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Polyvinyl Alcohol Incorporated with Hibiscus Extract Microcapsules as Combined Active and Intelligent Composite Film for Meat Preservation: Antimicrobial, Antioxidant, and Physicochemical Investigations

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Abstract : Numerous attempts are being performed in order to formulate suitable packaging materials for the meat products. However, to the best of our knowledge, the incorporation of the free hibiscus extract or its microcapsules in the pure polyvinyl alcohol (PVA) matrix as packaging materials for the meats is seldom reported. Therefore, this study aims at the protection of the aqueous crude extract of the hibiscus flowers utilizing the spry drying encapsulation technique. Results of the Fourier transform infrared (FTIR), the scanning electron microscope (SEM), and the particle size analyzer confirmed the successful formation of the assembled capsules via strong interactions, the spherical rough microparticles, and the particle size of ~ 235 nm, respectively. Also, the obtained microcapsules enjoy higher thermal stability than the free extract. Then, the obtained spray-dried particles were incorporated into the casting solution of the pure PVA film with a concentration of 10 wt. %. The segregated free-standing composite films were investigated, compared to the neat matrix, with several characterization techniques such as FTIR, SEM, thermal gravimetric analysis (TGA), mechanical tester, contact angle, water vapor permeability, and oxygen transmission. The results demonstrated variations in the physicochemical properties of the PVA film after the inclusion of the free and the extract microcapsules. Moreover, biological studies emphasized the biocidal potential of the hybrid films against the microorganisms contaminating the meat. Specifically, the microcapsules imparted not only antimicrobial but also antioxidant activities to the PVA matrix. Application of the prepared films on the real meat samples displayed a low bacterial growth with a slight increase in the pH over the storage time which continued up to 10 days at 4 oC, as further evidence to the meat safety. Moreover, the colors of the films did not significantly changed except after 21 days indicating the spoilage of the meat samples. No doubt, the dual-functional of the prepared composite films pave the way towards combined active and smart food packaging applications. This would play a vital role in the food hygiene, including also the quality control and the assurance.

Keywords : PVA, hibiscus, extraction, encapsulation, active packaging, smart and intelligent packaging, meat spoilage
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