

THE MICROBIOLOGY OF SELF-SERVICE, PACKAGED, SQUARE SLICES OF COOKED HAM¹

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The microbial flora of 113 packages of sliced cooked ham was studied over a period of 11 months (samples purchased bi-weekly). When opened and analyzed, 49 packages from stores I and II revealed counts of 1,000 to 42 million per square inch of surface area. Samples from 17 of 49 packages were sour (buttermilk odor) after 3 to 7 days at 4 to 11°C. The dominant organism in the sour samples was a non-heat resistant *Microbacterium*.

Twenty-four samples from packages of vacuum-packed, sliced ham from store III showed counts of fewer than 248,000 per square inch; 3 samples were sour at 7 days (4 to 11°C.) Eighteen packages of sliced ham from stores I and II were stored at 4 to 11°C for 7 days before opening; counts ranged from 3.4 million to 650 million, and 8 packages were sour. Eleven of 20 packages of vacuum-packed ham stored 7 days at 4 to 11°C before opening (store III) showed counts of 1,000 to 60,000; no souring was observed in any of the 20 packages.

Considerable work has been done on the microbiology of meats, especially beef. Slicing and packaging various meat products for self-service marketing may increase the possibilities of surface contamination with spoilage microorganisms; consequently, additional microbiological studies are indicated for these products.

Ayres (1) believed there was urgent need for more information regarding types of microorganisms on packaged meats, and the relation of such organisms to deterioration or spoilage. He stated that off-odor has been commonly used as a method for measuring storage life of meats, but that with cured meats, less work relating to microbial loads at the time of spoilage has been reported. It was his opinion that strong natural odors of these products kept off-odors from being readily detected. Surface contamination was thought to be largely responsible for microbial deterioration in packaged meats.

Jensen (3) reported that in the case of self-service packaged meats, a major problem for the producer is maintenance of quality during the time between production and consumption.

Sulzbacher and McLean (6) studied the bacterial flora of fresh pork sausage, and indicated that species

of *Microbacterium* may be responsible for development of an acid taste in sausage stored at home refrigerator temperature (5 to 8°C).

EXPERIMENTAL PROCEDURE

Beginning July, 1958, packages of square slices of cooked ham (displayed in self-service cabinets) were purchased bi-weekly from 3 of several stores doing a large volume of business in Riley County, Kansas. Within 15 minutes after purchase the packages were placed at 4° to 5°C; many shoppers probably unavoidably allow a longer time interval to elapse between purchase and refrigeration of such a product. Generally, initial microbiological analyses were made on an outside slice from each package 20 to 24 hours after purchase, although some packages were stored 7 days at various temperatures before opening.

No arrangements were made for obtaining temperatures of self-service cabinets; moreover, it was not known how long the packages were in the cabinets before purchase.

Six portions from at least 3 slices of each package opened 20 to 24 hours after purchase were re-wrapped in "saran wrap." Two of the 6 portions were placed at each of the following temperatures: 4 to 5°C, 7 to 8°C, and 10 to 11°C. After 3 to 4 days one sample from each of the 3 temperature ranges was removed and analyzed. The remaining 3 samples were stored 7 days before testing.

One square inch of lean ham (0.5 sq. in. of surface area on each side of slice) was excised with sterile scissors, and placed in 99 ml. of 0.15% peptone water (in 6-oz. screw-cap bottle). Straka and Stokes (5) observed that bacterial losses can be avoided for at least 1 hour by using as little as 0.1 per cent peptone as a diluent. Plate counts, using tryptone-glucose-yeast extract agar, were based on the numbers of microorganisms removed from 1-sq. in. area of meat by vigorous shaking for exactly 2 minutes on a Kahn type shaker, followed by appropriate dilutions in 0.15% peptone water (shaken 25 times by hand).

Plates were incubated 3 to 4 days at 20°C. In addition, comparable plates (prepared from the first 12 packages of meat) were incubated 1 week at 7 to 8°C; however, the lower incubation temperature was

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TABLE 1 — MICROBIAL POPULATIONS OF PACKAGED (VACUUM AND NONVACUUM PACKED) SLICED COOKED HAM SOON AFTER PURCHASE, AND AFTER STORING AT 4 TO 11°C. FOR 3 TO 7 DAYS.

