A comparison of the relative merits of quaternaries and of hypochlorites for mastitis sanitation procedures - such as washing teat cups and udders - showed that both types of sanitizers were about equally effective.

Conflicting claims have raised a question in the minds of many dairymen regarding the relative merits of quaternaries and hypochlorites for mastitis sanitation procedures. A brief review of certain fundamental properties of the two types of germicides should indicate their relative advantages and limitations for the various sanitation steps involved. The specific steps in mind in this discussion include washing udders and teats before milking and dipping teat cups in germicidal solution between cows. Another step sometimes carried out consists of dipping the teats in a germicide solution after milking.

The purpose of each of the above sanitation procedures is obvious and needs no elaboration. The common etiologic agents responsible for mastitis also are well established. Among the most important are the group consisting of Streptococcus agalactiae and related species, Streptococcus pyogenes, Micrococcus pyogenes var. aureus, and Micrococcus pyogenes var. albus, Aerobacter aerogenes, Escherichia coli, Pseudomonas aeruginosa, Corynebacterium pyogenes, and occasional other species of microorganisms. In spite of widespread antibiotic and sulfa therapy, the streptococci still are an important causative agent. The micrococci (staphylococci) and coliform species also frequently are responsible for serious infections. Much of the work carried out to evaluate sanitation procedures has utilized streptococci for test agents. The results in general, however, can be applied as well to the other bacterial species if individual characteristics of these are kept in mind.

Prevalence of Some Causative Agents of Mastitis

Segregation of infected cows represents the first important step in mastitis sanitation. This usually has reduced incidence of new infections. The failure of segregation to arrest completely the spread of mastitis in dairy herds may be due in some cases to low-grade, mild infections that are not detected in normal appearing animals, and also to the difficulty of preventing spread of mastitis bacteria throughout the dairy establishment.

Spencer et al.1,2 have shown that although S. agalactiae dies rapidly at normal temperatures, some cells may survive for several days on bedding, and the lower the temperature, the longer is the survival period. Bryan1 was able to isolate S. agalactiae from bedding and dust of dairy barns. Other studies have indicated success in infecting cows with mastitis streptococci inoculated onto bedding.

In an interesting study on possible modes of infection of S. agalactiae, Harrison3 was able consistently to isolate the streptococci from the hands of persons milking cows. He was unable to isolate the organism from hands of non-milkers such as office workers. He considered therefore that S. agalactiae was a member of the resident flora of milkers' hands. In a somewhat similar investigation, Spencer et al.1,2 were able to isolate S. agalactiae from the hands of two men who were hand milkers of an extensively infected herd. They were unable to isolate the organisms from the hands of eight men who used milking machines in infected herds and handled the udders only during the washing and stripping processes.

In most diseases one of the important factors determining whether infection occurs is the number of infective units waiting to invade the host. This undoubtedly is true of most mastitis infections, keeping in mind also the importance of infection.

Dr. P. B. Elliker has been Professor of Dairy Bacteriology at the Oregon State College since 1947. He received his Ph.D. degree from the University of Wisconsin, and served as Assistant and Associate Professor of Dairy Bacteriology at Purdue University, with experience in military research and development in biological warfare. He is Associate and Abstract Editor of the Journal of Dairy Science, has contributed many articles to the dairy and bacteriological literature, and is author of the book Practical Dairy Bacteriology.
juries as a predisposing factor. The above observations then indicate that agents such as hands of milkers and teat cups of milking machines are a frequent cause of transmission and they emphasize further the importance of any sanitation measures that may at least reduce numbers of mastitis bacteria on such surfaces. This reasoning applies regardless of whether the infectious agent is S. agalactiae or some other organisms such as a micrococcus or coliform type.

Further substantiation is presented in the report of Spencer and Kraft11 who followed incidence of infection in twelve herds in which chemotherapy was not practiced. Two herds considered to have satisfactory milking management from the sanitation standpoint showed a progressive increase in infection from 5.26 to 35 percent during the first four lactation periods and this increase then was followed by a decline. On the other hand, ten herds with poor milking management showed an increase from 60.61 to 72.73 percent during the first four lactations followed by a sharp increase. These workers concluded that large herds and poor sanitary practices were associated with high incidence of infection and the degree of exposure outweighed aging of the udder as a cause of increased infection with successive lactations.

