Controlling *Listeria monocytogenes* with Antimicrobial Agents in Ready-to-Eat Meat and Poultry Products: Validation Documents

Karaline Mayer[1], Elizabeth Boyle, Ph.D.[1], Dennis Burson, Ph.D.[2], and Harshavardhan Thippareddi, Ph.D.[3]

[1]Department of Animal Sciences and Industry, Kansas State University

[2]Department of Animal Science, [3]Department of Food Science and Technology, University of Nebraska

This project is partially funded through a grant from the National Integrated Food Safety Initiative (Special Emphasis Grant No. 2005-51110-03278) of the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

EP-152 January 2009

Introduction

This reference material is intended to assist you in identifying supporting documentation for meat or poultry HACCP plans. All materials cited are scientific documents obtained from peer-reviewed journal articles. While this material covers many cooked meat product studies, it is not intended to provide entire representation of every study currently published. As well, articles included in this publication may or may not be sufficient for addition in your specific HACCP plan. In order to use an article from this publication as supporting documentation for a hazard or critical control point, the process parameters described in the research study must be identical to the process used in your plant. For example, if an antimicrobial in a study is added at 2.0% directly into the brine formulation, but you apply the same antimicrobial to the finished product by spraying it onto the product surface, then the study would not provide sufficient supporting documentation for you process and should not be used.

Be aware that concentration levels used in the studies may be higher than the current limits permitted by USDA-FSIS or FDA. One should always adhere to current regulations set forth by appropriate regulating bodies. While antimicrobial usage levels vary by study, it is essential to note the level of log reduction, if any, that were obtained from individual concentrations. For instance, Study A may show a 1 log decrease with 1% sodium lactate while Study B shows a 1 log decrease with 1% sodium lactate plus sodium diacetate. Again, it is essential to note the specific antimicrobial(s) and concentration levels that are used.

Every study presented in this resource may not be acceptable as supporting documentation due to the results found. These studies have been included for your use when developing a new product, or adapting a product for use with an antimicrobial. Several of these studies fail to show reductions, and actually report log increases in bacterial counts over time.

Meat product names are presented as they were published in the particular journal article. For example, although bologna may accurately be described as a comminuted product, it is listed separately within the index located on the previous page. The bologna papers used formulations specifically labeled as bologna, and processors should not attempt to adapt a bologna study to an alternate comminuted product.

Table Guide

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
A	B	C	D	E	F	G

A. This column lists the specific product researched.
B. Essential parameters are described, such as antimicrobial concentration, a_w, pH, storage days and temperature, etc.
C. The level that *Listeria monocytogenes* was originally added, or inoculated, onto the product. This is the start level that log increases/decreases can be added to in order to find the ending bacterial count.

a. Inoculation Level 3 cfu/g
b. Log Increase/Decrease 2 log decrease
c. Final Bacterial Load 1 cfu/g

D. The specific strain, or type, of *Listeria monocytogenes* studied.
E. Days or hours that sampling occurred over time.
F. The change in bacterial level when compared to the start time/day.
   a. Day 0 3 cfu/g
   b. Day 2 4 cfu/g 1 log increase
   c. Day 4 4.5 cfu/g 1.5 log increase
   d. Day 6 2 cfu/g 1 log decrease
G. The reference document that sites and describes the all information presented.

Example for utilizing this index in the processing plant:

- The processor chooses to move cured ham production from Alternative 3 into Alternative 2, which may require the use of an antimicrobial agent. Cured ham is found under Fully Cooked, Not Shelf Stable: Cured Ham. Identify the process parameters that fit your process. Column F will show the potential log increases or reductions you should expect in your product. If the journal article is suitable for use in your situation under current governmental regulations, then Column G identifies the journal article to be sited.