Type of Product	Source	Number of packages	Initial counts	Approximate numbers of microorganisms per square inch of surface area						Total pkgs. sour after 3 to 7 days at 4 to 11°C.
				Time and temperature of storage (unopened packages; and portions of opened packages)						
				3 to 4 days at:			7 days at:			
		4 to 5°C	7 to 8°C	10 to 11°C	4 to 5°C	7 to 8°C	10 to 11°C			
Cooked ham	Store I	14	<1T to 25M	<1T to 300M	<1T to 1.3B	6T to 330M	<1T to 2B	600T to 7B	7M to 1.1B	4
	Store II	12	<1T to 5M	<1T to 30M	158T to 250M	800T to 460M	500T to 90M	28M to 1.6B	62M to 650M	2
Cooked ham	Stores I and II	9				a	3.4M 3.6M 4.6M	40M 156M 325M	65M 204M 650M	5
"Chopped" ham	Store I	12	<1T to 52M	7T to 67M	670T to 600M	1M to 130M	10T to 810M	100M to 1.4B	160M to 600M	5
	Store II	11	5T to 2.2M	7T to 74M	1.1M to 326M	2M to 149M	1.4M to 200M	7.6M to 950M	23M to 650M	6

T = Thousand
M = Million
B = Billion

^aThree packages of meat at a time were purchased periodically; the three counts corresponding to each purchase are listed horizontally. Packages not opened until 7 days storage.

abandoned when it was observed that counts were approximately the same or lower at 7 to 8°C when compared with counts obtained at 20°C.

After storage, and before microbial analyses, samples were inspected for abnormal odors; observations were recorded only if odors obviously indicated spoilage.

RESULTS

Bacterial counts on packages of meat held at 4 to 5°C 20 to 24 hours after purchase.

Initial counts made 20 to 24 hours after purchase, on sliced cooked ham and sliced "chopped"² cooked ham (Table 1) from store I, revealed 14 (54%) of 26 packages having plate counts from <1,000 to 650,000 per sq. in., while 12 packages ranged from 1.1 million to 52 million per sq. in. In similar products from store II, initial counts per sq. in. in 19 (82.6%) of 23 packages were <1,000 to 540,000, and 4 packages varied from 780,000 to 5 million. In vacuum-packed sliced cooked and vacuum-packed cooked "chopped" ham (Table 2) from store III, 24 (92.3%) of 26 packages yielded initial counts of 1,000 to 247,000, with 2 packages showing 620,000 and 1.1 million.

Bacterial counts and condition of samples from opened packages stored 3 to 4 days, and 7 days at various temperatures.

Store I (sliced cooked ham and "chopped" ham): Samples held at 4 to 5°C for 3 to 4 days, and 7 days, showed 10 of 26, and 7 of 26, respectively, having counts per square inch of 1,000 to 460,000; whereas at 7 to 11°C, inclusive, after 3 to 4 days, only 4 of 26 samples yielded counts of fewer than 1 million. After 7 days at 7 to 11°C, only 1 sample of 26 was below 1 million; the remaining 25 samples ranged from 3 million to 7 billion microorganisms per square inch (Table 1). Samples from 9 of 26 packages were sour after storing 3 to 7 days at 7 to 11°C.

Store II (sliced cooked and "chopped" ham): Eight of 23 samples revealed counts of fewer than 550,000 after 7 days at 4 to 5°C. Only 2 of 23 samples were below 600,000 after 3 to 4 days at 7 to 11°C, and no sample was below 7 million after 7 days at the same temperature range (Table 1). Eight of 23 packages yielded samples that were sour after seven days, with 1 sample sour after 3 to 4 days.

Store III (vacuum-packed sliced cooked and "chopped" ham): Twenty-four (92%) of 26 samples carried fewer than 248,000 microorganisms per square inch on initial counts; after 7 days at 4 to 5°C, 14 of 26 samples gave counts of fewer than 100,000. At 10

²The square slices of "chopped" ham were from irregular pieces of meat that had been compressed into a loaf.

to 11°C, 10 of 26 samples showed fewer than 429,000 organisms after 3 to 4 days; however, at 7 days (7 to 11°C) 23 samples yielded counts from 1.2 million to 585 million per square inch (Table 2). Samples from only 3 packages of the 26 were sour after 7 days at 7 to 11°C.

Bacterial counts and condition of packages stored 7 days before opening.

Stores I and II (sliced cooked and "chopped" ham): Five of 6 packages held at 4 to 5°C showed counts from 3.4 million to 39 million per square inch with one package having 50,000 (Tables 1 and 2); no noticeable spoilage odor was observed. Plate counts on 12 packages at 7 to 11°C were from 26 million to 650 million organisms per square inch. Of the 12 packages kept at 7 to 11°C, 8 were sour upon opening for analyses (Tables 1 and 2).

Store III (vacuum-packed sliced cooked and "chopped" ham): Nine of 20 packages yielded counts per square inch of fewer than 10,000 when stored at 4 to 11°C (Table 2); two packages gave counts of 40,000 and 60,000. The remaining 9 packages varied from 1.8 million to 325 million. No sour odor was observed in any of the 20 packages, opened after 7 days at 4 to 11°C.

