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Effect of lysozyme infusion, high-intensity ultrasound and controlled thermal treatment on the physicochemical and functional characteristics of *Chenopodium album* protein isolate based active packaging film

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ABSTRACT

The characteristic outcome of films developed from high-intensity ultrasound (HIUS) and controlled thermal treatments of album protein isolates incorporated with lysozyme at 50, 75 and 100 mg/g, protein basis has been investigation. Highest inhibitory zone of 38.46 mm against *Staphylococcus* spp. was displayed by HIUS treated album protein isolate film containing lysozyme at 100 mg/g concentration. Antioxidant activity, total phenolic content, tensile strength (7.93 MPa), elongation at break, crystallinity, thickness, a^* and b^* values of HIUS and heat-treated films containing lysozyme increased significantly whereas, decrease in L^* values, solubility, water vapor permeability has been observed. Fourier transform infra-red spectroscopy and morphological analysis indicated high ingredient cross-sectional interactions with comparatively smoother and compact biofilms. Highest glass transition temperature of 46.60 °C was observed for HIUS treated films when lysozyme was added at 100 mg/g, wherein, all films showed three characteristic peaks at 2Θ of about 20° and two minor peaks at 2Θ of 31° and 42° with highest crystallinity of 21 %. In addition, chemometric techniques like principal component analysis and hierarchical cluster analysis showed high correlation and interdependency between various film parameters studied.

1. Introduction

Development of antimicrobial films from protein-based materials can serve as an innovative approach to enhance the shelf life of high-quality foods. The demand for the development of antimicrobial films has increased in the last few years to counteract the potential threat from the harmful microorganisms (da-Silva, de Lima Costa, Cortez-Vega, Prentice, & Fonseca, 2020). Sarıcaoglu and Turhan (2020) reported that protein based edible films possess extraordinary characteristics than films produced from polysaccharides. Protein molecules are tightly packed, and their ordered structure arise because of hydrogen bonding (Atarés, Pérez-Masiá, & Chiralt, 2011). The tightly and ordered structure of protein molecules are responsible for film forming capability, barriers to gases, and excellent mechanical properties in comparison with films developed from other biomolecules. Proteins molecules are also composed of 20 different amino acids and each amino acid play a vital role in human body (Akram et al., 2011) and due to this reason protein-based films can be regarded as a source of nutrients also (Cao, Fu, & He, 2007). Protein from album has received tremendous attention particularly due to the presence of their essential amino acids.

The overall success of edible films depends upon their color, solubility and antimicrobial properties which vary with the composition of films. It has been observed that the edible films developed using protein have good aroma and excellent oxygen blocking properties and on the other hand they possess poor mechanical properties (Krochta, 1992; McHugh & Krochta, 1994). In authors' recent investigation, proteins from album and quinoa seeds were explored for their nutritional and functional characteristics. The results depicted that despite of their excellent nutritional profile, the proteins of album seeds are low in functional characteristics. Accordingly, protein from album was treated with HIUS and controlled thermal treatment which had resulted in an overall enhancement in the functional properties. HIUS and thermal treatment reduces the resultant particle size of the protein isolate which can improve the accessibility of bioactive compounds like antimicrobial agents and antioxidants (Otoni, Avena-Bustillos, Olsen, Bilbao-Sáinz, & McHugh, 2016). The reduction in particle size had also improved the mechanical as well as barrier properties of edible film (Saricaoglu, Tural, Gul, & Turhan, 2018). The denaturation and unfolding of proteins

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