Application of ultra-fine bubble technology to reduce *Listeria monocytogenes* contamination of fresh produce

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Summary

Water used for washing or hydrocooling can act as a source of produce contamination with *Listeria monocytogenes*. Since this could lead to human infections, controlling *L. monocytogenes* in hydrocooling water and produce is critical for food safety. This project aims to investigate the potential of a new technology that employs water containing ultra-fine bubbles (size ~1 micrometer or less), prepared with antimicrobial ozone gas, for washing produce.

Objectives

1. Investigate the stability of ultra-fine ozone (UFO) bubbles in a simulated single pass or circulating hydrocooling system.
2. Investigate the efficacy of UFO bubble water wash (either alone or in combination with commercial sanitizers) in inactivating *Listeria monocytogenes* on Gala apples, romaine lettuce and celery, and test the survival of the pathogen in the wash water.
3. Evaluate the effect of UFO bubble wash (with or without commercial sanitizers) on shelf life and color of Gala apples, romaine lettuce and celery.

Methods

The effect of water temperature (25, 4°C) on ozone solubility and stability was measured at different bubbling time (0, 5, 10, 15 min) using a quantitative ozone detection kit. The effect of water turbulence on degradation rate of dissolved ozone in deionized water was measured at 1 to 15 minutes post-bubbling time. The effect of ozone, either alone or in combination with chlorine, in inactivating *L. monocytogenes* (five-strain mixture) on romaine lettuce was investigated using standard food microbiology protocols; tested timepoints include 30 sec, 60 sec and 3 min.

Results to Date

- Dissolved ozone levels decreased faster in water maintained at 25°C as compared to water maintained at 4°C (**Figure 1**).
- An increase in water turbulence accelerated the degradation of dissolved ozone (**Table 1**).
- Ozone (6 ppm) and chlorine treatments were able to reduce *Listeria monocytogenes* populations on romaine lettuce by ~2 and 1.5 logs CFU/sample after as little as 30 seconds of treatment (**Figure 2**). Increasing the treatment time to 3 and 5 min did not change ozone antimicrobial efficacy. Efficacy of chlorine treatment was increased by 5 min of treatment time as compared to 1 and 3 min.

Benefits to the Industry

Successful completion of this project will provide the produce industry with novel antimicrobial treatments for disinfecting wash water and produce in single pass or re-circulated hydrocooling systems.

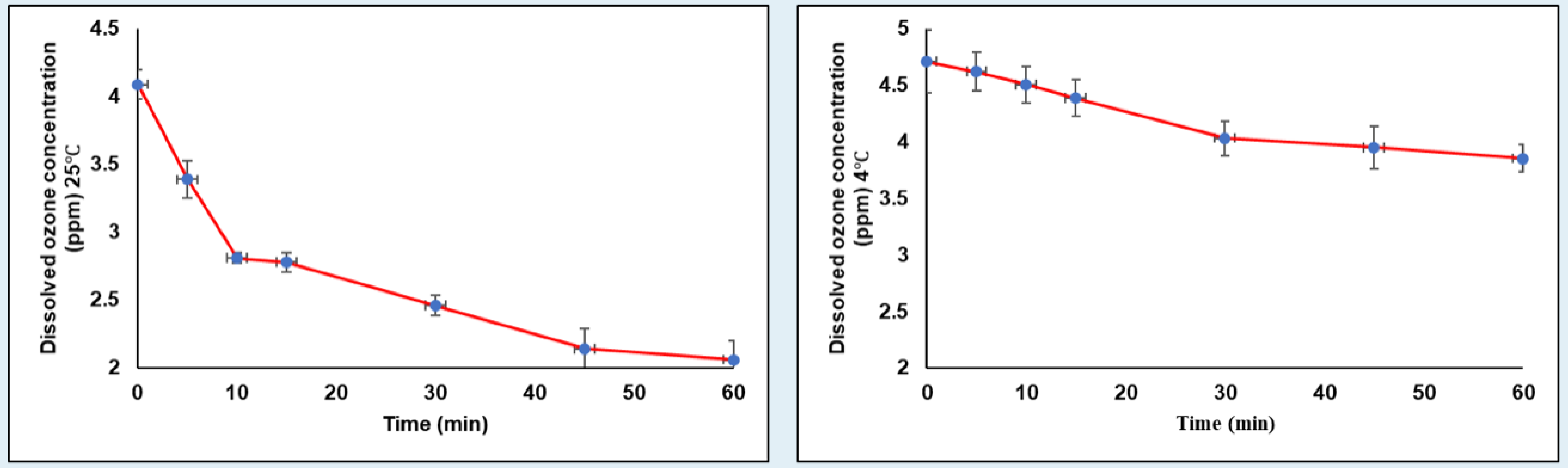

Figure 1. Effect of water temperature on ozone solubility and stability. The x-axis represents the time in minutes, and the y-axis represents dissolved ozone concentration at (A) 25°C or (B) 4°C.

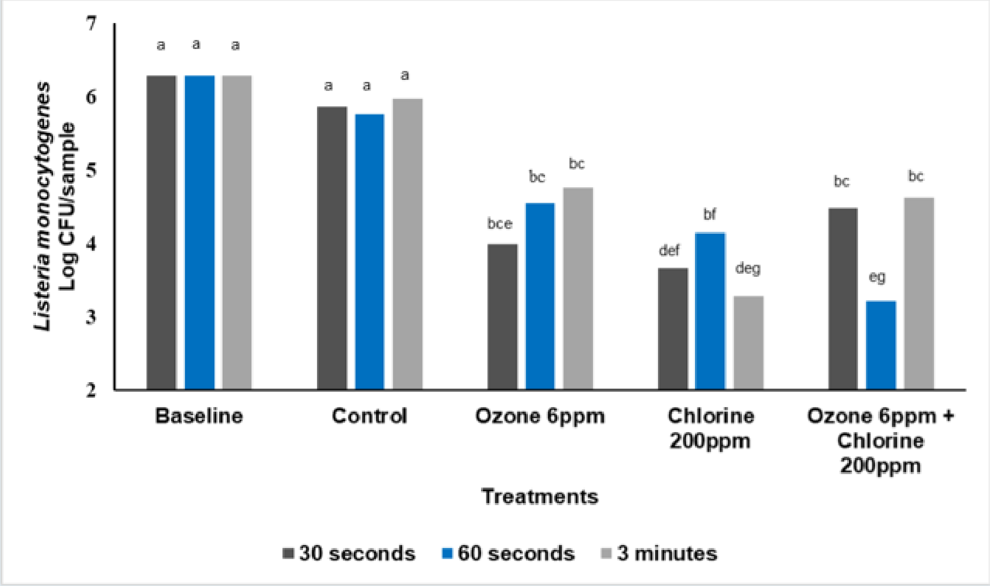

Figure 2. Effect of ozone, either alone or in combination with chlorine, in inactivating *L. monocytogenes* on romaine lettuce.

Initial concentration of ozone ~4 ppm Speed – 1150 rpm			
Time (min)	Control	Stirred	% Difference
1	3.78	4	-5.82
3	3.82	3.84	-0.52
5	3.88	2.9	25.25
10	3.42	2.35	31.28
15	2.98	0.92	69.13

Table 1. Effect of water turbulence on degradation rate of dissolved ozone in deionized water maintained at 4°C.