Molecular mobility, crystallinity and barrier properties of chitosan films

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Edible and biodegradable films have been successfully explored at experimental level, attracting interest in the food preservation and packaging technology fields. Chitosan is a biopolymer considered as being biocompatible, biodegradable and possesses antimicrobial activity and filmogenic properties, and for that has been thoroughly used in such studies. In this work, we aim to describe the link between water and the plasticizant mobility in the partially crystalline polymeric structure of chitosan films and the measured barrier properties. For that, film forming solutions of 1, 2 and 3% w/v of chitosan with different levels of plasticizant agent (glycerol 10, 50 and 90%w/v) were prepared, and films were produced by solvent casting. Films water vapor permeability and crystallinity, evaluated by Δh, were determined. Mobility was assessed by the water and glycerol relaxation times, studied using a nuclear resonance magnetic technique (NMR).

In general, results demonstrate that crystallinity increased with increasing water and glycerol mobility, showing that once the polymeric chains are organized in the crystalline form, the interaction polymer/ plasticizer is minimized. Also, films crystallinity increases in films with lower chitosan concentration and higher plasticizer quantity, indicating that the presence of glycerol increase chain molecular mobility, facilitating the ordering of polymer chains. Water vapor permeability was also correlated with molecular mobility. For films with the same thickness, WVP increased with mobility.

These results show that glycerol is inserted between the chitosan chains, decreasing intermolecular attractions and increasing free volume, thus facilitating molecular migration. Moreover, these results show the usefulness of NMR and molecular mobility studies in the matrix for characterization and development of edible films with improved functionality.