Journal of Food Protection, Vol. 44, No. 11, Pages 821-827 (November 1981)

Microbiological Quality of Some Delicatessen Meat Products

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(Received for publication October 27, 1980)

ABSTRACT

A total of 124 delicatessen meat products were analysed for microbiological quality shortly after purchase and following storage at 22 C for 24 h. Sixty-seven of these products were portion packages and 57 were cuts from bulk products. Coliforms, coagulase-positive staphylococci and *Clostridium perfringens* contamination was low. *Salmonella* was not detected in any of the samples. Initially, 34.3% of the portion-packed and 24.5% of bulk cuts contained more than 10^7 total aerobic plate count per g and, following storage this proportion increased to 62.7% and 57.9%, respectively. Eight samples (11.9%) of portion-packed and seven samples (12.3%) of bulk cuts contained more than 10^7 psychrotrophs per g initially. After storage, 35% of both types of products yielded $>10^7$ psychrotrophs per g. Significant levels of fecal streptococci and yeasts were also isolated from many of these products, indicating need for improvement in manufacturing procedures and retail storage conditions. However, the results of this investigation indicated that chances of a public health hazard from delicatessen meat products would be low.

Delicatessen meat products belong to the category of ready-to-eat food products which usually do not undergo further preparation or cooking treatment at the hands of the consumer. In recent years there has been an increase in consumption of delicatessen foods which are popular items with the consumer. There are no microbiological standards for prepared meat products and only a few studies have been reported on the quality of some of these products from retail outlets (*3-6,12*). Oblinger and Kennedy (*10*) have recently published the results of their investigation on selected sliced delicatessen meats.

To ensure sale and distribution of safe food products, the regulatory health authorities are constantly requesting some kind of standards or guidelines. It is difficult to formulate standards or guidelines in the absence of meaningful surveillance data. This study was undertaken to determine the microbiological quality of some delicatessen meat products as they are available to the consumers both in individual portion packs and as slices from bulk cuts.

MATERIALS AND METHODS

Collection of samples

These samples were collected at random at different times throughout the course of a year. To determine the difference between the retail packs and cuts from bulk products, samples were obtained from two kinds of sources. Retail packs were purchased from the delicatessen section of grocery stores or department stores. Bulk cuts were obtained from specialty delicatessen shops.

The samples were transported to the laboratory in insulated, iced containers. The analyses were started within 3 h of the arrival of these products in the laboratory. After removing the portion necessary for the initial analyses, the samples were stored for 24 h at 22 C to simulate possible abuse by consumers and then examined again for microbiological contaminants.

Analytical procedure

The samples were analysed for total aerobic plate count (APC), coliforms, coagulase-positive staphylococci, fecal streptococci, *Clostridium perfringens*, *Salmonella* and molds and yeasts according to procedures described in an earlier publication (*13*). Psychrotrophic bacteria were analyzed by plating samples in Plate Count Agar (Difco) and incubating the plates at 7 C for 10 days (*1*).

Moisture content was determined according to the procedure described in A.O.A.C. (*2*). A 1:3 suspension in distilled water was prepared, by blending the samples, for pH determination, using a Corning pH meter. The determinations, for pH and moisture were conducted only during the initial analysis of samples.

RESULTS AND DISCUSSION

A total of 124 samples of portion packs and bulk cuts of delicatessen meat products were analysed.

Microbiological quality of portion packed delicatessen products

The range of microbial counts in 67 portion packs of delicatessen products shortly after purchase and again following 24 h of storage at 22 C are presented in Tables 1A and 1B. On initial analysis, coliforms were not detected in any of the 67 products and only one head cheese sample showed (25,000/g) coliforms following 24 h of storage. Therefore, the coliform counts are not shown in the tables.

