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Where does Pulsed Electric Field Processing Stand for Preservation of Nutrition Quality of Foods

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Abstract

Pulsed electric fields (PEF) has gain a great attention from food industry for nonthermal processing of low viscosity food products providing both microbial and enzyme inactivation and keeping physical, nutritional and sensory properties. Although most studies focused on microbial inactivation, relatively lees studies are reported effect of PEF on nutritional quality and clinical studies of PEF treated food products. Thus this paper focused on effects of PEF on nutritional properties of food products.

Introduction

Interest about nonthermal technologies has been increased with recent claims that heat processing of foods although it provides enough microbial inactivation can cause dramatic undesirable changes on physical, sensory and nutritional properties of foods. This interest created a big demand to develop different technologies including application of pressure (high pressure processing), electric field (pulsed electric fields, ohmic heating), microwave or radio frequency which some of them categorized as nonthermal food process. Pulsed electric fields (PEF) is defined as the application of short burst of electric fields in the range of 20-80 kV/cm in a matter of micro to miliseconds that prevents heating of food with high frequency rate,and electric fields is applied as logarithmic, exponentially decay, instant charge reversal, monopolaras well as bipolar pulses [1].

When high intensity electric field pulses are applied to food material flowing through the treatment chamber buried inside the pulse generator, electricity is conducted to food by the presence of ions. The most common ions in food samples are the hydrogens and thus PEF are mostly applied to high acid foods such as fruit juices and milk. During electric field application different electrochemical reactions occur under electric current that cause microbial inactivation. It is well known fact that when electric field is applied to food samples although they have reasonable level of electrical conductivity food can develop resistance against applied electric field and that can be measured as current. This electrical resistance can cause several reactions such asohmic heating, electrolysis, cell membrane disruption and shock waves caused by arc discharge to occur during processing [2-5]. These reactions are dependent to each other and the magnitude of electric fields ends up as electrical energy determines the individual effect on microorganisms. The main objective of PEF processing is to inactivate microorganisms present while minimizing changes in physical, sensory and nutritional properties. Therefore, in order to minimize the undesirable effect of the reactions such as temperature increase, electrolytic oxidative effects, disintegration of food particles which have adverse effect on foods; duration of the high voltage pulses were applied with relatively long intervals [3,4,6,7], pulses applied during process is practiced with extremely short duration (1-100 µs) and pulse intervals between discharges is adjusted from 1 millisecond to seconds [8], whereas applied electric field is kept between 10-80 kV/cm in order to obtain maximum amount of microbial and enzyme inactivation [1].

It is reported by previous studies that most of the food spoilage; foodborne as well as plant pathogens can successfully inactivated by PEF processing. Inactivation studies also revealed that PEF is very effective to inactivate enzymes (poly phenol oxidase, pectin methyl esterase, lipoxygenase, etc) [9-12]. Most of the physical parameters such as pH, °Brix, titratable acidity, color (L, a and b), hue, chroma, total color difference, total antioxidant capacity, total phenolic substance, total monomeric anthocyanin content, phenolic compounds, antocyanin compounds, organic acids and fatty acid profile are not significantly changed by PEF processing parameters [13-19]. In terms of nutritional properties fate of some compounds and vitamins were searched. PEF processing up to 400 µs at field strengths from 18.3 to 27.1 kV/cm did not cause any decrease in the initial amount of vitamin A, thiamine (B1), riboflavin (B2), cholecalciferol (D), and tocopherol as well as ascorbic acid content after PEF treatment of 22.6 kV/cm for 400 µs, 93% of the ascorbic acid [20]. PEF treatment at 35 kV/cm for 73 µs showed no effect ofthe bovine milk IgG in a protein-enriched soymilk [21]. Studies with fruit juices mostly include retention of vitamin C in orange, apple and tomato and in most cases little or no changes occurred in the initial content [13,22,23].

