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Evaluation of consumer reheating methods for destruction of Listeria monocytogenes in frankfurters

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EVALUATION OF CONSUMER REHEATING METHODS FOR DESTRUCTION OF *LISTERIA MONOCYTOGENES* IN FRANKFURTERS

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Summary

The USDA Food Safety and Inspection Service has issued a "zero tolerance" for *Listeria monocytogenes* in ready-to-eat meat and poultry products. The Food Safety and Inspection Service recommends that consumers "Reheat [hotdogs] until steaming" to reduce the risk of listeriosis. We evaluated *L. monocytogenes* survival on inoculated frankfurters after reheating using common, in-home consumer practices. Frankfurters were inoculated with a six-strain mixture of *L. monocytogenes* to an initial level of approximately 10^7 colony forming units (CFU)/gram. Eight inoculated franks for each treatment were cooked using boiling water, a conventional electric oven, or a microwave oven. *L. monocytogenes* recovery was calculated after plating on Modified Oxford Agar and Tryptose Phosphate Agar. *L. monocytogenes* reductions were 3.2 $\log_{10}$ CFU/gram on franks microwaved with or without water for 60 seconds or cooked in a conventional electric oven at 500°F for 2 or 5 minutes. Franks cooked in boiling water for 30 and 60 seconds achieved reductions of 4.3 and 4.9 $\log_{10}$ CFU/gram, respectively. Franks wrapped in a paper napkin and microwaved for 60 seconds resulted in a 6.8 $\log_{10}$ CFU/gram reduction, the most effective consumer reheating protocol.

Introduction

Listeria monocytogenes is the major microbiological risk in ready-to-eat meat products. Fifty-three percent of vacuum packaged processed meat samples were contaminated with *L. monocytogenes*. Ineffective sanitizing procedures to eliminate biofilm-entrapped *L. monocytogenes* from frankfurter contact surfaces during processing and production facility environmental contamination are major causes of *L. monocytogenes* product recontamination.

USDA-Food Safety and Inspection Service has had a "zero tolerance" for *L. monocytogenes* in ready-to-eat products and began testing for the pathogen in 1987. However, outbreaks associated with hot dogs and deli meats in the fall of 1998 and spring of 2000 prompted the agency to advise plants to reconsider their HACCP plans relative to *L. monocytogenes* control. Several processing techniques developed to decontaminate frankfurters and deli meats prior to or immediately after final packaging include use of antibacterial peptides, antilisterial bacteria and/or competitive exclusion, organic acid treatments, high-pressure processing, and post-packaging treatments such as microwaves, hot water or steam, and gamma irradiation.

Although some methods were effective against *L. monocytogenes*, they are not widely accepted and some affect organoleptic qualities of the products. USDA recommends that consumers reheat hotdogs until steaming to prevent listeriosis, but consumer reheating practices for frankfurters have not been scientifically validated as to their effectiveness against *L. monocytogenes*.

Experimental Procedures

Six *L. monocytogenes* strains were grown independently under aerobic conditions in 5 ml Tryptic Soy Broth, transferred to 100 ml Tryptic Soy Broth, and incubated for 24

hours at 37°C. Cell pellets were resuspended in 60 ml of 0.1% peptone water after centrifuging the cultures.

All-beef frankfurters (approximately 0.9-inch diameter by 4.7 inches long) were purchased at two local supermarkets over an 8-month period. They contained 17 grams of fat and 640 milligrams of sodium per 57 gram serving. Franks were deposited with sterile tongs into a cooking rack, leaving empty places between franks. Franks were mist inoculated inside a sealed plexiglass chamber with the six-strain mixture (9 $\log_{10}$ CFU/ml) to achieve 7 $\log_{10}$ CFU/gram product. Eight inoculated franks were placed into Cryovac B 540 barrier bags and vacuum packaged. Sealed bags containing the inoculated franks were shrunk by exposing them to water at 176°F for 2 seconds. The packages were stored at 41°F for 1 week prior to simulated consumer cooking treatments.

Survival of *L. monocytogenes* was evaluated by randomly assigning each of eight inoculated and vacuum packaged franks to one of the following consumer cooking protocols:

1. No treatment control.

2. Place one frank in boiling water, cover container and remove it from heat; let stand 30 seconds.

3. Place one frank in boiling water, cover container and remove it from heat; let stand 60 seconds.

4. Place one frank in a small microwave-safe dish and heat on high for 60 seconds in a 1000-watt microwave oven.

5. Wrap one frank in a paper napkin and place it in a small microwave-safe dish and heat on high for 60 seconds.

6. Place one frank in ½ cup water in a small microwave safe dish and heat on high for 60 seconds.

7. Cook one frank for 2 minutes in a conventional oven preheated to 500°F.

8. Cook one frank for 5 minutes in a conventional oven preheated to 500°F.

Frankfurters' surface temperature and the internal temperature at 0.4 inches in depth, were measured from the frankfurter middle length and recorded before and after treatments using a type T thermocouple (Omega Engineering, Standford, CT) attached to a digital thermometer (Model HH23, Omega Engineering, Standford, CT).

Each heat-treated frank and the control was prepared, serially diluted in peptone water, and spiral plated onto Modified Oxford Agar and Tryptose Phosphate Agar (Buffered peptone and Bacto™ agar, Difco, Detroit, MI). Plates were enumerated after 24 hours incubation at 100°F, and the bacterial population was reported on a per gram basis. The USDA-Food Safety and Inspection Service *L. monocytogenes* enrichment procedure was followed for the samples where bacterial growth was not seen after 24 hours incubation on agar plates.

Results and Discussion

The inoculated frankfurters stored at 41°F for 1 week had a *L. monocytogenes* population of 7.3 $\log_{10}$ CFU/gram. Before treatments, the frankfurters had a surface temperature of 44°F and an internal temperature of 40°F. In general, the lowest *L. monocytogenes* reductions were observed when franks were reheated in a conventional oven for 2 minutes, microwaved in water for 60 seconds, or cooked in a conventional oven for 5 minutes. Bacterial reductions of 0.41, 0.68, and 1.00 $\log_{10}$ CFU/gram,

respectively, were observed using these protocols. Frankfurters microwaved in water reached a surface and an internal temperature of 96 and 72°F, respectively, and the water temperature was 111°F at the end of the 60-second treatment. When franks were cooked in a microwave oven for 60 seconds (without water), a 3.2 $\log_{10}$ CFU/gram *L. monocytogenes* reduction was observed. The surface and internal temperatures were 174 and 194°F, respectively. When franks were immersed in boiling water, followed by removing the container from the heating source, and kept for 30 and 60 seconds (treatments 2 and 3), bacterial reductions of 4.3 and 4.9 $\log_{10}$ CFU/gram, respectively, were achieved. The surface temperatures were 107 and 127°F and the internal temperatures were 50 and 59°F, respectively. The highest bacterial reduction, 6.9 $\log_{10}$ CFU/gram, was observed in franks wrapped with a paper napkin and microwaved for 60 seconds. With this treatment, surface and internal temperatures of 202 and 169°F, respectively, were observed.

The paper napkin likely entrapped the steam produced during microwaving of the product, keeping it in contact with the contaminated frankfurter surface, thus raising its surface temperature from 44 up to 202°F in 60 seconds. This procedure could easily be utilized by consumers. Reheating franks in a conventional oven for up to 5 minutes at 500°F was ineffective in destroying *L. monocytogenes*. Commonly, consumers place unwrapped franks into a microwave for a short reheating cycle. This protocol was only moderately effective at reducing surface contamination, as was placement of franks into boiling water for short periods.