Twenty-three (34.3%) samples had APC of more than

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TABLE 1A. *Range of aerobic plate and psychrotrophic counts per g in portion packs of delicatessen meat products shortly after purchase and after 24 h of storage at 22 C.*

Product	No. of samples	Aerobic plate count												Psychrotrophs											
		Initial						After storage						Initial						After storage					
		<300	300-10^3	10^3-10^5	10^5-10^7	10^7-10^8	>10^8	<300	300-10^3	10^3-10^5	10^5-10^7	10^7-10^8	>10^8	<300	300-10^3	10^3-10^5	10^5-10^7	10^7-10^8	>10^8	<300	300-10^3	10^3-10^5	10^5-10^7	10^7-10^8	>10^8
Uke sausage	5	2	1	1		1			1	2		1	1	2		1	2			1		1	2		1
Cervelat	5					4	1					4	1		1		1	2	1	1			2	2	
Beer sausage	2	1					1			1			1	1				1		1					1
Garlic sausage	2			2						2						2						2			
Italian salami	5				1	4						4	1			2	3					2	1	2	
Hungarian salami	6				1	5						6		1		1	4					1	5		
Knackwurst	3	1			2					1		1	1	1			2					1	1		1
Frankfurter	6	1	1	4						2	2	2		2		3	1					1	3	1	1
Pepperoni	4				1	2	1					1	3				3	1					1	2	1
Summer sausage	8	1		4	3					1	6	1		1	1	5	1			1		2	4		
Beef salami	2				1	1						1	1				1	1							2
Bologna	5	1		2	2						1	2	2	1		2	2						2	3	
Head cheese	4	1	1		1	1		1					3	1		1	1	1		1					3
Beef luncheon	2			1	1						1		1			1		1					1		1
Corned beef	3			1	2						1		2			1	2						1		2
German salami	3				1	2					1	2		1			2			1		1	1		
Smoked sausage	2	1	1						1	1				2						2					

TABLE 1B. *Range of fecal streptococcus and yeast counts per g in portion packs of delicatessen meat products shortly after purchase and after 24 h of storage at 22 C.*

Product	No. of samples	Fecal streptococci												Yeasts									
		Initial						After storage						Initial					After storage				
		<10	10^1-10^2	10^2-10^3	10^3-10^4	10^4-10^5	>10^5	<10	10^1-10^2	10^2-10^3	10^3-10^4	10^4-10^5	>10^5	<10	10^1-10^3	10^3-10^4	10^4-10^5	>10^5	<10	10^1-10^3	10^3-10^4	10^4-10^5	>10^5
Uke sausage	5	5						4	1					3	1		1		3		1	1	
Cervelat	5			1	1	2	1			1		3	1		1	1	3		1			3	1
Beer sausage	2	2						2						2					2				
Garlic sausage	2	2						2						2					2				
Italian salami	5	2		1	2			1		2		1	1				4	1				3	2
Hungarian salami	6	1		2	3			1		4	1					1	4	1				4	2
Knackwurst	3	2		1				1	1		1			2	1				2		1		
Frankfurter	6	4	2					3	2			1		3	1	1	1		3	2	1		
Pepperoni	4	3					1	2					2	2			1	1	2				2
Summer sausage	8	5		2			1	3		2	2		1	6	1	1			4	1	2	1	
Beef salami	2	2						1	1					1	1					2			
Bologna	5	5						3		2				5					2	2		1	
Head cheese	4	3	1					2	1		1			3	1				1	2		1	
Beef luncheon	2	2						1			1			2						2			
Corned beef	3	3						1	1		1			2	1				1		1		1
German salami	3			1		2				2		1		1	1		1			2		1	
Smoked sausage	2	2						2						2					1	1			

TABLE 2. *Geometric means per g of microbial counts, moisture[1] and pH[1] in portion packs of delicatessen meat products shortly after purchase and after 24 h of storage at 22 C.*