In terms of changes on the structure of functional proteins it is revealed that electric fields can cause complete loss of secondary structure of insulin chain B under static electric fields. After PEF processing significant nonthermal effects such as marked changes in the proteins secondary structure related to protein denaturation were noted in lysozyme structure [24]. Moreover, applied electricfield favors the switch of β-peptides from helical to β-sheet conformation [25]. It is proposed that hydrophobic interaction and disulfide bonds are the upper most binding forces in the formation of protein aggregates, and covalent bonds other than disulfide bonds are not involved in the protein polymerization under stress of PEF, and it is reported that main binding forces involved in the formation of protein–protein aggregates re induced by PEF [26-28].

With the application of electric field strength several changes in the protein molecules such as the movement of free electrons, ions and

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other charged particles, polarization, i.e., the displacementof bound charges, electrons in atoms, atoms in molecules, and the orientation of the molecular dipole moment,and increase in the dielectric constant of molecules that affect functionality of these protein molecules may take place. It is suggested that PEF may cause dissociation of non-covalently linkedprotein subunits involved in quaternary structure and increase in the dielectric constantof protein causing unfolding polypeptide. Afterward, thesecondary and tertiary structures of protein become lessdefined and loose. Changes induced by PEF may results in conformational differences with the conformational change of the active site, the inhibition of the binding of substrate to protein, and the destabilization of the protein structure [29,30]. Although studies performed to determine conformational changes on protein structure, mode detailed studies are needed to determine how PEF treated foods affect human body and certain organelles, and relationship on structural changes and nutritional properties as well as consumer acceptance.

