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Infrared-Powered Retort Sterilization of Canned Fish Compared to Conventional Retorting: Process Optimization and Product Storage Stability

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ABSTRACT

Recently, the infrared-based retort (RIR) was developed for sustainable food production in the canning process. However, its industrial applications require assessing its effects on product properties during storage. This study aims to comparatively evaluate the novel RIR and conventional retort (CR) for canned Talang Queenfish's quality parameters and to define optimal processing conditions by altering sterilization temperature (110°C–121°C) and time (10–20 min) to minimize peroxide value (PV), acid value (AV), free fatty acid (FFA), thiobarbituric acid (TBA), total volatile nitrogen (TVN), and maintain acceptable pH. Scanning Electron Microscopy (SEM), Fourier Transform Infrared Spectroscopy (FTIR), and sensory evaluation were also performed, and the products were assessed monthly during a 1-year storage period. The optimal product was achieved at 116.5°C/15.6 min, with significantly ($p < 0.05$) extended shelf-life and reduced PV, AV, FFA, TBA, TVN, with a slight decrease in pH compared to CR. SEM revealed that the RIR product exhibited more organized cellular structure with a smoother surface. Despite the similarity of spectra, FTIR analysis indicated differences in functunal group characteristics between RIR and CR samples, particularly in hydroxyl and carbonyl regions. RIR-sterilized fish achieved higher overall acceptance sensory score than CR (8.9 ± 0.6 vs. 7.4 ± 0.8). Results indicate RIR capability for practical applications and contribution to food quality enhancement and waste reduction.

1 | Introduction

The canning process, also known as retorting, refers to thermal sterilization methods that have been practiced for centuries to preserve low-acid foods, thereby contributing to human well-being, food safety, security, and affordability (Al-Mtury et al. 2025; Long et al. 2022). This process has been applied to a variety of foods, including seafood industry products (e.g., various types of fish), effectively enhancing microbial safety and extending shelf-life at ambient temperatures to several months to years (Owusu-Apenten and Vieira 2023; Vannini and Siroli 2025).

The demand for higher-quality and sustainably produced foods is increasing as 21st-century consumers become more aware of the environmental impact of the food production process and the relationship between food nutrition and health. This has led to significant development in the food preservation industry, providing sterile, nutritious, and economical food, as well as the emergence of innovative food processing technologies (Chaudhary and Kumar 2022; Gavahian 2024). This includes efforts to replace energy-intensive and low-efficiency processes, such as conventional retorts (CR) and boilers, in the canning industry. These include development in microwave stepwise retort (Yang et al. 2022), reciprocal agitating retort (Dixon et al. 2020),