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ORIGINAL ARTICLE

Evaluation of bioactive low-density polyethylene (LDPE) nanocomposite films in combined treatment with irradiation on strawberry shelf-life extension

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Abstract

A low-density polyethylene (LDPE) film reinforced with cellulose nanocrystals (CNCs) with an encapsulated bioactive formulation (cinnamon essential oil + silver nanoparticles) was developed for preservation of fresh strawberries. Antimicrobial activity of the active LDPE films was tested against *Escherichia coli* O157:H7, *Salmonella typhimurium*, *Aspergillus niger*, and *Penicillium chrysogenum* by agar volatilization assay. The optimal condition of the films showed ≥75% inhibitory capacity against the tested microbes. Strawberries were stored with different types of films: Group 1 (control): (LDPE + CNCs + Glycerol), Group 2: (LDPE + CNCs + Glycerol + AGPPH silver nanoparticles), Group 3: (LDPE + CNCs + Glycerol + cinnamon), Group 4: (LDPE + CNCs + Glycerol + active formulation), and Group 5: (LDPE + CNCs + Glycerol + active formulation + 0.5 kGy γ-radiation) at 4°C for 12 days. Weight loss (WL) (%), decay (%), firmness (N), color, and total phenolics and anthocyanin content of the strawberries were measured. Results showed that the most effective LDPE-nanocomposite film for reducing the microbial growth was LDPE + CNCs + Glycerol + active formulation film (Group 4). When combined with γ-irradiation (0.5 kGy), the

LDPE + CNCs + Glycerol + active formulation (Group 5) significantly reduced both decay and WL by 94%, as compared to the control samples after 12 days of storage. Total phenols (from 952 to 1711 mg/kg) and anthocyanin content (from 185 to 287 mg/kg) increased with storage time under the different treatments. The mechanical properties, water vapor permeability (WVP), and surface color of the films were also tested. Though the WVP of the films were not influenced by the types of antimicrobial agents, they did significantly ($p \leq 0.05$) change color and mechanical properties of the films. Therefore, combined treatment of active film and γ-irradiation has potential as an alternative method for extending the shelf-life of storage strawberries while maintaining fruit quality.

Practical Application

Bioactive Low-density polyethylene (LDPE) nanocomposite film was developed in the study by incorporating active formulation (essential oil and silver nanoparticle) to extend the shelf life of stored strawberries. The bioactive LDPE-based nanocomposite film along with γ-irradiation could be used to preserve fruits for long-term storage by controlling the growth of foodborne pathogenic bacteria and spoilage fungi.