limitations

HPP offers significant advantages to food processors, consumers, and the environment by enhancing food safety without heat. However, there is still a need for more scientific evidence to confirm the chemical safety of HPP-treated foods. Additionally, many countries lack specific food laws regulating non-thermal technologies like HPP, which restricts its wider industrial adoption (Agriopoulou et al., 2023).

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Pulsed Electric Fields (PEF) as a Versatile Technology

PEF is recognized globally as an important food processing method that supports energy-efficient and environmentally friendly food production. It accelerates processes such as pasteurization, drying, freezing, and extraction. PEF also promotes the creation of functional foods enriched with bioavailable ions essential for human health (Nowosad et al., 2020).

Pulsed Light (PL) Processing and Microbial Resistance

PL processing introduces innovative approaches for microbial inactivation, expanding options for food safety. However, certain microbial species exhibit resistance to PL, highlighting the need for further research on these organisms and affected foods to improve method effectiveness and safety. Despite these challenges, PL is expected to grow industrially in the coming years (Oliu et al., 2008).

Cold Plasma Technology for Shelf Life Extension

Cold plasma has recently attracted attention as a cutting-edge food treatment method. It can significantly extend the shelf life of perishable foods while preserving nutritional and sensory qualities by using low or ambient temperature plasma. Unlike traditional thermal treatments, cold plasma offers rapid, targeted processing that saves energy and maintains food quality. Its antimicrobial properties and eco-friendliness boost its acceptance in the food industry.

Ozone Treatment as an Eco-Friendly Preservation Method

Ozone, a naturally occurring reactive molecule produced under controlled conditions, exhibits strong antibacterial activity and is environmentally benign. It is increasingly replacing conventional sanitation methods such as chlorine, steam, and hot water in food processing. Ozone is valued as a safe, cost-effective, and chemical-free method for ensuring food safety (Nath et al., 2014).

Advancements in UVC Disinfection Systems

Recent engineering improvements have produced novel UVC systems with enhanced intensity and penetration for food product disinfection. However, food producers must perform thorough validation and due diligence before applying UVC to ensure that it does not compromise product safety or quality. Proper testing is essential to guarantee consumer safety and effective technology use (Fetters, 2023).

Ultrasound (US) in Improving Drying and Freezing Processes

Ultrasound technology has significantly enhanced mass and energy transfer in food freezing and dehydration processes. The use of US reduces drying times, leading to dehydrated products with higher contents of total phenolic compounds (TPC), flavonoids, and ascorbic acid. US also improves sensory qualities such as color and rehydration capacity, making it a valuable tool in food processing (Raso et al., 2021).

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Consumer Demand Driving Non-Thermal Food Processing

Increasing consumer expectations for safe, wholesome, and minimally processed foods have accelerated the adoption of non-thermal methods in the food industry. These technologies maintain food taste, texture, and heat-sensitive nutrients while ensuring microbial safety, addressing common concerns with conventional thermal processing.

Challenges in Scaling and Standardizing Non-Thermal Technologies

Despite their benefits, non-thermal food processing technologies face challenges including the development of bulk processing equipment, establishing processing standards, and overcoming consumer skepticism. Addressing these issues is critical to achieving broader industrial implementation and consumer acceptance.

Future Outlook: Integration and Collaboration for Food Innovation

Combining non-thermal technologies like PEF and US with traditional methods can optimize food safety, quality, and processing efficiency. Ongoing collaboration among food scientists, engineers, manufacturers, and regulators is vital to overcome current barriers and fully realize the potential of non-thermal processing. These efforts promise to transform food preservation and provide safer, healthier, and higher-quality products worldwide.

Applications and their significance:

1. **High Pressure Processing (HPP):** Enhances food safety and shelf life without heat, preserving nutritional and sensory quality.
2. **Pulsed Electric Fields (PEF):** Improves energy-efficient pasteurization and extraction, producing functional foods with better nutrient absorption.
3. **Cold Plasma:** Extends shelf life and provides rapid, eco-friendly microbial inactivation while maintaining food quality.
4. **Ultrasound (US):** Speeds up drying and freezing processes, improving antioxidant retention and sensory characteristics.