Products	No. of samples	Moisture range	pH range	Aerobic plate count		Psychrotrophs		Fecal streptococci		Yeasts	
				Initial	After storage	Initial	After storage	Initial	After storage	Initial	After storage
Uke sausage	5	44.80-56.12	5.9-6.4	6,900	210,000	8,600	100,000	<10	<10	13	29
Cervelat	5	24.80-39.62	4.3-5.1	60,000,000	65,000,000	2,900,000	600,000	22,000	21,000	3,100	3,600
Beer sausage	2	52.26-56.85	4.5-5.1	220,000	1,300,000	59,000	170,000	<10	<10	<10	<10
Garlic sausage	2	41.90-46.01	5.7-6.2	2,900	9,100	6,900	36,000	<10	<10	<10	<10
Italian salami	5	27.41-38.09	4.7-5.1	30,000,000	40,000,000	700,000	600,000	53	910	47,000	67,000
Hungarian salami	6	23.33-28.49	4.8-4.9	32,000,000	39,000,000	290,000	1,200,000	290	230	33,000	71,000
Knackwurst	3	48.48-63.09	5.9-6.0	200,000	4,000,000	180,000	2,600,000	<10	38	<10	12
Pepperoni	4	43.47-56.64	5.9-6.1	18,000,000	210,000,000	2,200,000	26,000,000	25	490	320	540
Summer sausage	8	52.26-63.15	4.6-5.9	15,000	910,000	8,600	160,000	17	110	<10	65
Beef salami	2	61.31-63.07	5.4-5.9	4,400,000	210,000,000	3,100,000	240,000,000	<10	<10	<10	98
Bologna	5	50.92-56.95	6.0-6.5	30,000	37,000,000	29,000	21,000,000	<10	12	<10	68
Head cheese	4	63.17-66.63	5.6-6.0	42,000	5,500,000	49,000	5,600,000	<10	11	<10	100
Beef luncheon	2	53.21-58.81	6.0-6.5	400,000	21,000,000	1,000,000	42,000,000	<10	88	<10	160
Corned beef	3	63.89-74.07	5.9-6.1	1,400,000	52,000,000	1,000,000	44,000,000	<10	53	<10	730
German salami	3	30.19-41.76	4.8-4.8	16,000,000	11,000,000	49,000	6,100	6,300	660	100	530
Smoked sausage	2	51.72-54.15	6.1-6.3	<300	1,900	<300	<300	<10	<10	<10	19
Frankfurter	6	37.13-64.03	5.7-6.3	6,300	2,900,000	11,000	2,300,000	<10	22	33	21

[1]Determined at the time of initial plating.

10^7/g and three (4.5%) samples had over 10^8/g. Eight samples (11.9%) contained more than 10^7 psychrotrophs per g. Other reports have suggested even a higher proportion of samples contaminated at this level. Duitschaever (*3*) reported that 50.7% of the luncheon meats he tested had APCs of more than 10^7/g. Paradis and Stiles (*12*) reported that 59.5% of vacuum-packaged sliced bologna samples from the retail market had APCs (at 21 C) of more than 10^6/g and 28.5% of the samples had more than 10^8 APC/g.

After storage for 24 h at 22 C, generally there was an increase in APC and psychrotroph counts. Consequently, 42 samples (62.7%) yielded more than 10^7 APC and 17 (25.4%) had more than 10^8/g. Twenty-three samples (34.3%) yielded more than 10^7 psychrotrophs per g; 12 (17.9%) samples had more than 10^8/g. However, it should be noted that in some samples there was no significant increase in these groups of bacteria or actually a decrease was noticed. Some samples of cervelat, Italian salami, Hungarian salami and German salami were in this category, suggesting that the microenvironment in these products was not conducive to rapid bacterial growth.

The mean APC was highest in cervelat samples (Table 2) and was lowest in smoked sausage. APCs in garlic sausage were also low. It is noteworthy that the contaminating bacteria did not show significant multiplication on storage of these smoked sausage and garlic sausage samples. It is possible that the ingredients in these sausages were inhibitory to bacterial growth. Garlic extract has bacteriostatic activity (*7,9*) and phenolic compounds of smoke are bactericidal agents.

No coagulase-positive staphylococci were detected in any of the products except one head cheese sample which yielded 1,300 of these bacteria per g after storage at 22 C.

