

2003

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### Recommended Citation

Reicks, A.L.; Thippareddi, H.; Phebus, Randall K.; Marsden, James L.; and Kastner, Curtis L. (2003) "Post-process steam pasteurization of packaged Frankfurters combined with acid/buffer treatments for control of *Listeria monocytogenes*," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 1. <https://doi.org/10.4148/2378-5977.1650>

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# Post-process steam pasteurization of packaged Frankfurters combined with acid/buffer treatments for control of *Listeria monocytogenes*

## Abstract

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*.

## Keywords

Cattlemen's Day, 2003; Kansas Agricultural Experiment Station contribution; no. 03-272-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 908; Beef; Steam pasteurization; Frankfurters; *Listeria monocytogenes*

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

*A. L. Reicks, H. Thippareddi, R. K. Phebus, J. L. Marsden, and C. L. Kastner*

**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. monocytogenes* 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<sub>10</sub> 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.