

# THE MICROBIOLOGY OF SELF-SERVICE, PREPACKAGED, FRESH PORK SAUSAGE<sup>1</sup>

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## SUMMARY

Ten different brands of self-service, prepackaged shipped-in fresh pork sausage (227 packages) were purchased during 22 months from 4 large volume stores. Bacterial counts at purchase ranged from 10,000 to 180 million per g. Samples taken from packages and stored at 3 to 7.5 C. for 3 to 7 days showed a wide range of bacterial populations, varying from fewer than 100,000 to more than 2 billion per g. Microbacteria and lactobacilli dominated the flora in the majority of packages of wrapped-roll sausages; conversely, *Pseudomonas-Achromobacter* types dominated in most of the skinless link type sausages.

This study is concerned with the numbers and kinds of microorganisms and their possible effect on the quality of numerous brands of prepackaged fresh pork sausage available in retail markets. Ingredients vary in different brands of sausage from highly spiced to mildly spiced. Prices also cover a wide range.

Cavett (1) concluded that vacuum sealed bacon with a sodium chloride content of 5 to 7% in the aqueous phase spoiled in about 15 days with a sour odor when stored at 20 C, probably due to the combined activities of micrococci and lactic acid bacteria.

Deibel, Niven, and Wilson (2) found that lactobacilli dominated the flora of processed sausage. Pseudomonads and other gram negative rods were present in small numbers, but were not cultured from finished products.

Dyett and Shelly (3) reported that British sausage containing 65% fresh pork wrapped in cellulose film yielded a plate count of  $10^8$  organisms per g in three to four days at 22 C when a sulphite preservative was added. Approximately the same count was obtained in sausage without a preservative stored three to four days at 3 to 5 C.

Halleck, Ball, and Stier (4) reported that fresh, ground fat pork with an initial count of 65,000 bacteria per g, then packaged in cans and stored at 1 to 3.5 C had a bacterial count of 1.4 million per g after 14 days. Then *Pseudomonas-Achromobacter* types out-numbered the lactobacilli 7 to 1.

In a similar experiment ground fat pork with an initial count of 130 per g was stored 14 days at 4.5 to 6.5 C. The bacterial count after this holding

period was 19 million per g, mainly *Pseudomonas-Achromobacter* types.

Miller (5) found 1.5 million Gram-negative psychrophilic bacteria per g in unseasoned ground pork prepared from a carcass stored 10 days at 1 C; they decreased to 40,000 per g in 10 months at -17.8 to -22 C.

Miller (6) observed that a species of *Microbacterium* almost invariably dominated the flora of square slices of self-service, prepackaged cooked ham that soured when stored 3 to 7 days at 4 to 8 C.

Sulzbacher (7) reported that counts of lipase forming organisms increased in fresh pork sausage stored at -3.9 C when the samples were protected from desiccation; this was thought to be significant because of rancidity in frozen pork.

Sulzbacher and McLean (8) observed that *Pseudomonas*, *Alcaligenes*, and *Achromobacter* comprised approximately 30% of the flora of fresh pork sausage. They noted, however, that species of *Microbacterium* made up a rather large proportion of the flora of fresh pork sausage stored at home refrigerator temperatures (5 to 8 C). They reasoned that these microbacteria may have contributed to the acid flavor of the samples.

Turner and Campbell (9) examined more than 300 packages of smoked sausage and sliced cured ham. Bacterial numbers varied widely between replicate samples of one code-date from each packer, suggesting the need for extensive replicating of samples for reliable estimates of bacterial numbers in a product. They suggested that processing methods for sliced cooked ham are not adequate to provide reasonable storage life under normal retail conditions. They recommended use of a code-dating system for consumers.

## EXPERIMENTAL PROCEDURE

Ten brands of self-service, prepackaged fresh pork sausages were purchased at weekly intervals for 22 months from 4 large volume stores in Riley County, Kansas. The sausages were not packaged at the retail stores. Sausage processed and wrapped at the store was not included in these studies, since it was felt that this would be less representative than a product packaged at a central plant and distributed to

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TABLE 1. MICROBIAL POPULATIONS OF PACKAGED FRESH PORK SAUSAGE (ROLLS) SOON AFTER PURCHASE, AND AFTER STORING AT 3 TO 7.5 C FOR 3 TO 7 DAYS

Brands of sausage	Number of packages	Initial counts	Approximate numbers of microorganisms per g			
			Time and temperature of storage (portions of opened packages)			
			3 to 4 days at:		7 days at:	
		3 to 4 C	7 to 7.5 C	3 to 4 C	7 to 7.5 C	
A Highly seasoned	11	10T-540T MD. = 90T	30T-4.8M MD. = 290T	60T-30M MD. = 1.4M	200T-100M MD. = 10M	17M-400M MD. = 95M
A Mildly seasoned	11	10T-150T MD. = 50T	10T-800T MD. = 180T	70T-7M MD. = 720T	20T-20M MD. = 2.6M	23M-150M MD. = 100M
B Highly seasoned	17	3T-60M MD. = 4.5M	4T-800M MD. = 15M	36T-700M MD. = 29M	40T-400M MD. = 52M	340T-1B MD. = 130M
B Mildly seasoned	24	6T-65M MD. = 145T	20T-400M MD. = 900T	20T-800M MD. = 5.5M	250T-400M MD. = 20M	650T-1.2B MD. = 65M

T = Thousand; M = Million; B = Billion; MD = Median

many stores.