Nature of the microbial flora.

The odor of sour samples referred to may be best

described as being similar to buttermilk. The dominating microorganism which was placed in the genus *Microbacterium*, was almost invariably associated with the souring mentioned above. This organism, a Gram-positive, non spore-forming rod, had an optimum temperature of approximately 20°C, and was catalase positive. Surface colonies tended to become rather large (3 to 4 mm. in diameter after several days). Smears made from surface colonies revealed organisms frequently indistinguishable from cocci, whereas sub-surface colonies of the same organism showed definite rods. Unlike *Microbacterium lacticum*, as described (2), the organism in question was not particularly heat resistant. It did not survive 72°C for 5 minutes. At 60°C for 5 minutes there were only approximately 70 surviving cells per ml out of 360,000 (original inoculum); however, there were still some survivors after 30 minutes.

The species of *Microbacterium* was present on slices of ham in approximately 60 per cent or more of 113 packages and dominated the flora in at least 50 per cent of samples after 3 to 7 days. Yeasts and micrococci were found on meat in 25% or more of the packages, and dominated the flora in approximately 7 to 10%. Microbacteria, yeasts, and micrococci were often present together in approximately equal numbers. Other microorganisms encountered less frequently were lactobacilli, streptococci, and pseudomonads.

No sour odors were noted when micrococci domi-

TABLE 2 — MICROBIAL POPULATIONS OF PACKAGED (VACUUM AND NON VACUUM PACKED) SLICED COOKED HAM SOON AFTER PURCHASE, AND AFTER STORING AT 4 TO 11°C. FOR 3 TO 7 DAYS.

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				Time and temperature of storage (unopened packages and portions of opened packages)							
				3 to 4 days at:			7 days at:				
				4 to 5°C	7 to 8°C	10 to 11°C	4 to 5°C	7 to 8°C	10 to 11°C		
"Chopped" cooked ham	Stores I and II	9			a		39M 50T 6.5M	132M 650M 26M	450M 500M 170M	3	
Vacuum packed cooked ham -Store III own label		15	0.9T to 1.1M	1T to 2.6M	<10T to 500M	<10T to 118M	<2T to 11M	26T to 320M	<10T to 380M	3	
Vacuum packed cooked ham -Store III own label	Store III	20					a	<10T <1T <10T 4.5M 1.8M <1T —	40T 2T <10T 65M 300M <1T 2.2M, 325M	60T 13M <10T 75M 11M <1T —	0
Vacuum packed "chopped" ham -not Store III label		11	0.2T to 44T	<1T to 240T	<1T to 32M	33T to 30M	<1T to 32M	54T to 176M	2.6M to 585M	0	

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*Three packages of meat at a time were purchased periodically; the three counts corresponding to each purchase are listed horizontally. Packages not opened until 7 days storage.

nated the flora (over 350 million per square inch in some samples) in 8 of 11 packages of meat from store III (not its own label). It was unusual also, that this was the only series of meat samples in which *Microbacterium* was not observed on the plates.

DISCUSSION

Packages of sliced ham were stored 7 days before opening for analyses to ascertain if there would be any difference in the microbial flora, etc., as compared with re-wrapped samples from similar packages opened 7 days previously. Multiplication of microorganisms (stores I and II) on ham slices from packages opened at 7 days was comparable to growth at 7 days on samples from previously opened packages. In general there were little or no observable differences in the types of microorganisms on meat from opened and unopened packages after seven days storage. Although different packages were involved, counts were appreciably lower in more vacuum packages stored 7 days at 4 to 11°C before opening, than in samples from opened, but previously vacuum-processed, packages stored at the same temperature range for 7 days (Table 2).

It is not known whether or not the over-all lower counts of the vacuum-packed meats were the result of better sanitation, etc. at the time of processing, or that possibly some microorganisms did not find conditions as favorable for growth in the unopened vacuum packages. It is possible that a combination of the above factors may have prevailed.

McLean and Sulzbacher (4) proposed the name *Microbacterium thermosphactum* for a non-heat resistant organism they repeatedly isolated from pork sausage. Their organism had characteristics similar to the bacterium found commonly present on pack-

aged sliced cooked ham in this study. Wolin, Evans and Niven (7) reported that although an irradiation dosage of 44,000-66,000 rads was sufficient to kill virtually all pseudomonads on fresh beef, the product eventually spoiled due to radiation-resistant organisms apparently identical to *Microbacterium thermosphactum*.

It is known that certain meats may carry large populations of microorganisms without undergoing deterioration. Members of the genus *Microbacterium*, although present in excessive numbers on sour ham samples, are harmless from a public health standpoint.

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