Bacteriological Survey of Raw Beef Patties Produced at Establishments Under Federal Inspection

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At the time of manufacture, 76% of 74 sets of raw beef patties collected in 42 federally inspected establishments had aerobic plate counts of 1,000,000 or fewer/g; 84% contained 100 or fewer coliforms/g; 92% contained 100 or fewer Escherichia coli/g; and 85% contained 100 or fewer Staphylococcus aureus/g (geometric means of 10 patties/set). Salmonellae were isolated from only three (0.4%) of 735 beef patties.

A survey was conducted to determine the bacterial levels of raw beef patties during preparation and as packaged for shipment from establishments under federal inspection in the United States.

Beef patties are fabricated from chilled lean beef cuts (labeled as boneless beef, cow meat, or bull meat) mixed with chilled, higher fat content, beef trimmings. The meats, weighed in proportions not to exceed the fat-to-lean ratio specified by the purchaser, are blended in a chopper or mixer (frozen meats are first passed through a flaker) and then ground. The ground meat is transferred to a patty-forming machine. The patties emerging from the machine are separated by squares of paper and are packed manually into cartons. The product is placed in either frozen or refrigerated storage. Generally, unfrozen patties are shipped to outlets within 24 h after fabrication.

Bacterial growth is unlikely during the production of raw beef patties, because the meat trimmings and cuts are chilled or frozen, the process is rapid, and the production area is maintained at or below 10 C. Measurable contamination from food contact surfaces appeared unlikely because raw trimmings and cuts have a substantial initial bacterial content, and the observed conditions of sanitation in the firms were acceptable.

MATERIALS AND METHODS

Sampling. From August 1971 to June 1973, samples were collected from 42 federally inspected establishments producing raw beef patties. Nine of the firms were located in the Northeast, 11 were in the South and Southeast, 20 were in the West and Midwest, and two were on the West Coast. Twenty-two establishments froze the patties before packing; the other firms froze a portion of the production to maintain a small inventory.

A total of 690 production line samples and 735 finished patty units were collected and analyzed. A group of samples from each plant included samples of the beef trimmings and cuts utilized for the patties, samples at each stage of processing, units of the finished patties related to the production line samples, and, from 31 plants, units of finished patties fabricated prior to the date of the plant visit. Nearly always, a group included 10 samples of the meat utilized for the patties and a set of 10 finished patty units per production date. A total of 74 sets of finished patties units was collected. The samples were frozen promptly and were shipped under dry ice to the laboratory. Generally, analysis was begun 3 to 4 weeks after collection.

Of the 42 firms, 34 added nothing to the ground meat, two added small amounts of salt and pepper, and six added 12 to 20% seasoned soy protein in water. Laboratory methods. Methods used for aerobic plate counts (APC), coliforms, Escherichia coli, Staphylococcus aureus, and salmonellae have been described (9).

RESULTS

Figure 1 shows the distribution of bacteria (APC at 35 C) in the individual samples of trimmings and patties and demonstrates that the grinding and mixing resulted in averaging the highest and lowest count trimmings to yield patties with intermediate bacterial levels. A similar effect was noted for coliforms, E. coli, and S. aureus.

This study deals with a non-negative random variable (bacterial counts) having distributions skewed to the right. Figure 1 shows that the skewness is much more pronounced in the trimmings than in the patties. Hence, the difference between the arithmetic average and
the median would be more pronounced in the trimmings than in the patties. Plots of the geometric means of APCs versus the medians of APCs of the trimmings and of the patties (not presented in this paper) show that the geometric means are approximately equal to the medians. Since the geometric mean indicates the location of the median, a plot of the geometric means of the APCs of paired sets of trimmings and patties (Fig. 2) shows that most of the points are above the diagonal line, because the medians of the trimmings and patties are significantly different. Thus, Fig. 2 reflects the difference in the medians of the bacterial distribution in the trimmings and the patties, not a difference in the numbers of bacteria.

Figure 3 shows that the geometric means of APCs and the arithmetic averages of APCs of the patties are nearly the same; thus, either can be used to show the overall level of bacteria in the patties. Accordingly, in Fig. 4, the arithmetic averages of the APCs of paired sets of trimmings and patties were plotted. The points of Fig. 4 fall in a scattered pattern above and below the diagonal line in a normal sample-to-sample variation, demonstrating the positive association between the bacterial condition of the trimmings and the bacterial condition of the

**Fig. 1.** Distribution of APCs at 35 C of trimmings and patties collected from 42 firms.

**Fig. 2.** Geometric means of trimmings versus geometric means of patties (APCs/g at 35 C) per paired sets. Each paired set consists of 10 samples of patties and 10 samples of the trimmings from which the patties were fabricated.

**Fig. 3.** Arithmetic averages versus geometric means (APCs/g at 35 C) of sets of patties. Each set consists of 10 patties.