It is our intention that this document will provide helpful resources for processors of every production size. As new studies are published over time, we will attempt to update this document in order to continue service to you, the processor.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Fully Cooked, Not Shelf Stable						
Beef Roast						
Roasts (Beef, Nitrite-Free)	Antimicrobial: 2% sodium lactate Addition: Directly into brine formulation Final product pH: 5.7 after first cooking; 5.8 after 2nd cooking Final product internal temperature: 62.8˚C per cooking time Storage: Weeks 0-2 at 2-4˚C, Weeks 3-4 at 7˚C, Week 5 at 10˚C	3 log cfu/cm^2 Products inoculated externally	Scott A	Weeks 0, 1, 2, 3, 4, 5	Cooked Once: Undetectable limits (<10 cfu/cm^2) on Week 0; 0.2 log cfu/cm^2 on Weeks 1, 2; Undetectable limits on Week 3; 1.6 log cfu/cm^2 on Week 4; 4.3 log cfu/cm^2 Cooked Twice: Undetectable limits on Weeks 0, 1, 2, 3, 4; 0.2 log cfu/cm^2 on Week 5	Unda, J. R., R. A. Molins, et al. (1991). "Clostridium sporogenes and Listeria monocytogenes: Survival and Inhibition in Microwave-ready Beef Roasts Containing Selected Antimicrobials." Journal of Food Science 56(1): 198-205, 219.
Round Roast (Cooked, Beef)	Antimicrobial: 1.5% sodium lactate Addition: Directly into brine; roasts pumped to 110% green weight Final product internal pH: 5.67 Storage: 2 weeks at 2-4˚C + 2 weeks at 7˚C + 1 week at 10˚C (5 wks total)	3 log cfu/cm^2	Scott A	Week 0, 1, 2, 3, 4, 5	0.07 log decrease on Week 1; 0.25 log increase on Week 2; 1 log increase on Weeks 3, 4; 2.7 log increase on Week 5	Stillmunkes, A. A., G. A. Prabhu, et al. (1993). "Microbiological Safety of Cooked Beef Roasts Treated with Lactate, Monolaurin or Gluconate." Journal of Food Science 58(5): 953-958.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Round Roast (Cooked, Beef)	Antimicrobial: 2.5% sodium lactate Addition: Directly into brine; roasts pumped to 110% green weight Final product internal pH: 5.68 Storage: 2 weeks at 2-4˚C + 2 weeks at 7˚C + 1 week at 10˚C (5 wks total)	3 log cfu/cm^2	Scott A	Week 0, 1, 2, 3, 4, 5	≤0.2 log decrease on Weeks 1, 2; 0.5 log increase on Weeks 3, 4; 0.94 log increase on Week 5	Stillmunkes, A. A., G. A. Prabhu, et al. (1993). "Microbiological Safety of Cooked Beef Roasts Treated with Lactate, Monolaurin or Gluconate." Journal of Food Science 58(5): 953-958.
Round Roast (Cooked, Beef)	Antimicrobial: 3.5% sodium lactate Addition: Directly into brine; roasts pumped to 110% green weight Final product internal pH: 5.58 Storage: 2 weeks at 2-4˚C + 2 weeks at 7˚C + 1 week at 10˚C (5 wks total)	3 log cfu/cm^2	Scott A	Week 0, 1, 2, 3, 4, 5	≤0.6 log decrease on Weeks 1, 2, 3; 2 log decrease on Week 4; 0.66 log decrease on Week 5	Stillmunkes, A. A., G. A. Prabhu, et al. (1993). "Microbiological Safety of Cooked Beef Roasts Treated with Lactate, Monolaurin or Gluconate." Journal of Food Science 58(5): 953-958.
Beef Top Round						
Top Rounds (Cooked Beef)	Antimicrobial: 2% sodium lactate Addition: Directly into formulation Storage: 28 days at 10˚C	3 log cfu/ml	ATCC 43256	Days 0, 7, 14, 21, 48	2.3 log increase on Day 7; 4.3 log increase on Day 14; 5 log increase on Day 21, 28	Miller, R. K. and G. R. Acuff (1994). "Sodium Lactate Affects Pathogens in Cooked Beef." Journal of Food Science 59(1): 15-19.
Top Rounds (Cooked Beef)	Antimicrobial: 3% sodium lactate Addition: Directly into formulation Storage: 28 days at 10˚C	3 log cfu/ml	ATCC 43256	Days 0, 7, 14, 21, 48	0.5 log increase on Day 7; 1.5 log increase on Day 14; 2.5 log increase on Days 21, 28	Miller, R. K. and G. R. Acuff (1994). "Sodium Lactate Affects Pathogens in Cooked Beef." Journal of Food Science 59(1): 15-19.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Top Rounds (Cooked Beef)	Antimicrobial: 4% sodium lactate Addition: Directly into formulation Storage: 28 days at 10˚C	3 log cfu/ml	ATCC 43256	Days 0, 7, 14, 21, 48	No change on Day 7; ≤0.8 log decrease on Days 14, 21, 28	Miller, R. K. and G. R. Acuff (1994). "Sodium Lactate Affects Pathogens in Cooked Beef." Journal of Food Science 59(1): 15-19.
Bologna						
Bologna	Antimicrobial: 2.5% sodium acetate Addition: Bologna slices dipped into solution Final product pH: 6.57 Storage: 120 days at 4˚C	~2 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	2.5 log increase on Day 10; >3 log increase on Day 20; ≥5 log increase on Days 35, 50, 70, 90, 120	Samelis, J., J. N. Sofos, et al. (2001). "Organic acids and their salts as dipping solutions to control *Listeria monocytogenes* inoculated following processing of sliced pork bologna stored at 4C in vacuum packages." Journal of Food Protection 64(11): 1722-1729.
Bologna	Antimicrobial: 5.0% sodium acetate Addition: Bologna slices dipped into solution Final product pH: 6.59 Storage: 120 days at 4˚C	~2 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	2 log increase on Day 10; 1.5 log increase on Day 20; beginning at a 3 log increase on Day 35, trends continued upward to 5.5 log increase on Day 120	Samelis, J., J. N. Sofos, et al. (2001). "Organic acids and their salts as dipping solutions to control *Listeria monocytogenes* inoculated following processing of sliced pork bologna stored at 4C in vacuum packages." Journal of Food Protection 64(11): 1722-1729.
Bologna	Antimicrobial: 2.5% sodium diacetate Addition: Bologna slices dipped into solution Final product pH: 6.05 Storage: 120 days at 4˚C	~2 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	2 log increase on Day 10; 1.5 log increase on Day 20; ~4 log increase on Days 35, 50, 70, 90; 4.5 log increase on Day 120	Samelis, J., J. N. Sofos, et al. (2001). "Organic acids and their salts as dipping solutions to control *Listeria monocytogenes* inoculated following processing of sliced pork bologna stored at 4C in vacuum packages." Journal of Food Protection 64(11): 1722-1729.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Bologna	Antimicrobial: 5.0% sodium diacetate Addition: Bologna slices dipped into solution Final product pH: 5.67 Storage: 120 days at 4˚C	~2 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	<1 log increase or decrease on Days 10, 20; 2.5 log increase on Day 35; <1.5 log increase on Days 50, 70, 90, 120	Samelis, J., J. N. Sofos, et al. (2001). "Organic acids and their salts as dipping solutions to control *Listeria monocytogenes* inoculated following processing of sliced pork bologna stored at 4C in vacuum packages." Journal of Food Protection 64(11): 1722-1729.
Bologna	Antimicrobial: 3.0% sodium lactate Addition: Bologna slices dipped into solution Final product pH: 6.41 Storage: 120 days at 4˚C	~2 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	2 log increase on Day 10; 4 log increase on Day 20;~ 5 log increase on Days 35, 50, 70; 4 log increase on Day 90; 5 log increase on Day 120	Samelis, J., J. N. Sofos, et al. (2001). "Organic acids and their salts as dipping solutions to control *Listeria monocytogenes* inoculated following processing of sliced pork bologna stored at 4C in vacuum packages." Journal of Food Protection 64(11): 1722-1729.
Bologna	Antimicrobial: 6.0% sodium lactate Addition: Bologna slices dipped into solution Final product pH: 6.48 Storage: 120 days at 4˚C	~2 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	2 log increase on Days 10, 20; ~5 log increase on Days 35, 50, 70; 4 log increase on Day 90; 5 log increase on Day 120	Samelis, J., J. N. Sofos, et al. (2001). "Organic acids and their salts as dipping solutions to control *Listeria monocytogenes* inoculated following processing of sliced pork bologna stored at 4C in vacuum packages." Journal of Food Protection 64(11): 1722-1729.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Bologna (Beef)	Antimicrobial: 2.5% sodium lactate Addition: Directly into formulation Final product pH: 6.3 Storage: 45 days at 5 or 10˚C	3 log cfu/g	Scott A 6-Strain Combo: Scott A, V-7, 10403S, EGD, ATCC 19117, *L. innocua*	**Scott A** 5˚C: Days 0, 10, 20, 30, 45 10˚C: Days 0, 5, 10, 15, 25, 45 **6-Strains** 5˚C: Days 0, 15, 30, 45 10˚C: Days 0, 10, 20, 30, 45	**Scott A** 5˚C: Slightly decreased through Day 30; <1 log increase on Day 45 10˚C: <1 log increase through Day 10; >2 log increase on Days 15, 25, 45 **6-Strain Combo** 5˚C: <1 log increase through Day 30; <2 log increase on Day 45 10˚C: <2 log increase through Day 10; >2 log increase on Days 20, 30, 45	Mbandi, E. and L. A. Shelef (2002). "Enhanced antimicrobial effects of combination of lactate and diacetate on *Listeria monocytogenes* and Salmonella spp. in beef bologna." International Journal of Food Microbiology 76(3): 191-198.
Bologna (Beef)	Antimicrobial: 0.2% sodium diacetate Addition: Directly into formulation Final product pH: 5.9 Storage: 45 days at 5 or 10˚C	3 log cfu/g	Scott A 6-Strain Combo: Scott A, V-7, 10403S, EGD, ATCC 19117, *L. innocua*	**Scott A** 5˚C: Days 0, 10, 20, 30, 45 10˚C: Days 0, 5, 10, 15, 25, 45 **6-Strains** 5˚C: Days 0, 15, 30, 45 10˚C: Days 0, 10, 20, 30, 45	**Scott A** 5˚C: *D*ecreased slightly or remained unchanged Day 0 through Day 45 10˚C: <1 log increase through Day 15; <2 log increase through Day 25; >2 log increase on Day 25 and Day 45 **6-Strains** 5˚C: <1 log increase throughout Day 45 10˚C: >2 log increase Days 10, 20, 30, 45	Mbandi, E. and L. A. Shelef (2002). "Enhanced antimicrobial effects of combination of lactate and diacetate on *Listeria monocytogenes* and Salmonella spp. in beef bologna." International Journal of Food Microbiology 76(3): 191-198.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Bologna (Beef)	Antimicrobial: 2.5% sodium lactate + 0.2% sodium diacetate Addition: Directly into formulation Final product pH: 6.1 Storage: 45 days at 5 or 10˚C	3 log cfu/g	Scott A 6-Strain Combo: Scott A, V-7, 10403S, EGD, ATCC 19117, *L. innocua*	**Scott A** 5˚C: Days 0, 10, 20, 30, 45 10˚C: Days 0, 5, 10, 15, 25, 45 **6-Strains** 5˚C: Days 0, 15, 30, 45 10˚C: Days 0, 10, 20, 30, 45	**Scott A** 5˚C: *Continuously* decreased through Day 45; >1.5 log decrease on Day 30; >3 log decrease on Day 45 10˚C: Slightly decreased or remained unchanged throughout Day 45 (no log changes) **6-Strains** 5˚C: Slightly decreased or remained unchanged throughout Day 45 (no log changes) 10˚C: >1.5 log increase on Day 20; >2 log increase by Day 30; continued increases through Day 45	Mbandi, E. and L. A. Shelef (2002). "Enhanced antimicrobial effects of combination of lactate and diacetate on *Listeria monocytogenes* and Salmonella spp. in beef bologna." International Journal of Food Microbiology 76(3): 191-198.
Bologna (Beef)	Antimicrobial: 2.5% sodium lactate Addition: Blended in product post-processing Final product pH: 6.3 Storage: 45 days at 5˚C	3 log cfu/g	5 Strain Combo: Scott A, V-7, 10403S, EGD, ATCC 19117	Days 0, 10, 20, 30, 45	<0.5 log decrease on Days 10, 20, 30; <0.5 log increase on Day 45	Mbandi, E. and L. A. Shelef (2002). "Automated measurements of antilisterial activities of lactate and diacetate in ready-to-eat meat." Journal of Microbiological Methods 49(3): 307-314.
Bologna (Beef)	Antimicrobial: 0.2% sodium diacetate Addition: Blended in product post-processing Final product pH: 5.9 Storage: 45 days at 5˚C	3 log cfu/g	5 Strain Combo: Scott A, V-7, 10403S, EGD, ATCC 19117	Days 0, 10, 20, 30, 45	<0.5 log decrease on Days 10, 20; 1 log decrease on Day 30; 0.5 log decrease on Day 45	Mbandi, E. and L. A. Shelef (2002). "Automated measurements of antilisterial activities of lactate and diacetate in ready-to-eat meat." Journal of Microbiological Methods 49(3): 307-314.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Bologna (Beef)	Antimicrobial: 2.5% sodium lactate + 0.2% sodium diacetate Addition: Blended in product post-processing Final product pH: 6.1 Storage: 45 days at 5˚C	3 log cfu/g	5 Strain Combo: Scott A, V-7, 10403S, EGD, ATCC 19117	Days 0, 10, 20, 30, 45	0.5 log decrease on Day 10; 1 log decrease on Day 20; 1.5 log decrease on Day 30; 3 log decrease on Day 45	Mbandi, E. and L. A. Shelef (2002). "Automated measurements of antilisterial activities of lactate and diacetate in ready-to-eat meat." Journal of Microbiological Methods 49(3): 307-314.
Bologna (Light)	Antimicrobial: 1.5% potassium lactate + 0.15% sodium diacetate Addition: Directly into formulation Storage: 18 weeks at 4˚C	1 log cfu/g	LCDC 861, F2399, NFPA 83, MAD 225, MAD 328	Weeks 1, 2, 4, 6, 8, 10, 12, 14, 16, 18	<0.5 log increase on Weeks 1, 2, 4, 6; 1 log increase on Week 8; <0.5 log increase on Weeks 10, 12, 14; ≤1 log increase on Weeks 16, 18	Seman, D. L., A. C. Borger, et al. (2002). "Modeling the Growth of *Listeria monocytogenes* in Cured Ready-to-Eat Processed Meat Products by Manipulation of Sodium Chloride, Sodium Diacetate, Potassium Lactate, and Product Moisture Content." Journal of Food Protection 65: 651-658.
Bologna (Light)	Antimicrobial: 2.5% potassium lactate + 0.15% sodium diacetate Addition: Directly into formulation Storage: 18 weeks at 4˚C	1 log cfu/g	LCDC 861, F2399, NFPA 83, MAD 225, MAD 328	Weeks 1, 2, 4, 6, 8, 10, 12, 14, 16, 18	<0.5 log increase throughout 18 weeks	Seman, D. L., A. C. Borger, et al. (2002). "Modeling the Growth of *Listeria monocytogenes* in Cured Ready-to-Eat Processed Meat Products by Manipulation of Sodium Chloride, Sodium Diacetate, Potassium Lactate, and Product Moisture Content." Journal of Food Protection 65: 651-658.
Bologna (Pork)	Antimicrobial: 1.8% sodium lactate Addition: Directly into formulation Final product a_w: 0.938 Storage: 90 days at 4˚C or 28 days at 10˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	4˚C: Days 0, 10, 20, 35, 70, 90 10˚C: 0, 4, 8, 12, 16, 20, 24, 28	4˚C: >1 log increase on Day 10; >3 log increase on Day 20 with continuous growth reaching a 5 log increase on Day 45 10˚C: 1 log increase on Day 4; 3 log increase on Day 8; >5 log increase on Days 12, 16, 20, 24, 28	Barmpalia, I. M., K. P. Koutsoumanis, et al. (2005). "Effect of antimicrobials as ingredients of pork bologna for *Listeria monocytogenes* control during storage at 4 or 10C." Food Microbiology 22(2-3): 205-211.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Bologna (Pork)	Antimicrobial: 0.125% sodium diacetate Addition: Directly into formulation Storage: 90 days at 4˚C or 28 days at 10˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	4˚C: Days 0, 10, 20, 35, 70, 90 10˚C: 0, 4, 8, 12, 16, 20, 24, 28	4˚C: <1 log by Day 10; ~1.5 log increase on Day 20; ~3 log increase on Day 35; ~5 log increase on Days 70, 90 10˚C: 1 log increase on Day 4; >2 log increase on Day 8; >4 log increase on Days 12, 16, 20, 24, 28	Barmpalia, I. M., K. P. Koutsoumanis, et al. (2005). "Effect of antimicrobials as ingredients of pork bologna for *Listeria monocytogenes* control during storage at 4 or 10C." Food Microbiology 22(2-3): 205-211.
Bologna (Pork)	Antimicrobial: 1.8% sodium lactate + 0.125% sodium diacetate Addition: Directly into formulation Storage: 90 days at 4˚C or 28 days at 10˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	4˚C: Days 0, 10, 20, 35, 70, 90 10˚C: 0, 4, 8, 12, 16, 20, 24, 28	4˚C: <1 log increase on Days 10, 20; ~1 log increase on Day 35; >3 log increase on Days 70, 90 10˚C: <1 log increase on Days 4, 8; ~2 log increase on Day 12; >3 log increase on Days 16, 20, 24, 28	Barmpalia, I. M., K. P. Koutsoumanis, et al. (2005). "Effect of antimicrobials as ingredients of pork bologna for *Listeria monocytogenes* control during storage at 4 or 10C." Food Microbiology 22(2-3): 205-211.
Bologna (Pork)	Antimicrobial: 1.8% sodium lactate + 0.25% sodium diacetate Addition: Directly into formulation Final product pH: 6.34 a_w: 0.972 Storage: 90 days at 4˚C or 28 days at 10˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	4˚C: Days 0, 10, 20, 35, 70, 90 10˚C: 0, 4, 8, 12, 16, 20, 24, 28	4˚C: <1 log increase or decrease throughout Day 90 10˚C: <1 log increase on Days 4, 8; 1 log increase on Day 12; 1.5 log increase on Day 16; <1 log increase on Days 20, 24, 28	Barmpalia, I. M., K. P. Koutsoumanis, et al. (2005). "Effect of antimicrobials as ingredients of pork bologna for *Listeria monocytogenes* control during storage at 4 or 10C." Food Microbiology 22(2-3): 205-211.
Bologna (Pork/Beef)	Antimicrobial: 2.5% Acetic Acid Addition: Cooked product immersed post-inoculation in solution for 2 min. and drained for 1 min. Final product pH: 4.82 a_w: 0.97 Storage: 48 days at 10˚C	~3 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 36, 48	≤0.5 log increase or decrease on Days 4, 8, 12; 1 log increase on Day 20; 1.5 log increase on Day 28; ≤1 log increase on Days 36, 48	Geornaras, I., K. E. Belk, et al. (2005). "Postprocessing Antimicrobial Treatments to Control *Listeria monocytogenes* in Commercial Vacuum-Packaged Bologna and Ham Stored at 10C." Journal of Food Protection 68: 991-998.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Bologna (Pork/Beef)	Antimicrobial: 2.5% Lactic Acid Addition: Cooked product immersed post-inoculation in solution for 2 min. and drained for 1 min. Final product pH: 4.78 a_w: 0.97 Storage: 48 days at 10˚C	~3 cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 36, 48	≤0.5 log decrease on Days 4, 8, 12, 20, 28; 0.5 log increase on Day 36; 1 log increase on Day 48	Geornaras, I., K. E. Belk, et al. (2005). "Postprocessing Antimicrobial Treatments to Control *Listeria monocytogenes* in Commercial Vacuum-Packaged Bologna and Ham Stored at 10C." Journal of Food Protection 68: 991-998.
Bologna-Type Sausage	Antimicrobial: 2.0% sodium lactate Addition: Directly into formulation Final product pH: 6.6 Storage: 35 days at 5 or 10 ˚C	3.4 x 10^2 cfu/g	Combined Serotypes 1, 4	5˚C: Days 0, 14, 21, 28, 35 10˚C: Days 0, 14, 21, 28, 35	5˚C: Remained unchanged or decreased slightly through Day 28; <1.5 log increase on Day 35 10˚C: >2 log increase on Days 14, 21, 28, 35	Qvist, S., K. Sehested, et al. (1994). "Growth suppression of *Listeria monocytogenes* in a meat product." International Journal of Food Microbiology 24: 283-293.
Bratwurst						
Bratwurst (Pork, Not Smoked or Cured)	Antimicrobial: 2% sodium lactate Addition: Directly into formulation Final product pH: 6.1 Storage: 84 days at 3 or 7˚C	3˚C: 5 log cfu/package 7˚C: 4 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	3˚C: Days 0, 14, 28, 42 7˚C: Days 7, 14, 28	3˚C: <0.25 log decrease on Day 14; <2 log increase on Day 28; 3 log increase on Day 42 7˚C: <0.5 log increase on Day 7; 1.25 log increase on Day 14; >2 log increase on Day 28	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Bratwurst (Pork, Not Smoked or Cured)	Antimicrobial: 3.4% sodium lactate + 0.1% sodium diacetate Addition: Directly into formulation Final product pH: 6.1 Storage: 84 days at 3 or 7˚C	3˚C: 5 log cfu/package 7˚C: 4 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	3˚C: Days 0, 14, 28, 42, 56, 84 7˚C: Days 7, 14, 28, 56	3˚C: ≤0.75 log decrease throughout 84 days 7˚C: ≤0.75 log decrease on Days 7, 14; <0.25 log increase on Day 28; 3.5 log increase on Day 56	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Bratwurst (Pork/Beef, Cured, Smoked)	Antimicrobial: 3.4% sodium lactate + 0.1% sodium diacetate Added Nitrite: 156 ppm Addition: Directly into formulation Final product pH: 6.0 Storage: 84 days at 3 or 7˚C	3˚C: 5 log cfu/package 7˚C: 4 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	3˚C: Days 0, 14, 28, 42, 56, 84 7˚C: Days 7, 14, 28, 56, 84	3˚C: ≤0.75 log decrease throughout 84 days 7˚C: ≤0.75 log decrease throughout 84 days	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Cervelat Sausage						
Cervelat Sausage	Antimicrobial: 2.5% sodium lactate + 0.25% sodium acetate (2.5% NaCl) Addition: Directly into formulation Final product pH: 6.4 Storage: 35 days at 4 or 9˚C	3 log cfu/g	3-Strain Combo: 2230/92, 167, 187	Days 0, 7, 14, 21, 28, 35	4˚C: <0.5 log decrease for Days 7, 14, 21; <1 log increase or decrease for Days 28, 35 9˚C: <1 log decrease throughout 35 days	Blom, H., E. Nerbrink, et al. (1997). "Addition of 2.5% lactate and 0.25% acetate controls growth of *Listeria monocytogenes* in vacuum-packed, sensory-acceptable servelat sausage and cooked ham stored at 4C." International Journal of Food Microbiology 38(1): 71-76.
