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A review on pulsed electric field modification of proteins: Effect on the functional and structural properties

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ABSTRACT

The application of proteins in food system largely depends upon their functional properties. Number of protein sources are available in nature and their degree of utilization in food industry is related to their functional properties. The behavior of food systems during preparation, processing, storage, and consumption is affected by functional properties of proteins and these properties of proteins affects the quality and sensory attributes of the food system. These properties depend upon the physicochemical characteristics of proteins which in turn is affected by the structure of proteins. The poor functional properties of proteins are attributed to their structural conformation or to the processing techniques, which eventually limits their industrial application. This pose a challenge in utilizing protein isolates having poor functionality in food industry. The challenges encountered in the utilization of protein isolates with low functionality can be overcome through modification of their structure. The use of nonthermal and chemical free modification technique have been increasingly used by the researcher to enhance the functional properties of proteins. Among the different nonthermal modification techniques pulsed electric field modification is more efficient and reliable, clean and is a low operating cost technology. Pulsed electric field (PEF) technology is uses short duration pulses of high voltage electric field on the food to obtain the desirable effect on the food structure. Application of pulsed electric field to the food protein improves their functional propeties due to changes in their structural conformations.

1. Introduction

Functional properties of protein depend upon physicochemical characteristics, interaction with protein and non-protein components and environmental conditions of the food system. These functional properties of food proteins affect the behavior of food during preparation, processing, storage, and consumption and also contribute to the quality and sensory attributes of the food system (Jianhua et al., 2012). The important functional properties of proteins in food application are solubility, swelling power, gelling capacity, water retention capacity, foaming properties, emulsifying and fat binding properties (Zayas, 1997). Different types of proteins have different physicochemical properties like molecular weight, net surface charge, conformation, amino acid composition and sequence and hence have different functional properties. For example, soy protein has poor emulsifying capacity, because of the compact globular structure stabilized mainly by hydrogen bonds and disulfide bonds, compared with the other protein emulsifiers such as milk protein (Molina et al., 2001; Roesch & Corredig, 2003). The formation and stabilization of gels, emulsion, foams and sols are the main functional properties of proteins and mechanisms concerned with these functional properties are protein surface activity, hydration and change in the protein structure (Malik et al., 2018). Protein film formation, emulsion and foaming activities are affected by the protein surface activities like hydrophilicity, hydrophobicity, and net charge. Water/oil solubility, wettability and thickening characteristics are affected by the hydration characteristic of proteins. Viscosity, elasticity, aggregation, adhesiveness and gelation are affected by the changes in the protein's structure such as shape, size, composition and amino acid sequence (Speroni et al., 2009). The functional properties of proteins are related to the structure of protein and industrial applications of proteins are dependent on the functional properties of proteins. Various types of protein extracted from various food sources have different functional properties. Among the proteins extracted from various food sources only few among them, having desirable functional

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