**Fig. 4.** Arithmetic averages of trimmings versus arithmetic averages of patties (APCs/g at 35 C) per paired sets. Each paired set consists of 10 samples of patties and 10 samples of the trimmings from which the patties were fabricated.
patties. Also, the scattered pattern of the points indicates that the processing of trimmings into patties contributed little, if any, to bacteria to the finished product. Collectively, Fig. 1 through 4 refute the belief that the physical process of grinding meat causes an increase in bacterial counts.

The incidence of salmonellae was very low. Only one of the 690 production line samples and only three of the 735 beef Patty samples were salmonellae positive.

APCs of 491 samples of the trimmings were determined at both 35 C (48-h incubation) and 20 C (4-day incubation). Of the 491 samples, 48 (9.8%) had APCs at least 10 times greater at the 20 C incubation temperature. These findings suggest that some of the meat from which the patties were fabricated had been under prolonged refrigerated storage.

The bacterial content of the raw beef patties is shown in Table 1. At the time of manufacture and by the laboratory methods employed, 76% of 74 sets of raw beef patties had APCs of 1,000,000 or fewer/g; 84% contained 100 or fewer coliforms/g; 92% contained 100 or fewer E. coli/g; and 85% contained 100 or fewer S. aureus/g (geometric means of 10 patties per set).

**DISCUSSION**

Stringer et al. (8) measured the microbial contamination of fresh beef from the time of slaughter to retail display. They reported that the number of bacteria on carcasses before shipment from the packing plant increased as time increased, that the number on carcasses increased during transportation from the packing plant to the retail store, and that an appreciable amount of contamination was transferred to steaks through the cutting procedures at the retail store. A reasonable projection of Stringer’s findings is that bacterial counts increase further on the trimmings and cuts accumulated and stored for subsequent grinding.

Most beef patty processors use purchased trimmings and cuts; only two of the 42 establishments used beef from animals slaughtered on the premises. Because this survey shows that the bacterial content of patties depends primarily on the bacteriological quality of the trimmings, the examination of patties at plant level measures the accumulative bacterial increase of meat from time of slaughter to packaged trimmings and cuts at time of use, rather than conditions of sanitation during fabrication of patties from the trimmings. The examination of patties collected at retail outlets would measure, in addition, any subsequent deleterious effects of transportation, further handling, and time and temperature of storage.

Reports by other investigators indicate that raw ground beef collected at retail levels may have high bacterial levels. Duitschaever et al. (1) found that 64% of 213 ground beef samples had APCs in excess of 10⁷/g and some in excess of 10⁸/g; Kirsch et al. (3) found seven of 20 samples over 10⁷/g; Rogers and McClesky (6) found ground beef in excess of 10⁷/g from 16 of 24 retail markets and, upon examination of 59 samples collected by a local inspector, found 20 in excess of 10⁶/g and 33 over 10⁶/g; Weinzirl and Newton (8) found 22 of 44 samples in excess of 10⁵/g; and Lefevre (4) reported results similar to those of Weinzirl and Newton. Larkin et al. (Abstr. Annu. Meet. Am. Soc. Microbiol., 1972) reported that 36% of ground beef samples from 50 retail outlets had APCs over 5 × 10⁶/g. Geer et al. (2) reported that 13 of 20 samples of unfrozen hamburger steak had counts in excess of 10⁷/g, and that frozen storage caused a material reduction in the numbers of bacteria; however, 10 samples stored at 0 F (−17.8 C) for 1 month had counts in excess of 10⁷/g.

As aptly put by Mercure (5): “One must realize that meat comes from an animal which was skinned, eviscerated, cooled, then cut into pieces and lastly carried from one establishment to another. These manipulations are made in a non-septic milieu. Even in taking the best

| Table 1. Bacterial content (geometric mean per gram) of 74 sets of raw beef patties |
|-----------------------------------------|-------------------|-------------------|-------------------|-------------------|
| **Bacteria**                           | **No. of sets with** |
|                                        | **<10⁴** | **10⁴ to 10⁶** | **>10⁶ to 10⁸** | **>10⁸** |
| **APCs**                               | 3       | 12               | 34               | 7               | 16               | 2               |
| Coliforms                              | 32      | 30               | 7                | 4                | 0                |
| E. coli                                | 44      | 24               | 3                | 3                | 0                |
| S. aureus                              | 32      | 31               | 9                | 1                |

*All sets but one consisted of 10 patties.*
hygienic precautions, the presence of numerous microorganisms on the surface of the meat is unavoidable. Since ground meat is, more often than not, made with trimmings, and since it offers a wider surface to contamination, one can conclude that the microbial flora of that product would be rather high.” (Translated from French)

We agree with Mercure, but we also believe, as suggested by Duitschaever (1) and Rogers (6), that the bacteriological quality of ground meat can be improved with improved practices in the handling and storage of meat from the time of slaughter to the consumer.

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LITERATURE CITED