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Recent advances in non-thermal processing technologies for enhancing shelf life and improving food safety

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ABSTRACT

Emerging non-thermal technologies for enhancing shelf life and food safety have revolutionized the food processing sector. Adopting different non-thermal techniques like supercritical carbon dioxide, high hydrostatic pressure, cold plasma, and ozone technology can improve food quality and enhance the storage life of foods by reducing spoilage and wastage. Evidence shows that these emerging innovative technologies not only ensure the freshness of the food but also keep the nutritionally heat-sensitive materials intact in the foods. Moreover, these can serve as alternatives to conventional heat processing methods resulting in hygienic and safe foods, retention of bioactive compounds, decontamination of microorganisms, and limited changes in the nutritional and sensory attributes. In this review, the basic principles of non-thermal technologies and their effect on the quality parameters of foods are reported. Also, the potential applications and benefits of these technologies as alternative processes for food preservation and to eliminate contamination and infection from food samples are discussed.

1. Introduction

In food processing, non-thermal innovative technologies have gained a lot of popularity as they enhance the shelf life of foods, and retain the quality such as nutritional, freshness, and sensory attributes of food products. Traditional thermal processing methods like evaporation, pasteurization, drying, sterilization, refrigeration (cold storage), and freezing (less than -18°C) are considered as the most significant energy-consuming techniques in food sector. These conventional techniques are directly in line with one of the main concern i.e., food safety that includes inhibition of spoilage enzymes including polyphenol oxidase (PPO), pectin methyl esterase (PME), lipo-oxygenase (LO), and peroxidase (PO) to decrease the microbial growth and consequently enhance the shelf life and safety of food products (Putnik et al., 2017a). In thermal processing, food is preserved by exposing it to a very high temperature that decreases microbial growth or contamination from food, but also leads to some deleterious effects in food product like loss of some heat sensitive nutritional components, textural changes in food, changes in rheological characteristics and changes in sensory attributes of food (Hernández et al., 2019), such as Horchata (Spanish beverage) contains increased concentration of starch, heating at high temperature more than 72°C may cause starch gelatinization and can adversely affect the organoleptic characteristics (Rosell-Soto et al., 2018), thermal sterilization in case of probiotic foods may influence the viability of probiotic strains (Asaithambi et al., 2021). Both LTLT and HTST (thermal processing) may have significant effects on nutritional and color values of pomegranate juice (Putnik et al., 2019). Thermal processing also results in the loss of hydration from food products, changes in fatty acids compositions, lipid oxidation etc. Meat barbequing process results in loss of juices in meat, reduction in saturated fatty acids, and escalation in poly unsaturated fatty acid (PUFA) in the developed product. The presence of PUFA in the product makes it more prone to lipid oxidation and reduction in the final quality of product such as off –flavor with decreased taste (Oz, 2021). Nowaday's consumers' consciousness regarding the safety of food has increased and they demand healthy high quality nutritional profile food with no microbial load and excellent mouthfeel. Hence, there was a need for search of better alternative such as non-thermal emerging technologies like ultrasound (US), pulsed light (PL), ultraviolet radiation (UV),ozone, high hydrostatic pressure (HHP), supercritical carbon dioxide (SC-CO2), and atmospheric cold plasma (ACP) (Manzocco et al., 2017; Pereira & Vicente, 2010; Putnik et al., 2017b) to attain high quality food with reduced microbial load. Different parameters have to be considered before applying these technologies like the type of food, processing time, processing conditions, and processing intensity. These novel technologies can result in changes in physical, chemical, and biological characteristics of food, leading to changes in

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