Effect of Temperature on Growth of *Salmonella* in Rehydrated Skim Milk from a Food-Poisoning Outbreak

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Low numbers of salmonellae in a dried skim milk sample that was implicated in an outbreak of salmonellosis grew rapidly upon rehydration and incubation.

Dried milk has been implicated in at least three food-poisoning outbreaks involving salmonellae (1, 3, 8). When found in dried foods, the level of these organisms is quite low and ranges usually from 1 to 10 cells/100 g of product (2, 9). The significance of such levels is often questioned, as these numbers are far below the millions of cells found necessary to infect adult human volunteers (4, 6, 7). More recently, however, outbreaks associated with the fecal dye marker carmine indicate that 15,000 to 30,000 salmonellae will elicit a reaction in infants and adults, respectively (5). No information is available regarding the minimal infectious dose for infants and children. In the household, most dried foods are reconstituted and immediately consumed or cooked and then consumed. However, dried milk may be reconstituted, a portion consumed, and the remainder kept for subsequent use. Thus, depending upon the holding conditions to which the reconstituted milk is subjected, a large *Salmonella* population might develop if these organisms are present in the original product.

A recent outbreak (3) of *Salmonella* food poisoning involving dried skim milk afforded an opportunity to investigate the effect of time and temperature of holding the product on the growth of the contaminating *Salmonella*. The outbreak occurred in St. John’s, Newfoundland, involving 32 persons from 17 families, and it took place over a 2-month period (February and March 1968). Considering the geographic location and season, the estimated ambient household temperature would be about 20 C. The only factor common to all the afflicted individuals was the consumption of a particular brand and batch of dried skim milk. Thus, this outbreak afforded the investigation of a naturally contaminated product containing organisms with a known infectious potential.

Six pounds (272 dg) of the incriminated product was obtained through the courtesy of P. W. Fardy, Department of Health, St. John’s, Newfoundland. Upon receipt, the product was placed in a large plastic bag and mixed well to distribute the contaminating bacteria. The product was stored at approximately 5 C during the study.

Duplicate most-probable-number determinations for *Salmonella* indicated nine organisms per 10 g of milk. E. H. Christenson, State Laboratory of Hygiene, Madison, Wis., kindly typed our isolates as *S. newport*, the serotype previously isolated from the product and from the stools of the afflicted individuals. No coliforms were detected in three 10-g samples of the product, and the total aerobic plate count was 50 organisms/g.

The reconstituted milk was incubated at various temperatures and MPN determinations for *Salmonella* were performed. To prepare each culture, 100 g of dried milk was added to 1 liter of sterile distilled water at the appropriate temperature in a 2-liter flask. Periodically, samples were withdrawn, diluted decimally in water, and pre-enriched in sterile milk for most-probable-number determinations by the enrichment serology procedure (9).

Though debilitated by drying, the salmonellae grew rather rapidly at 30 and 37 C (Fig. 1). Growth was much slower at the lower temperatures, but even at 20 C the count was significant after 30 hr of incubation. Although not shown in the figure, at 20 C the *Salmonella* count/ml increased to $1.5 \times 10^5$ at 36 hr and to $9.3 \times 10^7$ at 46 hr. At 14.5 C, the following *Salmonella* counts/ml were obtained: 23 at 48 hr, 2,300 at 72 hr, and $2.3 \times 10^6$ at 96 hr. Repeated experiments were performed at 5 and 10 C to estimate the growth
response at these low temperatures. At 10°C, after 5 days of incubation, the count increased from approximately 0.009 Salmonella cells/ml to 2.4/ml. Growth at 10°C was not detectable during the first 3 days of incubation. At 5°C no significant growth was observed after 5 days of incubation.

From the data obtained in this study and the observed outbreak, it appears that relatively small numbers of salmonellae, contaminating a food product to be consumed without heat treatment at the consumer level, can be significant. Of course, the possibility of temperature abuse at the consumer level and the creation of growth conditions are prime considerations in this specific instance. In any event, despite numerical considerations of dose and various aspects of host susceptibility, the small numbers of Salmonella cells in this food product apparently did result in a food-poisoning outbreak.

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LITERATURE CITED