Seven brands of sausage were packaged in 1-lb rolls, with an occasional 2-lb roll; 3 brands were boxed as "skinless link" type fresh sausages. Within 15 min after purchase the packages were placed at 3 to 4 C and initial microbiological analyses were made on each package within 5 hr.

Four portions from each package were removed and re-wrapped in "saran wrap." Two of the portions were placed at 3 to 4 C, and 2 at 7 to 7.5 C. After 3 to 4 days 1 sample from each of the 2 temperature ranges was removed and analyzed; the 2 remaining samples were held 7 days before analysis.

Appropriate dilutions in 0.15% peptone water were made starting with 10 g of sausage. The first 1 in 10 dilution was shaken 5 min on a Kahn type shaker; further dilutions from the liquid phase were shaken 25 times by hand. Eugonagar was the medium used, and plates were incubated 3 to 4 days at 23 C.

#### RESULTS AND DISCUSSION

Initial microbial counts made within 5 hr after purchase on 2 brands (A and B, Table 1) of higher priced fresh pork sausage (63 packages) ranged from 10,000 to 65 million per g with medians of 50,000 to 4.5 million.

Initial counts on 66 packages (brands C, D, E, F, and G, Table 2) of fresh pork sausage, cheaper than brands A and B, varied from 10,000 to 180 million with medians ranging from 4.5 million to 44 million per g.

Median counts on highly seasoned sausage in

brands A and B (Table 1) and brand D (Table 2) were generally higher than corresponding median counts on mildly seasoned packages sold under the same brand.

Abnormal odors (sour or otherwise) were observed oftener in samples from brands C, D, and H (Tables 2, 3), especially after 3 to 7 days storage at 3 to 7.5 C. Brands C, D, and H yielded higher initial median counts, and higher counts on samples stored at refrigerator temperatures 3 to 7 days, than did brands A, B, E, F, G, and I.

Representatives of several genera of microorganisms were cultured from the different brands. Catalase negative lactic acid bacteria and catalase positive microbacteria were found most commonly in wrapped rolls. Colonies of *Pseudomonas-Achromobacter* types were observed, especially in brands B, C, and D, and dominated the flora in several samples. Pinpoint colonies were seen in a few samples, and dominated the flora occasionally; they usually occurred along with *Pseudomonas-Achromobacter* types.

The microbiology of brands H, I, and J (skinless link sausage) differed considerably from that of the wrapped roll brands. *Pseudomonas-Achromobacter* types dominated the flora in 75% of brands I and J, and in 33% of brand H. Conversely, microbacteria and lactobacilli dominated the flora in the majority of packages of rolls.

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TABLE 2. MICROBIAL POPULATIONS OF PACKAGED FRESH PORK SAUSAGE (ROLLS) SOON AFTER PURCHASE, AND AFTER STORING AT 3 TO 7.5 C FOR 3 TO 7 DAYS

	Number of packages	Initial counts	Approximate numbers of microorganisms per g			
			Time and temperature of storage (portions of opened packages)			
			3 to 4 days at:		7 days at:	
		3 to 4 C	7 to 7.5 C	3 to 4 C	7 to 7.5 C	
C	19	260T-120M MD. = 10M	4M-600M MD. = 38.5M	3M-650M MD. = 104M	6.5M-1B MD. = 94M	60M-2B MD. = 300M
D Highly seasoned	12	110T-180M MD. = 44M	6.5M-600M MD. = 92M	8M-2B MD. = 500M	54M-1.3B MD. = 330M	50M-3B MD. = 900M
D Mildly seasoned	16	200T-100M MD. = 32.5M	10M-380M MD. = 71M	18M-900M MD. = 160M	17M-900M MD. = 150M	75M-1.3B MD. = 400M
Miscellaneous brands E, F, G	19	10T-40M MD. = 4.5M	5M-136M MD. = 45.5 M	7½M-208M MD. = 58M	13M-325M MD. = 96M	50M-450M MD. = 170M

T = Thousand; M = Million; B = Billion; MD = Median

TABLE 3. MICROBIAL POPULATIONS OF FRESH PORK SAUSAGE (SKINLESS LINKS) SOON AFTER PURCHASE, AND AFTER STORING AT 3 TO 7.5 C FOR 3 TO 7 DAYS

Brands of sausage	Number of packages	Initial counts	Approximate numbers of microorganisms per g			
			Time and temperature of storage (portions of opened packages)			
			3 to 4 days at:		7 days at:	
		3 to 4 C	7 to 7.5 C	3 to 4 C	7 to 7.5 C	
H	28	332T-29M MD. = 11M	15.5M-336M MD. = 75M	17M-500M MD. = 100M	48M-1.1B MD. = 235M	92M-2.3B MD. = 290M
I	37	14T-17.5M MD. = 600T	20T-354M MD. = 5.5M	12T-418M MD. = 14M	60T-1.6B MD. = 25M	390T-2.7B MD. = 41M
J	33	28T-17½M MD. = 3.4M	2M-118M MD. = 21½M	4M-240M MD. = 34M	3½M-1.6B MD. = 54M	23M-2.4B MD. = 344M

T = Thousand; M = Million; B = Billion; MD = Median

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