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Introduction to Innovative Food Processing and Technology

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Consumers around the world are better educated and more demanding in their identification and purchase of quality health-promoting foods. The food industry and regulatory agencies are searching for innovative technologies to provide safe and stable foods for their clientele. Thermal pasteurization and commercial sterilization of foods provide safe and nutritious foods that, unfortunately, are often heated beyond a safety factor that results in unacceptable quality and nutrient retention. Nonthermal processing technologies offer unprecedented opportunities and challenges for the food industry to market safe, high quality health-promoting foods. The development of nonthermal processing technologies for food processing is providing an excellent balance between safety and minimal processing, between acceptable economic constraints and superior quality, and between unique approaches and traditional processing resources (6). Nonthermal food processing is often perceived as an alternative to thermal food processing, yet there are many nonthermal preparatory unit operations as well as food processing and preservation opportunities and challenges that require further investigation by the food industry. Nonthermal technologies are useful not only for inactivation of microorganisms and enzymes, but also to improve yield and development of ingredients and marketable foods with novel quality and nutritional characteristics (1,4,5).

Nonthermal processing is effectively combined with thermal processing to provide improved food safety and quality. Nonthermal processing facilitates the development of innovative food products not

Previously envisioned. Niche markets for food products and processes will receive greater attention in future years. Nonthermal technologies successfully decontaminate, pasteurize, and potentially pursue commercial sterilization of selected foods while retaining fresh-like quality and excellent nutrient retention. The quest for technologies to meet consumer expectations with optimum quality safe processed foods is a most important priority for future food science research. Zhang et al. (2011) listed the relevant factors to consider when conducting research into novel nonthermal and thermal technologies as: 1) target microorganisms to provide safety; 2) target enzymes to extend quality shelf life; 3) maximization of potential synergistic effects; 4) alteration of quality attributes; 5) engineering aspects; 6) conservation of energy and water; 7) potential for convenient scale-up of pilot scale processes; 7) reliability and economics of technologies; and 8) consumer perception of the technologies. "The search for new approaches to processing foods should be driven, above all, to maximize safety, quality, convenience, costs, and consumer wellness" (4,5,6).

Morris et al. (2007) conclude that nonthermal unit operations in food processing interest food scientists, manufacturers, and consumers because the technologies expose fresh foods to minimal impact on nutritional and sensory qualities, yet presumably provide safe shelf stable foods by inactivating pathogenic microorganisms and spoilage enzymes. The presumption that nonthermal processing is energy efficient and environmentally friendly adds to contemporary popularity.

Additional benefits to the food industry include the provision of food safety, value-added heat labile foods, and new market opportunities.

Nonthermal food processing technologies are extensive with high hydrostatic pressure (HHP), pulsed electric fields (PEF), ultrasonics, ultra-violet light, ionizing irradiation (electron beams) and hurdle technologies leading the way. In addition, pulsed X-rays, pulsed high intensity light, high voltage arc discharge, magnetic fields, dense phase carbon dioxide, plasma, ozone, chlorine dioxide, and electrolysed water are receiving attention individually and as a hurdle in minimal processing protocols (2,3,4,5).

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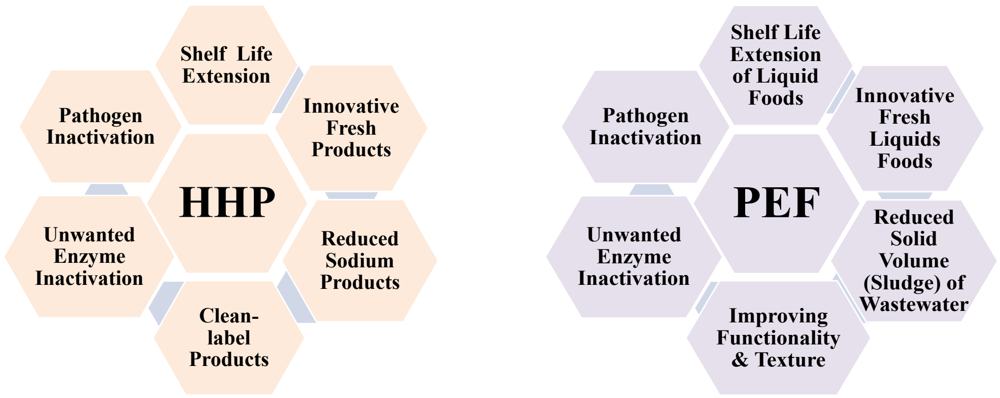

Figure 1. The Usage Area of High Hydrostatic Pressure (HHP) and Pulsed Electrical Field (PEF) (4,5)

Current researches devote attention to improving food functionality with high hydrostatic pressure (HHP) and pulsed electric fields (PEF). The focus on improving the quality and retaining bioactive constituents of fruits and vegetables and improving the quality of dairy, egg, meat and seafood products

with HHP is evident in many chapters. The inclusion of reviews of modelling and simulation of HHP inactivation of microorganisms and the relative effects of HHP processing on food allergies and intolerances broadens the scope of the information provided.

