Preparation and characterization of pullulan/carboxymethyl cellulose/nano-TiO_2 composite films for strawberry preservation

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Abstract

Biodegradable composite films based on pullulan/carboxymethyl cellulose/nano-TiO_2 were prepared using a solution casting method. In this study, the composite films were characterized by Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), differential scanning calorimetry (DSC), and scanning electron microscopy (SEM), and their physical, mechanical and antimicrobial properties were investigated. FTIR and XRD results confirmed that the presence of nano-TiO_2 could enhance the interaction between the film matrix. SEM analysis revealed that the composite films had a homogeneous network structure, and good particle dispersion could be obtained when the nano-TiO_2 particle content was low. DSC results indicated that the composite films possessed good thermal stability. The incorporation of nano-TiO_2 increased the thickness and contact angle while significantly decreasing the water solubility ($p < 0.05$). As the content of nano-TiO_2 increased, the water vapor and ultraviolet visible (UV–Vis) light barrier properties of composite films were significantly improved ($p < 0.05$). Mechanical analysis demonstrated that the tensile strength of the composite films first increased and then decreased, whereas the elongation at break decreased significantly ($p < 0.05$). In addition, the composite films exhibited excellent activity against *Escherichia coli* and *Staphylococcus aureus* mainly due to the inactivation of bacteria by nano-TiO_2 photocatalysis. Preservation experiments showed that the composite films could decrease the weight loss significantly and maintain the firmness, titratable acidity, vitamin c and skin color of strawberries, thereby improving the overall quality of strawberries and extending their shelf life. This finding suggested that pullulan/carboxymethyl cellulose/nano-TiO_2 composite films possessed excellent potential for application in food packaging.