THE FATE OF SALMONELLAE IN THE MANUFACTURE OF COTTAGE CHEESE

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Summary

The effects of cooking temperatures ranging from 110 to 130 F on the fate of salmonellae during the manufacture of Cottage cheese were determined. Seven test species noted for heat resistance and occurrence in dairy products were used to inoculate cheese milk. Salmonellae determinations were made on the milk, whey, curd and cheese at varying stages of manufacture. Salmonellae survived at 110 and 115 F in all trials, and at 120 F in 1 of 5 trials. None survived at 125 F. Creamed Cottage cheese was inoculated with salmonellae, stored at 40 F and analyzed periodically. No marked decrease in numbers was observed during storage.

The increasing awareness of salmonellae contamination in nonfat dry milk (NDM) and in certain NDM-containing foods has caused considerable concern to public health officials, consumers, and the dairy industry. In early 1966, 11 serotypes of salmonellae were isolated from NDM that had been manufactured in 20 drying plants located in 9 high milk-producing states *(3)*. However, none were found in 137 samples of NDM representing 26 brands. More recently, salmonellae have been found in a relatively small yet alarming percentage of NDM samples examined in federal and state surveillance programs.

Frequently, NDM is added directly to pasteurized skimmilk in the manufacture of Cottage cheese. In case the fortified milk is not pasteurized, there is a risk of salmonellae contamination. Furthermore, there is a chance that salmonellae may enter the milk from contaminated air or from human carriers as evidenced by an outbreak of salmonellosis traced to Cottage cheese infected by the maker *(1)*. Although Lyons and Mallmann have shown that salmonellae inoculated into packaged Cottage cheese survived long enough to present a health hazard *(2)*, no known information is available concerning their fate during the manufacture of Cottage cheese. Such information is urgently needed to properly evaluate the safety or potential danger of present manufacturing practices.

This report presents the results of a study to determine whether salmonellae survive during the manufacture and storage of Cottage cheese. Emphasis was on the cooking temperature.

Experimental

Seven test species of *Salmonella* were selected on the basis of their reported heat resistance and frequency of occurrence in dairy products. They were *Salmonella senftenberg* 775W, *Salmonella blockley* 2004, *Salmonella typhi-murium* TMI, *Salmonella new-brunswick* 1608, *Salmonella montevideo*, *Salmonella oranienburg* 200E, and *Salmonella worthington* 4661. From 2 to 4 species of 18-hr cultures grown in trypticase soy broth were added to the cheese milk approximately 1 hour prior to manufacture. The inoculum ranged from 200 to 500 thousand per ml of milk. Sixteen lots of Cottage cheese were made in 4 miniature steam-jacketed cheese vats, each having a capacity of 50 lb of milk. Four cooking temperatures ranging from 110-130 F were used to test each of 4 different combinations of salmonellae. In all tests, the large curd rennet-type, short-set Cottage cheese method was used. Large curd (1/2 inch) and a relatively short cooking period (1 to 1 1/2 hr) were selected because of a greater probability of survival. Fresh skimmilk was fortified to 10.5 to 11% solids with NDM, pasteurized, and cooled to 90 F before innoculation with the test organisms. An active, mixed-strain lactic starter was added at the rate of 5% and rennet was added at the rate of 1 ml/1000 lb of milk. The curd was cut when the titratable acidity of the cheese whey reached 0.53%. Cooking was initiated 15 minutes after cutting. The time required to reach the cooking temperature was 60 minutes. The curds and whey were held at their respective cooking temperatures for 20 minutes prior to draining. No attempt was made to obtain the same degree of curd firmness at different temperatures.

Analyses for salmonellae were made on: the cheese milk just prior to adding starter, the coagulated uncut curd after ripening (4-6 hr), the whey just before cooking, the whey just before draining, and the curd after washing and cooling.

Three procedures were employed to detect and enumerate salmonellae:

1. Direct plating on trypticase soy agar.
2. Direct streaking (0.1 ml aliquots of each dilution) on brilliant green agar.
3. Most probable number (MPN).