Quaternaries and Hypochlorites for Udder and Teat Disinfection

Although the in vitro resistance of most mastitis bacteria to germicides is low10, their destruction on skin surfaces such as the udder and teats is difficult. Spurgeon et al.13 in a study of destruction of S. agalactiae inoculated onto teats of cows found that hypochlorites and quaternaries did not eliminate all the organisms present; however, by rinsing with 250 ppm of either quaternary or hypochlorite, it was possible to destroy about 90 percent of the cells that remained following a rinse with plain water. It also was observed that at least three successive vigorous scrubblings with 300 ppm hypochlorite were necessary to remove all hemolytic streptococci from teats of cows in these trials. In no case were all mastitis streptococci removed or destroyed by a single washing or dipping of teats. The same circumstances would be expected under practical barn conditions and it should be borne in mind therefore that no form of udder wash or teat rinse will destroy all mastitis bacteria unless the procedure is carried out repeatedly several times in succession. Such treatment of course would be impractical for any dairy farm. The significant fact developed in these studies, however, is that both quaternaries and hypochlorites will destroy large numbers of mastitis bacteria present, and any reduction of numbers present should reduce chances for infection accordingly.

Barn trials indicate that quaternaries and hypochlorites provide about equivalent destruction of mastitis streptococci applied to udder and teat surfaces. An average of twelve different tests with two of the more active quaternary and two representative hypochlorite preparations yielded the following percent destruction of S. agalactiae inoculated in large numbers in a milk suspension onto teats: Quaternary A. 90 percent; quaternary B. 95 percent; hypochlorite A. 91 percent; and hypochlorite B. 89.1 percent.13 Nevertheless quaternaries are favored for this udder and teat washing because they usually result in less chapping and irritation of skin surfaces. This has been observed and commented on by many farmers and personal observation has indicated it to be an established fact. The difference in effect of quaternaries and hypochlorites usually is more noticeable in the colder months of the year. The same difference between quaternaries and hypochlorites has been observed with persons who wash or rinse their hands in germicide solution between cows or who wash the cows’ udders with germicidal solution.

Concentrations of germicide recommended for udder and teat disinfection range from 200 to 300 ppm. Individual cloths or towels are recommended and if the same cloth is used on a number of cows precautions should be taken to provide fresh germicide solution after a number of animals are washed in order to maintain germicide strength and a clean solution. In some installations a germicide such as quaternary may be injected into the warm water spray used to wash cows udders and flanks before milking.

One study7 suggests no effect on the final plate count of milk through use of a germicide in udder wash solutions. This would be expected, especially where cows are kept relatively clean. Nevertheless recommendation of a germicide such as quaternary for this procedure seems sound under practical operating conditions. Keith and Reuvers6 also have advocated use of quaternary ammonium compounds for this purpose.

Treatment of Teat Cups Between Cows

Results of a number of investigators5, 9, 10, 11 have emphasized the difficulties involved in destruction of mastitis streptococci on milking machine teat cups. Effectiveness of hypochlorite and quaternary compounds for teat cup disinfection have been reported by Spurgeon et al.14 In these controlled studies sterile teat cups were inoculated with milk suspensions of S. agalactiae and subjected to various treatments. Results of a portion of the trials are shown in tables 1 and 2. The results indicate that a brief but thorough rinsing with cool water followed by a rinse with either 200 ppm hypochlorite or quaternary germicide at 125°F may destroy all but a few of the mastitis streptococci. Complete disinfection by such a procedure is extremely difficult. Increasing the concentration to 500 ppm resulted in
**Mastitis Sanitation**

**Table 1** — Comparative Effectiveness of: (1) A Water Pre-rinse Plus Final Germicide Rinse and (2) Germicidal Pre-rinse Plus Final Germicidal Rinse in Destruction of *S. agalactiae* on Teat Cups

<table>
<thead>
<tr>
<th>No. of trial</th>
<th>Germicide used</th>
<th>Control cup-no. organisms before treatment</th>
<th>70°F water then 125°F water</th>
<th>70°F water then 125°F germicide</th>
<th>70°F germicide then 125°F germicide</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H-A</td>
<td>1605</td>
<td>218</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Q-A</td>
<td>1525</td>
<td>118</td>
<td>43</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>H-A</td>
<td>1515</td>
<td>139</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Q-A</td>
<td>1508</td>
<td>232</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>H-A</td>
<td>1285</td>
<td>122</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Q-A</td>
<td>1535</td>
<td>223</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>H-A</td>
<td>1400</td>
<td>104</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Q-A</td>
<td>1288</td>
<td>175</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

H — Hypochlorite  
Q — Quaternary


**Table 2** — Influence of Physical Condition of Teat Cup Inflations on Destruction of *S. agalactiae* by 250 ppm Hypochlorite and Quaternary Germicide Solutions