Improving food functionality with pulsed electric field (PEF) processes are focussed on dairy and egg products, fruit juices and wine. A chapter attending to industrial applications of HHP and PEF systems and potential commercial quality and shelf lives of food products concludes this discussion.

High hydrostatic pressure (HHP), ultra-high pressure (UHP), ultra-high pressure processing (HPP) are different names and acronyms for equivalent nonthermal processes employing pressures in the range of 200 to 1000 MPa with only small increases in processing temperature. The ultra-high pressures inactivate microbial cells by disrupting membrane systems, retaining the biological activity of quality, sensory and nutrient cell constituents, thus extending the shelf lives of foods.

High pressures inactivate enzymes by altering the secondary and tertiary structures of proteins, changing functional integrity, biological activity, and susceptibility to proteolysis. HHP processing of diary proteins reduces the size of casein micelles, denatures whey proteins, increases calcium solubility and induces color changes (2). The use of HHP to increase the yield of cheese curd from milk and accelerate the proteolytic ripening of Cheddar cheeses are promising improvements to the economics for the dairy food industry. The most widely available commercial applications of HHP include pasteurization of quacamole, tomato salsas, oysters, deli sliced meats, and yogurts. The provision of HHP processing to provide a preservation method for thermally labile tropical fruits is very promising.

Pulsed electric field processing (PEF) exposes fluid foods to microsecond bursts of high intensity electric fields, 10 to 100 kV/cm, inactivating selected microorganisms by electroporation, a disruption of cell membranes. PEF processing reliably results in five log reduction in selected pathogenic microorganisms, resulting in minimal detrimental alterations in physical and sensory properties of the fluid foods.

PEF adequately pasteurizes acid (pH < 4.5) fruit juices, and research is continuing on uniform adequate pasteurization of milk and liquid eggs. The commercial application of PEF to improve extraction yield of fruit juices and bioactive components of plant materials are in progress. PEF inactivation of enzymes is inconsistent and non-uniform resulting in plant products subject to short shelf lives at ambient temperatures. Although PEF is identified as a nonthermal process, temperature increases during PEF processing results in fluid foods at 35 to 50oC requiring cooling prior to packaging. The presence of particulates or bubbles in fluid foods subjected to PEF will result in dielectric breakdown, arcing and scorching of the food. Homogenization and vacuum degassing are necessary minimize the hazards associated with PEF processing of fluid foods.

Technical issues that must be addressed to commercialize PEF for approval as an adequate food pasteurization technology include: 1) consistent and uniform generation of high intensity electric fields; 2) identification of critical electric field intensities for uniform microbial inactivation; 3) identification of homogenization and vacuum degassing techniques to assure the absence of particulates and air cells that promote arcing, and 4) identification of flow rates, temperature control, cooling and aseptic packaging parameters to obtain processing uniformity and safe handling practices (2,4,5).

High hydrostatic pressure (HHP) and pulsed electric fields (PEF) processing of foods continues with a focus on heat labile acid fruits, vegetables and dairy foods that meet consumer expectations for a minimally process, safety, fresh-like quality and convenience. Nonthermal preservation extend shelf life without the addition of preservatives while retaining expected fresh-like appearance, sensory and nutrient quality. It will be necessary to combine nonthermal and thermal preservation technologies to inactivate heat resistant spores potentially contaminating low acid foods. Commercial nonthermal processing success stories such as pasteurized quacamole, oysters, salsa, yogurt and refrigerated meats and improved yields of fruit juices and bioactive compounds from herbs and other plant materials will demonstrate the efficacy and economic success of the technologies in niche markets. Successful research and identification of economic benefits including energy and water conservation as well as demonstrated safety and fresh-like quality attributes will improve consumer perception of nonthermal technologies and result in further development by the food industry around the world.

Conflict of interests: We declare that we have no conflict of interests.

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