Both of the beef luncheon samples contained *C. perfringens* organisms in low numbers. These organisms were isolated only by enrichment procedure. All other samples were found negative for these organisms. *Salmonella* organisms were not isolated from any of these samples. Fecal streptococci were isolated from 35.8% of the samples and 13 samples (19.4%) contained more than 10^3 of these bacteria per g initially. Eighteen samples (26.9%) yielded more than 10^3 fecal streptococci per g after storage. Although three samples shortly after purchase and five samples after storage contained more than 10^5 fecal streptococci per g, the geometric mean values were low except in cervelat samples. Other workers (*3,12*) have reported even higher proportions of samples they studied, to be contaminated with these organisms. There was an appreciable reduction in number of fecal streptococci following storage of German salami samples.

The mold content of all the samples was low, and all but one cervelat sample contained less than 10^2 molds per g even after storage. However, the incidence of contamination with yeasts was high. Thirty-one (46.2%) of the samples were contaminated with yeasts initially. Three samples initially and eight samples (11.9%) following storage yielded yeasts in excess of 10^5/g. In general, the samples with high APCs contained high number of yeasts.

Microbiological quality of bulk cuts of delicatessen meat products

The range and geometric means of microbial counts in 57 bulk cuts of delicatessen meat product samples are given in Tables 3A, 3B and Table 4, respectively.

Two Italian salami, one cervelat and one corned beef sample yielded coliforms in low numbers. However, these coliforms were not *E. coli*. Following storage, nine samples yielded coliforms, and *E. coli* was isolated from one sample each of head cheese (1,000/g), bologna (10/g) and corned beef (30/g).

Seventeen samples (29.8%) contained more than 10^7 APC per g and seven of these yielded more than 10^8 per g. Following storage, 33 samples (57.9%) yielded more than 10^7 APC per g. Seven samples (12.3%) were contaminated with more than 10^7 psychrotrophs per g. However, after storage 20 samples (35.1%) yielded more than 10^7 psychrotrophs per g.

Similar to observations of portion-packed cervelat, Italian salami, Hungarian salami and German salami; most bulk cut samples of Italian salami, cervelat and smoked ham did not show a significant increase in the numbers of contaminants after 24 h of storage; some actually showed a decrease. Rapid microbial multiplication was particularly noticeable in corned beef samples, suggesting that this product provides better conditions for microbial growth. However, Italian salami, cervelat and smoked ham samples contained much larger numbers of bacterial contaminants initially (Table 4).

Coagulase-positive staphylococci were again not isolated from any of the samples except one sample of frankfurter which yielded 100 of these bacteria per g following storage.

Low numbers of *C. perfringens* organisms were isolated from one sample each of frankfurter and knackwurst. Isolations were successful only by enrichment procedures. Again no *Salmonella* were isolated from any of these samples. Eleven samples (19.3%) yielded fecal streptococci in excess of 10^3 per g while 17 samples (29.8%) contained these bacteria at this level after storage. Italian salami and cervelat samples which had high geometric mean count of fecal streptococci as well as APC, showed reduction in number of these contaminants after holding.

Mold contamination was found to be low and only one Italian salami sample shortly after purchase and two of these samples following storage yielded more than 10^3 molds/g. The amount of contamination with yeasts was relatively high and this became more predominent on holding the samples. Table 3 shows that 96.5% of the samples yielded yeast as contaminants.

TABLE 3A. *Range of aerobic plate and psychrotrophic counts per g in bulk cuts of delicatessen meat products shortly after purchase and after 24 h of storage at 22 C.*

Products	No. of samples	Aerobic plate count												Psychrotrophs											
		Initial						After storage						Initial						After storage					
		<300	300-10^3	10^3-10^5	10^5-10^7	10^7-10^8	>10^8	<300	300-10^3	10^3-10^5	10^5-10^7	10^7-10^8	>10^8	<300	300-10^3	10^3-10^5	10^5-10^7	10^7-10^8	>10^8	<300	300-10^3	10^3-10^5	10^5-10^7	10^7-10^8	>10^8
Head cheese	6			3	3						2	2	2	1		3	2						3	1	2
Bologna	6			4	2						2	3	1			3	3						2	3	1
Uke sausage	2			1	1						2					2							2		
Pepperoni	6			6						4	2				2	4						2	3	1	
Summer sausage	4			2	2						1	3				4						2	2		
Italiam salami	6					2	4					3	3	1			5			1		1	3	1	
Cervelat	6					4	2					4	2				3	3					3	3	
Corned beef	5			1	2	1	1						5				2	2	1						5
Frankfurter	5			5						1	3	1		1	1	2	1					1	3		1
Garlic sausage	3			2	1						2	1		2		1				1			1	1	
Smoked ham	3					3					1	2				1	1	1					2	1	
Knackwurst	5			4	1					1	3	1			1	4						1	4		