Chicken Luncheon Meat						
Chicken Luncheon Meat	Antimicrobial: 15% [wt/vol] sodium diacetate Addition: Solution misted directly onto product slices Product pH 6.03 before antimicrobial spray Storage: 14 days at 4, 13, or 22˚C	3.63 log cfu/g	5 Strain Combo: H7962, H7762, H7969, H7764, H8733	Days 0, 3, 7, 10, 14	4˚C: <0.1 log decrease on Days 3, 7; <1 log decrease on Days 10, 14 13˚C: <0.5 log increase on Days 3, 7; <0.2 log decrease on Days 10, 14 22˚C: 1.54 log increase on Day 3; 1.33 log increase on Day 7; <0.6 log increase on Days 10, 14	Islam, M., J. Chen, et al. (2002). "Effect of Selected Generally Recognized as Safe Preservative Sprays on Growth of *Listeria monocytogenes* on Chicken Luncheon Meat." Journal of Food Protection 65(5): 794-798.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Chicken Luncheon Meat	Antimicrobial: 20% [wt/vol] sodium diacetate Addition: Solution misted directly onto product slices Product pH 6.03 before antimicrobial spray Storage: 14 days at 4, 13, or 22˚C	3.42 log cfu/g	5 Strain Combo: H7962, H7762, H7969, H7764, H8733	Days 0, 3, 7, 10, 14	4˚C: ≤0.15 log decrease on Days 3, 7; 0.79 log decrease on Day 10; 0.92 log decrease on Day 14 13˚C: ≤0.6 log increase on Days 3, 7, 10; 0.20 log decrease on Day 14 22˚C: ≤1.45 log increase on Days 3, 7; <0.4 log decrease on Days 10, 14	Islam, M., J. Chen, et al. (2002). "Effect of Selected Generally Recognized as Safe Preservative Sprays on Growth of *Listeria monocytogenes* on Chicken Luncheon Meat." Journal of Food Protection 65(5): 794-798.
Chicken Luncheon Meat	Antimicrobial: 25% [wt/vol] sodium diacetate Addition: Solution misted directly onto product slices Product pH 6.03 before antimicrobial spray Storage: 14 days at 4, 13, or 22˚C	3.14 log cfu/g	5 Strain Combo: H7962, H7762, H7969, H7764, H8733	Days 0, 3, 7, 10, 14	4˚C: <0.2 log decrease on Days 3, 7, 10; 0.74 log decrease on Day 14 13˚C: <0.4 log increase on Days 3, 7, 10; 0.03 log decrease on Day 14 22˚C: <1.6 log increase on Days 3, 7; 0.17 log decrease on Day 10; undetectable levels (<1 log cfu/g) on Day 14	Islam, M., J. Chen, et al. (2002). "Effect of Selected Generally Recognized as Safe Preservative Sprays on Growth of *Listeria monocytogenes* on Chicken Luncheon Meat." Journal of Food Protection 65(5): 794-798.
Comminuted Products						
Comminuted Beef with Added Broth	Antimicrobial: 4% sodium lactate Addition: Directly into formulation Final product pH: 6.27 Storage: 21 days at 5˚C, 8 hours at 20˚C, 66 hours at 35˚C	3 log cfu/g	Scott A	5˚C: Days 0, 7, 9, 14, 21 20˚C: Days 0, 1, 2, 3, 4, 5, 8 35˚C: Hours 0, 18, 42, 66	5˚C: 0.5 log decrease on Day 7;; 1 log increase on Day 9; 3 log increase on Day 14; 4 log increase on Day 21 20˚C: <1 log increase on Day 1; 3-4 log increases on Days 2, 3, 4; 5 log increase on Day 5; 5.5 log increase on Day 8 35˚C: 4.5 log increase on Hour 18; 5 log increase on Hours 42, 66	Shelef, L. A. and Q. Yang (1991). "Growth Suppression of *Listeria monocytogenes* by Lactates in Broth, Chicken, and Beef." Journal of Food Protection 54(4): 283-287.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Comminuted Beef with Added Broth	Antimicrobial: 4% potassium lactate Addition: Directly into formulation Final product pH: 6.27 Storage: 21 days at 5˚C, 8 hours at 20˚C, 66 hours at 35˚C	3 log cfu/g	Scott A	5˚C: Days 0, 7, 9, 14, 21 20˚C: Days 0, 1, 2, 3, 4, 5, 8 35˚C: Hours 0, 18, 42, 66	5˚C: 0.5 log decrease on Days 7, 9; 2 log increase on Day 14; 2.5 log increase on Day 21 20˚C: No change on Day 1; 3-4 log increases on Days 2, 3, 4, 5; 4.5 log increase on Day 8 35˚C: 3.5 log increase on Hour 18; 6 log increase on Hours 42, 66	Shelef, L. A. and Q. Yang (1991). "Growth Suppression of *Listeria monocytogenes* by Lactates in Broth, Chicken, and Beef." Journal of Food Protection 54(4): 283-287.
Comminuted Chicken with Added Broth	Antimicrobial: 4% sodium lactate Addition: Directly into formulation Final product pH: 6.5 Storage: 21 days at 5˚C, 8 hours at 20˚C, 66 hours at 35˚C	3 log cfu/g	Scott A	5˚C: Days 0, 7, 9, 14, 21 20˚C: Days 0, 1, 2, 3, 4, 5, 8 35˚C: Hours 0, 18, 42, 66	5˚C: 1.5 log increase on Day 7; 2.5 log increase on Day 9; 4 log increase on Day 14; 6 log increase on Day 21 20˚C: <1 log increase on Day 1; 5.5 log increase on Days 2, 3, 4, 5, 8 35˚C: 4.5 log increase on Hour 18; 6 log increase on Hour 42; 6.5 log increase on Hour 66	Shelef, L. A. and Q. Yang (1991). "Growth Suppression of *Listeria monocytogenes* by Lactates in Broth, Chicken, and Beef." Journal of Food Protection 54(4): 283-287.
Comminuted Chicken with Added Broth	Antimicrobial: 4% potassium lactate Addition: Directly into formulation Final product pH: 6.5 Storage: 21 days at 5˚C, 8 hours at 20˚C, 66 hours at 35˚C	3 log cfu/g	Scott A	5˚C: Days 0, 7, 9, 14, 21 20˚C: Days 0, 1, 2, 3, 4, 5, 8 35˚C: Hours 0, 18, 42, 66	5˚C: 0.5 log increase on Day 7; 1 log increase on Day 9; 4 log increase on Day 14; 6.5 log increase on Day 21 20˚C: <1 log increase on Day 1; 5.5-6 log increases on Days 2, 3, 4, 5, 8 35˚C: 4 log increase on Hour 18; 5.5-6 log increases on Hours 42, 66	Shelef, L. A. and Q. Yang (1991). "Growth Suppression of *Listeria monocytogenes* by Lactates in Broth, Chicken, and Beef." Journal of Food Protection 54(4): 283-287.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Cotto Salami						
Cotto Salami	Antimicrobial: 1.5% potassium lactate + 0.15% sodium diacetate Addition: Directly into formulation Storage: 18 weeks at 4˚C	1 log cfu/g	LCDC 861, F2399, NFPA 83, MAD 225, MAD 328	Weeks 1, 2, 4, 6, 8, 10, 12, 14, 16, 18	<0.75 log increase throughout 18 weeks	Seman, D. L., A. C. Borger, et al. (2002). "Modeling the Growth of *Listeria monocytogenes* in Cured Ready-to-Eat Processed Meat Products by Manipulation of Sodium Chloride, Sodium Diacetate, Potassium Lactate, and Product Moisture Content." Journal of Food Protection 65: 651-658.
Cotto Salami	Antimicrobial: 2.5% potassium lactate + 0.15% sodium diacetate Addition: Directly into formulation Storage: 18 weeks at 4˚C	1 log cfu/g	LCDC 861, F2399, NFPA 83, MAD 225, MAD 328	Weeks 1, 2, 4, 6, 8, 10, 12, 14, 16, 18	<0.5 log increase throughout 18 weeks	Seman, D. L., A. C. Borger, et al. (2002). "Modeling the Growth of *Listeria monocytogenes* in Cured Ready-to-Eat Processed Meat Products by Manipulation of Sodium Chloride, Sodium Diacetate, Potassium Lactate, and Product Moisture Content." Journal of Food Protection 65: 651-658.
Cured Ham						
Cured Ham	Antimicrobial: 1.5% sodium lactate Addition: Directly into formulation Final product pH: 6.2 aw at 25˚C: 0.977 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	<0.5 log increase or decrease throughout 41 days	Stekelenburg, F. K. and M. L. T. Kant-Muermans (2001). "Effects of sodium lactate and other additives in a cooked ham product on sensory quality and development of a strain of *Lactobacillus curvatus* and *Listeria monocytogenes*." International Journal of Food Microbiology 66(3): 197-203.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Cured Ham	Antimicrobial: 2.0% sodium lactate Addition: Directly into formulation Final product pH: 6.1 aw at 25˚C: 0.961 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	<0.5 log decrease throughout 41 days	Stekelenburg, F. K. and M. L. T. Kant-Muermans (2001). "Effects of sodium lactate and other additives in a cooked ham product on sensory quality and development of a strain of *Lactobacillus curvatus* and *Listeria monocytogenes*." International Journal of Food Microbiology 66(3): 197-203.
Cured Ham	Antimicrobial: 0.1% sodium diacetate Addition: Directly into formulation Final product pH: 6.0 aw at 25˚C: 0.973 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	<1 log increase or decrease throughout 41 days	Stekelenburg, F. K. and M. L. T. Kant-Muermans (2001). "Effects of sodium lactate and other additives in a cooked ham product on sensory quality and development of a strain of *Lactobacillus curvatus* and *Listeria monocytogenes*." International Journal of Food Microbiology 66(3): 197-203.
Cured Ham	Antimicrobial: 0.2% sodium diacetate Addition: Directly into formulation Final product pH: 5.9 aw at 25˚C: 0.972 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	<0.5 log increase or decrease throughout 41 days	Stekelenburg, F. K. and M. L. T. Kant-Muermans (2001). "Effects of sodium lactate and other additives in a cooked ham product on sensory quality and development of a strain of *Lactobacillus curvatus* and *Listeria monocytogenes*." International Journal of Food Microbiology 66(3): 197-203.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Cured Ham	Antimicrobial: 1% buffered sodium citrate (15 parts sodium citrate + 1 part citric acid wt/wt) Addition: Directly into formulation Final product pH: 6.0 aw at 25˚C: 0.974 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	>0.5 log increase on Days 2, 5; 1 log increase on Day 9; >2 log increase on Days 12, 14; ≥3 log increase on Days 16 through 41	Stekelenburg, F. K. and M. L. T. Kant-Muermans (2001). "Effects of sodium lactate and other additives in a cooked ham product on sensory quality and development of a strain of *Lactobacillus curvatus* and *Listeria monocytogenes*." International Journal of Food Microbiology 66(3): 197-203.
Cured Ham	Antimicrobial: 2.4% potassium lactate + 0.25% sodium diacetate Addition: Directly into brine formulation Final product pH: 5.82 Storage: 56 days at 4˚C or 35 days at 10˚C	5.6 log cfu/g	5 Strain Combo: Scott A (4b), Potato 5KA (4A), KC (3A), ATCC (4C), FSIS Product Isolate (1/2B)	4˚C: Days 0, 7, 14, 21, 28, 35, 49, 56 10˚C: Days 0, 2, 5, 8, 10, 12, 15, 17, 19, 22, 24, 26, 29, 31, 33, 35	4˚C: Least square means throughout 56 day storage was 5.31 log cfu/g (0.5 log cfu/g decrease) 10˚C: <0.5 log increase on Day 2; ≤0.5 log decrease on Days 5, 8, 10, 12, 15, 17, 19, 22, 24, 26, 29, 31; 1 log decrease on Day 33; 0.5 log decrease on Day 35	Michaelsen, A. R., J. G. Sebranek, et al. (2006). "Effects of Microbial Inhibitors and Modified Atmosphere Packaging on Growth of Listeria monocytogenes and Salmonella enterica Typhimurium and on Quality Attributes of Injected Pork Chops and Sliced Cured Ham." Journal of Food Protection 69: 2671-2680.
Cured Ham	Antimicrobial: 2.5% Acetic Acid Addition: Cooked product immersed post-inoculation in solution for 2 min. and drained for 1 min. Final product pH: 4.63 a_w: 0.98 Storage: 48 days at 10˚C	~3 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 36, 48	≤0.5 log decrease or increase on Days 4, 8, 12, 20, 28; 1.5 log increase on Day 36; 1 log increase on Day 48	Geornaras, I., K. E. Belk, et al. (2005). "Postprocessing Antimicrobial Treatments to Control *Listeria monocytogenes* in Commercial Vacuum-Packaged Bologna and Ham Stored at 10C." Journal of Food Protection 68: 991-998.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Cured Ham	Antimicrobial: 2.5% Lactic Acid Addition: Cooked product immersed post-inoculation in solution for 2 min. and drained for 1 min. Final product pH: 4.62 a_w: 0.98 Storage: 48 days at 10˚C	~3 cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 36, 48	≤0.5 log decrease or increase on Days 4, 8, 12, 20; 1 log increase on Day 28; 1.5 log increase on Day 36; 4.5 log increase on Day 48	Geornaras, I., K. E. Belk, et al. (2005). "Postprocessing Antimicrobial Treatments to Control *Listeria monocytogenes* in Commercial Vacuum-Packaged Bologna and Ham Stored at 10C." Journal of Food Protection 68: 991-998.
Cured Ham	Antimicrobial: sodium lactate + sodium diacetate (no concentrations given) Addition: Directly into formulation Final product pH: 6.2 a_w: 0.957 Storage: 10 days at 4˚C as whole ham, then sliced and stored for 12 days at 7˚C	1-2 log cfu/cm^2	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	7˚C: Days 0, 4, 8, 12	0.5 log increase on Day 4; 1.5 log increase on Day 8; 2.5 log increase on Day 12	Lianou, A., I. Geornaras, et al. (2007). "Fate of Listeria monocytogenes in Commercial Ham, Formulated with or without Antimicrobials, under Conditions Simulating Contamination in the Processing or Retail Environment and during Home Storage." Journal of Food Protection 70: 378-385.
Cured Ham	Antimicrobial: sodium lactate + sodium diacetate (no concentrations given) Addition: Directly into formulation Final product pH: 6.2 a_w: 0.957 Storage: 20 days at 4˚C as whole ham, then sliced and stored for 12 days at 7˚C	1-2 log cfu/cm^2	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	7˚C: Days 0, 4, 8, 12	0.5 log increase on Day 4; 1.5 log increase on Day 8; 2 log increase on Day 12	Lianou, A., I. Geornaras, et al. (2007). "Fate of Listeria monocytogenes in Commercial Ham, Formulated with or without Antimicrobials, under Conditions Simulating Contamination in the Processing or Retail Environment and during Home Storage." Journal of Food Protection 70: 378-385.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Cured Ham	Antimicrobial: sodium lactate + sodium diacetate (no concentrations given) Addition: Directly into formulation Final product pH: 6.2 a_w: 0.957 Storage: 35 days at 4˚C as whole ham, then sliced and stored for 12 days at 7˚C	1-2 log cfu/cm^2	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	7˚C: Days 0, 4, 8, 12	<0.5 log increase on Day 4; 1 log increase on Day 8; 2 log increase on Day 12	Lianou, A., I. Geornaras, et al. (2007). "Fate of Listeria monocytogenes in Commercial Ham, Formulated with or without Antimicrobials, under Conditions Simulating Contamination in the Processing or Retail Environment and during Home Storage." Journal of Food Protection 70: 378-385.
Cured Ham	Antimicrobial: sodium lactate + sodium diacetate (no concentrations given) Addition: Directly into formulation Final product pH: 6.2 a_w: 0.957 Storage: 60 days at 4˚C as whole ham, then sliced and stored for 12 days at 7˚C	1-2 log cfu/cm^2	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	7˚C: Days 0, 4, 8, 12	1 log increase on Day 4; 2 log increase on Day 8; 2.5 log increase on Day 12	Lianou, A., I. Geornaras, et al. (2007). "Fate of Listeria monocytogenes in Commercial Ham, Formulated with or without Antimicrobials, under Conditions Simulating Contamination in the Processing or Retail Environment and during Home Storage." Journal of Food Protection 70: 378-385.
Cured Ham	Antimicrobial: 2.5% sodium lactate + 0.25% sodium acetate (2.5% NaCl) Addition: Directly into formulation Storage: 35 days at 4 or 9˚C	3 log cfu/g	3-Strain Combo: 2230/92, 167, 187	Days 0, 7, 14, 21, 28, 35	4˚C: <0.5 log decrease throughout 35 days 9˚C: <0.5 log increase or decrease for Days 7, 14, 21; 1 log increase on Day 28; <2 log increase on Day 35	Blom, H., E. Nerbrink, et al. (1997). "Addition of 2.5% lactate and 0.25% acetate controls growth of *Listeria monocytogenes* in vacuum-packed, sensory-acceptable servelat sausage and cooked ham stored at 4C." International Journal of Food Microbiology 38(1): 71-76.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Cured Ham	Antimicrobial: 1.5% sodium lactate Addition: Directly into formulation Final product pH: 6.2 a_w at 25˚C: 0.969 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	<0.5 log increase or decrease throughout 40 days	Kant-Muermans, M. L. T. and F. K. Stekelenburg (1998). The influence of different additives on the quality of cooked ham product. TNO Report. D. I. M. D. Northolt. The Netherlands, TNO Nutrition and Food Research Institute. 98.
Cured Ham	Antimicrobial: 2% sodium lactate Addition: Directly into formulation Final product pH: 6.1 a_w at 25˚C: 0.961 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	<0.5 log increase or decrease throughout 40 days	Kant-Muermans, M. L. T. and F. K. Stekelenburg (1998). The influence of different additives on the quality of cooked ham product. TNO Report. D. I. M. D. Northolt. The Netherlands, TNO Nutrition and Food Research Institute. 98.
Cured Ham	Antimicrobial: 0.1% diacetate Addition: Directly into formulation Final product pH: 6.0 a_w at 25˚C: 0.973 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	<0.5 log increase or decrease through Day 9; <1.5 log increase throughout 40 days	Kant-Muermans, M. L. T. and F. K. Stekelenburg (1998). The influence of different additives on the quality of cooked ham product. TNO Report. D. I. M. D. Northolt. The Netherlands, TNO Nutrition and Food Research Institute. 98.
Cured Ham	Antimicrobial: 0.2% diacetate Addition: Directly into formulation Final product pH: 5.9 a_w at 25˚C: 0.972 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	>0.5 log increase or decrease throughout 40 days	Kant-Muermans, M. L. T. and F. K. Stekelenburg (1998). The influence of different additives on the quality of cooked ham product. TNO Report. D. I. M. D. Northolt. The Netherlands, TNO Nutrition and Food Research Institute. 98.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Cured Ham	Antimicrobial: 0.9% sodium lactate + 0.1% diacetate Addition: Directly into formulation Final product pH: 6.0 a_w at 25˚C: 0.968 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	>0.5 log increase or decrease throughout 40 days	Kant-Muermans, M. L. T. and F. K. Stekelenburg (1998). The influence of different additives on the quality of cooked ham product. TNO Report. D. I. M. D. Northolt. The Netherlands, TNO Nutrition and Food Research Institute. 98.
Cured Ham	Antimicrobial: 1.5% sodium lactate + 0.1% diacetate Addition: Directly into formulation Final product pH: 6.0 a_w at 25˚C: 0.966 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	>0.5 log increase or decrease throughout 40 days	Kant-Muermans, M. L. T. and F. K. Stekelenburg (1998). The influence of different additives on the quality of cooked ham product. TNO Report. D. I. M. D. Northolt. The Netherlands, TNO Nutrition and Food Research Institute. 98.
Cured Ham	Antimicrobial: 1.0% buffered sodium citrate Addition: Directly into formulation Final product pH: 6.0 a_w at 25˚C: 0.974 Storage: 40 days at 4˚C	2 log cfu/g	Type A	Days 0, 2, 5, 9, 12, 14, 16, 19, 21, 23, 26, 41	<0.5 log increase or decrease through Day 5; beginning at a 1 log increase on Day 9, trends continued increasing to 3.5 log increase on Day 40	Kant-Muermans, M. L. T. and F. K. Stekelenburg (1998). The influence of different additives on the quality of cooked ham product. TNO Report. D. I. M. D. Northolt. The Netherlands, TNO Nutrition and Food Research Institute. 98.
Cured Ham	Antimicrobial: 1.8% potassium lactate Addition: Directly into formulation Storage: 90 days at 1 and 6˚C	4 log cfu/g	3-Strain Combo: CTC1010, CTC1011, CTC1034	Days 0, 15, 30, 45, 60, 75, 90	1˚C: <0.5 log decrease on Days 15, 30, 45, 60, 75; No change on Day 90 6˚C: <0.5 log increase on Days 15, 30, 45, 60, 75; 3 log increase on Day 90	Jofre, A., M. Garriga, et al. (2008). "Inhibition of *Salmonella* sp. *Listeria monocytogenes* and *Staphylococcus aureus* in cooked ham by combining antimicrobials, high hydrostatic pressure and refrigeration." Meat Science 78: 53-59.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Cured Ham (Smoked-Cooked)	Antimicrobial: 1.5% potassium lactate + 0.15% sodium diacetate Addition: Directly into formulation Storage: 18 weeks at 4˚C	1 log cfu/g	LCDC 861, F2399, NFPA 83, MAD 225, MAD 328	Weeks 1, 2, 4, 6, 8, 10, 12, 14, 16, 18	No change throughout 18 weeks	Seman, D. L., A. C. Borger, et al. (2002). "Modeling the Growth of *Listeria monocytogenes* in Cured Ready-to-Eat Processed Meat Products by Manipulation of Sodium Chloride, Sodium Diacetate, Potassium Lactate, and Product Moisture Content." Journal of Food Protection 65: 651-658.
