FILMS OF XYLAN/POLYETHYLENIMINE WITH DIFFERENT MASS RATIOS

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ABSTRACT

Through polyelectrolyte complexes, films with interesting mechanical properties using xylan (xyl), as a main component, and Polyethylenimine (PEI) were obtained. Hemicellulose, present as a polymer in lignocellulosic biomass, is the second vegetable polysaccharides more abundant in earth, and is an interesting renewable resource to obtain new value-added materials. PEI is a low cost, branched synthetic polyamine with high solubility, which is admitted in certain food packaging materials.

In this study, xylan was extracted from sugar cane bagasse following conditions previously optimized (50°C during, 180 minutes and a charge of 40% NaOH on bagasse). Xylan was isolated by precipitation in a 50 % alcohol solution.

Polyelectrolytes complexes (PECs) with different mass ratio were prepared adding the xylan solution (4 g/l) on the PEI solution (2.5 g/l) under stirring after adjusting the pH of both solutions at 5.0. Films were obtained by casting/evaporation of the PECs solution, in silicone molds at 40 oC. The effect of mass ratio on mechanical properties and other characteristics of films was studied, using an increasing amount of xylan from 50/50 up to 95/5 mass ratio. Colloidal electrical charge during PECs formation was monitored by the streaming current analyzer. The neutralization of electric charge was achieved at 82/18 xylan to PEI mass ratio. For this ratio or higher, a sedimentation of PECs was observed. This sedimentation allowed the removal of supernatant liquid. In this way, it was possible to obtain a concentrated PECs solution which is beneficial for the reduction of the energy during the evaporation stage and the reduction of salt content in the film.

Mechanical properties (stress and strain at break) were determined according to ASTM D882 and water vapor transmission rate (WVTR) according ASTM E96-98. The swelling capacity and solubility of the films were determined by immersion them in distilled water during 1 h, at room temperature.

Homogeneous, translucent, brownish and handable films can be obtained in all cases without the presence of plasticizer or crosslinking agent. The stress at break was increased up to 35 MPa but strain at break was decreased from 22.0 to 2.0 % when the xylan content was increased. A stepped change of the stress at break values took place at the region of mass ratio corresponding to charge neutralization. The increase in ratio improved the stress at break up to 35 MPa but the strain was reduced from 22.0 to 2.0 %. On the other hand, the strength was increased and the solubility of the high xylan content film (90/10 and 85/15 films) was favorably reduced from 27% or 22% to 12%, when supernatant was removed from PEC precipitate. The rate of permeability to water vapor resulted similar to other xylan based film (WVTR = 0.0047 g/seg.m² for 85/15 film). Results indicate that the combination of xylan, as main component, and PEI allows to obtain bio-based film, with properties that can be controlled by the mass ratio and can be acceptable for food packaging.

Keywords: Bio-based films, mechanical properties, packaging film.