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Carboxymethyl cellulose/lignin blended films: physicochemical and antioxidant properties

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The worldwide interest in bio-based polymers has increased due to the desire and need to find renewable resources-based polymers, that could reduce the dependence on fossil fuels[1]. Carboxymethyl cellulose (CMC) is considered a promising material to replace non-degradable polymer in the packaging applications, however, CMC films, as almost biodegradable films, present a poor water resistance, as well as weak mechanical and barrier properties, making them often non-competitive with other non-biodegradable polymers[2]. Thus, lignin, the second most abundant natural renewable biopolymer, has been used as filler in different polymeric matrices to improve the properties of films due to its high thermal stability, antioxidant and antimicrobial properties, biodegradability, hydrophobicity, adhesive and others[3]. In this context, the aim of this work was to develop CMC/lignin blended films and evaluate the incorporation of lignin in the physicochemical properties of films made thereof. Organosolv lignin (OL) was evaluated at different concentrations (12.5, 25 and 50% w/w_{CMC}) in CMC-based films (1% w/w), which were produced by the casting method. CMC-based films showed a good lignin distribution within the matrix, but also a high impartation of brown color that significantly influenced their optical properties. On the other hand, SEM images showed that the CMC/lignin blended films presented higher roughness when compared with neat CMC films (that showed a smooth surface). This roughness is related to a evaporation-induced self-assembly process that leads to the formation of small aggregate structures. The adddition of lignin into CMC films led to a pronounced decrease of film solubility and water vapour permeability (WVP) values, and higher contact angle values. The high water resistance property of CMC/lignin blended films is probably due to the high hydrophobicity and insolubility of OL in water, while the reduction in WVP values might be due to the strong intermolecular interaction between CMC and lignin molecules. FTIR spectra showed a slight changes in the structural characteristics of the CMC/lignin blended films, with a new peak at 1513 cm^{-1} that corresponds to aromatic skeletal vibrations of lignin. Regarding the mechanical properties, results showed that the tensile strength was not severely affected at low concentrations of lignins, but it decreased on films with 50% of lignin. Elongation at break (EB) values showed that at high concentrations of lignin (25 and 50%) films become quite brittle, as observed by the decrease of EB values from 15.3 to 6.7%. Further, the Young´s modulus (YM) of CMC films increased with the incorporation of lignin in the film from 8.2 to 9.5 Mpa. Finally, lignin provided to the CMC-based film a radical scavenging capacity, showing to be a promising compound to develop active CMC-based films.

References:

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