HIGH HYDROSTATIC PRESSURE AND PULSED ELECTRIC FIELDS. AN OVERVIEW

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Abstract: The conventional heat treatment ensures food safety but can lead to undesirable changes both in the nutritional and in the sensorial properties of the foods. In order to avoid these unfavourable changes during the heat treatment, in the last decades alternative food technologies are receiving much attention. High Hydrostatic Pressure (HHP) and Pulsed Electric Fields (PEF), as alternative food technologies, are considered to be the best options for expanding the shelf life based on results of quality food parameters. The aim of this review is to present some general aspects about HHP and PEF technologies.
Key words: Food safety; HHP; PEF.

1. Introduction

The grown interest in fresh like food products that consumers have lately has chalanged food technology to develop novel minimal processing technologies that are alternatives for classic food preservation while ensuring microbilogical safety of foods (Stoica *and al.,* 2011). High hydrostatic pressure (HHP) is a non-thermal technology that has been successfully applied in producing microbiologically safe food products while maintaining the natural characteristics of the food (Knoerzer *and al.*, 2010; Pereira and Vicente, 2010; Rendueles *and al.,* 2010). Pulsed electric field (PEF) is a non-thermal technology that provides minimally processed, safe, nutritious and fresh-like food products to consumers (Oms-Oliu *and al.,* 2009; Stoica *and al.,* 2011). The chapter 2 documents some aspects associated with the industrial relevance of HHP while the chapter 3 presents the general aspects regarding of PEF.

2. High Hydrostatic Pressure – an industrial reality

HHP creates new opportunities to improve the balance between safety and quality of foods and is used for preservation of meat, fish and seafood, dairy and vegetable products, but also for some fermented products such as beer or wine (Koseki and Yamamoto, 2006; Min *and al.,* 2007; Bilbao-Sáinz *and al.,* 2009; Rendueles *and al.,* 2010; Vervoort *and al.,* 2012). In general, the HHP processing inactivates the microorganisms, modifies the biopolymers such as enzymes and proteins, while the food nutritional values colour and flavor components are largely unaffected. The pressure acts mostly instantaneously and uniformly in all points of the food products which mean that no matter the food shape or size the effect of pressure in evenly distributed according to Pascal law (Rendueles *and al.,* 2010). When appling HPP food is typically subjected to pressures up to 400 or 600 MPa for a period of a few seconds up to several minutes depending on the desired objective (Vervoort *and al.*, 2012). The 600 MPa pressure is considered by many authors as threshold value and also is considered to be economical and microbiologically safe for achieving the pasteurization level (Garriga *and al.,* 2004; Aymerich *and al.*, 2008; Perera *and al.,* 2010). The critical process factors in HHP include pressure level, time at pressure, time to achieve

treatment pressure, adabatic heating, decompression time, treatment temperature, product initial temperature, intrinsic factors of the food product (*p*H, composition, water activity), packaging materials and extrinsic factors prior to processing, during storage and distribution (Kadam *and al.*, 2012).

3. Pulsed Electric Fields (PEF) – general aspects

PEF involves the discharge of high voltage electric short pulses through the food (Barbosa-Cánovas and Altunakar, 2006; Stoica *and al.,* 2011). PEF processing is considered more efficient than traditional heat treatments of food and consequently it presents several advantages over conventional heat treatments: better retention of flavor, colour and nutritional value, improved protein functionality, increased shelf-life and reduced pathogen levels (Stoica *and al.,* 2011). Successful application of PEF treatment depends on biological factors such as: cell type, size and shape of the cell, cells density, arrangement and cell position; dielectric breakdown and physical and chemical properties of food are also considered (conductivity, *p*H, and ionic strength) (Mittal 2009; Stoica *and al.*, 2011). The type and characteristics of the used electric field waveform in PEF are critical for the outcome of this process. The breakdown of the cell membrane, as effect of the PEF, can be a reversible or irreversible process (Stoica *and al.*, 2011) (Figure 1).

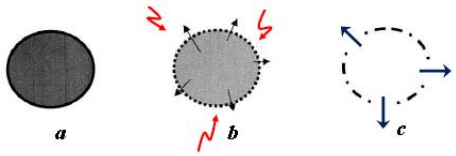

Fig. 1. Reversible and irreversible breakdown: (a) intact cell, (b) cell membrane reversible permeabilized, (c) cell membrane irreversibly permeabilized (inactive cell), source: Stoica and al., 2011.

