APPLIED AND ENVIRONMENTAL MICROBIOLOGY, June 1989, p. 1565–1569
0099-2240/89/061565-05$02.00/0

Vol. 55, No. 6

Fate of *Listeria monocytogenes* in Processed Meat Products during Refrigerated Storage

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Received 3 January 1989/Accepted 28 March 1989

The fate of *Listeria monocytogenes* during refrigerated storage was determined on several processed meat products, including ham, bologna, wieners, sliced chicken, sliced turkey, fermented semidried sausage, bratwurst, and cooked roast beef. The meats were surface inoculated with a five-strain mixture of ≤200 or ca. 10^5 *L. monocytogenes* cells per package, vacuum packaged, and stored at 4.4°C. Survival or growth of listeriae was determined for up to 12 weeks of storage or until the product was spoiled. The organism survived but did not grow on summer sausage, grew only slightly on cooked roast beef, grew well on some wiener products but not on others, grew well (10^3 to 10^4 CFU/g increase within 6 weeks) on ham, bologna, and bratwurst, and grew exceptionally well (10^3 to 10^5 CFU/g increase within 4 weeks) on sliced chicken and turkey. The rate of growth depended largely upon the type of product and the pH of the product. Growth was most prolific on processed poultry products. The organism generally grew well on meats near or above pH 6 and poorly or not at all on products near or below pH 5. These results indicate the importance of preventing postprocessing contamination of *L. monocytogenes* in a variety of ready-to-eat meat products.

Recent foodborne outbreaks of listeriosis (13) have prompted concern about the presence of *Listeria monocytogenes* in ready-to-eat foods. No outbreaks of listeriosis to date have been associated with eating meat or poultry products, although a recent report of a population-based case-control study of risk factors for sporadic listeriosis suggested there is an epidemiologic association between eating either uncooked hot dogs or undercooked chicken and human listeriosis (11). Wild and domestic animals have been identified as carriers of *L. monocytogenes*, and the organism can be isolated from animal feces (4, 12). A survey of muscle, lung, and spleen tissues of 514 cattle at slaughter revealed that *L. monocytogenes* was detectable in the lungs or spleen of 3% of the animals but was not isolated from muscle tissue (1).

Surveys of retail meats in France revealed that *L. monocytogenes* was present in 4 of 18 (22%) samples of ready-to-eat dry sausage and sausage meat and in 5 of 52 (9.6%) frozen chopped beef samples (9). The organism was isolated from 19 of 67 (28%) retail ground beef samples in Denmark (12). Surveys of retail, oven-ready poultry in the United Kingdom revealed that 14.7 (2) and 60% (10) of samples were contaminated with *L. monocytogenes*. Johnson et al. (5) determined that *L. monocytogenes*, when initially present at $>10^3$ CFU/g of sausage batter, can survive during the fermentation, drying, and refrigerated storage of hard salami, but at reduced levels. Similar observations were made by Glass and Doyle (3) about the fate of *L. monocytogenes* during the manufacture and refrigerated storage of pepperoni.

Little is known about the fate of the organism when it contaminates processed meats after thermal processing. The objective of this study was to determine the fate of *L. monocytogenes* on a variety of processed meat products during refrigerated storage under vacuum-packaged conditions.

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MATERIALS AND METHODS

Preparation of bacterial inocula and confirmation of *L. monocytogenes*. *L. monocytogenes*, including strains Scott A (serotype 4), V7 (serotype 1), and three sausage isolates, LM-101M (serotype 4), LM-102M (serotype 1), and LM-103M (serotype 1), were grown individually in 100 ml of tryptose broth (Difco Laboratories, Detroit, Mich.) overnight at 37°C. Cells were sedimented by centrifugation (2,000 × *g*, 30 min, 4°C) and suspended in 10 ml of 0.01 M phosphate-buffered saline solution, pH 7.2. Cells were adjusted on the basis of spectrophotometric measurement (A_{500} = 0.5; ca. 10^9 CFU/ml), further diluted to an approximately equal concentration of each isolate, and enumerated on tryptose agar (Difco) (37°C, 48 h) to verify the number of *L. monocytogenes* in the cell suspension of each isolate. An equivalent concentration of each isolate was combined to provide a five-strain mixture of *L. monocytogenes* for inoculation of products.