Cured Ham (Smoked-Cooked)	Antimicrobial: 2.5% potassium lactate + 0.15% sodium diacetate Addition: Directly into formulation Storage: 18 weeks at 4˚C	1 log cfu/g	LCDC 861, F2399, NFPA 83, MAD 225, MAD 328	Weeks 1, 2, 4, 6, 8, 10, 12, 14, 16, 18	No change throughout 18 weeks	Seman, D. L., A. C. Borger, et al. (2002). "Modeling the Growth of *Listeria monocytogenes* in Cured Ready-to-Eat Processed Meat Products by Manipulation of Sodium Chloride, Sodium Diacetate, Potassium Lactate, and Product Moisture Content." Journal of Food Protection 65: 651-658.
Cured Ham Slices	Antimicrobial: sodium lactate + sodium diacetate (no concentrations given) Addition: Directly into formulation Final product pH: 6.2 a_w: 0.957 Storage: 10 days at 4˚C + 12 days at 7˚C	2 log cfu/cm^2	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	7˚C: Days 0, 4, 8, 12	<1 log increase on Day 4; 1.5 log increase on Day 8; 2 log increase on Day 12	Lianou, A., I. Geornaras, et al. (2007). "Fate of Listeria monocytogenes in Commercial Ham, Formulated with or without Antimicrobials, under Conditions Simulating Contamination in the Processing or Retail Environment and during Home Storage." Journal of Food Protection 70: 378-385.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Cured Ham Slices	Antimicrobial: sodium lactate + sodium diacetate (no concentrations given) Addition: Directly into formulation Final product pH: 6.2 a_w: 0.957 Storage: 20 days at 4˚C + 12 days at 7˚C	2 log cfu/cm^2	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	7˚C: Days 0, 4, 8, 12	0.5 log increase on Day 4; 1.0 log increase on Day 8; 1.5 log increase on Day 12	Lianou, A., I. Geornaras, et al. (2007). "Fate of Listeria monocytogenes in Commercial Ham, Formulated with or without Antimicrobials, under Conditions Simulating Contamination in the Processing or Retail Environment and during Home Storage." Journal of Food Protection 70: 378-385.
Cured Ham Slices	Antimicrobial: sodium lactate + sodium diacetate (no concentrations given) Addition: Directly into formulation Final product pH: 6.2 a_w: 0.957 Storage: 35 days at 4˚C + 12 days at 7˚C	2 log cfu/cm^2	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	7˚C: Days 0, 4, 8, 12	0.5 log increase on Day 4; <1.5 log increase on Days 8, 12	Lianou, A., I. Geornaras, et al. (2007). "Fate of Listeria monocytogenes in Commercial Ham, Formulated with or without Antimicrobials, under Conditions Simulating Contamination in the Processing or Retail Environment and during Home Storage." Journal of Food Protection 70: 378-385.
Cured Ham Slices	Antimicrobial: sodium lactate + sodium diacetate (no concentrations given) Addition: Directly into formulation Final product pH: 6.2 a_w: 0.957 Storage: 60 days at 4˚C + 12 days at 7˚C	4 log cfu/cm^2	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	7˚C: Days 0, 4, 8, 12	<1 log increase throughout 12 days	Lianou, A., I. Geornaras, et al. (2007). "Fate of Listeria monocytogenes in Commercial Ham, Formulated with or without Antimicrobials, under Conditions Simulating Contamination in the Processing or Retail Environment and during Home Storage." Journal of Food Protection 70: 378-385.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter						
Frankfurter	Antimicrobial: 0.1% sodium diacetate Addition: Directly into formulation Final product pH: 6.1 aw at 25˚C: 0.973 Storage: 29 days at 4˚C	2 log cfu/g	Type 4a	Days 0, 1, 2, 4, 7, 10, 14, 17, 21, 28	<0.5 /og increase on Days 1, 2, 4; <1 log increase on Day 10; <1.5 log increase on Days 14, 17, 21, 28	Stekelenburg, F. K. (2003). "Enhanced inhibition of *Listeria monocytogenes* in Frankfurter sausage by the addition of potassium lactate and sodium diacetate mixtures." Food Microbiology 20(1): 133-137.
Frankfurter	Antimicrobial: 1.8% potassium lactate Addition: Directly into formulation Final product pH: 6.3 aw at 25˚C: 0.964 Storage: 29 days at 4˚C	2 log cfu/g	Type 4a	Days 0, 1, 2, 4, 7, 10, 14, 17, 21, 28	≤0.5 log increase on Days 0, 1, 2, 4, 7, 10, 14, 17; 1 log increase on Day 21; 1.5 log increase on Day 28	Stekelenburg, F. K. (2003). "Enhanced inhibition of *Listeria monocytogenes* in Frankfurter sausage by the addition of potassium lactate and sodium diacetate mixtures." Food Microbiology 20(1): 133-137.
Frankfurter	Antimicrobial: 1.12% potassium lactate/sodium diacetate Addition: Directly into formulation Final product pH: 6.2 aw at 25˚C: 0.969 Storage: 29 days at 4˚C	2 log cfu/g	Type 4a	Days 0, 1, 2, 4, 7, 10, 14, 17, 21, 28	≤0.5 log increase throughout all days	Stekelenburg, F. K. (2003). "Enhanced inhibition of *Listeria monocytogenes* in Frankfurter sausage by the addition of potassium lactate and sodium diacetate mixtures." Food Microbiology 20(1): 133-137.
Frankfurter	Antimicrobial: 1.4% potassium lactate/sodium diacetate Addition: Directly into formulation Final product pH: 6.2 aw at 25˚C: 0.968 Storage: 29 days at 4˚C	2 log cfu/g	Type 4a	Days 0, 1, 2, 4, 7, 10, 14, 17, 21, 28	≤0.25 log increase or decrease throughout all days	Stekelenburg, F. K. (2003). "Enhanced inhibition of *Listeria monocytogenes* in Frankfurter sausage by the addition of potassium lactate and sodium diacetate mixtures." Food Microbiology 20(1): 133-137.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter	Antimicrobial: 1.68% potassium lactate/sodium diacetate Addition: Directly into formulation Final product pH: 6.2 aw at 25˚C: 0.966 Storage: 29 days at 4˚C	2 log cfu/g	Type 4a	Days 0, 1, 2, 4, 7, 10, 14, 17, 21, 28	≤0.25 log increase or decrease throughout all days	Stekelenburg, F. K. (2003). "Enhanced inhibition of *Listeria monocytogenes* in Frankfurter sausage by the addition of potassium lactate and sodium diacetate mixtures." Food Microbiology 20(1): 133-137.
Frankfurter	Antimicrobial: 2.0% potassium lactate Addition: Directly into formulation Final product pH: 5.84 Storage: 90 days at 4˚C or 60 days at 10˚C	20 cfu/package	5-Strain Combo: Scott A, H7776, LM-101M, F6854, MFS-2	4˚C: 0, 7, 15, 21, 28, 60, 90 10˚C: 0, 5, 8, 11, 21, 28, 40, 60	4˚C: <0.5 log increase through Day 60; 1 log increase on Day 90 10˚C: <0.5 log increase through Day 21; ~1 log increase on Days 28, 40, 60	Porto, A. C. S., B. D. G. M. Franco, et al. (2002). "Viability of a five-strain mixture of *Listeria monocytogenes* in vacuum-sealed packages of frankfurters, commercially prepared with and without 2.0 or 3.0% added potassium lactate, during extended storage at 4 and 10C." Journal of Food Protection 65(2): 308-315.
Frankfurter	Antimicrobial: 3.0% potassium lactate Addition: Directly into formulation Final product pH: 6.11 Storage: 90 days at 4˚C or 60 days at 10˚C	20 cfu/package	5-Strain Combo: Scott A, H7776, LM-101M, F6854, MFS-2	4˚C: 0, 7, 15, 21, 28, 60, 90 10˚C: 0, 5, 8, 11, 21, 28, 40, 60	4˚C: <0.5 log increase throughout 90 days 10˚C: <0.5 log increase throughout 28 days; 1 log increase on Day 40; 1 log decrease on Day 60	Porto, A. C. S., B. D. G. M. Franco, et al. (2002). "Viability of a five-strain mixture of *Listeria monocytogenes* in vacuum-sealed packages of frankfurters, commercially prepared with and without 2.0 or 3.0% added potassium lactate, during extended storage at 4 and 10C." Journal of Food Protection 65(2): 308-315.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter	Antimicrobial: 3.0% potassium lactate Addition: Directly into formulation Final product pH: 6.11 Storage: 90 days at 4˚C or 60 days at 10˚C	500 cfu/package	5-Strain Combo: Scott A, H7776, LM-101M, F6854, MFS-2	4˚C: 0, 7, 15, 21, 28, 60, 90 10˚C: 0, 5, 8, 11, 21, 28, 40, 60	4˚C: <0.5 log increase on Days 7, 15; <1 log decrease on Days 21, 28, 40, 60 10˚C: <0.5 log decrease throughout 60 days	Porto, A. C. S., B. D. G. M. Franco, et al. (2002). "Viability of a five-strain mixture of *Listeria monocytogenes* in vacuum-sealed packages of frankfurters, commercially prepared with and without 2.0 or 3.0% added potassium lactate, during extended storage at 4 and 10C." Journal of Food Protection 65(2): 308-315.
Frankfurter	Antimicrobial: Zesti-B liquid smoke extract Addition: Peeled franks sprayed with pressurized spray canister Storage: 10 weeks at 6°C	1, 2, or 3 log cfu/ml	4 Strain Combo: Scott A-2, V7-2, 39-2, 383-2	1 log cfu/ml: Wk 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 2 log cfu/ml: Wk 0, 1, 2, 4, 6, 8, 10 3 log cfu/ml: Wk 0, 1, 2, 4, 6, 8, 10	1 log cfu/ml: Decrease to undetectable levels by Week 1 and remained throughout 10 weeks 2 log cfu/ml: <1 log decrease on Weeks 1, 2; Undetectable levels Weeks 4-10 3 log cfu/ml: 1 log decrease on Week 1; 0.25 log increase on Week 2; No change on Week 4; ≤0.5 log increase on Weeks 6, 8; 0.75 log increase on Week 10	Gedela, S., J. R. Escoubas, et al. (2007). "Effect of Inhibitory Smoke Fractions on Listeria monocytogenes during Long-Term Storage of Frankfurters." Journal of Food Protection 70(2): 386-391.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter	Antimicrobial: AM-3 liquid smoke extract Addition: Cooked, unpeeled franks dipped into solution for 30, 60 or 120 sec. + 5 min. dry time Storage: 10 weeks at 6°C	1 log cfu/ml inoculated post-peeling	4 Strain Combo: Scott A-2, V7-2, 39-2, 383-2	Weeks 0, 1, 2, 4, 6, 8, 10	30 sec dip: No change on Weeks 1, 2; <0.25 log increase on Week 4; <1 log increase on Week 6; 2 log increase on Week 8; 3 log increase on Week 10 60 sec dip: <0.5 log decrease on Week 1; No change on Weeks 2, 4; <1 log increase on Week 6; 1.5 log increase on Week 8; 2 log increase on Week 10 120 sec dip: <0.5 log increase on Weeks 1, 2, 4; 0.75 log increase on Weeks 6, 8, 10	Gedela, S., J. R. Escoubas, et al. (2007). "Effect of Inhibitory Smoke Fractions on Listeria monocytogenes during Long-Term Storage of Frankfurters." Journal of Food Protection 70(2): 386-391.
Frankfurter (~15% fat)	Antimicrobial: 2% sodium lactate Addition: Directly into formulation Final product pH: 6.13 aw: 0.936 Storage: 56 days at 4˚C	3 log cfu/g	ATCC 43256	Weeks 0, 1, 2, 3, 4, 6, 8	<1 log increase or decrease throughout 8 weeks	Choi, S. H. and K. B. Chin (2003). "Evaluation of sodium lactate as a replacement for conventional chemical preservatives in comminuted sausages inoculated with *Listeria monocytogenes*." Meat Science 65(1): 531-537.
Frankfurter (Beef)	Antimicrobial: 0.25% or 0.5% CharDex Hickory Liquid Smoke (Red Arrow) Addition: Franks immersed into liquid smoke solution Storage: 100 hours at 1˚C	4 log cfu/ml	LCDC 81-861 (4b)	Hourly	0.25%: 4 log decrease to undetectable levels in 24 hours 0.5%: 5 log decrease to undetectable levels in 4 hours	Messina, M. C., H. A. Ahmad, et al. (1988). "The effect of liquid smoke on *Listeria monocytogenes*." Journal of Food Protection 51(8): 629-631.
Frankfurter (Beef)	Antimicrobial: 0.25% or 0.5% CharSol-10 Liquid Smoke (Red Arrow) Addition: Franks immersed into liquid smoke solution Storage: 100 hours at 1˚C	4 log cfu/ml	LCDC 81-861 (4b)	Hourly	0.25%: 4 log decrease to undetectable levels in 5 hours 0.5%: 5 log decrease to undetectable levels in 4 hours	Messina, M. C., H. A. Ahmad, et al. (1988). "The effect of liquid smoke on *Listeria monocytogenes*." Journal of Food Protection 51(8): 629-631.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Beef)	Antimicrobial: 0.25% or 0.5% Aro-Smoke P-50 Liquid Smoke (Red Arrow) Addition: Franks immersed into liquid smoke solution Storage: 100 hours at 1˚C	4 log cfu/ml	LCDC 81-861 (4b)	Hourly	0.25%: 4 log decrease to undetectable levels in 5 hours 0.5%: 5 log decrease to undetectable levels in 4 hours	Messina, M. C., H. A. Ahmad, et al. (1988). "The effect of liquid smoke on *Listeria monocytogenes*." Journal of Food Protection 51(8): 629-631.
Frankfurter (Beef)	Antimicrobial: 0.25% or 0.5% CharSol PN-9 Liquid Smoke (Red Arrow) Addition: Franks immersed into liquid smoke solution Storage: 100 hours at 1˚C	4 log cfu/ml	LCDC 81-861 (4b)	Hourly	0.25%: 4 log decrease to undetectable levels in 48 hours 0.5%: 5 log decrease to undetectable levels in 24 hours	Messina, M. C., H. A. Ahmad, et al. (1988). "The effect of liquid smoke on *Listeria monocytogenes*." Journal of Food Protection 51(8): 629-631.
Frankfurter (Beef)	Antimicrobial: 0.25% or 0.5% CharOil Hickory Liquid Smoke (Red Arrow) Addition: Franks immersed into liquid smoke solution Storage: 100 hours at 1˚C	4 log cfu/ml	LCDC 81-861 (4b)	Hourly	0.25%: 4 log decrease to undetectable levels in 96 hours 0.5%: 5 log decrease to undetectable levels in 24 hours	Messina, M. C., H. A. Ahmad, et al. (1988). "The effect of liquid smoke on *Listeria monocytogenes*." Journal of Food Protection 51(8): 629-631.
Frankfurter (Beef)	Antimicrobial: 6.0% sodium lactate + 3.0% sodium diacetate Addition: Post-processed franks dipped into solution Final product pH: ~6.12 Storage: 3 weeks at 4˚C	7 log cfu/ml	LM 108M LM 101M H7776 F6854 4-Strain Combo: LM 108M, LM 101M, H7776, F6854	Weeks 0, 2, 3	LM 108M: 1 log decrease on Week 2; 2 log decrease on Week 3 LM 101M: 1.5 log decrease on Weeks 2, 3 H7776: 1 log decrease on Week 2; 1.5 log decrease on Week 3 F6854: 1 log decrease on Weeks 2, 3 4-Strain Combo: LM 108M, LM 101M, H7776, F6854: 1 log decrease on Week 2; 2 log decrease on Week 3	Uhart, M., S. Ravishankar, et al. (2004). "Control of *Listeria monocytogenes* with combined antimicrobials on beef franks stored at 4C." Journal of Food Protection 67(10): 2296-2301.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Beef)	Antimicrobial: 10% sodium lactate (in solution) Addition: Cooked frankfurters dipped into solution for 5 minutes + 10 min. air-drying Final product pH: 5.71 Storage: 28 days at 4˚C	5 log cfu/g	5 Strain Combo: LM 101M, LM 108M, H7776, F6854	Days 0, 7, 14, 28	≤0.5 log decrease throughout 28 days	Patel, J. R., G. C. Sanglay, et al. (2007). "Combining antimicrobials and hydrodynamic pressure processing for control of Listeria monocytogenes in frankfurters." Journal of Muscle Foods 18: 1-18.
Frankfurter (Beef)	Antimicrobial: 8% sodium diacetate (in solution) Addition: Cooked frankfurters dipped into solution for 5 minutes + 10 min. air-drying Final product pH: 5.55 Storage: 28 days at 4˚C	5 log cfu/g	5 Strain Combo: LM 101M, LM 108M, H7776, F6854	Days 0, 7, 14, 28	≤0.75 log decrease throughout 28 days	Patel, J. R., G. C. Sanglay, et al. (2007). "Combining antimicrobials and hydrodynamic pressure processing for control of Listeria monocytogenes in frankfurters." Journal of Muscle Foods 18: 1-18.
Frankfurter (Beef)	Antimicrobial: sodium lactate + sodium diacetate (in solution; concentrations not listed) Addition: Cooked frankfurters dipped into solution for 5 minutes + 10 min. air-drying Final product pH: 5.52 Storage: 28 days at 4˚C	5 log cfu/g	5 Strain Combo: LM 101M, LM 108M, H7776, F6854	Days 0, 7, 14, 28	≤0.75 log decrease throughout 28 days	Patel, J. R., G. C. Sanglay, et al. (2007). "Combining antimicrobials and hydrodynamic pressure processing for control of Listeria monocytogenes in frankfurters." Journal of Muscle Foods 18: 1-18.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Beef/Pork)	Antimicrobial: 2% potassium lactate Addition: Directly into formulation Final product pH: 6.27 a_w: 0.975 Storage: 12 weeks at 4.5˚C	8 cfu/ml (5 log cfu/frank)	4 Strain Combo: ATCC 15313, ATCC 51414, ATCC 43256, ATCC 49594	Weeks 0, 2, 4, 6, 8, 10, 12	0.5 log decrease on Week 2; 0.4 log increase on Week 4; 0.9 log decrease on Week 6; 2.5 log increase on Week 8; 0.9 log increase on Week 10; 2.4 log increase on Week 12	Nuñez De Gonzalez, M. T., J. T. Keeton, et al. (2004). "Effectiveness of Acidic Calcium Sulfate with Propionic and Lactic Acid and Lactates as Postprocessing Dipping Solutions To Control *Listeria monocytogenes* on Frankfurters with or without Potassium Lactate and Stored Vacuum Packaged at 4.5C." Journal of Food Protection 67: 915-921.
Frankfurter (Beef/Pork)	Antimicrobial: 2% potassium lactate Addition: Directly into formulation Antimicrobial: 2% potassium lactate Addition: Post-processing franks dipped into solution for 30 seconds and allowed to dry for 30 sec. Final product pH: 6.19 a_w: 0.971 Storage: 12 weeks at 4.5˚C	8 cfu/ml (5 log cfu/frank)	4 Strain Combo: ATCC 15313, ATCC 51414, ATCC 43256, ATCC 49594	Weeks 0, 2, 4, 6, 8, 10, 12	0.2 log decrease on Week 2; 0.9 log increase on Week 4; 2.9 log increase on Week 6; 3.5 log increase on Week 8; 4 log increase on Weeks 10, 12	Nuñez De Gonzalez, M. T., J. T. Keeton, et al. (2004). "Effectiveness of Acidic Calcium Sulfate with Propionic and Lactic Acid and Lactates as Postprocessing Dipping Solutions To Control *Listeria monocytogenes* on Frankfurters with or without Potassium Lactate and Stored Vacuum Packaged at 4.5C." Journal of Food Protection 67: 915-921.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Beef/Pork)	Antimicrobial: 2% potassium lactate Addition: Directly into formulation Antimicrobial: 3% lactic acid Addition: Post-processing franks dipped into solution for 30 seconds and allowed to dry for 30 sec. Final product pH: 6.18 a_w: 0.970 Storage: 12 weeks at 4.5˚C	8 cfu/ml (5 log cfu/frank)	4 Strain Combo: ATCC 15313, ATCC 51414, ATCC 43256, ATCC 49594	Weeks 0, 2, 4, 6, 8, 10, 12	≤0.5 log decrease on Weeks 2, 4; No change on Week 6; 1.2 log increase on Week 8; 0.9 log decrease on Week 10; 0.6 log increase on Week 12	Nuñez De Gonzalez, M. T., J. T. Keeton, et al. (2004). "Effectiveness of Acidic Calcium Sulfate with Propionic and Lactic Acid and Lactates as Postprocessing Dipping Solutions To Control *Listeria monocytogenes* on Frankfurters with or without Potassium Lactate and Stored Vacuum Packaged at 4.5C." Journal of Food Protection 67: 915-921.
Frankfurter (Beef/Pork)	Antimicrobial: 2%) potassium lactate Addition: Post-processing franks dipped into solution for 30 seconds and allowed to dry for 30 sec. Final product pH: 6.3 a_w: 0.978 Storage: 12 weeks at 4.5˚C	8 cfu/ml (5 log cfu/frank)	4 Strain Combo: ATCC 15313, ATCC 51414, ATCC 43256, ATCC 49594	Weeks 0, 2, 4, 6, 8, 10, 12	<1 log increase on Weeks 2, 4; 2 log increase on Weeks 6, 8; 2.4 log increase on Week 10; 2 log increase on Week 12	Nuñez De Gonzalez, M. T., J. T. Keeton, et al. (2004). "Effectiveness of Acidic Calcium Sulfate with Propionic and Lactic Acid and Lactates as Postprocessing Dipping Solutions To Control *Listeria monocytogenes* on Frankfurters with or without Potassium Lactate and Stored Vacuum Packaged at 4.5C." Journal of Food Protection 67: 915-921.
Frankfurter (Beef/Pork)	Antimicrobial: 3% lactic acid Addition: Post-processing franks dipped into solution for 30 seconds and allowed to dry for 30 sec. Final product pH: 6.19 a_w: 0.977 Storage: 12 weeks at 4.5˚C	8 cfu/ml (5 log cfu/frank)	4 Strain Combo: ATCC 15313, ATCC 51414, ATCC 43256, ATCC 49594	Weeks 0, 2, 4, 6, 8, 10, 12	0.2 log decrease on Week 2; 0.4 log increase on Week 4; 2.3 log increase on Weeks 6, 8; 3 log increase on Week 10; 3.6 log increase on Week 12	Nuñez De Gonzalez, M. T., J. T. Keeton, et al. (2004). "Effectiveness of Acidic Calcium Sulfate with Propionic and Lactic Acid and Lactates as Postprocessing Dipping Solutions To Control *Listeria monocytogenes* on Frankfurters with or without Potassium Lactate and Stored Vacuum Packaged at 4.5C." Journal of Food Protection 67: 915-921.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Beef/Pork/ Poultry)	Antimicrobial: 1.68% potassium lactate + 0.12% sodium diacetate Addition: Directly into formulation Storage: 8 weeks at 4˚C	7 log cfu/frank	4 Strain Combo: ATCC 15313, ATCC 51414, ATCC 43256, ATCC 74166	Weeks 0, 2, 4, 6, 8	≤0.5 log decrease throughout 8 weeks	Knight, T. D., A. Castillo, et al. (2007). "Effectiveness of Potassium Lactate and Sodium Diacetate in Combination with Irradiation to Control Listeria monocytogenes on Frankfurters." Journal of Food Science 72(1): M26-M30.
