Behavior of Salmonellae in Sliced Luncheon Meats

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Salmonellae inoculated onto the surface of bologna and liver cheese survived protracted storage at 5 C. Salmonellae grew when the meats were incubated at room temperature.

There have been numerous reports of food-borne salmonellosis traced to delicatessens and other catering operations (2). In most of these outbreaks, poultry or poultry products have been the vehicle for the infectious agent. Heath and Kaufman (1) described an outbreak that was attributed to salads and meats purveyed by a delicatessen. Examination of the equipment on the premises disclosed that the meat-slicing machine and food grinder were contaminated and had most likely seeded the products passing through them. Equipment of this type is recognized as a problem because of contact with many different products thereby increasing the opportunities for cross-contamination to occur. Moreover, such equipment is not adequately cleaned due to laxness by the operator or because the machinery is constructed in such a manner as to render efficient cleaning difficult. It is conceivable that a product might become contaminated with salmonellae through contact with an inadequately cleaned slicing machine.

This study was undertaken to investigate the behavior of salmonellae in cooked luncheon meats held under a variety of conditions. During processing these products are cooked to an extent that precludes the survival of salmonellae. The following data are representative of what might be expected if the products were contaminated during the slicing or packaging operation.

Sliced luncheon meats (bologna and liver cheese) were purchased from local retail outlets. The meat was inoculated with Salmonella typhimurium or S. anatum by spreading 0.1 ml of a suitable dilution of a 24-hr nutrient broth culture over the surface of the slice. The level of inoculum was chosen to give an initial load of $10^3$ to $5 \times 10^4$ salmonellae per g of meat. All inoculated sliced-meat samples were then vacuum-packaged in Saran-coated mylar pouches (Oscar Mayer and Co., Madison, Wis.) and stored in the refrigerator (5 C) for 7 days before use.

Viable salmonellae were enumerated by the three-tube most-probable-number method involving preenrichment at 37 C in nutrient broth for 20 to 24 hr, followed by enrichment in selenite-cystine broth at 37 C for a similar period of time. One loopful of enrichment broth was streaked on Brilliant Green Sulfad agar. Somatic and flagellar agglutination tests confirmed the identity of the isolates as the salmonellae that were inoculated into the product.

Figure 1 shows the behavior of S. typhimurium in luncheon meats that were vacuum-packed and held at 5 C for six weeks. There was a reduction in viable cells of 30 to 90% in the first two weeks. After this period, the population of salmonellae stabilized and there was no further decline for the remainder of the experiment. A similar survival pattern was evidenced by S. anatum. These data indicate that salmonellae will

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persist (although at a reduced level) throughout the shelf life of the products.

Since the salmonellae survived extended holding in these products (under refrigeration), it was of interest to determine whether the organisms would grow if the products were subjected to abuse. First, several pouches of contaminated, vacuum-packed bologna and liver cheese were removed from refrigeration and left unopened at room temperature (23°C). Pouches were then opened and sampled at suitable intervals over a 48-hr period. The results are summarized in Fig. 2. With the exception of S. anatum in bologna, the salmonellae did not proliferate significantly during the initial 24-hr after removal from refrigeration. During the second 24-hr period, the number of viable S. typhimurium in bologna and liver cheese and S. anatum in bologna increased 25- to 30-fold.

In a second experiment, several pouches of contaminated meat were removed from the refrigerator. These pouches were opened immediately, and the contents were removed and rewrapped (without vacuum) in household Saran Wrap. The repackaged product was left at room temperature. The behavior of S. typhimurium in the rewrapped meats incubated at room temperature for 48 hr is shown in Fig. 3.

Several differences in the behavior of salmonellae in vacuum-packed meats and the rewrapped meats were noted. The lag period before active growth began was about twice as long in the vacuum-packaged product as in the rewrapped product. The magnitude of the salmonella population increase under aerobic conditions was double that in the vacuum-packed product.

Interestingly, a difference in the growth response of the salmonellae in the two products under aerobic conditions was observed. The bologna supported more rapid and extensive growth of both serotypes of Salmonella than did the liver cheese. The difference was not observed under conditions of anaerobic incubation. The reasons for this difference are not known, but quite possibly this is a reflection of the difference in formulation of the two products.

In the final experiment, several slices of contaminated meat were left completely exposed to the room environment. Under these conditions the products browned, oiled off, and dried in a matter of a few hours. There was no multiplication by the salmonellae in this material, and, indeed, a dying off was noted as the product dried out.

The data presented suggest that the reason meat products of this type are not more often associated with salmonelloses may be their relative inadequacy to serve as substrates for the proliferation of these organisms. Although the minimum number of salmonellae that are necessary to cause illness is not known, it is generally agreed that larger numbers are more likely to cause disease than smaller numbers. The evidence presented suggests that to achieve high numbers of salmonellae in products of this type, it would be necessary to inoculate the meat with very high initial loads. To do this, considerable growth of salmonellae would have to occur on the food contact surfaces of the equipment to which the product is exposed. Any degree of attention to cleaning and sanitation of this equipment should prevent a buildup of this kind.
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LITERATURE CITED

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