Isolates recovered from inoculated meats were confirmed as *L. monocytogenes* by streaking cultures onto tryptose agar and testing isolated colonies for catalase production and for the following characteristics: tumbling motility at 25°C, carbohydrate fermentation (maltose, dextrose, mannitol, xylose, rhamnose, salicin, dulcitol, and esculin), nitrate reduction, methyl red reaction, litmus milk reduction, umbrella motility at 25°C, beta-hemolysis, Gram staining, and reactivity with *Listeria* type 1 and type 4 antisera (Difco). Pathogenicity was determined by injecting (intraperitoneally) a 24-h culture of about 10^9 cells suspended in 0.01 M phosphate-buffered saline into each of five mice (ICR females, 16 to 18 g; Harlan Sprague-Dawley, Indianapolis, Ind.) and observing the mice for 7 days.

Meat products used for studies. Several processed meat products, including ham, bologna, wieners, sliced chicken, sliced turkey, fermented semidried sausage, bratwurst, and cooked roast beef, were supplied in retail packaged form by different meat processors. Products for studies were inoculated within 7 days of manufacture. Representative samples of each product were assayed for moisture, protein, fat,

TABLE 1. Fate of *L. monocytogenes* in processed meat products with a high level (ca. 10^5 *L. monocytogenes* per package) of inoculum during storage at 4.4°C (study 1)

Sample description	Sample size (g/package)	No. of *L. monocytogenes*/g				
		Day 0	Week 2	Week 4	Week 6	When spoiled
Ham 1	170	6.1×10^3	3.0×10^4	4.0×10^6	2.5×10^{7a}	
Ham 2	114	2.0×10^3	1.7×10^4	4.6×10^5	7.6×10^{6a}	
Bologna 1	341	2.0×10^2	3.6×10^3	8.8×10^4	2.8×10^{5a}	
Bologna 2	454	3.6×10^2	1.9×10^4	1.3×10^5	7.9×10^{5a}	
Sliced chicken	170	6.1×10^2	8.8×10^6	2.9×10^{8a}		
Sliced turkey 1	170	1.1×10^3	1.1×10^5	1.4×10^6	6.6×10^{4a}	
Sliced turkey 2	170	7.4×10^2	5.1×10^6	1.9×10^{8a}		
Wieners 1	227	7.9×10^2	1.5×10^2	4.7×10^3	3.0×10^5	3.7×10^7 (week 9)[a]
Wieners 2	341	1.9×10^2	8.4×10^1	3.8×10^2	8.1×10^{2a}	
Bratwurst	454	6.1×10^2	3.9×10^4	2.2×10^6	2.8×10^{6a}	
Roast beef 1	168 (avg)	3.9×10^2	1.1×10^3	3.5×10^3	3.4×10^4	6.7×10^2 (week 10)[a]
Roast beef 2	213 (avg)	3.3×10^2	6.0×10^3	1.5×10^3	4.0×10^1	7.7×10^2 (week 10)[a]
Summer sausage 1	341	1.7×10^2	1.9×10^2	5.1×10^1	7.1×10^1	2.0×10^2 (week 12)[b]
Summer sausage 2	454	1.2×10^2	2.2×10^2	3.6×10^1	7.2×10^0	1.8×10^2 (week 12)[b]

[a] Time when product was visibly spoiled and last assayed.
[b] Product was not visibly spoiled but was last assayed at week 12.

sodium chloride, residual sodium nitrite, carbohydrate, pH, and titratable acidity by the manufacturers.

Inoculation and analysis of meat products. Products were inoculated with the five-strain mixture of *L. monocytogenes* (ca. 10^5 listeriae per package for the first study and ≤200 listeriae per package for the second study) by applying a 0.5-ml (total) inoculum in about 0.1-ml portions onto different areas on the surface of each sample. Each sample was packaged individually in gas-impermeable Curlon bags (nylon-Saran-polyethylene [O_2 transmission of 0.8 to 1.0 cm^3/645 cm^2 per 24 h at 22.8°C; CO_2 transmission of 2.5 to 3.0 cm^3/645 cm^2 per 24 h at 22.5°C; H_2O transmission of 0.5 g/645 cm^2 per 24 h at 37.8°C and 90% relative humidity]; Curwood, Inc., New London, Wis.) by using a Multivac AGW vacuum packager (Sepp Haggemuller KG, Wolfertschwenden, Federal Republic of Germany) and was refrigerated (4.4°C). Samples (three per sampling time) were taken at 0, 2, 4, and 6 weeks and when the product was spoiled (determined visually [gas formation in pouch and/or turbidity in exudate]) or at 12 weeks (whichever occurred first).