TABLE 3B. *Range of fecal streptococcus and yeast counts per g in bulk cuts of delicatessen meat products shortly after purchase and after 24 h of storage at 22 C.*

Product	No. of samples	Fecal streptococci												Yeasts											
		Initial						After storage						Initial						After storage					
		<10	10^1-10^2	10^2-10^3	10^3-10^4	10^4-10^5	>10^5	<10	10^1-10^2	10^2-10^3	10^3-10^4	10^4-10^5	>10^5	<10	10^1-10^3	10^3-10^4	10^4-10^5	>10^5	<10	10^1-10^3	10^3-10^4	10^4-10^5	>10^5
Head cheese	6	3	1	1	1			2	1	2		1		2	2	2			1	1		3	1
Bologna	6	5		1				1		3	1	1		1	4	1				1	2	2	1
Uke sausage	2	2						2						2						2			
Pepperoni	6	6						6							5	1			1	1	2	2	
Summer sausage	4	3		1				3		1					2	1	1				2	2	
Ifalian sausage	6		1	1	3	1			2		3	1			2		3	1			2	2	2
Cervelat	6			1	1	3	1		1		1	2	2	1	2	2	1			3	1	1	1
Corned beef	5	2	1	2				1		1	3				1		1	3				1	4
Frankfurter	5	5						4	1					4	1					4		1	
Garlic sausage	3	3						2		1				2		1				1		2	
Smoked ham	3		2	1					1	2					3					1	1	1	
Knackwurst	5	3		1		1		1	1	1	1	1		1	4					3	1	1	

TABLE 4. *Geometric means per g of microbial counts, moisture[1] and pH[1] in bulk cuts of delicatessen meat products shortly after purchase and after 24 h of storage at 22 C.*

Products	No. of samples	Moisture range	pH range	Aerobic plate count		Psychrotrophs		Fecal streptococci		Yeasts	
				Initial	After storage	Initial	After storage	Initial	After storage	Initial	After storage
Head cheese	6	57.24-76.38	5.1-6.5	24,000	12,000,000	16,000	7,600,000	13	54	71	5,800
Bologna	6	56.26-63.68	5.6-6.2	64,000	16,000,000	100,000	16,000,000	<10	340	120	6,900
Uke sausage	2	53.57-53.91	5.8-6.2	100,000	180,000	11,000	120,000	<10	<10	<10	150
Pepperoni	6	29.66-59.26	5.8-6.0	20,000	150,000	7,400	110,000	<10	<10	61	810
Summer sausage	4	50.67-68.47	4.9-5.8	52,000	1,800,000	21,000	400,000	<10	<10	1,000	8,500
Italian salami	6	28.52-43.12	4.7-5.1	110,000,000	83,000,000	120,000	250,000	1,800	990	5,200	48,000
Cervelat	6	34.85-46.17	4.1-5.1	67,000,000	60,000,000	5,300,000	5,700,000	20,000	15,000	450	1,500
Corned beef	5	56.16-74.26	5.9-6.7	3,600,000	400,000,000	7,100,000	760,000,000	12	430	4,600	470,000
Frankfurter	5	54.06-61.88	5.5-6.2	21,000	450,000	3,000	310,000	<10	<10	<10	360
Garlic sausage	3	50.36-67.90	5.8-6.0	64,000	1,100,000	430	83,000	<10	<10	13	2,900
Smoked ham	3	39.27-62.91	5.4-5.8	32,000,000	6,600,000	2,300,000	1,000,000	29	170	100	2,600
Knackwurst	5	38.73-62.02	5.6-6.0	16,000	1,000,000	5,000	1,400,000	22	180	25	1,300

[1]Determined at the time of initial plating.