References

1. Barbosa-Canovas GV, Pothakamury UR, Palou E, Swanson BG (1998) Non-thermal Preservation of Foods.pp. 9–48, 53–110, 113–136, 139–159. Marcel Dekker, New York.
2. Sastry SK, Barach JT (2001) Ohmic and inductive heating. Journal of Food Science. 65 (Suppl): 42-46.
3. Hülsheger H, Niemann EG (1980) Lethal effects of high-voltage pulses on E. coli K12. Radiat Environ Biophys 18: 281-288.
4. Sitzmann W (1995) High-voltage pulse techniques for food preservation. In New Methods of Food Preservation.pp. 236–251. Blackie Academic and Professional, London.
5. Zuckermann H, Krasik YE, Felsteiner J (2002) Inactivation of microorganisms using pulsed high-current underwater discharges. Innovative Food Science and Emerging Technologies 3: 329-336.
6. Palaniappan S, Sastry SK (1990) Effects of electricity on microorganisms: A review. Journal of Food Processing and Preservation 14: 393-414.
7. Zhang Q, Chang FJ, Barbosa-Canovas GV, Swanson BG (1994) Inactivation of microorganisms in a semisolid model food using high voltage pulsed electric fields. LWT 27: 538-543.
8. Qin BL, Pothakamury UR, Vega-Mercado H, Martin-Belloso OM, Barbosa-Canovas GV, et al. (1995) Food pasteurisation using high-intensity pulsed electric fields. Food Tech 49: 55-60.
9. Yeom HW, Streaker CB, Zhang QH, Min DB (2000) Effects of pulsed electric fields in the activity of microorganisms and pectin methyl esterase in orange juice. Journal of Food Science. 65: 1359-1363.
10. Min S, Min SK, Zhang QH (2003) Inactivation kinetics of tomato juice lipoxygenase by pulsed electric fields. Journal of Food Science. 68: 1995-2001.
11. Hitit B (2011) Effects of pulsed electric fields on the quality of fruit juices (in Turkish).Ms.C. thesis Abant Izzet Baysal University, Bolu Turkey
12. Agcam E, Akyildiz A, Evrendilek GA (2014a) Effects of PEF and heat pasteurization on PME activity in orange juice with regard to a new inactivation kinetic model. Food Chem 165: 70-76.
13. Evrendilek GA, Jin ZT, Ruhlman KT, Qiu X, Zhang QH, et al. (2009) Microbial safety and shelf-life of apple juice and cider processed by bench and pilot scale PEF systems. Innovative Food Science and Emerging Technologies. 1: 77-86.
14. Zulueta A, Esteve MJ, Frasquet I, Frigola A (2007) Fatty acid profile changes during orange juice–milk beverage processing by high-pulsed electric field. European Journal of Lipid Science and Technology 109: 25-31.
15. Altuntas J, Evrendilek GA, Sangun MK, Zhang HQ (2011) Processing of peach nectar by pulsed electric fields with respect to physical and chemical properties and microbial inactivation. Journal of Food Process Engineering 34: 1506-1522.
16. Altuntas J, Evrendilek GA, Sangun MK, Zhang HQ (2010) Effects of pulsed electric field processing on the quality and microbial inactivation of sour cherry juice. International Journal of Food Science and Technology 45: 899-905.
17. Morales-de la Peña M, Salvia-Trujillo L, Rojas-Graü MA, Martín-Belloso O (2010) Impact of high intensity pulsed electric field on antioxidant properties and quality parameters of a fruit juice–soymilk beverage in chilled storage. LWT Food Science and Technology 43: 872–881.
18. Zhang BG, Zhang M, Shi J, Xu,Y (2010) Pulsed electric field processing effects on physicochemical properties, flavor compounds and microorganisms of longan juice. Journal of Food Processing and Preservation 34: 1121-1138.
19. Agcam E, AkyÄ±ldÄ±z A, Akdemir Evrendilek G (2014) Comparison of phenolic compounds of orange juice processed by pulsed electric fields (PEF) and conventional thermal pasteurisation. Food Chem 143: 354-361.
20. Bendicho S, Estela C, Giner J, Barbosa-Cánovas GV, Martin O (2002) Effects of high intensity pulsed electric field and thermal treatments on a lipase from Pseudomonas fluorescens. J Dairy Sci 85: 19-27.
21. Li SQ, Zhang QH, Lee YZ, Pham TV (2003) Effects of pulsed electric fields and thermal processing on the stability of bovine immunoglobulin G (IgG) in enriched soymilk. J Food Sci 68: 1201-1207.
22. Torregrosa F, Esteve MJ, Frígola A, Cortés C (2006) Ascorbic acid stability during refrigerated storage of orange–carrot juice treated by high pulsed electric field and comparison with pasteurized juice. J Food Eng 73: 339-345.
23. Wu Y, Mittal GS, Griffiths MW (2005) Effect of pulsed electric field on the inactivation of microorganisms in grape juices with and without antimicrobials. Biosystems Engineering. 90: 1-7.
24. English NJ, Solomentsev GY, O'Brien P (2009) Nonequilibrium molecular dynamics study of electric and low frequency microwave fields on hen egg white lysozyme. Journal of Chemical Physics 131: 35106–35116.
25. Toschi F, Lugli F, Biscarini F, Zerbetto F (2009) Effects of electric field stress on a beta-amyloid peptide. J Phys Chem B 113: 369-376.
26. Zhao W, Yang R (2009) Effect of high-intensity pulsed electric fields on the activity, conformation and self-aggregation of pepsin. Food Chem 114: 777–781.
27. Zhao W, Yang R (2012) Pulsed electric field induced aggregation of food proteins: ovalbumin and bovine serum albumin. Food and Bioprocess Technology 5: 1706-1714.
28. Zhao W, Yang R, Tang Y, Zhang W, Hua X (2009) Investigation of the protein-protein aggregation of egg white proteins under pulsed electric fields. J Agric Food Chem 57: 3571-3577.
29. Hédoux A, Guinet Y, Paccou L (2011) Analysis of the mechanism of lysozyme pressure denaturation from Raman spectroscopy investigations, and comparison with thermal denaturation. J Phys Chem B 115: 6740-6748.
30. Zhao W, Yang R (2010) Experimental study on conformational changes of lysozyme in solution induced by pulsed electric field and thermal stresses. J Phys Chem B 114: 503-510.

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