Products after inoculation were assayed for *L. monocytogenes*, pH, and titratable acidity. Before inoculation with *L. monocytogenes*, three samples of each product (study 2 only) were assayed for aerobic plate count (plate count agar, 48 h at 35°C). *L. monocytogenes* counts were done on rinse material obtained after soaking and massaging the contents of each package for about 3 min in 100 ml of sterile Butterfield phosphate buffer. *L. monocytogenes* was enumerated by direct plating of serial dilutions (0.01 M phosphate-buffered saline) onto LPM agar (6) (30°C, 48 h), by a three-tube most-probable-number procedure using the USDA-FSIS enrichment procedure (7) (done with 25-, 2.5-, and 0.25-ml portions of rinse solution), or by filtering 30 to 50 ml of rinse solution through an ISO-GRID 0.45-μm membrane filter (QA Laboratories, Toronto, Canada) and incubating the filter on LPM agar. Colonies typical of *L. monocytogenes* on LPM agar were isolated from plates of the highest dilution. These isolates were confirmed as *L. monocytogenes* by the procedure described above. Each result reported is an average of three determinations and was determined on the basis of CFU per g of meat.

After being rinsed, a 10-g portion of each sample was macerated for 2 min with 90 ml of distilled, deionized water in a stomacher bag and pH was measured by using a combination electrode and a pH meter (model 140; Corning

TABLE 2. pH and titratable acidity of processed meat products inoculated with *L. monocytogenes* during storage at 4.4°C (study 1)

Sample description	pH (% titratable acidity)				
	Day 0	Week 2	Week 4	Week 6	When spoiled
Ham 1	6.45 (0.475)	6.39 (0.438)	6.26 (0.444)	5.76 (0.486)[a]	
Ham 2	6.52 (0.393)	6.43 (0.407)	5.98 (0.435)	5.13 (0.650)[a]	
Bologna 1	6.45 (0.270)	6.39 (0.249)	5.95 (0.314)	5.06 (0.372)[a]	
Bologna 2	6.09 (0.201)	6.46 (0.189)	6.20 (0.240)	6.19 (0.244)[a]	
Sliced chicken	6.39 (0.519)	6.36 (0.468)	5.99 (0.542)[a]		
Sliced turkey 1	6.52 (0.513)	6.16 (0.621)	5.54 (0.750)	4.97 (0.791)[a]	
Sliced turkey 2	6.26 (0.675)	6.34 (0.564)	5.75 (0.793)[a]		
Wieners 1	6.18 (0.237)	6.10 (0.249)	6.04 (0.225)	6.16 (0.208)	5.81 (0.232) (week 9)[a]
Wieners 2	6.04 (0.272)	6.07 (0.300)	6.09 (0.302)	5.44 (0.370)[a]	
Bratwurst	6.45 (0.239)	6.39 (0.209)	6.13 (0.259)	5.35 (0.335)[a]	
Roast beef 1	5.89 (0.422)	4.82 (0.528)	4.93 (0.570)	4.61 (0.785)	4.96 (0.799) (week 10)[a]
Roast beef 2	5.80 (0.414)	5.31 (0.518)	4.94 (0.512)	4.67 (0.739)	4.57 (0.810) (week 10)[a]
Summer sausage 1	4.86 (0.723)	5.12 (0.567)	5.06 (0.696)	5.06 (0.694)	5.00 (0.750) (week 12)[b]
Summer sausage 2	5.19 (0.729)	4.89 (0.618)	4.85 (0.696)	4.78 (0.709)	4.76 (0.761) (week 12)[b]

[a] Time when product was visibly spoiled and last assayed.
[b] Product was not visibly spoiled but was last assayed at week 12.

TABLE 3. Chemical analyses of processed meat products before inoculation with *L. monocytogenes* (study 1)[a]

