Effect of cellulose nanofiber from soybean straw on the physicochemical properties of biodegradable films

VELQUEZ CASTILLO L. (1), MARTELLI TOSI M. (1), DO AMARAL SOBRAL P. (1,2)
1 Department of Food Engineering, University of S Paulo, Avenida Duque de Caxias Norte, 225, Jardim Elite, 13.635-900, Pirassununga, Brazil
2 Food Research Center (FoRC), University of S Paulo, Rua do Lago, 250, Semi-industrial building, block C, 05508-080, S Paulo, Brazil

Cellulose nanofibers (CNF) are appealing candidates for enhancing the properties of plastic packaging based on natural biopolymers. In this work, CNF were obtained from soybean straw and incorporated as a reinforcing agent in films prepared using different matrices, (type A and B) gelatin, pectin, and chitosan. CNFs were prepared by alkaline treatment followed by enzymatic hydrolysis, mechanical dispersion, and sonication. The films were produced by solution casting and the influence of CNF concentrations (0, 0.5, 1.0, 3.0, and 5.0%, w/w) on morphological, mechanical, and thermal properties were investigated. The CNF and film morphologies were analyzed by atomic force and scanning electron microscopy, respectively. The mechanical properties were determined by uniaxial tensile tests (ASTM method D882-10) and the thermal properties by differential scanning calorimetry. The CNF exhibited fiber morphology with a nanometric diameter (~16.8±1.2 nm) and micrometric length (460-1100 nm). Regardless of CNF concentrations, their incorporation changed the morphology of the films. These films presented air-side drying and cross-sections of heterogeneous surfaces, especially at higher CNF concentrations. The CNF presence decreased the resistance of type-A gelatin (0-5%) and chitosan films at 0.5%. In contrast, the resistance of type-B gelatin and pectin films increased by ~40%, from 1% to 5% CNF. The elongation at break was not affected by the increase of CNF concentration. The behavior observed in type-A gelatin films could be attributed to aggregates formed by CNF/gelatin complex coacervates at preparing conditions (pH<pI= 5.30). For films based on type-B gelatin, pectin, and chitosan, it could be related to electrostatic repulsive interactions between functional groups of the matrix film and CNF, which influences their distribution at different CNF concentrations. On the other hand, the thermal properties of the films were not significatively affected by CNF concentration. The films presented two glass transition temperatures, attributed to plasticizer-rich (glycerol) and biopolymer-rich phases; and the melting temperature, associated with crystals melting. This research enables a further understanding of the effects of CNF concentrations produced by enzymatic hydrolysis on the morphological, mechanical, and thermal properties of biocomposite films; which is of value for future food packaging applications.