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Nanotechnology Applied to Marine Polysaccharides - Potential Biobased Packaging Films

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Nano-solutions for the twenty-first century - the advancement in the field of nanoscience and nanotechnology and its application to the field of food and food packaging has revolutionized the 21st century - . Nanoencapsulation of nutraceuticals, smart delivery of nutrients, rapid sampling of biological and chemical contaminants, active and smart packaging are some of the emerging topics of nanotechnology for food sector.

The biopolymer-based packaging, although they have advantages (due to their biodegradable nature) over their petroleum-based plastic competitors, nevertheless, their use is strongly limited because of some shortcomings such as the weak mechanical and barrier properties. To overcome these limitations, and therefore to expand their applications, it is imperative that the issues related to their mechanical and barrier properties be addressed. Here we explore the water-evaporation-induced self-assembly technique approach for improvement of the Chitosan (CS) physical properties by addition of nano-additives such as unmodified clay (NaCl) and cellulose nano-whiskers (CNW). We will show that the mechanical properties of the CS films were improved by two factors: (i) slow evaporation of water is a spontaneous process, which reaches balanced states, with minimum free energy and without internal stress, leading to nacre-like structures; (ii) a synergistic effect was created between NaCl and CNW. The best mechanical properties were obtained with a weight ratio NaCl/CNW 1:2, leading to an improvement of tensile strength (+ 230%), tensile modulus (+ 448%) and elongation at break (+ 40%), compared to control chitosan films. Mixing CS with NaCl and CNW enhanced the thermal stability of CS films. This enhancement of thermal stability of the CS films seems to come from the surrounding, fixation, and stabilization of the polymer with clay platelets. The water vapor transfer rate, and oxygen transmission rate were reduced depending on the binary (NaCl/CS) or ternary (NaCl/CNW/CS) system used. This barrier may be attributed to a greater dispersion of the non-permeable inorganic unmodified clay platelets, leading to a longer and tortuous pathway for water vapor/oxygen molecules diffusion through the nacre-like layered structure formed, that was confirmed by scanning electron microscopy and X-ray analysis.

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