Product description	Moisture (%)	Protein (%)	Fat (%)	Salt (%)	$NaNO_2$ (ppm)	Carbohydrate (%)	pH
Ham 1	73.9	17.3	3.9	3.0	28	0.4	
Ham 2	74.8	20.4	3.1	2.5	42	0.9	6.4
Bologna 1	56.5	11.6	26.5	2.3	48	3.1	6.3
Bologna 2	53.1	10.7	29.3	2.6	25	3.7	6.3
Sliced chicken	71.3	18.9	5.7	1.7	NA[b]	1.3	6.5
Sliced turkey 1	74.0	18.9	1.6	2.7	NA	1.7	6.4
Sliced turkey 2	74.0	22.6	1.3	1.4	NA	0.9	6.3
Wieners 1	54.1	10.5	29.7	2.4	31	1.5	6.2
Wieners 2	51.4	12.0	30.6	2.6	22	2.8	5.9
Bratwurst	52.8	11.8	29.1	2.3	NA	3.4	6.2
Roast beef 1	64.2	21.8	11.8	0.6	NA	0.8	5.4
Roast beef 2	68.7	25.1	4.2	1.0	NA	0.8	
Summer sausage 1	48.0	16.6	28.7	3.4	0	2.5	4.9
Summer sausage 2	47.6	17.4	28.7	3.0	3.5	0.5	4.8

[a] Data are results of analyses obtained by product manufacturers.
[b] NA, None added.

Glass Works, Corning, N.Y.). Similarly, a 25-g sample was macerated with 100 ml of hot (ca. 60°C) distilled, deionized water. The homogenate was poured into a 250-ml graduated cylinder, and the volume was brought up to 250 ml by washing out the stomacher bag several times. The mixture was allowed to cool, and the fat layer was removed before filtering it through Whatman no. 1 filter paper. Titratable acidity was determined on 100 ml of this filtrate by using 0.098 N NaOH as the titrant, and titratable activity was expressed as percent lactic acid.

RESULTS

The fate of *L. monocytogenes* on processed meats was product dependent. In study 1 (products inoculated with about 10^5 *L. monocytogenes* per package), the organism did not grow but remained at approximately constant levels on summer sausage through 12 weeks of storage (Table 1). *L. monocytogenes* grew slightly (ca. 1 $\log_{10}$ CFU/g increase) on roast beef during the first 2 weeks of storage but decreased thereafter on one processor's product (roast beef 2) and continued to increase up to 6 weeks on the other processor's product (roast beef 1). Major differences were observed in the growth of listeriae on wieners; substantial growth (>4 $\log_{10}$ CFU/g in 9 weeks) occurred on one processor's product (wieners 1), whereas relatively little growth (<1 $\log_{10}$ CFU/g) occurred on the other processor's product (wieners 2). *L. monocytogenes* grew consistently well within 6 weeks (10^3 to 10^4 CFU/g increase) on all ham, bologna, and bratwurst samples tested. The organism grew exceptionally well on chicken and turkey products, with an increase of 10^3 to 10^5 CFU/g within 4 weeks.

With the exception of wieners 2, on which relatively little growth of *L. monocytogenes* occurred at above pH 6, growth of the organism on processed meats was closely related to the pH of the product (Table 2). The organism generally grew well on meats near or above pH 6 and poorly or not at all on products near or below pH 5.

Results of the chemical analyses of processed meat products of study 1 before inoculation with *L. monocytogenes* are shown in Table 3. All values were typical of those for the products evaluated.

In general, results of growth or survival of *L. monocytogenes* on processed meats inoculated with ≤200 *L. monocytogenes* cells per package (Table 4) paralleled results of study 1, in which ca. 10^5 *L. monocytogenes* cells per package were inoculated. Interestingly, in many instances similar numbers of listeriae were present on equivalent products of both studies at the time when the products were spoiled, although substantially more listeriae were inoculated in study 1. An exception was bologna 2 of study 2, in which the pH decreased to 5.5 by 4 weeks of storage (Table 5), which apparently inhibited the growth of *L. monocytogenes*.

As was observed in study 1, growth of *L. monocytogenes* on processed meat generally correlated well with the pH of the product (Table 5). The best growth occurred when the pH was near or above 6, and little or no growth occurred near or below pH 5.

Results of aerobic plate counts and chemical analyses of processed meat products of study 2 before inoculation with *L. monocytogenes* are shown in Table 6. The aerobic plate counts of bologna 1 and roast beef 2 were slightly high, but

TABLE 4. Fate of *L. monocytogenes* in processed meat products with a low level (≤2×10^2 *L. monocytogenes* per package) of inoculum during storage at 4.4°C (study 2)

