**Title** Antimicrobial packaging system for optimization of electron beam irradiation of fresh produce

**Author** Jaejoon Han

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## Abstract

This study evaluated the potential use of an antimicrobial packaging system in combination with electron beam irradiation to enhance quality of fresh produce. Irradiated romaine lettuce up to 3.2 kGy showed negligible ($p > 0.05$) changes in color, but texture and sensory attributes were less acceptable with increased dose.

We established the antimicrobial effectiveness of various active compounds incorporated into the low-density polyethylene (LDPE)/polyamide films to increase radiation sensitivity of surrogate bacteria (*Listeria innocua* and *Escherichia coli*). All films showed inhibition zones in an agar diffusion test. In the liquid culture test, the active compounds reduced the specific growth rate and decreased final cell concentration of strains. Films incorporated with active compounds increased the radiation sensitivity of the tested strains, demonstrating their potential to reduce the dose required to control microbial contamination using electron beam technology. The active compounds maintained their antimicrobial activity by exposure to ionizing radiation up to 3 kGy.

Antimicrobial activity of LDPE/polyamide films incorporated with trans-cinnamaldehyde was tested with fresh-cut romaine lettuce. Total aerobic plate counts (APC) and yeast and mold counts (YMC) were determined as a function of dose (0, 0.5, and 1.0 kGy) for 14 days of storage at 4°C. Irradiation exposure significantly lowered APCs of lettuce samples by 1-log CFU/g compared to the non-irradiated controls; however, it only slightly reduced YMCs. The effectiveness of using irradiation with antimicrobial films was enhanced with increased radiation dose and trans-cinnamaldehyde concentration.

Electron beam irradiation up to 20 kGy did not affect the tensile strength and toughness of the polymeric films. The film's flexibility and barrier properties were significantly improved by exposure to 20 kGy. The addition of an active compound did not affect the tensile strength and barrier properties of the films, but decreased the percent elongation-at-break and toughness, making them slightly more brittle.

Ionizing radiation affected the release kinetics of the antimicrobial agent from the packaging material into a model food system. Irradiated films exhibited slower release rates than non-irradiated film

by 69%. In addition, release rate was lower at 4°C by 62.6% than at 21-35°C. The pH of the simulant solution affected release rate with pH 4 yielding higher rates than pH 7 and 10.