ABSTRACT

The selection of an ideal plasticizer is important to develop biopolymer-based edible films for food packaging. The effect of different plasticizers (Glycerol, Polyethylene glycol, Sorbitol) and their concentration (0-50%) on the mechanical, water vapour barrier, optical and moisture sorption properties of solution cast Hydroxypropyl methylcellulose (HPMC) films were examined in this study. Mechanical properties and Water vapour permeability (WVP) of films were determined using standard ASTM methods. Seven different sorption models were fitted to experimental Moisture sorption isotherm (MSI) of different HPMC films. The goodness of fit of these models was compared based on the Akaike information criterion (AIC). Plasticizing efficacy of different plasticizers was significantly different for HPMC film in the studied concentration range. Water vapour permeability (WVP) for native HPMC film was 0.451 g.mm/kPa.m^2.h, which further increased to 0.972, 0.890 and, 0.615 g.mm/kPa.m^2.h when 25% (w/w of HPMC) glycerol, PEG and sorbitol were added as plasticizers, respectively. Added plasticizers effectively provided desirable elongation to HPMC film, which is beneficial for coating and shrink-wrap packaging applications but adversely affected the films' tensile strength and barrier properties. Henderson's equation and Oswin model were selected as the best fit models for the experimental sorption data based on AIC values. Analysis of plasticized HPMC films showed that a plasticizer concentration above 25% is not desirable for preparing HPMC films and PEG was the best plasticizer among all three. Zinc oxide nanoparticles (ZnO NPs) were prepared by wet chemical synthesis. Nanorods and hexagonal plate shape ZnO NPs were obtained for different reaction times of 2 hours and 24 hours, respectively. The effect of HPMC as capping material on the morphology, size distribution and optical properties of ZnO nanoparticles was studied by FESEM, TEM, DLS, UV-visible spectroscopy, and XRD analyses. Results showed that HPMC as capping material prevented the agglomeration of nanoparticles during synthesis and maintained uniformity in ZnO NP size. Prepared ZnO NPs exhibited strong antimicrobial activity against *Staphylococcus aureus* and *Penicillium expansum*. HPMC-ZnO bionanocomposite films, prepared by incorporating capped ZnO NPs in HPMC biopolymer, showed improved mechanical and barrier properties and decreased film transparency. Results showed that capped ZnO NPs obtained from 24 h reaction time were more effective in improving the moisture barrier properties of HPMC film. HPMC-based edible coating with/without incorporating ZnO NPs on strawberries' quality and shelf life, stored at 10°C and 90% relative humidity (RH), was investigated. The coating solutions used were, 4% HPMC (H4), HPMC added with 15% PEG as plasticizer (H4+P15), and HPMC-ZnO bionanocomposite (HZBNC) coating solutions, H4+P15+Z0.5 and H4+P15+Z1, obtained by adding ZnO NPs (0.5 mg/mL and 1mg/mL) in H4+P15. HZBNC coatings significantly ($p<0.05$) reduced the post-harvest deterioration by arresting the microbial growth and reduced the fungal decay percentage to 13.33% (H4+P15+Z0.5) and 5%(H4+P15+Z1) from 93% (H4+P15) during storage. This edible coating also significantly decreased ($p<0.05$) the respiration rate of strawberries and delayed the senescence by retaining the colour, firmness and vitamin C compared to the untreated sample. Compared to uncoated and HPMC coated strawberry fruit, HZBNC coating significantly reduced the moisture loss and alterations in various quality parameters such as pH, TTA and TSS. No significant difference in the overall acceptability of the fruit was observed during the sensory analysis. Moreover, the added ZnO in the coating solution will provide supplementation for zinc, which is an essential micronutrient for humans. However, further studies are required for the bioavailability and absorption of added ZnO NPs.

Keywords: Mechanical properties, edible films, barrier properties, moisture sorption isotherm, antibacterial activity, respiration rate.