Dynamic Mechanical Analysis of Zein Thin Films

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The aim of this study was to characterize the mechanical properties of hydrophobic thin films of protein zein with different additions of oleic acid (OA) as plasticizer. Zein is the main storage protein in the corn endosperm and makes up more than half the total mass of the seed proteins. Present good film forming ability, being suitable for applications as gas and moisture-barrier and effective action on decreasing bacterial population when used as edible coating [1], offering a range of products for agricultural and industrial applications. Films made from zein however are too brittle and their tensile strength too low, making necessary the addition of low molecular-weight plasticizers (e.g., glycerol and lipids) in order to improve film flexibility by reducing the chain-to-chain interactions.

The zein used in this work was extracted from corn gluten meal (CGM), a by-product of starch production in the wet-milling process. The extraction followed the adopted sequence [2]. Zein solutions were prepared using 70% ethanol as solvent in a concentration of 4.0% in mass. The oleic acid (OA) were separately added in the proportion of 0.25; 0.50 and 1.0% wt. Films were prepared by solution casting onto acrylic Petri dishes at room temperature. After drying the films were peeled from the dishes (thickness $\theta \cong 50$ μm). DMA analysis (TA Instrument DMA 2930, tensile mode, heating rate: 5ºC mim^{-1}, amplitude: 20μm and frequency: 1 Hz). The mechanical properties of films are summarized on Table 1. In general, all films exhibited brittle failure with little plastic deformation (maximum 2%) and moderately resistant. However, films prepared with different plasticizer concentration exhibited variations in their resistance to breakage; i.e., higher plasticity is attained as the AO proportion increases, where the maximum strain values increase and Young's modulus decrease as AO proportion increases.

TABLE 1. Values of Young's modulus (MPa) and maximum strain (%) for the tested materials.

Sample	Young's modulus	Tensile strength	Maximum strain
Zein (0.25% OA)	2309	6.6	0.4
Zein (0.50% OA)	1587	6.4	0.5
Zein (1.00% OA)	418	6.0	1.4

The zein films had low oxygen, carbon dioxide and water vapor permeability, and therefore its potential as bio-based packaging technologies to improve the quality and safety of fresh and processed foods. The tensile strengths of no plasticizer added zein films are in good agreement with the literature [3].

Keywords: chitosan, zein, natural polymeric films, packaging materials.
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