<table>
<thead>
<tr>
<th>Trial</th>
<th>Type of inflation</th>
<th>H-A</th>
<th>H-B</th>
<th>Q-A</th>
<th>Q-B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>New</td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>New</td>
<td>4</td>
<td>20</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>Old</td>
<td>116</td>
<td>72</td>
<td>260</td>
<td>225</td>
</tr>
</tbody>
</table>

H — Hypochlorite  
Q — Quaternary


more complete destruction than lower concentrations, but usually a few streptococci again survived. Results of table 1 indicate that merely rinsing with cool water before dipping in germicide solution removes large numbers of organisms inoculated by swabbing teat cups with a milk suspension. The two successive rinses in germicide solution were intended to determine effect of adding a germicide to the cool water in the first rinsing to remove milk solids. Some studies have indicated a repeated recontamination of teat cups from the cool water pail after an infected cow has been milked. It may be desirable to destroy mastitis bacteria in this rinse solution as fast as they are added from infected cows.

Fourt *et al.* and Mueller and Seeley have recommended using an extra head and teat cup assembly for each milking unit. This enables immersion of one teat cup assembly in germicide while the other is in use and thus provides a longer exposure to germicide.

As might be expected, the number of mastitis bacteria inoculated onto teat cups determines how complete destruction by the germicidal rinse will be. When low numbers were inoculated, destruction was almost complete, but higher numbers rendered complete destruction more difficult. Another very important factor is the physical (and possible sanitary) condition of the teat cup inflations. As shown in table 2, old, worn inflations were extremely difficult to disinfect in the mastitis sanitation pro-
procedure. This has been demonstrated repeatedly. Results indicate that a worn and cracked inflation may even approach the condition of a reservoir of mastitis bacteria along with other types.

The marked reduction in every case in numbers of mastitis streptococci on teat cups due to the germicide rinse, and the simplicity of the added step certainly justify its inclusion in the milking procedure. This step together with the udder wash before milking both fit into the fast milking system and occasion hardly any delay in the milking routine. Changing the germicide solution frequently enough to maintain solution strength obviously is desirable. Results indicate about equivalent destruction of mastitis streptococci by quaternaries and hypochlorites. One advantage of quaternaries over hypochlorites for teat cup disinfection in the mastitis sanitation procedure is that a warm solution of hypochlorite may cause faster deterioration of rubber inflations due to the oxidizing effect of the hypochlorite. Quaternaries also may avoid chapping of teat surfaces coming in contact with the germicide on the disinfected teat cups.

Species of bacteria such as M. pyogenes aureus may show greater resistance to action of some germicides than does S. agalactiae but the sanitation principles developed in the studies on mastitis streptococci in general should apply as well to other causative bacteria.

The question of quaternary contamination of milk from teat cup disinfection procedures is frequently brought up. Studies indicate that this step with reasonable care introduces an insignificant quantity of quaternary into the milk. Equipment such as pails, strainers, surface coolers and cans, sanitized with quaternary instead of hypochlorite may contribute detectable quantities of quaternary to the milk. Quantities of quaternary contributed by proper mastitis sanitation procedures have been below detectable levels.

References
12. Spencer, G. R., McCarty, Janet and Beach, B. A. Reservoirs of Infection of Streptococcus agalactiae. Ibid., 7, 32 (1946).

Thermal Methods
(continued from page 21)

for or adaptable to the measurement of holding time by thermal methods were compared with those obtained with the 3-A standard salt test. These comparative tests were run on two pasteurizers with capacities of about 3,000 and 6,000 pounds per hour, respectively. The correction factor, or difference between the holding times as measured by the salt test and a particular thermal test, varied with the different instruments when they were used on the same pasteurizer. The correction factors also varied when the same instrument was used on different pasteurizers. Correction factors found in these tests ranged from about 0.4 second to 8.0 seconds.

When the experimental, 6,000-pound-per-hour pasteurizer was operated at 75 percent of its rated capacity, there was a marked increase in the correction factor over that found for the normal capacity. Increasing the capacity of the pasteurizer 25 percent above normal caused little change in the correction factor.

The holding time, and hence the correction factor, varied with the pasteurization temperature when using a thermal timer with a preset response point. With a pasteurizer operated at 6,200 pounds of water per hour, the correction factor went from 5.78 seconds at 159°F to 2.62 seconds at 162°F when the response point for both bulbs was set at 162.4°F.