Development and Characterisation of Bioplastic Films from Red Seaweed *Kappaphycus alvarezii* as a Sustainable Alternative to Conventional Plastics

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Plastic pollution is a rising environmental issue in today's world. As a sustainable alternative, *Kappaphycus alvarezii* based bioplastics have gained increasing attention due to their biodegradability and renewable origin. However, the studies focusing on utilising the whole thallus of *K. alvarezii* for bioplastic production remain scarce in Sri Lanka. Therefore, the present study aimed to develop and characterise bioplastic films from whole *K. alvarezii* thallus as primary raw material, using glycerol as plasticizer. Four different formulations of bioplastic films were developed by incorporating varying concentrations of dried whole seaweed, 1, 2, 3, and 4% (w/v), and a constant concentration of glycerol 2% (v/v). Characterisation of films was done based on Fourier Transform Infrared Spectroscopy (FTIR) analysis, thickness, water solubility, tensile strength (TS), elongation at break (EB), Thermogravimetric-Derivative Thermogravimetric (TGA-DTG) analysis, and biodegradability. FTIR analysis confirmed the presence of carrageenan and other functional groups. All films exhibited a thickness ranging from 0.098 ± 0.008 to 0.120 ± 0.007 mm. The highest TS (9.18 ± 0.63 MPa) of film was obtained from using 4% *K. alvarezii,* while the highest EB (2.16 ± 9.68%) from 2% *K. alvarezii*. All films showed a multi-stage thermal degradation profile. With increasing seaweed concentration, water solubility increased from 81.06 ± 0.28% to 87.36 ± 1.04% while biodegradability decreased from 81.66 ± 6.10% to 38.73 ± 0.41% in 30 days of soil burial. Statistically significant differences ($p<0.05$) were observed in thickness, water solubility, TS, EB, and biodegradability of films. The formulation of 4% *K. alvarezii* and 2% glycerol showed better physical and mechanical properties. Overall, the present study suggests that the whole *K. alvarezii* can be effectively utilised as a raw material for low-cost sustainable bioplastic production as an alternative to conventional plastics to reduce plastic pollution.

Keywords: *Biodegradation, Kappaphycus alvarezii, Plastic pollution, Seaweed-based bioplastic films*