Frankfurter (Low-Fat)	Antimicrobial: lactate + diacetate (No concentrations listed) Addition: Directly into formulation Antimicrobial: Zesti-B liquid smoke extract (pH 4.2-4.4) Addition: Cooked franks dipped into solution for various times (1, 5, 15, 30, 60, or 90 sec.) + 5 min. dry time Storage: 10 weeks at 1.7°C	1 log cfu/ml	4 Strain Combo: Scott A-2, V7-2, 39-2, 383-2	Weeks 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10	10-90 sec. dipping times similarly decreased Lm; Counts decreased on Week 1 to undetectable limits and remained undetectable throughout 10 Weeks 1 or 5 sec: undetectable levels on Week 1; ≤0.5 log decrease on Weeks 2, 3; undetectable limits on Weeks 4-10	Gedela, S., J. R. Escoubas, et al. (2007). "Effect of Inhibitory Smoke Fractions on Listeria monocytogenes during Long-Term Storage of Frankfurters." Journal of Food Protection 70(2): 386-391.
Frankfurter (Low-Fat)	Antimicrobial: lactate + diacetate (No concentrations listed) Addition: Directly into formulation Antimicrobial: Zesti-B liquid smoke extract (pH 4.2-4.4) Addition: Cooked franks sprayed with pressurized spray canister immediately following peeling Storage: 10 weeks at 1.7°C	1 log cfu/ml	4 Strain Combo: Scott A-2, V7-2, 39-2, 383-2	Weeks 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10	Undetectable levels on Week 1; ≤0.5 log decrease on Weeks 2, 3; undetectable limits on Weeks 4-10	Gedela, S., J. R. Escoubas, et al. (2007). "Effect of Inhibitory Smoke Fractions on Listeria monocytogenes during Long-Term Storage of Frankfurters." Journal of Food Protection 70(2): 386-391.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate Addition: Directly into formulation Final product pH: 6.05 a_w: 0.96 Storage: 40 days at 10˚C	2 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	<1 log increase on Days 4, 8; 2 log increase on Day 12; 3 log increase on Day 20; 4 log increase on Day 28; 5 log increase on Day 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.
Frankfurter (Pork)	Antimicrobial: 0.25% sodium diacetate Addition: Directly into formulation Final product pH: 5.54 a_w: 0.96 Storage: 40 days at 10˚C	2 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	≤1 log increase on Days 4, 8, 12; 2 log increase on Day 20; 2.5 log increase on Day 28; 4.5 log increase on Day 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate + 0.25% sodium diacetate Addition: Directly into formulation Final product pH: 5.58 a_w: 0.96 Storage: 40 days at 10˚C	2 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	<0.5 log decrease or increase throughout all days	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate + 0.125% sodium diacetate Addition: Directly into formulation Final product pH: 6.0 a_w: 0.96 Storage: 40 days at 10˚C	2 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	<0.5 log increase on Days 4, 8, 12; ≤1 log increase on Days 20, 28; 1.5 log increase on Day 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Pork)	Antimicrobial: 2.5% lactic acid Addition: Post-processing franks dipped in solution for 2 min. Final product pH: 0.967 a_w: 0.96 Storage: 40 days at 10˚C	<1 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	2 log increase on Day 4; 3 log increase on Day 8; 6 log increase on Day 12; 7.5 log increase on Days 20, 28; 8 log increase on Day 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate Addition: Directly into formulation Antimicrobial: 2.5% lactic acid Addition: Post-processing franks dipped in solution for 2 min. Final product pH: 5.7 a_w: 0.96 Storage: 40 days at 10˚C	1 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	<1 log decrease on Days 4, 8, 12; 1.5 log increase on Days 20, 28, 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.
Frankfurter (Pork)	Antimicrobial: 0.25% sodium diacetate Addition: Directly into formulation Antimicrobial: 2.5% lactic acid Addition: Post-processing franks dipped in solution for 2 min. Final product pH: 5.2 a_w: 0.96 Storage: 40 days at 10˚C	1 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	<1 log decrease on Days 4, 8, 12; No change on Day 20; 1.5 log increase on Days 28, 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate + 0.25% sodium diacetate Addition: Directly into formulation Antimicrobial: 2.5% lactic acid Addition: Post-processing franks dipped in solution for 2 min. Final product pH: 5.3 a_w: 0.96 Storage: 40 days at 10˚C	1 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	≤0.5 log decrease on Days 4, 8, 12, 20; 1 log decrease on Days 28, 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate + 0.125% sodium diacetate Addition: Directly into formulation Antimicrobial: 2.5% lactic acid Addition: Post-processing franks dipped in solution for 2 min. Final product pH: 5.7 a_w: 0.96 Storage: 40 days at 10˚C	1 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	≤0.5 log decrease on Days 4, 8; 1 log decrease on Day 12; ≤0.5 log decrease on Days 20, 28; 1 log decrease on Day 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.
Frankfurter (Pork)	Antimicrobial: 2.5% acetic acid Addition: Post-processing franks dipped in solution for 2 min. Final product a_w: 0.96 Storage: 40 days at 10˚C	1 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	0.25 log increase on Day 4; 1 log increase on Day 8; 2.5 log increase on Day 12; 4.5 log increase on Day 20; 5.5 log increase on Day 28; 7 log increase on Day 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate Addition: Directly into formulation Antimicrobial: 2.5% acetic acid Addition: Post-processing franks dipped in solution for 2 min. Final product pH: 5.7 a_w: 0.96 Storage: 40 days at 10˚C	<1 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	≤0.5 log increase on Days 4, 8, 12; 1 log increase on Day 20; 1.5 log increase on Day 28; 1 log increase on Day 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.
Frankfurter (Pork)	Antimicrobial: 0.25% sodium diacetate Addition: Directly into formulation Antimicrobial: 2.5% acetic acid Addition: Post-processing franks dipped in solution for 2 min. Final product pH: 5.2 a_w: 0.96 Storage: 40 days at 10˚C	<1 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	≤0.5 log decrease on Days 4, 8, 12, 20, 28; 1 log increase on Day 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate + 0.25% sodium diacetate Addition: Directly into formulation Antimicrobial: 2.5% acetic acid Addition: Post-processing franks dipped in solution for 2 min. Final product pH: 5.3 a_w: 0.96 Storage: 40 days at 10˚C	1 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	≤1 log decrease throughout all days	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate + 0.125% sodium diacetate Addition: Directly into formulation Antimicrobial: 2.5% acetic acid Addition: Post-processing franks dipped in solution for 2 min. Final product pH: 5.7 a_w: 0.96 Storage: 40 days at 10˚C	1 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 40	≤0.5 log decrease on Days 4, 8, 12, 20; ≤1 log decrease on Days 28, 40	Barmpalia, I. M., I. Geornaras, et al. (2004). "Control of Listeria monocytogenes on Frankfurters with Antimicrobials in the Formulation and by Dipping in Organic Acid Solutions." Journal of Food Protection 67(11): 2456-2464.
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate Addition: Directly into formulation Final product pH: 6.35 a_w: 0.962 Storage: 120 days at 4˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	<0.5 log decrease on Days 10, 20, 35; 2 log increase on Day 50; 3 log increase on Days 70, 90, 120	Samelis, J., G. K. Bedie, et al. (2002). "Control of *Listeria monocytogenes* with Combined Antimicrobials after Postprocess Contamination and Extended Storage of Frankfurters at 4C in Vacuum Packages." Journal of Food Protection 65: 299-307.
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate + 0.25% sodium acetate Addition: Directly into formulation Final product pH: 6.25 a_w: 0.958 Storage: 120 days at 4˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	<1 log decrease on Days 10, 20, 35; 1.5 log decrease on Day 50; ~1 log decrease on Days 70, 90, 120	Samelis, J., G. K. Bedie, et al. (2002). "Control of *Listeria monocytogenes* with Combined Antimicrobials after Postprocess Contamination and Extended Storage of Frankfurters at 4C in Vacuum Packages." Journal of Food Protection 65: 299-307.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate + 0.25% sodium diacetate Addition: Directly into formulation Final product pH: 6.12 a_w: 0.957 Storage: 120 days at 4˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	<1 log decrease on Days 10, 20, 35; 1.5 log decrease on Day 50; 1 log decrease on Days 70, 90; 1.5 log decrease on Day 120	Samelis, J., G. K. Bedie, et al. (2002). "Control of *Listeria monocytogenes* with Combined Antimicrobials after Postprocess Contamination and Extended Storage of Frankfurters at 4C in Vacuum Packages." Journal of Food Protection 65: 299-307.
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate Addition: Directly into formulation Thermal Treatment: Vacuum-packaged product was immersed in 80˚C hot water bath for 60 seconds Final product pH: 6.18 a_w: 0.962 Storage: 120 days at 4˚C	~3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	<0.5 log decrease or increase on Days 10, 20; <1 log increase on Day 35; 1.5 log increase on Day 50; <3 log increase on Days 70, 90; 3.5 log increase on Day 120	Samelis, J., G. K. Bedie, et al. (2002). "Control of *Listeria monocytogenes* with Combined Antimicrobials after Postprocess Contamination and Extended Storage of Frankfurters at 4C in Vacuum Packages." Journal of Food Protection 65: 299-307.
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate + 0.25% sodium acetate Addition: Directly into formulation Thermal Treatment: Vacuum-packaged product was immersed in 80˚C hot water bath for 60 seconds Final product pH: 6.31 a_w: 0.958 Storage: 120 days at 4˚C	~3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	≤1 log decrease on Days 1, 10, 20, 35, 50, 70, 90; 1 log increase on Day 120	Samelis, J., G. K. Bedie, et al. (2002). "Control of *Listeria monocytogenes* with Combined Antimicrobials after Postprocess Contamination and Extended Storage of Frankfurters at 4C in Vacuum Packages." Journal of Food Protection 65: 299-307.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate + 0.25% sodium diacetate Addition: Directly into formulation Thermal Treatment: Vacuum-packaged product was immersed in 80˚C hot water bath for 60 seconds Final product pH: 6.006 a_w: 0.957 Storage: 120 days at 4˚C	~3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	<1 log decrease on Days 10, 20, 35; 1 log decrease on Day 50; 1.5 log decrease on Days 70, 90, 120	Samelis, J., G. K. Bedie, et al. (2002). "Control of *Listeria monocytogenes* with Combined Antimicrobials after Postprocess Contamination and Extended Storage of Frankfurters at 4C in Vacuum Packages." Journal of Food Protection 65: 299-307.
Frankfurter (Pork)	Antimicrobial: 0.25% sodium acetate Addition: Directly into formulation Final product pH: 6.35 a_w: 0.964 Storage: 120 days at 4˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	0.3 log decrease on Day 10; 0.5 log increase on Day 20; 2 log increase on Day 35; 3.3 log increase on Day 50; 4 log increase on Days 70, 90; 4.6 log increase on Day 120	Bedie, G. K., J. Samelis, et al. (2001). "Antimicrobials in the Formulation To Control *Listeria monocytogenes* Postprocessing Contamination on Frankfurters Stored at 4 C in Vacuum Packages." Journal of Food Protection 64: 1949-1955.
Frankfurter (Pork)	Antimicrobial: 5% sodium acetate Addition: Directly into formulation Final product pH: 63.36 a_w: 0.969 Storage: 120 days at 4˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	<1 log decrease on Days 10, 20; 0.9 log increase on Day 35; 1.6 log increase on Day 50; 2.5 log increase on Days 70, 90; 2.9 log increase on Day 120	Bedie, G. K., J. Samelis, et al. (2001). "Antimicrobials in the Formulation To Control *Listeria monocytogenes* Postprocessing Contamination on Frankfurters Stored at 4 C in Vacuum Packages." Journal of Food Protection 64: 1949-1955.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Pork)	Antimicrobial: 0.25% sodium diacetate Addition: Directly into formulation Final product pH: 6.03 a_w: 0.963 Storage: 120 days at 4˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	0.7 log decrease on Day 10; 1.1 log increase on Day 20; 1.5 log increase on Day 35; 1.2 log increase on Day 50; 2 log increase on Day 70; >2 log increase on Days 90, 120	Bedie, G. K., J. Samelis, et al. (2001). "Antimicrobials in the Formulation To Control *Listeria monocytogenes* Postprocessing Contamination on Frankfurters Stored at 4 C in Vacuum Packages." Journal of Food Protection 64: 1949-1955.
Frankfurter (Pork)	Antimicrobial: 5% sodium diacetate Addition: Directly into formulation Final product pH: 5.87 a_w: 0.962 Storage: 120 days at 4˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	1 log decrease on Day 10; <1 log decrease on Days 20, 35, 50; <2 log decrease on Days 70, 90, 120	Bedie, G. K., J. Samelis, et al. (2001). "Antimicrobials in the Formulation To Control *Listeria monocytogenes* Postprocessing Contamination on Frankfurters Stored at 4 C in Vacuum Packages." Journal of Food Protection 64: 1949-1955.
Frankfurter (Pork)	Antimicrobial: 1.8% sodium lactate Addition: Directly into formulation Final product pH: 6.23 a_w: 0.946 Storage: 120 days at 4˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	<1 log decrease on Days 10, 20, 35; <1 log increase on Days 50, 70; ~1 log increase on Days 90, 120	Bedie, G. K., J. Samelis, et al. (2001). "Antimicrobials in the Formulation To Control *Listeria monocytogenes* Postprocessing Contamination on Frankfurters Stored at 4 C in Vacuum Packages." Journal of Food Protection 64: 1949-1955.
Frankfurter (Pork)	Antimicrobial: 3.6% sodium lactate Addition: Directly into formulation Final product pH: 6.31 a_w: 0.933 Storage: 120 days at 4˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 10, 20, 35, 50, 70, 90, 120	<1 log decrease on Days 10, 20, 35, 50, 70; <1.5 log decrease on Days 90, 120	Bedie, G. K., J. Samelis, et al. (2001). "Antimicrobials in the Formulation To Control *Listeria monocytogenes* Postprocessing Contamination on Frankfurters Stored at 4 C in Vacuum Packages." Journal of Food Protection 64: 1949-1955.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Pork, 97% Fat-Free)	Antimicrobial: 1.5% potassium lactate + 0.5% sodium diacetate Addition: Directly into formulation Final product pH: 6.23 a_w: 0.948 Storage: 48 days at 10˚C	3 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 36, 48	≤0.5 log increase on Days 4, 8, 12; 1.5 log increase on Day 20; 2.5 log increase on Day 28; 3 log increase on Days 36, 48	Geornaras, I., P. N. Skandamis, et al. (2006). "Postprocess Control of *Listeria monocytogenes* on Commercial Frankfurters Formulated with and without Antimicrobials and Stored at 10C." Journal of Food Protection 69: 53-61.
Frankfurter (Pork, 97% Fat-Free)	Antimicrobial: 1.5% potassium lactate + 0.5% sodium diacetate Addition: Directly into formulation Antimicrobial: 2.5% Acetic Acid Addition: Cooked franks immersed post-inoculation in solution for 2 min. and drained for 1 min. Final product pH: 5.94 a_w: 0.95 Storage: 48 days at 10˚C	2 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 36, 48	≤0.5 log decrease or increase throughout all days	Geornaras, I., P. N. Skandamis, et al. (2006). "Postprocess Control of *Listeria monocytogenes* on Commercial Frankfurters Formulated with and without Antimicrobials and Stored at 10C." Journal of Food Protection 69: 53-61.
Frankfurter (Pork, 97% Fat-Free)	Antimicrobial: 1.5% potassium lactate + 0.5% sodium diacetate Addition: Directly into formulation Antimicrobial: 2.5% Lactic Acid Addition: Cooked franks immersed post-inoculation in solution for 2 min. and drained for 1 min. Final product pH: 5.38 a_w: 0.95 Storage: 48 days at 10˚C	2 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 36, 48	≤0.5 log decrease or increase throughout all days	Geornaras, I., P. N. Skandamis, et al. (2006). "Postprocess Control of *Listeria monocytogenes* on Commercial Frankfurters Formulated with and without Antimicrobials and Stored at 10C." Journal of Food Protection 69: 53-61.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Pork, 97% Fat-Free)	Antimicrobial: 2.5% Acetic Acid Addition: Cooked franks immersed post-inoculation in solution for 2 min. and drained for 1 min. Final product pH: 5.97 a_w: 0.97 Storage: 48 days at 10˚C	2 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 36, 48	≤0.5 log decrease or increase on Days 4, 8, 12, 20; 1 log increase on Day 28; 2 log increase on Days 36, 48	Geornaras, I., P. N. Skandamis, et al. (2006). "Postprocess Control of *Listeria monocytogenes* on Commercial Frankfurters Formulated with and without Antimicrobials and Stored at 10C." Journal of Food Protection 69: 53-61.
Frankfurter (Pork, 97% Fat-Free)	Antimicrobial: 2.5% Lactic Acid Addition: Cooked franks immersed post-inoculation in solution for 2 min. and drained for 1 min. Final product pH: 5.41 a_w: 0.97 Storage: 48 days at 10˚C	1 log cfu/cm^2	10 Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 36, 48	≤0.5 log increase on Days 4, 8; 1 log increase on Day 12; <4 log increase on Day 20; 6 log increase on Day 28; 6.5 log increase on Days 36, 48	Geornaras, I., P. N. Skandamis, et al. (2006). "Postprocess Control of *Listeria monocytogenes* on Commercial Frankfurters Formulated with and without Antimicrobials and Stored at 10C." Journal of Food Protection 69: 53-61.
Frankfurter (Pork/Beef)	Antimicrobial: 1% acetic acid Addition: Product immersed post-processing for 2 minutes Storage: 77 days at 5˚C	≤1.3 log cfu/g	7 Strain Combo: RMI, RMII, ATCC 7644, V7, Scott A, Murray B, V97	Days 7, 14, 21, 28, 35, 42, 49, 63, 77	1.5 log increase on Day 7; 2 log increase on Days 14, 21; 2.5 log increase on Day 28; 1.5 log increase on Day 35; ~2 log increase on Days 42, 49; 2.5 log increase on Days 63, 77	Palumbo, S. A. and A. C. Williams (1994). "Control of *Listeria monocytogenes* on the surface of frankfurters by acid treatments." Food Microbiology 11(4): 293-300.
Frankfurter (Pork/Beef)	Antimicrobial: 1% citric acid Addition: Product immersed post-processing for 2 minutes Storage: 77 days at 5˚C	≤1.3 log cfu/g	7 Strain Combo: RMI, RMII, ATCC 7644, V7, Scott A, Murray B, V97	Days 7, 14, 21, 28, 35, 42, 49, 63, 77	1.5-2 log increases on Days 7, 14, 21, 28; 2.5 log increase on Day 35; 3.5 log increase on Day 42; 3.25 log increase on Day 49; 3.5 log increase on Day 63; 4 log increase on Day 77	Palumbo, S. A. and A. C. Williams (1994). "Control of *Listeria monocytogenes* on the surface of frankfurters by acid treatments." Food Microbiology 11(4): 293-300.
Frankfurter (Pork/Beef)	Antimicrobial: 0.5% acetic acid + 0.5% citric acid Addition: Product immersed post-processing for 2 minutes Storage: 77 days at 5˚C	≤1.3 log cfu/g	7 Strain Combo: RMI, RMII, ATCC 7644, V7, Scott A, Murray B, V97	Days 7, 14, 21, 28, 35, 42, 49, 63, 77	~1 log increase on Days 7, 14, 21, 28; 0.5 log increase on Day 35; 1 log increase on Day 42; undetectable limits (≤1.3 log cfu/g) on Days 49, 63; 2 log increase on Day 77	Palumbo, S. A. and A. C. Williams (1994). "Control of *Listeria monocytogenes* on the surface of frankfurters by acid treatments." Food Microbiology 11(4): 293-300.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Frankfurter (Pork/Beef)	Antimicrobial: 5% acetic acid Addition: Product immersed post-processing for 2 minutes Storage: 86 days at 5˚C	3.5 log cfu/g	7 Strain Combo: RMI, RMII, ATCC 7644, V7, Scott A, Murray B, V97	Days 7, 14, 21, 28, 35, 42, 49, 56, 63, 69, 72, 79, 86	≤0.5 log decrease on Days 7, 14, 21, 28; 1 log decrease on Day 35; 0.5 log decrease on Day 42; 1 log on Day 49; 0.75 log decrease on Day 56; No change on Day 63; 1 log decrease on Day 69; 0.5 log decrease on Days 72, 79, 86	Palumbo, S. A. and A. C. Williams (1994). "Control of *Listeria monocytogenes* on the surface of frankfurters by acid treatments." Food Microbiology 11(4): 293-300.
