Title Decontamination of berries with ozone and pulsed UV-light

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Abstract

This research investigated the use of gaseous ozone, aqueous ozone, and pulsed UV-light for the purpose of decontaminating *Escherichia coli* O157:H7 and *Salmonella* spp. on the surfaces of blueberries, raspberries, and strawberries.

Blueberries, strawberries, and raspberries were artificially contaminated with five strains of *Escherichia coli* O157:H7 and *Salmonella* spp. Combined continuous and pressurized treatment yielded high $\log_{10}$ reductions of 3.6 and 3.8 CFU/g of *Salmonella* and *E. coli* O157:H7, respectively, for raspberries, whereas 2.6 and 2.9 CFU/g of *Salmonella* and *E. coli* O157:H7, respectively, for strawberries. For blueberries, the highest $\log_{10}$ reductions resulted after treatment with continuous ozone for *E. coli* O157:H7 and was 2.2 CFU/g and for *Salmonella* the highest reductions resulted after the 64-min pressurized treatment and were 3.0 $\log_{10}$ CFU/g.

The efficacy of ozone as a water additive for washing blueberries, raspberries, and strawberries was investigated. Pathogen inoculated fruit were treated with aqueous ozone at 20°C for 2 to 64 min at ozone concentrations of 1.7 to 8.9 mg/L, at 4°C for 64 min at a concentration of 21 mg/L, and with water as a control. Washing with water (sparging with air as control) resulted in reductions of only 1 $\log_{10}$ CFU/g.

Pulsed UV-light was applied to blueberries, strawberries, and raspberries at varying UV doses and times. On raspberries, maximum reductions of *E. coli* O157:H7 and *Salmonella* were 3.9 and 3.4 $\log_{10}$ CFU/g at 72 and 59.2 J/cm^2, respectively. On the surfaces of strawberries maximum reductions were 2.1 and 2.8 $\log_{10}$ CFU/g at 25.7 and 34.2 J/cm^2, respectively. Maximum reductions of 4.3 and 2.9 $\log_{10}$ CFU/g were achieved on blueberries after a UV dose of 22.6 J/cm^2 for *E. coli* O157:H7 and *Salmonella*, respectively. There was no observable damage to the fruits at these UV doses.

The inactivation data from the studies conducted on blueberries, raspberries, and strawberries inoculated with *Escherichia coli* O157:H7 and *Salmonella* after treatment with gaseous ozone, aqueous ozone, and pulsed UV-light were used to construct models to estimate the inactivation. Two models were constructed, a log-linear (based on first-order kinetics) and a Weibull model. The results indicated that

first-order kinetics are not suitable for the estimation of microbial inactivation on berries treated with ozone or pulsed UV-light, but that the Weibull model can be successfully used to estimate the reductions of *E. coli* O157:H7 and *Salmonella* on blueberries, raspberries, and strawberries treated with ozone or pulsed UV-light.

The ability of pulsed UV-light to effectively inactivation microorganism in clear liquids has been well documented; however, the effect of opaque food materials on the penetration of pulsed UV-light has not been adequately studied. Inactivation data and energy penetration obtained from the treatment of agar and whey protein gels after treatment with pulsed UV-light was used to construct several models to estimate the amount of energy penetrating the sample at a given depth and the inactivation of *E. coli* K12. The inactivation curves obtained indicated that the relationship between UV dose and inactivation was non-linear and the Weibull model was used to estimate these inactivations. The model further incorporated a modified exponential model to characterize the decay of UV energy through either agar or whey protein isolate. It was determined that energy measurements were not a good basis for the estimation of microbial inactivation and that each depth had to be treated as a unique scenario due to filtration of wavelengths by the material. The results indicated that pulsed UV-light can penetrate materials up to 10 mm in the depth, and that the Weibull model can be successfully used to model the inactivation of *E. coli* K12. (Abstract shortened by UMI.)