MPN was determined by selenite F broth enrichment, followed by streaking onto brilliant green agar and confirming typical colonies on triple sugar iron agar, lysine iron agar and

[1]Deceased July 9, 1967.

TABLE 1. SURVIVAL OF SALMONELLA DURING COTTAGE CHEESE MANUFACTURE

Cooking temperature	Numbers of salmonellae			
	Trial 1		Trial 2	
	Direct no./ml-g	MPN no./100 ml-g	Direct no./ml-g	MPN no./100 ml-g
Vat 1 - 110 F				
Cheese milk	$35x10^4$	—	$40x10^4$	—
Milk-coag. (before cut)	$43x10^4$	—	$86x10^3$	—
Whey-before cook	$31x10^3$	—	$25x10^2$	—
Whey-before drain	$16x10^2$	$35x10^3$	$7x10^1$	$35x10^1$
Curd-uncreamed	$18x10^1$	$32x10^3$	0	$19x10^1$
Vat 2 - 115 F				
Cheese milk	$39x10^4$	—	$20x10^4$	—
Milk-coag. (before cut)	$48x10^4$	—	$51x10^3$	—
Whey-before cook	$56x10^3$	—	$16x10^2$	—
Whey-before drain	$17x10^1$	$16x10^3$	6	$54x10^1$
Curd-uncreamed	0	$78x10^1$	0	$24x10^1$
Vat 3 - 120 F				
Cheese milk	$46x10^4$	—	$34x10^4$	—
Milk-coag. (before cut)	$54x10^4$	—	$35x10^3$	—
Whey-before cook	$42x10^3$	—	$26x10^2$	—
Whey-before drain	0	9.3	0	$24x10^1$
Curd-uncreamed	0	0	0	8
Vat 4 - 125 F				
Cheese milk	$52x10^4$	—	$30x10^4$	—
Milk-coag. (before cut)	$60x10^4$	—	$81x10^3$	—
Whey-before cook	$52x10^3$	—	$33x10^2$	—
Whey-before drain	0	0	0	0
Curd-uncreamed	0	0	0	0

motility medium. The MPN enrichment procedure was necessary when small numbers of salmonellae were present.

The MPN in milk and whey was determined by inoculating 5 tubes of selenite F broth for each dilution. After incubation for 18 hours at 37 C, a loopful of broth was streaked on brilliant green agar and typical colonies were picked and confirmed after 18 hours' incubation at 37 C. The MPN in curd and creamed Cottage cheese was determined as follows: Sterile distilled water was added to 50 g of curd or cheese, made to a final volume of 100 ml and blended in a Waring blendor.[2] Ten-, 1-, and 0.1-ml aliquots were added respectively to 90, 9, and 10-ml portions of selenite broth. Incubation, streaking, and confirmation of salmonellae were as described above.

The Effects of Creaming Mixture and Storage.

The effects of 3 Cottage cheese creaming mixtures on the survival of salmonellae in Cottage cheese at 40 F storage were studied. One lot (A) of uncreamed commercial Cottage curd was creamed with a normal sweet cream dressing, a second lot (B) with a dressing containing *Leuconostoc* spp. and a third lot (C) with a lactic-cultured cream dressing. Mixtures containing equal amounts of 3 different species of salmonellae were added to each cheese and the inoculum was mixed into the cheese in a Waring blendor. The cheeses were analyzed for their salmonellae content at zero, 3, 6, and 12 days storage.

[2]Reference to certain products or companies does not imply endorsement by the Department over others not mentioned.

RESULTS AND DISCUSSION

Differences among species did not appear to be a major factor in the survival of salmonellae during Cottage cheese making. Heat resistant strains, S. *senftenberg* and S. *blockley*, showed no evidence of being more resistant to the cooking temperatures. Sixteen lots of Cottage cheese were tested; typical data from 8 of these are shown in Table 1. None of the salmonellae survived a cooking temperature of 125 F and, in 4 of the 5 trials, 120 F was sufficient for complete killing. Only a few (8/100 g) survived in 1 of the trials at 120 F; the isolates were identified as S. *typhi-murium*. Salmonellae survived in all lots at both 110 and 115 F. These results indicate that a cooking temperature above 120 F is necessary to insure complete killing. Private communication with industry representatives indicates that most manufacturers employ cooking temperatures of 120 F or higher.