Frankfurter (Pork/Beef)	Antimicrobial: 5% lactic acid Addition: Product immersed post-processing for 2 minutes Storage: 86 days at 5˚C	2.5 log cfu/g	7 Strain Combo: RMI, RMII, ATCC 7644, V7, Scott A, Murray B, V97	Days 7, 14, 21, 28, 35, 42, 49, 56, 63, 69, 72, 79, 86	0.25 log decrease on Day 7; undetectable limits (≤1.3 log cfu/g) on Day 14; 0.75 log decrease on Day 14; undetectable limits on Days 21, 28, 35, 42; 0.5 log decrease on Day 49; 0.25 log increase on Day 56; undetectable limits on Day 63; 0.75 log decrease on Day 69; 0.5 log increase on Day 72; undetectable limits on Days 79, 86	Palumbo, S. A. and A. C. Williams (1994). "Control of *Listeria monocytogenes* on the surface of frankfurters by acid treatments." Food Microbiology 11(4): 293-300.
Frankfurter (Pork/Beef)	Antimicrobial: 2.5% acetic acid + 2.5% citric acid Addition: Product immersed post-processing for 2 minutes Storage: 86 days at 5˚C	3 log cfu/g	7 Strain Combo: RMI, RMII, ATCC 7644, V7, Scott A, Murray B, V97	Days 7, 14, 21, 28, 35, 42, 49, 56, 63, 69, 72, 79, 86	≤0.5 log decrease on Days 7, 14; 1.5 log decrease on Day 21; undetectable limits (≤1.3 log cfu/g) on Days 28, 35; 1 log decrease on Day 42; 1.5 log decrease on Day 49; 0.5 log decrease on Day 56; undetectable limits on Days 63, 69, 72, 79, 86	Palumbo, S. A. and A. C. Williams (1994). "Control of *Listeria monocytogenes* on the surface of frankfurters by acid treatments." Food Microbiology 11(4): 293-300.
Ground Beef						
Ground Beef (Cooked)	Antimicrobial: 1.8% sodium lactate Addition: Directly into meat pre-cooking Final product pH: 5.5 Storage: 6 days at 4˚C	2 log cfu/g	9-Strain Combo: Scott A, Brie-1, V7, V37CE, LM 101M, LM 103M, F5027, F5069, LCDC 81-861	Days 0, 2, 4, 6	2 log decrease on Day 2; 1 log decrease on Day 4; 1.5 log decrease on Day 6	Harmayani, E., J. N. Sofos, et al. (1993). "Fate of *Listeria monocytogenes* in raw and cooked ground beef with meat processing additives." International Journal of Food Microbiology 18: 223-232.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Ground Beef (Cooked, 55% moisture)	Antimicrobial: 2.0% sodium lactate Addition: Directly into meat pre-cooking Final product a_w: 0.972 Storage: 7 days at 20˚C	3 log cfu/g	Scott A	Days 0, 1, 2, 3, 4, 5, 6, 7	<1 log increase on Day 1; 2.5 log increase on Day 2; 3.5 log increase on Day 3; 4.5 log increase on Day 4; 5 log increase on Days 5, 6, 7	Chen, N. and L. A. Shelef (1992). "Relationship between water activity, salts of lactic acid, and growth of *Listeria monocytogenes* in a meat model system." Journal of Food Protection 55(8): 574-578.
Ground Beef (Cooked, 55% moisture)	Antimicrobial: 3.0% sodium lactate Addition: Directly into meat pre-cooking Final product a_w: 0.968 Storage: 7 days at 20˚C	3 log cfu/g	Scott A	Days 0, 1, 2, 3, 4, 5, 6, 7	<1 log increase on Days 1, 2; 1.5 log increase on Day 3; 2 log increase on Day 4; 2.5 log increase on Day 5; ~4 log increase on Days 6, 7	Chen, N. and L. A. Shelef (1992). "Relationship between water activity, salts of lactic acid, and growth of *Listeria monocytogenes* in a meat model system." Journal of Food Protection 55(8): 574-578.
Ground Beef (Cooked, 55% moisture)	Antimicrobial: 4.0% sodium lactate Addition: Directly into meat pre-cooking Final product pH: 6.31 a_w: 0.964 Storage: 7 days at 20˚C	3 log cfu/g	Scott A	Days 0, 1, 2, 3, 4, 5, 6, 7	<0.5 log decrease throughout 7 days	Chen, N. and L. A. Shelef (1992). "Relationship between water activity, salts of lactic acid, and growth of *Listeria monocytogenes* in a meat model system." Journal of Food Protection 55(8): 574-578.
Ground Beef (Cooked, 55% moisture)	Antimicrobial: 2.0% sodium lactate + 2.0% sodium chloride Addition: Directly into meat pre-cooking Final product a_w: 0.951 Storage: 7 days at 20˚C	3 log cfu/g	Scott A	Days 0, 1, 2, 3, 4, 5, 6, 7	<0.5 decrease or increase throughout 7 days	Chen, N. and L. A. Shelef (1992). "Relationship between water activity, salts of lactic acid, and growth of *Listeria monocytogenes* in a meat model system." Journal of Food Protection 55(8): 574-578.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Ground Beef (Cooked, 55% moisture)	Antimicrobial: 3.0% sodium lactate + 2.0% sodium chloride Addition: Directly into meat pre-cooking Final product a_w: 0.947 Storage: 7 days at 20˚C	3 log cfu/g	Scott A	Days 0, 1, 2, 3, 4, 5, 6, 7	<0.5 log decrease throughout Days 0, 1, 2, 3, 4, 5, 6; 0.5 log increase on Day 7	Chen, N. and L. A. Shelef (1992). "Relationship between water activity, salts of lactic acid, and growth of *Listeria monocytogenes* in a meat model system." Journal of Food Protection 55(8): 574-578.
Liver Sausage						
Liver Sausage (Pork/Beef)	Antimicrobial: 1.8% sodium lactate Addition: Directly into formulation Final product fat content: 22% or 67% Storage: 50 days at 4˚C or 14 days at 10˚C	4 log cfu/g	Scott A	4˚C: Days 0, 50 10˚C: Days 0, 14	4˚C 22% Fat: 0.5 log decrease on Day 50 67%: 1.8 log decrease on Day 14 10˚C 22%: 4.7 log increase on Day 50 67%: 1.5 log increase on Day 14	Hu, A. C. and L. A. Shelef (1996). "Influence of Fat Content and Preservatives on the Behavior of *Listeria monocytogenes* in Beaker Sausage." Journal of Food Safety 16: 175-181.
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 2% sodium lactate Addition: Added post-processing followed by heat sterilization Final product pH: 6.12 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: <1 log increase on Days 10, 20; 1.5 log increase on Days 30, 40, 50 10˚C: 1 log increase on Day 1; 4.5 log increase on Day 3; 5 log increase on Days 5, 7, 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 3% sodium lactate Addition: Added post-processing followed by heat sterilization Final product pH: 6.06 a_w: 0.962 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: 0.5 log increase on Day 10; 1 log decrease on Day 20; 0.5 log decrease on Days 30, 40; 1 log increase on Day 50 10˚C: 0.5 log increase on Day 1; 2.5 log increase on Day 3; 4 log increase on Days 5, 7, 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 2% sodium lactate + 2% NaCl Addition: Added post-processing followed by heat sterilization Final product pH: 6.07 a_w: 0.945 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: 1 log decrease on Day 10; 0.5 log decrease on Days 20, 30, 40, 50 10˚C: <0.5 log increase on Day 1; 2 log increase on Day 3; 2.5 log increase on Day 5; 3 log increase on Day 7; 3.5 log increase on Day 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 3% sodium lactate + 1% NaCl Addition: Added post-processing followed by heat sterilization Final product pH: 6.06 a_w: 0.951 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: No change on Day 10; <1 log decrease on Days 20, 30; 1 log decrease on Day 40; 0.5 log decrease on Day 50 10˚C: <0.5 log increase on Days 1, 3; 2.5 log increase on Day 5; <3 log increase on Day 7; <3.5 log increase on Day 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 2% potassium lactate Addition: Added post-processing followed by heat sterilization Final product pH: 6.09 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: <0.5 log decrease on Days 10, 20; <1 log decrease on Day 30; <0.5 log decrease on Day 40; 0.5 log increase on Day 50 10˚C: 0.5 log increase on Day 1; 4 log increase on Day 3; 4.5 log increase on Day 5; 5 log increase on Days 7, 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 3% potassium lactate Addition: Added post-processing followed by heat sterilization Final product pH: 6.12 a_w: 0.959 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: ≤0.5 log decrease on Days 10, 20, 30, 40; <1 log decrease on Day 50 10˚C: No change on Day 1; 3 log increase on Day 3; ~4 log increase on Days 5, 7; 4.5 log increase on Day 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 2% potassium lactate + 2% NaCl Addition: Added post-processing followed by heat sterilization Final product pH: 6.07 a_w: 0.949 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: ≤0.5 log decrease on Days 10, 20; ≤1 log decrease on Days 30, 40, 50 10˚C: <0.5 log decrease on Day 1; 1 log increase on Days 3; 1.5 log increase on Day 5; 2.5 log increase on Day 7; 3.5 log increase on Day 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 3% potassium lactate + 1% NaCl Addition: Added post-processing followed by heat sterilization Final product pH: 6.08 a_w: 0.953 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: ≤0.5 log decrease on Days 10, 20; ~1 log decrease on Days 30, 40, 50 10˚C: <0.5 log decrease on Day 1; <1 log increase on Days 3, 5; 1.5 log increase on Day 7; 2.5 log increase on Day 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 2% calcium lactate Addition: Added post-processing followed by heat sterilization Final product pH: 5.56 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: ≤1 log decrease on Days 10, 20, 30; ≤1.5 log decrease on Days 40, 50 10˚C: 0.5 log increase on Day 1; 1.5 log increase on Day 3; 2 log increase on Days 5, 7; 3 log increase on Day 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 3% calcium lactate Addition: Added post-processing followed by heat sterilization Final product pH: 5.47 a_w: 0.968 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: ≤1 log decrease on Days 10, 20, 30; ≤1.5 log decrease on Days 40, 50 10˚C: ≤0.5 log decrease on Days 1, 3; <1 log decrease on Days 5, 7; 1 log decrease on Day 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 2% calcium lactate + 2% NaCl Addition: Added post-processing followed by heat sterilization Final product pH: 5.53 a_w: 0.952 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: ≤1 log decrease on Days 10, 20, 30; ≤1.5 log decrease on Days 40, 50 10˚C: 0.5 log increase on Days 1, 3; 1 log decrease on Days 5, 7, 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 3% calcium lactate + 1% NaCl Addition: Added post-processing followed by heat sterilization Final product pH: 5.50 a_w: 0.958 Storage: 50 days at 5˚C or 10 days at 20˚C	~5 log cfu/g	Scott A	5˚C: Days 0, 10, 20, 30, 40, 50 10˚C: Days 0, 1, 3, 5, 7, 10	5˚C: ≤1 log decrease on Days 10, 20, 30; ≤1.5 log decrease on Days 40, 50 10˚C: ≤0.5 log decrease on Days 1, 3, 5; 1 log decrease on Days 7, 10	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 3% sodium lactate Addition: Directly to formulation Final product pH: 6.06 a_w: 0.962 Storage: 49 days at 5˚C	~5 log cfu/g	Scott A	Days 0, 7, 14, 21, 28, 35, 42, 49	1 log decrease on Day 7; 1 log increase on Days 14, 21; ≤3.5 log increase on Days 28, 35; 2.5 log increase on Days 42, 49	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 3% potassium lactate Addition: Directly to formulation Final product pH: 6.12 a_w: 0.959 Storage: 49 days at 5˚C	~5 log cfu/g	Scott A	Days 0, 14, 21, 28, 35, 42 49	1 log increase on Days 14, 21; 3.5 log increase on Day 28; 2 log increase on Days 35, 42; 3 log increase on Day 49	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Liver Sausage (Pork/Beef) 55% moisture, 2% NaCl	Antimicrobial: 3% calcium lactate Addition: Directly to formulation Final product pH: 5.47 a_w: 0.968 Storage: 49 days at 5˚C	~5 log cfu/g	Scott A	Days 0, 7, 14, 21, 28, 35, 49	1 log decrease on Days 7, 14; 2 log decrease on Days 21, 28, 35, 49	Weaver, R. A. and L. A. Shelef (1993). "Antilisterial Activity of Sodium, Potassium or Calcium Lactate in Pork Liver Sausage." Journal of Food Safety 13: 133-146.
Pork Sausage						
Sausage (Low-Fat Pork, Contains Fat Replacer)	Antimicrobial: 1% sodium lactate Addition: Directly into formulation Fat: ~1.7% Final product pH: 6.15 a_w: 0.934 Storage: 8 weeks at 4˚C	3 log cfu/g	ATCC 43256	Weeks 0, 1, 2, 4, 6, 8	<0.25 log increase on Weeks 1, 2, 4, 6; 2.5 log increase on Week 8	Choi, S. H., K. H. Kim, et al. (2003). "Growth Suppression of Inoculated *Listeria monocytogenes* and Physiochemical and Textural Properties of Low-fat Sausages as Affected by Sodium Lactate and a Fat Replacer." Journal of Food Science 68(8): 2542-2546.
Sausage (Low-Fat Pork, Contains Fat Replacer)	Antimicrobial: 2% sodium lactate Addition: Directly into formulation Fat: ~1.7% Final product pH: 6.13 a_w: 0.932 Storage: 8 weeks at 4˚C	3 log cfu/g	ATCC 43256	Weeks 0, 1, 2, 4, 6, 8	No change on Weeks 1, 2; 0.5 log decrease on Weeks 4, 6; 1 log increase on Week 8	Choi, S. H., K. H. Kim, et al. (2003). "Growth Suppression of Inoculated *Listeria monocytogenes* and Physiochemical and Textural Properties of Low-fat Sausages as Affected by Sodium Lactate and a Fat Replacer." Journal of Food Science 68(8): 2542-2546.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Sausage (Low-Fat, Contains Fat Replacer)	Antimicrobial: 3% sodium lactate Addition: Directly into formulation Fat: ~1.7% Final product pH: 6.20 a_w: 0.930 Storage: 8 weeks at 4˚C	3 log cfu/g	ATCC 43256	Weeks 0, 1, 2, 4, 6, 8	≤0.5 log decrease on Weeks 1, 2, 4; <1 log decrease on Week 6; No change on Week 8	Choi, S. H., K. H. Kim, et al. (2003). "Growth Suppression of Inoculated *Listeria monocytogenes* and Physiochemical and Textural Properties of Low-fat Sausages as Affected by Sodium Lactate and a Fat Replacer." Journal of Food Science 68(8): 2542-2546.
Saveloy Sausage						
Saveloy Sausage (pork, cooked, cured, emulsion-type sausage)	Antimicrobial: 2.0% sodium lactate + 0.5% sodium acetate Nitrite Added: 60ppm Addition: Directly into formulation Final product pH: 6.37 Storage: 28 days at 5 and 10˚C	10 cfu/g	N/A	5˚C: Days 1, 7, 14, 28 10˚C: Days 1, 7, 14, 28	5˚C: ≤0.5 log increase or decrease throughout 28 days 10˚C: ≤0.2 log increase or decrease throughout 28 days	Juncher, D., C. S. Vestergaard, et al. (2000). "Effects of chemical hurdles on microbiological and oxidative stability of a cooked cured emulsion type meat product." Meat Science 55: 483-491.
Saveloy Sausage (pork, cooked, cured, emulsion-type sausage)	Antimicrobial: 2.0% sodium lactate + 0.5% sodium acetate Nitrite Added: 150ppm Addition: Directly into formulation Final product pH: 6.42 Storage: 28 days at 5 and 10˚C	10 cfu/g	N/A	5˚C: Days 1, 7, 14, 28 10˚C: Days 1, 7, 14, 28	5˚C: <0.5 log increase throughout 28 days 10˚C: <0.6 log increase throughout 28 days	Juncher, D., C. S. Vestergaard, et al. (2000). "Effects of chemical hurdles on microbiological and oxidative stability of a cooked cured emulsion type meat product." Meat Science 55: 483-491.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Smoked Sausage						
Smoked Sausage	Antimicrobial: 1.5% potassium lactate + 0.05% sodium diacetate Addition: Directly into formulation Final product pH: 6.02 Storage: 48 days at 10˚C	3 log cfu/cm^2	10-Strain Combo: Scott A, NA-3, NA-19, 101M, 103M, 558, PVM1, PVM2, PVM3, PVM4	Days 0, 4, 8, 12, 20, 28, 36, 48	<0.5 log increase or decrease on Days 4, 8, 12, 20; 1 log increase on Day 28; 2 log increase on Day 36; 1 log increase on Day 48 (Results based on TSBYE Inoculum)	Geornaras, I., P. N. Skandamis, et al. (2006). "Post-processing application of chemical solutions for control of *Listeria monocytogenes*, cultured under different conditions, on commercial smoked sausage formulated with and without potassium lactate-sodium diacetate." Food Microbiology 23: 672-771.
Turkey Products						
Turkey Bologna	Antimicrobial: 2.0% sodium lactate Addition: Directly into formulation Final product pH: 6.73 Storage: 98 days at 4˚C	2 log cfu/g	7-Strain Combo: Scott A (4b), Na-16 (1/2a), Na-12 (4b), #11 (1/2), #503 (1/2b), #163 (4), #65 (1)	Days 0, 7, 14, 21, 28, 35, 42, 49, 56, 63, 70, 77, 84, 91, 98	≤1 log increase for Days 7-63; <2 log increase through Day 91; ~2.5 log increase on Day 98	Wederquist, H. J., J. N. Sofos, et al. (1994). "*Listeria monocytogenes* inhibition in refrigerated vacuum packaged turkey bologna by chemical additives." Journal of Food Science 59(3): 498-500, 516.
Turkey Bologna	Antimicrobial: 0.5% sodium acetate Addition: Directly into formulation Final product pH: 6.63 Storage: 98 days at 4˚C	2 log cfu/g	7-Strain Combo: Scott A (4b), Na-16 (1/2a), Na-12 (4b), #11 (1/2), #503 (1/2b), #163 (4), #65 (1)	Days 0, 7, 14, 21, 28, 35, 42, 49, 56, 63, 70, 77, 84, 91, 98	≤1 log increase throughout Day 98	Wederquist, H. J., J. N. Sofos, et al. (1994). "*Listeria monocytogenes* inhibition in refrigerated vacuum packaged turkey bologna by chemical additives." Journal of Food Science 59(3): 498-500, 516.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Turkey Bologna	Antimicrobial: 5 g/kg sodium acetate Addition: Directly into bowl chopper Final product pH: 6.63 a_w: 0.945 Storage: 28 days at 4˚C	2 log cfu/g	7 Strain Combo: Scott A, Na-16, Na-12, #11, #503, #163, #65	Days 0, 14, 21, 28	0.5 log increase on Day 14; 1 log increase on Days 21, 28	Wederquist, H. J., J. N. Sofos, et al. (1995). "Culture Media Comparison for the Enumeration of *Listeria monocytogenes* in Refrigerated Vacuum Packaged Turkey Bologna Made with Chemical Additives." Lebensmittel-Wissenschaft und-Technologie 28(5): 455-461.
Turkey Bologna	Antimicrobial: 20 g/kg sodium lactate Addition: Directly into bowl chopper Final product pH: 6.73 a_w: 0.954 Storage: 28 days at 4˚C	2 log cfu/g	7 Strain Combo: Scott A, Na-16, Na-12, #11, #503, #163, #65	Days 0, 14, 21, 28	<0.5 log increase on Day 14; <1 log increase on Days 21, 28	Wederquist, H. J., J. N. Sofos, et al. (1995). "Culture Media Comparison for the Enumeration of *Listeria monocytogenes* in Refrigerated Vacuum Packaged Turkey Bologna Made with Chemical Additives." Lebensmittel-Wissenschaft und-Technologie 28(5): 455-461.
Turkey Breast (Cook-In-Bag)	Antimicrobial Agent: 1.54% potassium lactate + 0.11% sodium diacetate Addition: Directly into formulation Antimicrobial Process: Post-processed CIBTB subjected to 95°C water for 3 min. Final product pH: 6.51 Storage: 60 days at 4°C	5 log cfu/ml CIBTB inoculated before water bath	5 Strain Combo: Scott A, H7776, LM 101M, F6854, MFS-2	Days 0, 7, 14, 21, 28, 45, 60	1.75 log decrease after water bath (Day 0); 1.6 log decrease on Day 7; 1.2 log decrease on Day 14; 0.25 log decrease on Day 21; <0.5 log increase on Day 28; 1.4 log increase on Day 45; 2.3 log increase on Day 60	Luchansky, J. B., G. Cocoma, et al. (2006). "Hot Water Postprocess Pasteurization of Cook-in-Bag Turkey Breast Treated with and without Potassium Lactate and Sodium Diacetate and Acidified Sodium Chlorite for Control of Listeria monocytogenes." Journal of Food Protection 69(1): 39-46.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Turkey Breast (Cook-In-Bag)	Antimicrobial Agent: 1.54% potassium lactate + 0.11% sodium diacetate Addition: Directly into formulation Final product pH: 6.51 Storage: 60 days at 4°C	5 log cfu/ml CIBTB inoculated before water bath	5 Strain Combo: Scott A, H7776, LM 101M, F6854, MFS-2	Days 0, 7, 14, 21, 28, 45	<0.5 log increase on Day 7; <1.5 log increase on Days 14, 21; 2.7 log increase on Day 28; 3.4 log increase on Day 45	Luchansky, J. B., G. Cocoma, et al. (2006). "Hot Water Postprocess Pasteurization of Cook-in-Bag Turkey Breast Treated with and without Potassium Lactate and Sodium Diacetate and Acidified Sodium Chlorite for Control of Listeria monocytogenes." Journal of Food Protection 69(1): 39-46.