Moisture and pH

There was no relation apparent between the moisture content of the samples and microbiological quality (Tables 2 and 4). Similarly, pH did not seem to influence the quality of the products since low pH was not always reflected in low counts of the products. Pace (*11*) also reported that pH values did not influence the microbial content of delicatessen salads. However, generally samples with low pH values of close to 5.0 did not show significant bacterial multiplication on storage.

Delicatessen salads have often been incriminated as vehicles in food-poisoning outbreaks, and Pace (*11*), based on his study of the quality of these products, concluded that bacteriological standards are needed from health hazard, consumer quality and producer quality aspects. Some states in the U.S. have introduced microbial guidelines for delicatessen foods (*14*).

The results reported here suggest that although certain groups of microflora multiplied on temperature abuse of the product during storage for 24 h, foodborne illness-producing bacteria were not encountered as the problem. When present in the products, their numbers were low; temperature abuse of the products did not cause a significant increase in numbers present. The data obtained here indicate that unless grossly abused, the delicatessen products are not likely to be a major public health problem. Similar conclusions were drawn by Paradis and Stiles (*12*), who found that incidence of contamination of vacuum-packaged bologna with potential pathogens was low. Oblinger and Kennedy (*10*) derived similar conclusions from their study on sliced delicatessen meat products. However, the samples found contaminated with coagulase-positive staphylococci or *C. perfringens* had potential to be hazardous if handled with negligence.

Significant contamination from fecal streptococci and yeasts suggests that sanitary conditions during the manufacturing of these products need to be improved. Duitschaever (*3*) found that microbiological quality of luncheon meats from retail markets showed wide variation and manufacturing conditions were major contributing factors. Kempton and Bobier (*8*) also found that improved sanitary practices improved the bacteriological quality of luncheon meats. Somewhat similar conclusions were drawn by Fruin et al. (*5*). However, Duitschaever (*3*) pointed out that there was wide-spread temperature abuse at the hands of the retailer and 85% of the samples had internal temperature between 10 and 14 C at the time of purchase. How much contribution did the storage conditions in retail stores make towards the microbial content of the products is not clear from this investigation. If the suggested level of 10^5 APC/g is taken as the guideline for accepting the samples (*14*), 58% of retail packages and 50% of bulk cuts would have to be rejected. Undoubtedly, both manufacturing and subsequent handling conditions would have to be improved to reduce the microbial count to an acceptable level for these ready-to-eat products.

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were detected by the screening procedure in all but a small percentage of samples. The screening procedure greatly decreases analytical time, equipment, glassware and buffers. The use of the single test organism and disposable swabs decrease the possibility of cross-contamination occurring from laboratory manipulations.

The screening procedure detected antimicrobial activity when reference procedures were negative in approximately 9% of all cases. Since all positive screening samples are repeated by reference procedures, this level of over sensitivity is not objectionable. This increased sensitivity appears to be due to the use of undiluted tissue fluids and increasing the sensitivity of the *B. subtilis* bioassay by thinning the spore lawn, removal of glucose from the base and seed agars, and reducing the incubation temperature. Although these procedures have increased the sensitivity of *B. subtilis* to antibiotics, our experience of 11 missed positives and the probable cause of this indicates that standardization of all aspects of preparing the test plates and conducting of the test itself is essential.

The screening procedure is now routinely used in examining meat and poultry tissues for antibiotic residues. Its use has allowed us to test more samples with no increase in employees. The simplicity of the test makes it adaptable to use in the field. We evaluated the test in-plant and confirmed its efficacy. The test is now used routinely by federal and state inspectors at selected slaughterhouses throughout the United States. Through these efforts we expect to further reduce the incidence of meat and poultry containing illegal levels of antibiotic residues from entering the food chain.

ACKNOWLEDGMENT

The authors wish to thank June Swann and Sande Nickerson for their competent technical assistance.

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