Title Radiosensitization strategies for enhanced e-beam irradiation treatment of fresh produce

Author Carmen Gomes and Rosana G. Moreira

Citation Thesis, Doctor of Philosophy, Texas A&M University. 2010.

Keywords Food safety; Irradiation; Radiosensitization; Fresh produce; Modified atmospheric packaging

Abstract

Fresh produce is increasingly implicated in outbreaks of foodborne illness. Internalization of bacterial pathogens into produce is of particular concern as internalized pathogens are unlikely to be removed by surface sanitizers. It is therefore necessary to develop treatments that will reduce their prevalence and numbers on fresh produce.

Irradiation is a penetrating nonthermal treatment that effectively eliminates bacteria. Irradiated baby spinach leaves up to 1.0 kGy showed negligible ($P>0.05$) changes in color, texture, vitamin C, total carotenoids, and chlorophyll content compared to non-irradiated controls throughout storage (15 days at 4°C).

This research also shows that irradiation effectively reduces viable *Escherichia coli* cells internalized in lettuce, and that decontamination is not influenced ($P>0.05$) by lettuce variety. Irradiation effectively reduced the population of internalized pathogens in a dose-dependent manner (3-4 log reduction at 1.0 kGy). Microscopy images suggest that the contamination sites of pathogens in leafy vegetables are mainly localized on crevices and in the stomata. A careful design of the treatment (understanding dose distribution) will effectively eliminate pathogens while maintaining produce quality.

The use of modified atmosphere packaging increased ($P<0.05$) the sensitivity of pathogens (*Salmonella* spp. and *Listeria* spp.) to irradiation in baby spinach leaves (up to 25%). Increasing concentration of oxygen increased ($P<0.05$) sensitivity of both microorganisms. Radiosensitization could be affected ($P<0.05$) by production of ozone, which increases with increasing dose-rate and oxygen concentration, and reducing temperatures.

Antimicrobial effectiveness of various active compounds was determined against *Salmonella* spp. and *Listeria* spp. Inclusion complexes were prepared with antimicrobial compounds and β-cyclodextrin. The effectiveness of the microencapsulated compounds was tested by spraying them on the surface of baby spinach leaves inoculated with *Salmonella* spp. The increase in radiosensitivity (up to 40%) varied with the antimicrobial compound.

Spherical poly (DL-lactide-*co*-glycolide) (PLGA) nanoparticles with entrapped eugenol and trans-cinnamaldehyde were synthesized for future antimicrobial delivery applications. All loaded nanoparticles proved to be efficient in inhibiting growth of *Salmonella* spp. and *Listeria* spp. The entrapment efficiency for eugenol and trans-cinnamaldehyde was 98% and 92%, respectively. Controlled release experiments (*in vitro* at 37°C for 72 hrs) showed an initial burst followed by a slower release rate of the antimicrobial entrapped inside the PLGA matrix.