The authors believe that most Cottage cheese manufacturing procedures will kill any salmonellae which may be present in the cheese milk or in NDM used for fortification. However, if a cooking temperature of less than 125 F is used, it is recommended that the cheese milk be pasteurized after fortification with NDM. The importance of this recommendation is supported by data in Table 2 which show that salmonellae present in the curd outlive the shelf life of the cheese. Salmonellae inoculated into commercial cheese showed only a slight decline during storage (Table 2). An exception may be in Sample C which contained the lactic dressing. Its pH was 4.85, compared to 5.2 for samples A and B. This probably accounts for the lower counts after storage.

TABLE 2. SURVIVAL OF SALMONELLA IN COTTAGE CHEESE DURING STORAGE

Sample	Bacterial count (no./gm)	
	Nutrient agar	Brilliant green agar
A — Before inoc.	$7x10^3$	0
After inoc.	$54x10^5$	$51x10^5$
3 days	$122x10^4$	$52x10^5$
12 days	$89x10^4$	$99x10^4$
B — Before inoc.	$9x10^5$	0
After inoc.	$24x10^5$	$20x10^5$
3 days	$102x10^4$	$68x10^5$
12 days	$85x10^4$	$47x10^4$
C — Before inoc.	$18x10^6$	0
After inoc.	$26x10^6$	$20x10^5$
3 days	$36x10^5$	$34x10^3$
12 days	$12x10^4$	$13x10^3$

A = Sweet cream dressing.
B = Leuconostoc dressing.
C = Mixed lactic dressing.

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ASSOCIATION AFFAIRS

HARRY L DELOZIER - 1902-1967

Harry L. DeLozier, after an extended illness, died on September 4, 1967. "De", as he was known by his friends from coast to coast, leaves, in memorium, a heritage to the milk industry of nearly 40 years of leadership in control administration.

"De" started his career as a milk inspector for the City of Louisville in 1928. Ten years later he was appointed Director of the Milk Division of the City of Louisville Health Department.

In 1942, the Louisville Health Department and the Jefferson County Health Department were joined into a single unit and Mr. DeLozier assumed direction of the Milk Division of the combined City-County Health unit. He held this post until his death.

During World War II, "De" assumed the task of Director of the total environmental program of the newly created Health Department as well as the Milk Division.

The City of Louisville entered into the Grade A milk control program early in its inception, adopting the PHS recommended ordinance and code in 1931. Through diligent educational means "De" was able, by 1942, to boast that 100% of the city's milk supply was pasteurized and the program carried a survey rating of 95% with an enforcement rating of 99%.

The first bulk tanks appeared in the Louisville milk shed in 1954 and by 1956 70% of the 1700 odd shippers employed this means of storage. This was probably one of the largest and fastest transitions, in terms of numbers of shippers and time lapse, in the country; yet, the administration and programming was such that the transition was made without major incident.

Brucellosis control found a champion in Harry DeLozier. In order to comply with the 1953 code provisions "De" brought together Federal, state and local officials and interested parties, including the farmer, and through a series of meetings in southern Indiana and Kentucky, gained their agreement and cooperation. By continuous effort, July 1, 1957 saw all producers in the milk shed following Plan A and 37 counties in Kentucky certified as brucellosis free.

Over the years "De" has provided industry-wide leadership in mastitis control. He has contributed to both national and state deliberations and added much to the continued stature of this program.

Louisville, being a borderline City, has made interstate shipment cooperation a must. In this field, as in none other, "De" excelled. Since the inception of the interstate certification program he was one of its strongest supporters and it is partially due to his fine personal relationship with other regulatory agents that the Louisville milk shed has been able to grow and find market acceptance of surplus supplies in other areas.

"De" was a founding member of the Kentucky Association of Milk and Food Sanitarians. He was instrumental in both its founding and its continued success. He was also a long time participating member of the International Association.