Sample description	Sample size (g/package)	No. of *L. monocytogenes*/g				
		Day 0	Week 2	Week 4	Week 6	When spoiled
Ham 1	170	3.8×10^{-1}	1.7×10^4	1.9×10^5	4.8×10^{7a}	
Ham 2	114	1.2×10^{-1}	3.4×10^3	9.4×10^5	1.6×10^5	4.3×10^7 (week 10)[a]
Bologna 1	341	1.0×10^{-2}	5.8×10^3	4.7×10^5	1.6×10^6	1.8×10^6 (week 10)[a]
Bologna 2	454	8.0×10^{-2}	8.8×10^1	6.1×10^1	1.1×10^{1a}	
Sliced chicken	170	1.0×10^0	7.9×10^5	2.2×10^{8a}		
Sliced turkey 1	170	5.0×10^{-2}	2.4×10^2	5.4×10^3	3.3×10^{3a}	
Sliced turkey 2	170	2.0×10^{-2}	6.2×10^4	5.0×10^7	2.1×10^{8a}	
Wieners 1	227	9.0×10^{-1}	2.0×10^{-2}	4.4×10^1	9.5×10^2	1.4×10^8 (week 12)[b]
Wieners 2	341	1.0×10^{-2}	8.4×10^2	2.1×10^3	4.3×10^{2a}	
Bratwurst	454	1.0×10^{-1}	1.2×10^4	1.1×10^6	8.5×10^{8a}	
Roast beef 1	344 (avg)	3.0×10^{-2}	1.0×10^{-2}	3.2×10^0	4.4×10^1	1.8×10^2 (week 8)[a]
Roast beef 2	168 (avg)	3.0×10^{-2}	2.0×10^{-4}	3.3×10^{-1}	2.0×10^0	2.0×10^{-3} (week 10)[a]
Summer sausage 1	341	2.0×10^{-2}	1.0×10^{-2}	3.0×10^{-2}	5.0×10^{-3}	4.0×10^{-3} (week 9)[a]
Summer sausage 2	227	1.0×10^{-2}	6.6×10^{-1}	2.2×10^0	1.5×10^{-1}	2.0×10^{-2} (week 11)[a]

[a] Time when product was visibly spoiled and last assayed.
[b] Product was not visibly spoiled but was last assayed at week 12.

TABLE 5. pH and titratable acidity of processed meat products inoculated with *L. monocytogenes* (≤2 × 10^2 CFU/package) during storage at 4.4°C (study 2)

Sample description	pH (% titratable acidity)				
	Day 0	Week 2	Week 4	Week 6	When spoiled
Ham 1	6.33 (0.520)	6.30 (0.506)	6.32 (0.506)	6.23 (0.491)[a]	
Ham 2	6.29 (0.412)	6.21 (0.453)	5.85 (0.522)	5.49 (0.566)	5.39 (0.576) (week 10)[a]
Bologna 1	6.24 (0.267)	5.53 (0.309)	5.95 (0.338)	6.07 (0.315)	5.09 (0.416) (week 10)[a]
Bologna 2	6.26 (0.208)	6.01 (0.309)	5.49 (0.320)	5.25 (0.322)[a]	
Sliced chicken	6.35 (0.476)	6.36 (0.509)	6.08 (0.548)[a]		
Sliced turkey 1	6.46 (0.585)	6.01 (0.604)	5.65 (0.847)	5.32 (0.973)[a]	
Sliced turkey 2	6.26 (0.620)	6.18 (0.643)	5.55 (0.708)	5.56 (0.784)[a]	
Wieners 1	5.89 (0.247)	5.88 (0.238)	5.83 (0.220)	5.86 (0.231)	554 (0.262) (week 12)[b]
Wieners 2	6.16 (0.291)	6.17 (0.313)	5.28 (0.403)	4.41 (0.532)[a]	
Bratwurst	6.48 (0.205)	6.40 (0.224)	5.85 (0.265)	5.43 (0.312)[a]	
Roast beef 1	5.79 (0.644)	5.71 (0.650)	5.12 (0.665)	4.89 (0.794)	4.87 (0.855) (week 8)[a]
Roast beef 2	5.86 (0.594)	5.30 (0.650)	5.15 (0.604)	5.08 (0.716)	5.29 (0.709) (week 10)[a]
Summer sausage 1	4.97 (0.738)	4.91 (0.745)	4.93 (0.779)	4.90 (0.806)	4.81 (0.776) (week 9)[a]
Summer sausage 2	4.77 (0.620)	4.82 (0.666)	4.73 (0.716)	4.54 (0.760)	4.62 (0.723) (week 11)[a]

[a] Time when product was visibly spoiled and last assayed.
[b] Product was not visibly spoiled but was last assayed at week 12.

in general both the microbiological and chemical results were typical of those for the products evaluated.

