Characterization of Polymer Structure and Evaluation of Functional Properties of *Kappaphycus alvarezii* Seaweed-Based Bioplastic Films

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The global demand for eco-friendly food packaging solutions is on the rise. Bioplastics from natural resources have been explored widely as sustainable food packaging with an increasing focus towards seaweed-based bioplastics. Polymer characterization is an important aspect to enhance the performance of bioplastics. Therefore, the aims of the present study were, to characterize *Kappaphycus alvarezii* seaweed-based bioplastics plasticized with glycerol (three different concentrations), to determine the functional properties and to evaluate the applicability of the synthesized bioplastic for food packaging. Material characterizations were performed using FTIR-ATR spectroscopy, XRD, TGA, UV-Vis spectrophotometry, colorimetry and tensile testing. Water vapor permeability (WVP) was determined using the wet cup method at 33%, 75% and 84% relative humidity (RH) conditions. Water solubility was evaluated using the method described by Fakhoury et al. Applicability of the developed bioplastic films and the coating solution was investigated on selected fresh fruits. Fresh-cut watermelon pieces were wrapped with films and L*, a*, b* values, TSS and visual aspects at ambient conditions were monitored for three days. Bananas (variety: Cavendish) with a ripening index of 5 were coated with film forming solutions and weigh loss %, firmness, TSS and peel browning were monitored for six days. FTIR spectra revealed the presence of chlorophyll a, carotenoids, phaeophytin; C-C 3,6-anhydrogalactose, and D-galactose-4-sulfate; C-O 3,6-anhydrogalactose, and D-galactose-4-sulfate; C-O, C=O and C-C stretching of pyranose ring; S=O bond of the sulfate ester groups; -CH_3 stretching and -OH stretching vibration. X-ray diffractograms revealed the amorphous nature of the polymer matrix. All three types of bioplastics exhibited a type 04 TGA curve indicating the multiple stage decomposition of polymer. The bioplastic films showed acceptable transparency and whiteness index. WVP of the films was found to be affected by the glycerol content and the RH. Tensile stress showed a decreasing pattern with increasing glycerol content. Water solubility ranged from 50.23% to 66.78% when increasing glycerol concentration from 10% to 20%. The 10% glycerol added film was identified as the most effective film type except for the transparency. Case hardening was observed in unwrapped watermelon within one day of storage and there was a significant effect ($P<0.05$) on flesh color after wrapping by the film. 20% glycerol added coating solution was identified as the most effective in decreasing the surface moisture removal and reduction of peel browning of bananas.

Keywords: *Bioplastic, Biopolymer, Characterization, Coating, Glycerol, Seaweed*