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Viscoelastic Characterization of Gelatin/Cellulose Nanocrystals Aqueous Bionanocomposites

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Abstract : The increasing environmental concern regarding the plastic pollution worldwide has stimulated the development of low-cost biodegradable materials. Proteins are renewable feedstocks that could be used to produce biodegradable plastics. Gelatin, for example, is a cheap film-forming protein extracted from animal skin and connective tissues of Brazilian Livestock residues; thus it has a good potential in low-cost biodegradable plastic production. However, gelatin plastics are limited in terms of mechanical and barrier properties. Cellulose nanocrystals (CNC) are efficient nanofillers that have been used to extend physical properties of polymers. This work was aimed at evaluating the reinforcing efficiency of CNC on gelatin films. Specifically, we have employed the continuous casting as the processing method for obtaining the gelatin/CNC bionanocomposites. This required a first rheological study for assessing the effect of gelatin-CNC and CNC-CNC interactions on the colloidal state of the aqueous bionanocomposite formulations. CNC were isolated from eucalyptus pulp by sulfuric acid hydrolysis (65 wt%) at 55 °C for 30 min. Gelatin was solubilized in ultra-pure water at 85°C for 20 min and then mixed with glycerol at 20 wt.% and CNC at 0.5 wt%, 1.0 wt% and 2.5 wt%. Rotational measurements were performed to determine linear viscosity (η) of bionanocomposite solutions, which increased with increasing CNC content. At 2.5 wt% CNC, η increased by 118% regarding the neat gelatin solution, which was ascribed to percolation CNC network formation. Storage modulus (G') and loss modulus (G″) further determined by oscillatory tests revealed that a gel-like behavior was dominant in the bionanocomposite solutions (G' > G'') over a broad range of temperature (20 – 85 °C), particularly at 2.5 wt% CNC. These results confirm effective interactions in the aqueous gelatin-CNC bionanocomposites that could substantially increase the physical properties of the gelatin plastics. Tensile tests are underway to confirm this hypothesis. The authors would like to thank the Fapesp (process n 2016/03080-3) for support.

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