DISCUSSION

The results of these studies indicate that *L. monocytogenes* can grow on a variety of processed meat products at refrigeration temperature (4.4°C). The rate of growth appeared to depend largely on the type and pH of the product. Growth was most rapid on some poultry products and was slowest or inhibited on roast beef and summer sausage. Interestingly, growth of *L. monocytogenes* was substantially slower on sliced turkey product (STP) 1 than on sliced chicken or STP 2. This may be due to the higher level of sodium chloride and carbohydrate in STP 1 than in the other poultry products. The pH of STP 1 decreased more rapidly during refrigerated storage than did the pH of sliced chicken or STP 2, probably due to fermentation of available carbohydrate by lactic acid bacteria. The combined interaction of sodium chloride and acid likely contributed to slowing the growth of listeriae.

Differences also were observed in the rate of growth of *L. monocytogenes* on wieners of different meat processors. Studies by Messina et al. (8) have revealed that liquid smoke preparations that are used in manufacture of wieners have antimicrobial activity against *L. monocytogenes*. They also observed differences in the degree of antilisterial activity among different liquid smoke preparations. They suggest that this antilisterial activity may be due to phenols present in the liquid smoke preparations. Perhaps differences in the phenolic content of smoke applied to the wieners used in our studies accounted for the different growth rates of *L. monocytogenes* that were observed.

Interestingly, little or no growth of *L. monocytogenes* occurred on precooked roast beef during refrigerated storage. This was likely due to the relatively low initial pH (ca. 5.8) and the continual decrease of pH of the product during storage. Similarly, the organism did not grow on summer sausage, again apparently due to the low initial pH (4.8 to 5.2) of the product.

These results indicate the importance of preventing post-processing contamination of ready-to-eat meat products with *L. monocytogenes*. The long-held premise that refrigeration at 4 to 7°C will prevent the growth of foodborne pathogens clearly is not valid. Meat processors can no longer rely

TABLE 6. Aerobic plate count and chemical analyses of processed meat products before inoculation with *L. monocytogenes* (study 2)[a]

Product description	APC (CFU/g)	Moisture (%)	Protein (%)	Fat (%)	Salt (%)	$NaNO_2$ (ppm)	Carbohydrate (%)	pH
Ham 1	3.1 × 10^3	73.3	18.3	5.2	2.9	29	0.5	6.5
Ham 2	1.9 × 10^4	74.3	18.7	3.4	2.4	35	0.1	6.3
Bologna 1	1.3 × 10^5	54.1	11.6	28.1	2.4	57	3.0	6.2
Bologna 2	5.1 × 10^3	53.1	10.7	29.3	2.6	25	3.7	6.3
Sliced chicken	3.0 × 10^2	72.3	19.8	5.4	1.3	NA[b]	0.5	6.4
Sliced turkey 1	5.3 × 10^3	74.0	18.9	1.6	2.7	NA	1.7	6.4
Sliced turkey 2	3.5 × 10^3	73.6	22.5	0.9	1.3	NA	0.4	6.3
Wieners 1	2.3 × 10^2	52.2	10.8	32.2	2.6	30	0.5	6.0
Wieners 2	9.3 × 10^3	53.9	11.1	28.9	2.4	22	3.0	6.0
Bratwurst	2.1 × 10^4	52.8	11.8	28.9	2.3	NA	3.0	6.2
Roast beef 1	2.3 × 10^4	69.3	22.9	4.5	1.2	NA	1.2	5.6
Roast beef 2	4.2 × 10^5	65.3	21.3	10.6	1.0	NA	1.0	6.0
Summer sausage 1	8.0 × 10^1	48.0	16.6	28.7	3.4	0	2.5	4.9
Summer sausage 2	2.8 × 10^2	46.3	18.1	29.5	2.8	1.9	2.8	4.9

[a] With the exception of APC (aerobic plate count), data are results of analyses obtained by product manufacturers.
[b] NA, None added.

entirely on refrigerated storage at 4 to 7°C to be assured of pathogen control. Novel, nontraditional approaches, such as the use of antimicrobial agents, reduced-temperature (<2°C) storage, reformulation of products, or postprocessing pasteurization of products, may need to be considered for the control of *L. monocytogenes* in meats. Additionally, an effective and properly applied sanitation program should be strictly followed to prevent *L. monocytogenes* from contaminating meats after processing.

ACKNOWLEDGMENTS

This work was supported by the American Meat Institute, by the College of Agriculture and Life Sciences, University of Wisconsin-Madison, and by contributions to the Food Research Institute.

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