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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.

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