SOME VARIATIONS OF THE HEAT METHOD FOR STERILIZING MILKING MACHINES[1]

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INTRODUCTION

The method of sterilizing milking machines by the use of heat has been advocated only during the last few years. The chief criticism of this method has been that it is too injurious to the rubber parts of the machines.

REVIEW OF LITERATURE

Bulletin 492 [2] of the New York Agricultural Experiment Station reports experiments carried on by Ruehle in 1917 on the use of hot water for the sterilization of milking machines. In these experiments the teat cups and tubes were washed by drawing cold water, hot alkali water, and clean hot water through them. They were then placed on a stove in a 30-quart covered pail containing water which was heated to 180° to 200° F. The disks and mouthpieces became useless after two days of this treatment. These were replaced, and the temperature was reduced to 160° to 170° F. At this temperature the mouthpieces and disks lasted 17 days, during which time the bacterial counts were very low. At a temperature between 150° and 160° a new set of mouthpieces and disks lasted 25 days, and another set 13 days. Bacterial counts, although still low, were higher than those in the previous tests. Ruehle reached the conclusion that the heat-sterilization method gave very good results bacteriologically but was very destructive to certain rubber parts.

In 1921, Robertson [2] repeated the tests made by Reuhle in 1917, using a temperature of 160° to 170° F. The results were about the same as those obtained by Ruehle. No mention is made of how long the rubber mouthpieces and disks lasted under chemical methods of sterilization. The bulletin mentioned reports that data obtained from control laboratories showed that at least one farm furnishing certified milk in New York State used the heat-sterilization method without undue destruction of the rubber parts.

Reports from laboratory tests conducted in 1918 and 1921 on rubber parts obtained from seven generally used milkers showed that the rubber parts supplied with the majority of milkers were more resistant to heat than was commonly believed. This applied particularly to the best grade of cloth-wrapped, pole-lined, steam-vulcanized tubing, but did not apply so well to the tubing vulcanized in iron molds. It was also noted that in some instances with some metals the rubber apparently melted and stuck to the metal parts.

[1] Received for publication Sept. 2, 1926; issued January, 1927.

[2] ROBERTSON, A. H., FINCH, M. W., and BREED, R. S. MILKING MACHINES: VII. FURTHER STUDIES ON METHODS OF STERILIZATION. N. Y. State Agr. Expt. Sta. Bul. 492, 36 p. 1922.

These tests were made under laboratory conditions only, and the parts were subjected to each of the following conditions daily for 20 days: Under steam pressure in autoclave, in flowing steam, in boiling water, and in hot water at 160° to 170° F. It was not stated whether one method was more or less detrimental than another. The final conclusion was that heat sterilization could be recommended as an effective method for those machines which were, or could be, equipped with rubber parts that would withstand heating twice a day for a reasonable length of time.

In 1920 Hart and Stabler [3] published a report of their experiments in California with the heat-sterilization method. Tests were conducted at two high-class dairies and one ordinary dairy at a temperature of 160° to 190° F. for 15 to 30 minutes. Excellent results were obtained at the two high-class dairies, but the bacterial counts at the ordinary dairy were much higher, running in to the hundreds of thousands. They were lower in number, however, than those obtained before the heat-sterilization method was used. From these tests Hart and Stabler came to the conclusion that "heat sterilization is the only way to sterilize successfully milking machine rubber parts under ordinary ranch conditions." They reported the length of life of the rubber parts at one high-class dairy to be from two to four months, the tubing lasting longer than the inflations.

In 1923, the writer [4] published the results of tests on the heat method of sterilization at temperatures of 160° to 170° F. The parts, after being washed, were submerged in water at these temperatures and allowed to remain undisturbed until the next milking, the water cooling gradually. The results obtained at 20 farms showed the effectiveness of this method of sterilization. The length of life of teat-cup liners ranged from 6 to 17 weeks.

In 1925 the results were published of investigations made by the writer [5] on the comparative value of the heat method, the chlorine method, and the salt and chlorine method of sterilizing milking machines. These tests showed that the heat method, under conditions as nearly identical as possible, gave more uniform and appreciably lower bacterial counts than did the other two methods.

PRESENT INVESTIGATIONS

EXPERIMENTAL METHODS

In order to find a method that would give as good results bacteriologically as the heat method but with an increase in the length of life of the rubber parts, the present investigations were undertaken.

In the heat method referred to, the unit, consisting of teat cups, claw, and tubing, after being washed is placed in hot water at a temperature of 160° to 165° F., and allowed to remain there between milkings, the water cooling gradually.