Turkey Breast (Uncured, RTE)	Antimicrobial: 0.1% sodium diacetate Addition: Directly into formulation Final product pH: 6.2 Storage: 7 days at 25˚C or 42 days at 4˚C Note: Research completed in slurry with 1 part turkey breast and 3 parts sterile deionized H_2O; salt concentrations adjusted to undiluted product's salt concentration	4 log cfu/ml	4 Strain Combo: Scott A, LM108M, LM103M, MF9044AP63	25˚C: Days 0, 1, 3, 5, 7 4˚C: Days 0, 7, 14, 28, 42	25˚C: 3 log increase on Day 1; 4 log increase on Days 3, 5, 7; 4˚C: 1 log increase on Day 7; 2 log increase on Day 14; 3 log increase on Day 28; 3.7 log increase on Day 42	Schlyter, J. H., K. A. Glass, et al. (1993). "The effects of diacetate with nitrite, lactate, or pediocin on the viability of *Listeria monocytogenes* in turkey slurries." International Journal of Food Microbiology 19(4): 271-281.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Turkey Breast (Uncured, RTE)	Antimicrobial: 0.3% sodium diacetate Addition: Directly into formulation Final product pH: 6.2 Storage: 7 days at 25˚C or 42 days at 4˚C Note: Research completed in slurry with 1 part turkey breast and 3 parts sterile deionized H2O; salt concentrations adjusted to undiluted product's salt concentration	4 log cfu/ml	4 Strain Combo: Scott A, LM108M, LM103M, MF9044AP63	25˚C: Days 0, 1, 3, 5, 7 4˚C: Days 0, 7, 14, 28, 42	25˚C: 0.41 log increase on Day 1; 2.5 log increase on Day 3; 4 log increase on Days 5, 7 4˚C: <0.5 log decrease on Days 7, 14; <0.75 log decrease on Days 28, 42	Schlyter, J. H., K. A. Glass, et al. (1993). "The effects of diacetate with nitrite, lactate, or pediocin on the viability of *Listeria monocytogenes* in turkey slurries." International Journal of Food Microbiology 19(4): 271-281.
Turkey Breast (Uncured, RTE)	Antimicrobial: 0.5% sodium diacetate Addition: Directly into formulation Final product pH: 6.2 Storage: 7 days at 25˚C or 42 days at 4˚C Note: Research completed in slurry with 1 part turkey breast and 3 parts sterile deionized H2O; salt concentrations adjusted to undiluted product's salt concentration	4 log cfu/ml	4 Strain Combo: Scott A, LM108M, LM103M, MF9044AP63	25˚C: Days 0, 1, 3, 5, 7 4˚C: Days 0, 7, 14, 28, 42	25˚C: ≤0.5 log decrease throughout all days 4˚C: 0.47 log decrease on Day 7; 0.6 log decrease on Days 14, 28; 1 log decrease on Day 42	Schlyter, J. H., K. A. Glass, et al. (1993). "The effects of diacetate with nitrite, lactate, or pediocin on the viability of *Listeria monocytogenes* in turkey slurries." International Journal of Food Microbiology 19(4): 271-281.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Turkey Breast (Uncured, RTE)	Antimicrobial: 2.5% sodium lactate (60% wt/wt) Addition: Directly into formulation Final product pH: 6.2 Storage: 7 days at 25˚C or 42 days at 4˚C Note: Research completed in slurry with 1 part turkey breast and 3 parts sterile deionized H2O; salt concentrations adjusted to undiluted product's salt concentration	4 log cfu/ml	4 Strain Combo: Scott A, LM108M, LM103M, MF9044AP63	25˚C: Days 0, 1, 3, 5, 7 4˚C: Days 0, 7, 14, 28, 42	25˚C: ~4 log increase on Days 1, 3, 5; 4.45 log increase on Day 7 4˚C: 1.5 log increase on Day 7; 3.25 log increase on Day 14; 4 log increase on Days 28, 42	Schlyter, J. H., K. A. Glass, et al. (1993). "The effects of diacetate with nitrite, lactate, or pediocin on the viability of *Listeria monocytogenes* in turkey slurries." International Journal of Food Microbiology 19(4): 271-281.
Turkey Breast (Uncured, RTE)	Antimicrobial: 2.5% sodium lactate (60% wt/wt) + 0.1% sodium diacetate Addition: Directly into formulation Final product pH: 6.2 Storage: 7 days at 25˚C or 42 days at 4˚C Note: Research completed in slurry with 1 part turkey breast and 3 parts sterile deionized H2O; salt concentrations adjusted to undiluted product's salt concentration	4 log cfu/ml	4 Strain Combo: Scott A, LM108M, LM103M, MF9044AP63	25˚C: Days 0, 1, 3, 5, 7 4˚C: Days 0, 7, 14, 28, 42	25˚C: 1.52 log increase on Day 1; 3.5-4 log increases on Days 3, 5, 7 4˚C: <0.5 log decrease throughout all days	Schlyter, J. H., K. A. Glass, et al. (1993). "The effects of diacetate with nitrite, lactate, or pediocin on the viability of *Listeria monocytogenes* in turkey slurries." International Journal of Food Microbiology 19(4): 271-281.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Turkey Breast (Uncured, RTE)	Antimicrobial: 2.5% sodium lactate (60% wt/wt) + 0.3% sodium diacetate Addition: Directly into formulation Final product pH: 6.2 Storage: 7 days at 25˚C or 42 days at 4˚C Note: Research completed in slurry with 1 part turkey breast and 3 parts sterile deionized H2O; salt concentrations adjusted to undiluted product's salt concentration	4 log cfu/ml	4 Strain Combo: Scott A, LM108M, LM103M, MF9044AP63	25˚C: Days 0, 1, 3, 5, 7 4˚C: Days 0, 7, 14, 28, 42	25˚C: 0.03 log increase on Day 1; ≤0.3 log decrease on Days 3, 5, 7 4˚C: ≤0.5 log decrease throughout all days	Schlyter, J. H., K. A. Glass, et al. (1993). "The effects of diacetate with nitrite, lactate, or pediocin on the viability of *Listeria monocytogenes* in turkey slurries." International Journal of Food Microbiology 19(4): 271-281.
Turkey Breast (Uncured, RTE)	Antimicrobial: 2.5% sodium lactate (60% wt/wt) + 0.5% sodium diacetate Addition: Directly into formulation Final product pH: 6.2 Storage: 7 days at 25˚C or 42 days at 4˚C Note: Research completed in slurry with 1 part turkey breast and 3 parts sterile deionized H2O; salt concentrations adjusted to undiluted product's salt concentration	4 log cfu/ml	4 Strain Combo: Scott A, LM108M, LM103M, MF9044AP63	25˚C: Days 0, 1, 3, 5, 7 4˚C: Days 0, 7, 14, 28, 42	25˚C: 0.37 log increase on Day 1; ≤0.5 log decrease on Days 3, 5, 7 4˚C: <0.5 log decrease on Days 7, 14; <1 log decrease on Days 28, 42	Schlyter, J. H., K. A. Glass, et al. (1993). "The effects of diacetate with nitrite, lactate, or pediocin on the viability of *Listeria monocytogenes* in turkey slurries." International Journal of Food Microbiology 19(4): 271-281.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Turkey Breast (Uncured, RTE)	Antimicrobial: 1.5% potassium lactate + 0.05% sodium diacetate Addition: Directly into formulation Final product pH: 6.18 Storage: Vacuum-packaged for 5 days at 4˚C followed by aerobic storage at 7˚C for 12 days	~2 log cfu/cm^2	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	Days 0, 3, 6, 9, 12 of aerobic storage	0.5 log increase on Day 3; 1 log increase on Day 6; 1.5 log increase on Day 9; 2 log increase on Day 12	Lianou, A., I. Geornaras, et al. (2007). "Behavior of *Listeria monocytogenes* at 7C in commercial turkey breast, with or without antimicrobials, after simulated contamination for manufacturing, retail and consumer settings." Food Microbiology 24: 433-443.
Turkey Breast (Uncured, RTE)	Antimicrobial: 1.5% potassium lactate + 0.05% sodium diacetate Addition: Directly into formulation Final product pH: 6.18 Storage: Vacuum-packaged for 15 days at 4˚C followed by aerobic storage at 7˚C for 12 days	2 log cfu/cm^2	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	Days 0, 3, 6, 9, 12 of aerobic storage	0.5 log increase on Day 3; 1 log increase on Day 6; 1.5 log increase on Days 9, 12	Lianou, A., I. Geornaras, et al. (2007). "Behavior of *Listeria monocytogenes* at 7C in commercial turkey breast, with or without antimicrobials, after simulated contamination for manufacturing, retail and consumer settings." Food Microbiology 24: 433-443.
Turkey Breast (Uncured, RTE)	Antimicrobial: 1.5% potassium lactate + 0.05% sodium diacetate Addition: Directly into formulation Final product pH: 6.18 Storage: Vacuum-packaged for 25 days at 4˚C followed by aerobic storage at 7˚C for 12 days	3 log cfu/g	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	Days 0, 3, 6, 9, 12 of aerobic storage	<1 log increase on Days 3, 6; ~1 log increase on Days 9, 12	Lianou, A., I. Geornaras, et al. (2007). "Behavior of *Listeria monocytogenes* at 7C in commercial turkey breast, with or without antimicrobials, after simulated contamination for manufacturing, retail and consumer settings." Food Microbiology 24: 433-443.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Turkey Breast (RTE, Uncured)	Antimicrobial: 1.5% potassium lactate + 0.05% sodium diacetate Addition: Directly into formulation Final product pH: 6.18 Storage: Vacuum-packaged for 50 days at 4˚C followed by aerobic storage at 7˚C for 12 days	5 log cfu/g	10-Strain Combo: 558, NA-1, N-7150, N1-225, N1-227, R2-500, R2-501, R2-763, R2-764, R2-765	Days 0, 3, 6, 9, 12 of aerobic storage	<0.5 log increase on Days 3, 6, 9; No change on Day 12	Lianou, A., I. Geornaras, et al. (2007). "Behavior of *Listeria monocytogenes* at 7C in commercial turkey breast, with or without antimicrobials, after simulated contamination for manufacturing, retail and consumer settings." Food Microbiology 24: 433-443.
Turkey Breast Meat (RTE, Uncured)	Antimicrobial: 0.1% sodium diacetate Addition: Diacetate added to RTE meat; studies conducted with 1 part turkey to 3 parts dH_20 forming slurry Storage: 7 days at 25˚C	3 log cfu/ml	4 Strain Combo: Scott A, LM108M, LM103M, MF9044AP63	Days 0, 1, 3, 5, 7	4 log increase throughout 7 days	Schlyter, J. H., A. J. Degnan, et al. (1993). "Evaluation of Sodium Diacetate and ALTA 2341 on Viability of *Listeria monocytogenes* in Turkey Slurries." Journal of Food Protection 56(9): 808-810.
Turkey Breast Meat (RTE, Uncured)	Antimicrobial: 0.3% sodium diacetate Addition: Diacetate added to RTE meat; studies conducted with 1 part turkey to 3 parts dH_20 forming slurry Storage: 7 days at 25˚C	3 log cfu/ml	4 Strain Combo: Scott A, LM108M, LM103M, MF9044AP63	Days 0, 1, 3, 5, 7	1 log increase on Day 1; 1.85 log increase on Day 3; 3 log increase on Days 5, 7	Schlyter, J. H., A. J. Degnan, et al. (1993). "Evaluation of Sodium Diacetate and ALTA 2341 on Viability of *Listeria monocytogenes* in Turkey Slurries." Journal of Food Protection 56(9): 808-810.
Turkey Breast Meat (RTE, Uncured)	Antimicrobial: 0.5% sodium diacetate Addition: Diacetate added to RTE meat; studies conducted with 1 part turkey to 3 parts dH_20 forming slurry Storage: 7 days at 25˚C	3 log cfu/ml	4 Strain Combo: Scott A, LM108M, LM103M, MF9044AP63	Days 0, 1, 3, 5, 7	No change on Days 1, 3; ≤0.3 log decrease on Days 5, 7	Schlyter, J. H., A. J. Degnan, et al. (1993). "Evaluation of Sodium Diacetate and ALTA 2341 on Viability of *Listeria monocytogenes* in Turkey Slurries." Journal of Food Protection 56(9): 808-810.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Turkey Deli Loaf	Antimicrobial: 3% sodium lactate NaCl: 1.5% Addition: Directly into marination (marinade tumbled with product for 1 hr.) Post marination pH: 5.84 Storage: 77 days at 4˚C	~3 log cfu/cm^2	3 Strain Combo: Scott A, ATCC 7644, Brie 1	Days 0, 7, 14, 21, 28, 35, 42, 49, 56, 63, 74	<0.5 log increase on Days 7, 14; 2 log increase on Day 21; ~1 log increase on Days 28, 35; 2 log increase on Days 42, 49, 56; 1 log increase on Day 63; 2 log increase on Day 74	Carroll, C. D., L. D. Thompson, et al. (2007). "Marination of Turkey Breast Fillets to Control the Growth of *Listeria monocytogenes* and Improve Meat Quality in Deli Loaves." Poultry science 86(1): 150-155.
Turkey Deli Loaf	Antimicrobial: 0.25% sodium diacetate NaCl: 1.5% Addition: Directly into marination (marinade tumbled with product for 1 hr.) Post marination pH: 5.98 Storage: 77 days at 4˚C	~3 log cfu/cm^2	3 Strain Combo: Scott A, ATCC 7644, Brie 1	Days 0, 7, 14, 21, 28, 35, 42, 49, 56, 63, 74	≤0.5 log decrease or increase on Days 7, 14, 21, 28; 1 log increase on Day 35; 0.5 log increase on Day 42; 2 log increase on Day 49; 0.5 log increase on Day 56; 2 log increase on Day 62; 3 log increase on Day 74	Carroll, C. D., L. D. Thompson, et al. (2007). "Marination of Turkey Breast Fillets to Control the Growth of *Listeria monocytogenes* and Improve Meat Quality in Deli Loaves." Poultry science 86(1): 150-155.
Turkey Deli Loaf	Antimicrobial: 0.75% sodium citrate NaCl: 1.5% Addition: Directly into marination (marinade tumbled with product for 1 hr.) Post marination pH: 6.02 Storage: 77 days at 4˚C	~3 log cfu/cm^2	3 Strain Combo: Scott A, ATCC 7644, Brie 1	Days 0, 7, 14, 21, 28, 35, 42, 49, 56, 63, 74	≤0.5 log decrease or increase on Days 7, 14, 21, 28; 1 log increase on Day 35; 1.5 log increase on Days 42, 49; 2 log increase on Days 56, 63; 3 log increase on Day 74	Carroll, C. D., L. D. Thompson, et al. (2007). "Marination of Turkey Breast Fillets to Control the Growth of *Listeria monocytogenes* and Improve Meat Quality in Deli Loaves." Poultry science 86(1): 150-155.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Turkey Deli Loaf	Antimicrobial: 3% sodium lactate + 0.25% sodium diacetate NaCl: 1.5% Addition: Directly into marination (marinade tumbled with product for 1 hr.) Post marination pH: 6.05 Storage: 77 days at 4˚C	~3 log cfu/cm^2	3 Strain Combo: Scott A, ATCC 7644, Brie 1	Days 0, 7, 14, 21, 28, 35, 42, 49, 56, 63, 74	≤0.5 log decrease or increase on Days 7, 14, 21; 1 log decrease on Day 28; ≤0.75 log increase or decrease on Days 35, 42, 49, 56, 63; 2 log increase on Day 74	Carroll, C. D., L. D. Thompson, et al. (2007). "Marination of Turkey Breast Fillets to Control the Growth of *Listeria monocytogenes* and Improve Meat Quality in Deli Loaves." Poultry science 86(1): 150-155.
Turkey Frankfurter	Antimicrobial: 15% sodium diacetate (wt/vol) (<0.3% sodium diacetate in final frankfurter) Addition: Cooked franks dipped in solution for 1 min, drained, dried for 5 min. Final surface pH: 4.6 Storage: 14 days at 4, 13, or 22˚C	2 log cfu/g	5 Strain Combo: H7962, H7762, H7969, H7764, H8733	Days 0, 3, 7, 10, 14	4˚C: <0.2 log increase or decrease on Days 3, 7, 10; 0.44 log decrease on Day 14 13˚C: <0.5 log increase throughout all days 22˚C: 0.5 log increase on Day 3; 1.7 log increase on Day 7; 2.6 log increase on Day 10; 3.9 log increase on Day 13	Islam, M., J. Chen, et al. (2002). "Control of *Listeria monocytogenes* on Turkey Frankfurters by Generally-Recognized-as-Safe Preservatives." Journal of Food Protection 65: 1411-1416.
Turkey Frankfurter	Antimicrobial: 20% sodium diacetate (wt/vol) (<0.3% sodium diacetate in final frankfurter) Addition: Cooked franks dipped in solution for 1 min, drained, dried for 5 min. Final surface pH: 4.6 Storage: 14 days at 4, 13, or 22˚C	2 log cfu/g	5 Strain Combo: H7962, H7762, H7969, H7764, H8733	Days 0, 3, 7, 10, 14	4˚C: <0.5 log increase or decrease throughout all days 13˚C: <0.4 log increase or decrease throughout all days 22˚C: 0.5 log increase on Day 3; 1.3 log increase on Day 7; 1.4 log increase on Day 10; 3 log increase on Day 13	Islam, M., J. Chen, et al. (2002). "Control of *Listeria monocytogenes* on Turkey Frankfurters by Generally-Recognized-as-Safe Preservatives." Journal of Food Protection 65: 1411-1416.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Turkey Frankfurter	Antimicrobial: 25% sodium diacetate (wt/vol) (<0.3% sodium diacetate in final frankfurter) Addition: Cooked franks dipped in solution for 1 min, drained, dried for 5 min. Final surface pH: 4.6 Storage: 14 days at 4, 13, or 22˚C	2 log cfu/g	5 Strain Combo: H7962, H7762, H7969, H7764, H8733	Days 0, 3, 7, 10, 14	4˚C: <0.3 log decrease throughout all days 13˚C: ≤0.5 log increase or decrease throughout all days 22˚C: ≤1 log increase on Days 3, 7; 1.3 log increase on Day 10; 2.5 log increase on Day 13	Islam, M., J. Chen, et al. (2002). "Control of *Listeria monocytogenes* on Turkey Frankfurters by Generally-Recognized-as-Safe Preservatives." Journal of Food Protection 65: 1411-1416.
Weiners						
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 3% sodium diacetate Addition: Cooked weiners immersed in solution, agitated for 2 min., and drained for 15 min. Final product pH: 6.3 Storage: 45 days at 4.5˚C	~5.8 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 1, 30, 45	No change on Day 1; ~1.8 log increase on Days 30, 45	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 3.6% sodium lactate Addition: Cooked weiners immersed in solution, agitated for 2 min., and drained for 15 min. Final product pH: 6.3 Storage: 45 days at 4.5˚C	~5.8 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 1, 30, 45	No change on Days 1, 30; 0.5 log increase on Day 45	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 3.6% sodium lactate + 3% sodium diacetate Addition: Cooked weiners immersed in solution, agitated for 2 min., and drained for 15 min. Final product pH: 6.3 Storage: 45 days at 4.5˚C	~5.8 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 1, 30, 45	<0.5 log decrease throughout 45 days	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 3.6% sodium lactate + 3% sodium diacetate Addition: Cooked weiners immersed in solution, agitated for 5 seconds, and drained for 10 seconds Final product pH: 6.3 Storage: 60 days at 4.5˚C	~5.8 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 0, 7, 14, 30, 45, 60	No change on Days 7, 14; 0.67 log increase on Day 30; 0.28 log increase on Day 45; 1.32 log increase on Day 60	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial:1.8% sodium lactate + 3% sodium diacetate Addition: Cooked weiners immersed in solution, agitated for 5 seconds, and drained for 10 seconds Final product pH: 6.3 Storage: 60 days at 4.5˚C	~5.8 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 0, 7, 14, 30, 45, 60	≤.42 log decrease or increase throughout 60 days	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 1.32% sodium lactate Addition: Directly into formulation Final product pH: 6.4 Storage: 60 days at 4.5˚C	5 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 0, 7, 14, 30, 45, 60	<0.25 log increase on Days 7, 14; 2.5 log increase on Day 30; 4.5 log increase on Day 45; >5 log increase on Day 60	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 2% sodium lactate Addition: Directly into formulation Final product pH: 6.2 Storage: 60 days at 4.5˚C	5 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 0, 7, 14, 30, 45, 60	<0.25 log decrease or increase on Days 7, 14, 30; ≤1 log increase on Days 45; 60	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 2.5% sodium lactate Addition: Directly into formulation Final product pH: 6.3 Storage: 60 days at 4.5˚C	5 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 0, 7, 14, 30, 45, 60	<0.5 log decrease or increase on Days 7, 14, 30; ≤3 log increase on Days 45, 60	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 3% sodium lactate Addition: Directly into formulation Final product pH: 6.3 Storage: 60 days at 4.5˚C	5 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 0, 7, 14, 30, 45, 60	<0.5 log decrease throughout 60 days	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 3.5% sodium lactate Addition: Directly into formulation Final product pH: 6.3 Storage: 60 days at 4.5˚C	5 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 0, 7, 14, 30, 45, 60	<0.5 log decrease throughout 60 days	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 1% sodium lactate + 0.1% sodium diacetate Addition: Directly into formulation Final product pH: 6.1 Storage: 60 days at 4.5˚C	5 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 0, 7, 14, 30, 45, 60	<0.5 log decrease throughout 60 days	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 1% sodium lactate + 0.25% sodium diacetate Addition: Directly into formulation Final product pH: 5.9 Storage: 60 days at 4.5˚C	5 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 0, 7, 14, 30, 45, 60	<0.5 log decrease throughout 60 days	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Weiners (Pork/ Turkey, Fully Cooked, Naturally Smoked)	Antimicrobial: 2% sodium lactate + 0.1% sodium diacetate Addition: Directly into formulation Final product pH: 6.2 Storage: 60 days at 4.5˚C	5 log cfu/package	5-Strain Combo: Scott A, LM101, LM 108, LM 310,V7	Days 0, 7, 14, 30, 45, 60	<0.5 log decrease throughout 60 days	Glass, K. A., D. A. Granberg, et al. (2002). "Inhibition of *Listeria monocytogenes* by Sodium Diacetate and Sodium Lactate on Wieners and Cooked Bratwurst." Journal of Food Protection 65: 116-123.
Wieners	Antimicrobial: 1.5% potassium lactate + 0.15% sodium diacetate Addition: Directly into formulation Storage: 18 weeks at 4˚C	1 log cfu/g	LCDC 861, F2399, NFPA 83, MAD 225, MAD 328	Weeks 1, 2, 4, 6, 8, 10, 12, 14, 18	<0.25 log increase or decrease throughout 18 weeks	Seman, D. L., A. C. Borger, et al. (2002). "Modeling the Growth of *Listeria monocytogenes* in Cured Ready-to-Eat Processed Meat Products by Manipulation of Sodium Chloride, Sodium Diacetate, Potassium Lactate, and Product Moisture Content." Journal of Food Protection 65: 651-658.