The reversible breakdown has wide applications in biotechnology and medicine, while the irreversible breakdown finds applications in food industry, pharmaceutical research, public health and water purification. PEF as, an innovative minimal processing, is receiving considerable much attention from research groups as well as food companies as a new technique with potential to be fully adapted to processing food at larger industrial users (Stoica *and al.,* 2011).

4. Concluding comments

For giving to consumers the food they want, producers should balance between extended shelf-life and fresh, healthy and nonetheless tastey products. Application of the High Hydrostatic Pressure and the Pulsed Electric Field treatment seems to be a good choice for the achieving this goal. Both the HHP and the PEF technologies are considered to be novel very promising alternative to classical processing technologies. A clear advantage of the two techniques for certain operating parameters is the inactivation of pathogens while preserving the natural characteristics of the foods.

References

Aymerich T., Picouet P.A., Monfort J.M. Decontamination technologies for meat products, *Meat Science*, 78 (2008) 114–129.

Barbosa-Cánovas G.V., Altunakar B., Pulsed Electric Fields Processing of Foods: An Overview. In Raso J, Heinz V, eds. *Food Pulsed Electric Fields Technology for the Food Industry, Fundamentals and Applications*. New York, NY Springer; 2006:3-26.

Bilbao-Sáinz C., Younce F.L., Rasco B., Clark S. Protease stability in bovine milk under combined thermal-high hydrostatic pressure treatment, *Innovative Food Science and Emerging Technologies*, 10 (2009) 314–320.

Garriga M., Grebol N., Aymerich M.T., Monfort J.M., Hugas M. Microbial inactivation after high-pressure processing at 600 MPa in commercial meat products over its shelf life, *Innovative Food Science and Emerging Technologies*, 5 (2004) 451– 457.

Kadam P.S., Jadhav B.A., Salve R.V., Machewad G.M. Review on the High Pressure Technology (HPT) for Food Preservation, *Journal of Food Processing & Technology*, 3 (2012) 135, doi:10.4172/2157-7110.1000135

Knoerzer K., Buckow R., Versteeg C. Adiabatic compression heating coefficients for high-pressure processing – A study of some insulating polymer materials, *Journal of Food Engineering*, 98 (2010) 110–119.

Koseki S., Yamamoto K. pH and solute concentration of suspension media affect the outcome of high hydrostatic pressure treatment of Listeria monocytogenes, *International Journal of Food Microbiology*, 111 (2006) 175–179.

Min S., Sastry S.K., Balasubramaniam V.M. In situ electrical conductivity measurement of select liquid foods under hydrostatic pressure to 800 MPa, *Journal of Food Engineering*, 82 (2007) 489–497.

Mittal G.S. Non-Thermal Food Processing with Pulsed Electric Field Technology, *Magazine*. 16 (2) (2009) 6-8.

Oms-Oliu G., Odriozola-Serrano I., Soliva-Fortuny R., Martín-Belloso O. Effects of high-intensity pulsed electric field processing conditions on lycopene, vitamin C and antioxidant capacity of watermelon juice, *Food Chemistry*, 115 (2009) 1312–1319.

Pereira R.N., Vicente A.A. Environmental impact of novel thermal and non-thermal technologies in food processing, *Food Research International*, 43 (2010) 1936–1943.

Perera N., Gamage T.V., Wakeling L., Gamlath G.G.S., Versteeg C. Colour and texture of apples high pressure processed in pineapple juice, *Innovative Food Science and Emerging Technologies*, 11 (2010) 39–46.

Rendueles E., Omer M.K., Alvseike O., Alonso-Calleja C., Capita R., Prieto M. Microbiological food safety assessment of high hydrostatic pressure processing: A review, *Food Science and Technology*, (2010), doi:10.1016/j.lwt.2010.11.001

Stoica M., Bahrim, G., Cârâc, G. Factors that Influence the Electric Field Effects on Fungal Cells, In *Science against microbial pathogens: communicating current research and technological advances*, A. Méndez-Vilas (Ed.), Publisher: Formatex Research Center, 1 (2011) 291-302.

Vervoort L., Van der Plancken I., Grauwet T., Verlinde P., Matser A., Hendrickx M., Van Loey A. Thermal versus high pressure processing of carrots: A comparative pilot-scale study on equivalent basis, Innovative Food Science and Emerging Technologies (2012), doi:10.1016/j.ifset.2012.02.009