Three single units were used in these tests. They were washed, sterilized,[6] and handled personally by the writer during the entire

[3] HART, G. H., and STABLER, W. H. EXPERIMENTS WITH AND PRACTICAL APPLICATION OF HEAT STERILIZATION FOR ALL PARTS OF MILKING MACHINES. Jour. Dairy Sci. 3: 33–51. 1920.

[4] BURGWALD, L. H. CLEANING MILKING MACHINES. U. S. Dept. Agr. Farmers' Bul. 1315, 16 p., illus. 1923.

[5] BURGWALD, L. H. CLEANING MILKING MACHINES. Jour. Agr. Research 31: 191–195. 1925.

[6] The term "sterilize" used in this paper indicates a condition of practical rather than of absolute sterilization.

period of each test, each unit receiving exactly the same treatment except for the method of sterilizing or the disposition after sterilization.

Immediately after milking, each unit was rinsed by drawing clean, cold water through by vacuum, washed with a brush in hot water (110° to 120° F.) containing washing powder, and rinsed in clean, hot water. The buckets and heads were rinsed in cold water, washed with a brush in hot water containing washing powder, and rinsed in hot water at a temperature above 160° F. They were again rinsed with hot water (above 160° F.) before using.

The units were taken apart after every sixth to eighth milking, and the rubber parts, consisting of teat cups, claw, and tubing were thoroughly washed. In a few cases they were taken apart only once a week.

EFFECT OF DIFFERENT METHODS OF HANDLING MILKING UNITS ON THE BACTERIAL COUNT OF THE MILK

Throughout one set of tests the units were sterilized as follows:

All the units were placed in a tank of hot water at a temperature ranging from 160° to 167° F., the average temperature being about 163°, and the water was allowed to cool gradually. At the end of 20 to 35 minutes, the average time being 30 minutes, two of the units, Nos. 1 and 2, were removed. No. 1 was placed in a refrigerator, and No. 2 was placed in a weak solution of chlorinated lime. A stock solution was made by dissolving a 12-ounce can of chlorinated lime, containing 24 per cent available chlorine, in 1 gallon of water. This was filtered into a glass bottle, stoppered, and kept in a dark, cool place. The soak solution (about 1:20,000), in which unit No. 2 was kept between milkings, was made by using 1 ounce of the stock solution to 3 gallons of water and was made fresh daily. Unit No. 3 remained in the hot water between milkings.

In winter the temperature of the refrigerator in which unit No. 1 was placed after sterilization ranged from 32° to 48° F., the average being 35°. Temperature readings were taken both when the unit was put in and when it was taken out. The temperature of the weak chlorine solution in which No. 2 was kept between milkings and of the water in which No. 3 was kept ranged from 32° to 62°, the average being 45° at the time the units were removed. The bacterial counts of milk drawn in winter with machines handled as described above are given in Table 1.

TABLE 1.—*Summary of bacterial counts obtained in winter from samples of milk drawn with machines handled in various ways after sterilizing*

Method of handling after sterilizing	Number of samples of milk	Range in bacterial count per cubic centimeter	Average bacterial count per cubic centimeter	Samples having a bacterial count of 10,000 per cubic centimeter or less	
				Number	Per cent
Unit No. 1, placed in refrigerator	188	300 to 10,900	3,130	187	99.5
Unit No. 2, placed in weak chlorine solution	186	200 to 9,300	2,320	186	100.0
Unit No. 3, remaining in hot water	184	300 to 7,400	2,660	184	100.0

In summer the temperature of the refrigerator in which unit No. 1 was placed after sterilization ranged from 34° to 60° F., the average

temperature being 40°. Temperature readings were taken both when the unit was put in and when it was taken out. The majority of readings were 36° to 44°. The temperature of the weak chlorine solution in which No. 2 was kept and of the water in which No. 3 was kept between milkings ranged from 60° to 86°, the average temperature being 73° at the time the units were removed. The bacterial counts of milk drawn in summer with machines handled as here described are given in Table 2.

TABLE 2.—*Summary of bacterial counts obtained in summer from samples of milk drawn with machines handled in various ways after sterilizing*

Method of handling after sterilizing	Number of samples of milk	Range in bacterial count per cubic centimeter	Average bacterial count per cubic centimeter	Samples having a bacterial count of 10,000 per cubic centimeter or less	
				Number	Per cent
Unit No. 1, placed in refrigerator	108	600 to 10,700	3,080	107	99.1
Unit No. 2, placed in weak chlorine solution	106	300 to 5,800	1,990	106	100.0
Unit No. 3, remaining in hot water	106	300 to 5,700	2,410	106	100.0

The results of the winter and summer tests combined are shown in Table 3.

