Thesis title: Development of a potato starch-guar gum based active bio-nanocomposite film incorporating components from petioles of betel leaf (*Piper betle* L.)

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Abstract

Growing awareness about food safety and eco-friendly packaging film have created necessity to develop active biodegradable food packaging film for avoiding trillion tonnes of non-biodegradable plastic waste polluting the global environment. With this necessity, the current study dealt with development of a potato starch (PS) and guar gum (GG) based active bio-nanocomposite film by incorporating extract and cellulose nanocrystal (CNC) of petioles of betel leaf (BLP). The proportion of PS, GG and glycerol (plasticizer) was optimized by rotatable central composite design and the optimum values of PS, GG and glycerol were obtained as 3.70%, 0.40% and 15% (of total dry weight of PS & GG), respectively. Three different organic acids, namely succinic, malic and tartaric acids were tested as cross-linkers to improve mechanical and water barrier properties. However, these acids behaving as plasticizer in potato starch-guar gum (PSGG) composite polymer matrix, caused deterioration of the properties and hence, rejected. Two different chemical treatment methods were adopted to extract cellulose from BLP. The successful method included dilute acid hydrolysis treatment (1% HCl) followed by acidic bleaching (1.70% NaClO2), alkali treatment (8% NaOH) and again acidic bleaching treatment. This method extracted 81.15% of pure cellulosic fibre from BLP. For extraction of CNC, the cellulosic fibre was subjected to sulphuric acid hydrolysis treatment, and extracted BLP-CNC had rod-like structure with length of 54–347 nm and diameter of 2.82–10.17 nm. Incorporation of the CNC into PSGG film improved mechanical and barrier properties of the film. Among four different selected solvents, namely hexane, acetone, ethanol and toluene:ethanol (1:2), acetone was found to be the most suitable solvent for preparation of BLP extract with superior antioxidant and anti-microbial activity. The addition of this extract to PSGG film imparted antioxidant activity to the film but diminished its mechanical and water barrier properties. Hence, BLP-CNC was embedded into extract blended PSGG (PSGG-BLPE) films and it was found that the CNC was also effective in improving the properties of PSGG-BLPE films. The developed film completely degraded within 35–42 days in soil.

Keywords: *Bio-composite film; Potato starch; Guar gum; Organic acids; Cellulose; Acid hydrolysis; Cellulose nanocrystal; Petioles of betel leaf; Extract; Antioxidant; Antimicrobial; Film properties; SEM; AFM; XRD; TEM; FTIR; TG; Biodegradability*