Design and characterization of a starch/chitosan bilayer film for use in sustainable food packaging

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Food packaging plays a fundamental role in preserving the quality and safety of food during distribution and storage. From a sustainability perspective, there is a growing interest in biodegradable and eco-friendly materials. The present study focuses on the development and characterization of an innovative bilayer film composed of starch and chitosan, intended for use as a biopackaging material. Compared to previous studies, the film-forming dispersions of starch and chitosan have been optimized, improving their stability and processability. These dispersions proved to be suitable for producing homogeneous and high-quality films. The bilayer film was obtained by depositing the chitosan dispersion onto a pre-existing starch film. The material was analyzed with characterization techniques including microscopy, IR spectroscopy, mechanical tests, thermal analysis and gas permeability tests, in line with the most recent experimental practices in the field. The particular double-layer configuration has improved performance compared to single-component materials, highlighting the synergy between starch and chitosan in terms of functionality and durability. In particular, the film exhibits high hydrophobicity, with a contact angle of 100°, and remarkable thermal stability, with a mass loss of only 10% up to 200 °C, which enables its use even in domestic ovens. From the perspective of the gas barrier, the material is entirely impermeable to carbon dioxide at atmospheric pressure. It has a permeability of 15.16 bar at a transmembrane pressure of 5 bar, thus helping to extend the shelf life of packaged foods. The contribution of the research group is therefore part of the broader framework of innovation in bio-based materials, proposing a solution that combines sustainability, functionality and industrial potential. This research strengthens the direction towards the development of high-performance natural composite materials, contributing concretely to the expansion of biopolymer applications in the field of chemical engineering and sustainable food packaging. Finally, the concept of technology transfer is explored and an optimization study of the experiments has been conducted, with the aim of minimizing the production costs of the final product, in view of its commercialization.

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