TABLE 3.—*Summary of bacterial counts (Tables 1 and 2 combined)*

Method of handling after sterilizing	Number of samples of milk	Range in bacterial count per cubic centimeter	Average bacterial count per cubic centimeter	Samples having a bacterial count of 10,000 per cubic centimeter or less	
				Number	Per cent
Unit No. 1, placed in refrigerator	296	300 to 10,900	3,110	294	99.3
Unit No. 2, placed in weak chlorine solution	292	200 to 9,300	2,200	292	100.0
Unit No. 3, remaining in hot water	290	300 to 7,400	2,570	290	100.0

There was little difference in the results obtained by the three methods as shown in Tables 1, 2, and 3. All were good. The unit placed in a weak chlorine solution after sterilization gave somewhat lower counts than were secured by the other methods, while the unit placed in the refrigerator gave somewhat higher counts. However, the differences were not significant.

In another set of tests with three units, one unit (No. 4) was sterilized in hot water at a temperature of 145° to 150° F., the average temperature being 148°, and allowed to remain therein between milkings, the water cooling gradually. The other two units (Nos. 3 and 5) were sterilized in hot water at a temperature of 160° to 165°, the average temperature being 162°. At the end of 20 to 45 minutes (average 33 minutes) unit No. 5 was removed, hung in a warm room, and protected from dirt and contamination. Unit No. 3 remained in the hot water between milkings, the water cooling gradually, and was used as a control. The temperature of the room in which unit No. 5 was hung after being removed from the hot water ranged from 70° to 82° F., the average temperature being 75.5° F. The results of these experiments are shown in Tables 4 and 5.

TABLE 4.—*Summary of bacterial counts of samples of milk drawn with units sterilized at different temperatures*

Sterilization temperature	Number of samples of milk	Range in bacterial count per cubic centimeter	Average bacterial count per cubic centimeter	Samples having a bacterial count of 10,000 per cubic centimeter or less	
				Number	Per cent
Unit No. 4, 145° to 150°F	142	3,000 to 51,000	11,930	73	51
Unit No. 3 (control), 160° to 165°F	40	700 to 6,000	2,520	40	100

TABLE 5.—*Summary of bacterial counts of samples of milk drawn with units sterilized at 160° to 165° F., and receiving different subsequent treatment*

Disposition of unit after sterilizing	Number of samples of milk	Range in bacterial count per cubic centimeter	Average bacterial count per cubic centimeter	Samples having a bacterial count of 10,000 per cubic centimeter or less	
				Number	Per cent
Unit No. 5, left in hot water for 20 to 45 minutes, then hung in warm room.	154	1,100 to 24,000	5,540	137	89
Unit No. 3 (control), remaining in hot water	40	700 to 6,000	2,520	40	100

The unit sterilized at 145° to 150° F. gave somewhat higher counts than were obtained by the other methods. The unit heated to 160° to 165° for 20 to 45 minutes and then hung in a warm room gave good results, although somewhat higher counts than those shown in Tables 1, 2, and 3.

As a rule, the units were taken apart and thoroughly washed twice a week, but on a few occasions they were taken apart only once a week. Whether they were taken apart once or twice a week, however, seemed to make little if any difference in the bacterial count of the milk, as is shown in Table 6.

TABLE 6.—*Effect of taking units apart frequently for washing, as shown by bacterial counts of milk drawn with a unit sterilized at 160° to 165° F. and allowed to remain in the water between milkings*

Day No.	Number of milkings since unit was taken apart for washing	Number of samples of milk	Range in bacterial count per cubic centimeter	Average bacterial count per cubic centimeter	Average bacterial count per cubic centimeter for total number of samples on first three and on last three days
1	1	39	400 to 7,400	2,910	
	2	41	700 to 5,400	2,660	
2	3	40	400 to 6,500	2,410	2,580
	4	40	300 to 6,700	2,510	
3	5	36	300 to 6,300	2,410	
	6	36	400 to 6,500	2,570	
4	7	28	700 to 4,700	2,200	
	8	25	1,100 to 5,000	2,540	
5	9	14	900 to 5,900	2,660	2,520
	10	7	1,400 to 5,000	2,590	
6	11	11	1,400 to 5,000	2,860	
	12	12	800 to 6,000	2,740	
	Total	329	300 to 7,400	2,560	

It was noted, however, that the rubber tubing had a tendency to stick to the metal parts at times when the unit was taken apart only once a week.

