PROPERTIES OF BIODEGRADABLE FILMS PREPARED FROM HYDROXYPROPYLMETHYLCELLULOSE, CASEIN, GLYCEROL AND CASTOR OIL

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Introduction. Oil derived plastics generate environmental problems such as greenhouse gas emissions apart from the significant amount of oil used to produce plastics. This situation has led to the search for renewable sources of environmentally degradable polymers, such as waste cellulose derivatives. In particular, hydroxypropylmethylcellulose (HPMC), is one of the most attractive for being economic. Moreover its use contributes to the reduction of environmental pollution. In addition, biodegradable films fabricated with milk proteins such as casein and whey are selective barriers to migration of gases and solutes [1] and are characterized by being transparent, and provide better mechanical properties [2].

In this work, several strategies were implemented for modifying the properties of biopolymers HPMC/casein: addition of calcium to enhance the structural rigidity of the lattice of the polymeric chains, temperature treatment to improve the miscibility between the biopolymers, and incorporating natural castor oil to increase hydrophobicity.

Methods. Homogeneous and uniform films were prepared from HPMC, casein, glycerol, and castor oil, and cast in PVC molds or in glass using slow wet procedure. All the components used were reactive grade and ultrapure reagent quality water was used. Studies were conducted by FTIR, TGA, DTGA, DSC, and DSC to characterize the materials. An optical tensiometer was used to measure contact angle.

Results. Spectroscopic analysis showed the presence of intermolecular interactions between the starting biopolymers and demonstrated the formations of new materials with specific characteristics. These films were further improved in their mechanical properties with the best results obtained with a composition of 2.8 % (v/v) glycerol.

The hydrophobicity of the films was then increased by the introduction of castor oil up to 34.39%, measured by contact angle of pure water on the films, from $\theta = 18.15°$ in the initial films HPMC/casein/glycerol up to $\theta = 52.54°$ in laminated films in glass by slow wetting. The best results were achieved with the following composition: 48.6% (v/v) HPMC and casein, 2.8% (v/v) glycerol, and 1% (w/w) castor oil.

Through composting assay, it was observed that the films disappear after 108 h, so that the blend films have to be classified as biodegradable and compostable according to ASTM 6400-99.

Conclusions. Elastic, resilient and pliable biodegradable films were obtained with the blend of HPMC, casein, glycerol, and castor oil. HPMC miscibility in glycerol significantly increases the stability of the HPMC in the mixture and promotes the emergence of new bonds improving the mechanical properties. The addition of castor oil to the mixtures does not seem to weaken the network of inter and intramolecular bonds but increases the hydrophobicity of the films.

These new biodegradable polymers may have a use as active coatings for packaging in food industry.

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References.

[1] Nazan, T., Sancak, Z. Ö. E., Ayana, B. et al. (2007). *J. Food Process Eng*. 30: 485–500.

[2] Rungsinee, S., Rhim, J., Hong, S. (2009). *J. Food Eng.* 91(3): 468–473.