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DEVELOPMENT OF HEMICELLULOSE FILMS FROM PINEAPPLE PEEL BY MICROWAVE-ASSISTED EXTRACTION

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ABSTRACT

Pineapple is a commercial crop that generates a vast amount of waste such as pineapple peel (PP) during processing and represents another abundant raw material in Malaysia. PP hemicellulose extracted by microwave-assisted extraction could be interest in potential applications in various fields of materials science. The aim of this study is to prepare hemicellulose film from pineapple peel. The MAE conditions (temperature, time and sodium hydroxide, NaOH concentration) were optimised to obtain the highest yield of PP hemicellulose using response surface methodology (RSM). In order to optimise the extraction conditions of microwave-assisted water extraction (MAWE) and microwave-assisted alkali extraction (MAAE) for maximum hemicellulose yield, RSM with Central Composite Design was employed. The optimised samples were characterised for lignin content, and also by using fourier-transformed infrared spectroscopy (FTIR), X-ray diffraction (XRD), thermal (TGA), and scanning electron microscopy (SEM) analysis. Hemicellulose films with different hemicellulose concentration such as 0 %, 2 %, 4 %, and 6 % (w/v) were developed. The properties of films such as colour measurement, thickness measurement, water vapour permeability and water vapour transfer rate, mechanical properties, hydration properties, thermal properties, and attenuated total reflectance-fourier transform infrared (ATR-FTIR) analysis were evaluated. The results showed that the optimum conditions (125 °C, 14 minutes) for MAWE contributed hemicellulose yield of 14.9 ± 0.5 %, whereas 88.3 ± 0.5 % was obtained at optimum conditions (122 °C, 29 minutes, 7 % NaOH) for MAAE. The determination of lignin content showed optimised hemicellulose extracted via MAAE had the highest lignin content (3.12 %). The FTIR analysis revealed important peaks indicating the presence of hemicellulose in the range of 1700 cm^{-1} and 700 cm^{-1}. XRD analysis showed the highest crystallinity index of PP residue by MAWE was 37.65%. TGA analysis concluded that the decomposition temperature for optimised hemicellulose extracted via MAWE, and MAAE were 276 °C and 277 °C, respectively. The SEM characterisation indicated that the morphological structure of the dried PP and microwave treated PPs were different from each other. A film with 6% (w/v) hemicellulose concentration showed a dark yellowish-brown in colour. The thickness of films (0.08 mm – 0.15 mm), moisture content (18.4 % – 32.18 %), and water vapour permeability (1.88×10^{-8} g/h.mm.pa - 8.21×10^{-8} g/h.mm.pa) increased significantly which differ from water solubility (56.03 - 42.84 %) properties that decreased significantly with increasing hemicellulose concentration in the films. For mechanical properties, the tensile strength (33.16 Mpa - 0.97 Mpa) decreased whereas elongation at break (19.70 % – 63.66 %) increased when the hemicellulose concentration increased. Film 6% was thermally stable (onset temperature 217 °C) compared to the others. ATR-FTIR analysis demonstrated an important peak around 1707 cm^{-1} that was attributed to the crosslinking reaction between hemicellulose, chitosan, glycerol and citric acid. Therefore, the utilisation of PP hemicellulose in biocomposite film preparation was successfully developed and Film 6% showed suitability film-forming properties that contributed to the packaging product application.

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