EFFECT OF DIFFERENT METHODS OF HANDLING MILKING UNITS ON THE LENGTH OF LIFE OF THE RUBBER PARTS

A record was kept of the length of life of the rubber parts when different methods of sterilization were employed. The machine used was of the molded rubber teat-cup liner type. The units were generally used to milk four or five cows each at a milking for two milkings a day. Occasionally, however, they were used for only one milking a day.

The teat-cup liners were the first rubber parts to wear out, the rubber tubing outlasting them considerably. The results of tests to determine the length of life of teat-cup liners under different methods of treatment are given in Table 7.

TABLE 7.—*Length of life of teat-cup liners under various methods of sterilization*

Method of sterilizing	Length of life of teat-cup liners	
	Number of milkings	Number of days allowing two milkings a day
Heat method, 160° to 167° F., remaining in water between milkings	175	87.5
Do	188	94.0
Heat method, 160° to 167° F., 20 to 35 minutes, and placed in refrigerator	315	157.5
Heat method, 145° to 150° F., remaining in water between milkings	218	109.0

As here shown the average life of the teat-cup liners was about three months when sterilized at 160° to 167° F. and allowed to remain in the water between milkings. Removing the unit at the end of 20 to 35 minutes and placing it in a refrigerator increased the length of life of the teat-cup liners to a little over five months. The bacterial counts were almost equally as low as those obtained when the unit remained in hot water between milkings, as shown in Tables 1, 2, and 3.

When a sterilizing temperature of 145° to 150° F. was used and the unit was allowed to remain in the water between milkings, the water cooling gradually, the length of life of the teat-cup liners was increased to 109 days. Bacterial counts of the milk samples drawn with this unit were not so low, however, as those obtained by the other methods. Nearly 50 per cent of the samples had a count of over 10,000 per cubic centimeter, as shown in Table 4.

The short rubber milk tubes on the unit heated to 160° to 167° F. and remaining in the water between milkings, lasted for 332 milkings, or 166 days; while the short air tubes and long milk tube lasted for 432 milkings, or 216 days. The tubing on the machines sterilized by the other methods was still in good condition at the end of 267 days, when the tests were discontinued.

A unit sterilized in a saturated brine and chlorine solution (1:5,000) was also used. The teat-cup liners of this unit were employed for 534 milkings, or 267 days, and were still in excellent condition and probably good for a few more months when the tests were discontinued.

SUMMARY

Heating a unit in water at a temperature of 160° to 167° F. for 20 to 35 minutes and then removing it to a refrigerator and keeping it there between milkings increased the length of life of the rubber parts materially over those left in the hot water between milkings. Bacterial counts on samples of milk drawn with the unit which was placed in the refrigerator were very low, being only slightly higher than those in milk drawn with the unit which was left in the hot water.

Bacterial counts made on samples of milk drawn with a unit sterilized at the same temperature and for the same length of time as the one placed in the refrigerator, but placed in a weak chlorine solution (about 1:20,000) between milkings, were even lower than those obtained with the unit which remained in hot water.

Bacterial counts made on samples of milk drawn with the unit sterilized at a temperature of 160° to 165° F. for 20 to 45 minutes, removed and hung in the warm washroom, and protected from dust and contamination between milkings, were fairly low, although considerably higher than those obtained on milk drawn with the unit which remained in hot water between milkings.

The experiments indicate that sterilizing the units at a temperature of 160° to 167° F. for 20 to 35 minutes and placing them in a weak chlorine solution (about 1:20,000) or hanging them in a refrigerator or cold place (below 50°) protected from dust or contamination, will give excellent bacterial results and that the life of the rubber parts will be materially longer than when the units are allowed to remain in the hot water between milkings. Using the same treatment but hanging the units in a clean, warm place gave low bacterial counts, although not quite so low as those obtained by the other methods.

At a temperature of 145° to 150° F. the life of the rubber parts was somewhat longer than at a temperature of 160° to 165°, but the bacterial counts were not nearly so low as at the higher temperatures.

The rubber tubing always outlasted the teat-cup liners.

The heat method of sterilization or any of its variations shortened the life of the rubber parts more than the salt and chlorine methods.

From a bacteriological standpoint, taking the units apart twice a week seemed to have no advantage over once a week when the heat method was used for sterilizing. The rubber tubing, however, had a tendency occasionally to stick to the metal parts when the units were taken apart only once a week.

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