Potential Hazard: Growth of *L. monocytogenes*

Product	Process Parameters	Inoculation Level	*L. monocytogenes* Strain(s)	Times Sampled	Log Increase/Decrease Reported *Log changes compared to sampling start day*	Scientific Documentation
Wieners	Antimicrobial: 2.5% potassium lactate + 0.15% sodium diacetate Addition: Directly into formulation Storage: 18 weeks at 4˚C	1 log cfu/g	LCDC 861, F2399, NFPA 83, MAD 225, MAD 328	Weeks 1, 2, 4, 6, 8, 10, 12, 14, 18	<0.25 log increase or decrease on Weeks 1, 2, 4, 6, 8, 10; 2.75 log increase on Week 12; No change on Weeks 14, 18	Seman, D. L., A. C. Borger, et al. (2002). "Modeling the Growth of *Listeria monocytogenes* in Cured Ready-to-Eat Processed Meat Products by Manipulation of Sodium Chloride, Sodium Diacetate, Potassium Lactate, and Product Moisture Content." Journal of Food Protection 65: 651-658.
Heat Treated, Shelf Stable						
Beef Jerky						
Beef Jerky	Antimicrobial: 5.0% acetic acid solution Addition: Beef slices dipped into solution followed by traditional marination & drying Final product pH: 4.88 aw: 0.658 Storage: 10 hours at 60˚C (drying) followed by 60 days at 25˚C	~6 log cfu/cm^2	5-Strain Combo: LM101, LM103, N-7143, N-7144, TB2000	Hours: 0, 4, 7, 10 Days: 0, 15, 30, 60	1.5 log decrease on Hour 0; 5 log decrease on Hour 4; 6 log decrease on Hours 7, 10 and Day 0; Days 15, 30, and 60 dropped below detection limits NOTE: Log decreases reported from initial inoculation level of 6 log cfu/cm^2. Hour 0 began after inoculation, marination, and 24 hours of refrigeration. Day 0 began upon completion of drying (Hour 10). Results reported from PALCAM analysis.	Calicioglu, M., J. N. Sofos, et al. (2002). "Destruction of acid- and non-adapted *Listeria monocytogenes* during drying and storage of beef jerky." Food Microbiology 19: 545-559.
Beef Jerky	Antimicrobial: 5.0% acetic acid Addition: Beef slices dipped into solution followed by traditional marination & drying Final product pH: 4.85 a_w: 0.627 Storage: 60 days at 25˚C	5 log cfu/cm^2	5-Strain Combo: LM101, LM103, N-7143, N-7144, TB2000	Days 0, 7, 14, 28, 42, 60	4 log decrease on Day 7; 4.5 log decrease on Day 14; 6 log decrease on Days 28, 42, and 60 resulting in bacterial counts below detectable limits.	Calicioglu, M., J. N. Sofos, et al. (2003). "Influence of marinades on survival during storage of acid-adapted and nonadapted *Listeria monocytogenes* inoculated post-drying on beef jerky." International Journal of Food Microbiology 86: 283-292.