POST-PROCESS STEAM PASTEURIZATION OF PACKAGED FRANKFURTERS COMBINED WITH ACID/BUFFER TREATMENTS FOR CONTROL OF *LISTERIA MONOCYTOGENES*

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Summary

The efficacy of a saturated steam-based post-process pasteurization system to reduce/eliminate *Listeria monocytogenes* on frankfurters was evaluated. Frankfurters were packaged individually or in a single layer format (4 per package, touching). Samples were surface treated with 2% lactic acid, 4% lactic acid, 2% buffered sodium citrate, or 2% buffered sodium lactate, vacuum packaged, and steam pasteurized to end-point surface temperatures of 160, 170 or 180°F using a Townsend Post-Process Pasteurization system (formerly Stork-RMS Protecon). Pasteurization of inoculated single layer franks to surface end point temperature targets of 160, 170, and 180°F resulted in *L. monocytogenes* reductions ($P<0.05$) of 0.92, 1.44 and 2.89 log colony forming units (CFU)/frank, respectively. Greater reductions in *L. monocytogenes* populations were observed for individually packaged frankfurters with 2.32, 4.62 and 6.52 log CFU/frank reductions at target surface end point temperatures of 160, 170, and 180°F, respectively. No differences ($P>0.05$) were noted between various surface acid treatments applied. Post-process pasteurization of frankfurters (in-package) using the saturated-steam-based Townsend system was effective in reducing numbers of *L. monocytogenes*.

Introduction

Listeria monocytogenes, an important foodborne pathogen, may be present on a variety of foods including coleslaw, raw vegetables, milk, and poultry. Most recently, outbreaks have involved ready-to-eat meats such as hot dogs and lunch meats. Even though these ready-to-eat products are free of *L. monocytoge*nes when exiting the cooker, further handling and packaging of the meats may lead to re-contamination of product surfaces.

Post-process pasteurization can eliminate *L. monocytogenes* by exposing the product (in-package) to steam, which thermally destroys the bacteria. Other means of destroying bacteria include the use of acid or buffer treatments as product washes prior to packaging. Treatment of ready-to-eat meats using various acid and buffer treatments in conjunction with post-process pasteurization may provide additional assurance to consumers of a safe product, even if contaminated after initial heat processing. The objective of this research was to quantify *L. monocytogenes* reductions on packaged frankfurters using the Townsend system and to determine if organic acid pre-treatment of products enhanced the thermal effectiveness of this system.

Experimental Procedures

Inoculum preparation. A five-strain cocktail of *L. monocytogenes* [108 M, 109, serotype 4c ATCC, serotype 3 ATCC, and H7738 (food outbreak strain)] was used. The cultures were maintained on Tryptic Soy Agar (Difco, Detroit, MI) slants at 39°F. Fresh cultures of the inoculum were prepared from the slants by transferring the cultures to 5 mL of Tryptic Soy Broth (Difco, Detroit, MI) and incubating at 95°F for 24 hours. After incubation, 1 mL of fresh culture was transferred into centrifuge bottles containing 100 mL Tryptic Soy Broth and further incubated at 95°F for 18

hours. Cultures were then centrifuged, resuspended with 50 mL of 0.1% peptone water (Difco, Detroit, MI), and centrifuged again. The remaining pellet was resuspended with 10 mL peptone water. All strains were combined aseptically in a sterile bottle to form a five-strain cocktail of *L. monocytogenes*.

Product inoculation. Beef, pork, and turkey frankfurters were obtained from a local retail store and stored at 39°F until treatment and pasteurization. Frankfurter packages were opened and individual surfaces were blotted dry with a paper towel. The products were mist inoculated in a bio-containment chamber. A 1-hour attachment period was provided. Inoculated products were treated and vacuum-packaged individually (1 per package) or in a single layer (4 per package) format.

Acid/buffer treatment. Inoculated franks [except controls (no wash treatment, no heat)] were treated using a spray washer developed by Kansas State University. The treatments tested were 2% lactic acid, 4% lactic acid, 2% buffered sodium citrate, and 2% buffered sodium lactate at 20 psi.

Post-pasteurization treatment. The franks were aseptically vacuum-packaged and pasteurized to target product sub-surface temperatures of 160, 170, and 180°F. Temperature was measured between the two middle frankfurters for single layer frankfurters, which is the slowest heating surface. For the individually packaged frankfurters, sub-surface (1 mm from the surface) temperature was used to measure the target temperature. At a pasteurization chamber temperature of 205°F, times for surfaces of individually packaged frankfurters to reach 160, 170, and 180°F were 38, 58, and 96 seconds, respectively. Pasteurization times of 4 minutes 14 seconds, 5 minutes 4 seconds, and 6 minutes and 2 seconds, were required for single layer franks to attain temperatures of 160, 170, and 180°F, respectively. After pasteurization, the franks were chilled in an ice water bath for 15 minutes before sampling.

Sampling. The entire frank from the individual packaged product or one frank from the two middle franks in the single layer package was aseptically transferred to a filter stomacher bag. Each sample was homogenized in a stomacher (Tekmar Co., Cincinnati, OH) with 50 mL of 0.1% sterile peptone water for 2 minutes. Samples were serially diluted using 9 mL peptone blanks and plated on Modified Oxford Agar (Oxoid Ltd., Basingstoke, Hampshire, England) and Tryptose Phosphate Agar (Difco, Detroit, MI). Plates were incubated at 95°F for 48 hours. Colonies were counted and reported at $\log_{10}$ CFU/frank.

Results and Discussion

Individually packaged frankfurters. Pasteurization of franks to target surface end point temperatures of 160, 170, and 180°F resulted in 2.32, 4.62, and 6.52 log CFU/frank reductions ($P<0.05$) of *L. monocytogenes*, respectively. The various acid and buffer treatments applied to the franks did not reduce *L. monocytogenes* ($P>0.05$) populations on the surface of the franks beyond the steam pasteurization effect. Larger reductions in *L. monocytogenes* on frankfurters were achieved using an individual frankfurter format compared to the single layer (touching franks) format, and shorter pasteurization times were required for the individually packaged product.

Single layer frankfurters. Acid treatment alone of frankfurters resulted in approximately 0.7 log reductions in surface *L. monocytogenes* ($P<0.05$), and no interaction between the wash treatment and target temperature was observed. Pasteurization of inoculated franks to target end-point temperatures of 160, 170, and 180°F resulted in *L. monocytogenes* reductions of 0.92, 1.44 and 2.89 log CFU/frank.

Listeria monocytogenes, a fairly acid tolerant organism, can grow at pH 4.6. The antimicrobial action of organic acids in order of increasing effectiveness previously was reported as acetic>citric>lactic>malic acids. Incorporation of some type of organic acid treatment, especially lactic or acetic, was expected to provide additional safety for frankfurters and reduce the risk of *L. monocytogenes* growth. However, this did not prove true in this experiment.

Risk of *L. monocytogenes* on frankfurters can be reduced by post-process, in-package pasteurization to eliminate *L. monocytogenes* surface recontamination of ready-to-eat products. The steam based post-process pasteurization system alone or in combination with a wash treatment is effective in reducing *L. monocytogenes* populations on surfaces of frankfurters and can be used as a critical control point in the manufacture of frankfurters and similar ready-to-eat meat products. This system was more effective on an individually packaged frank compared to franks packaged in a single layer.