quent appraisal of the presence of the antibiotic and pesticide residues will become a costly burden. Many of the analytical procedures thus far developed are specific, and require extensive and expensive laboratory facilities and personnel. There are in use many pesticide agents, many of which may become adulterants; the use of antibiotics in feeds is increasing. Some practical means must be found to both reduce, and properly assign, the cost of these appraisals, and the supervision in control of use of the agricultural chemicals.

COTERIE OF THOUGHTS

Finally, in this coterie of thoughts, it may be wise to reflect that the problems of use of antibiotics will not become simpler by legislative fiat. The population of the world is increasing; the sobering thought is that surpluses exist only in the western world, and food deficiency is possible even in a foreseeable future. Man and his cultivated food supplies have many enemies: diseases, pestilence, insects, weeds. It has been stated that the effectiveness of one man in a chemical factory is equivalent in agricultural productivity to the work of 4,000 men armed with hoes. Thus, in the foreseeable future, the uses of agricultural chemicals, begun in France only some 20 years ago, will probably be with us a long time to come.

THE INCIDENCE OF POTENTIALLY PATHOGENIC STAPHYLOCOCCI IN DAIRY PRODUCTS AT THE CONSUMER LEVEL

I. FLUID MILK AND FLUID MILK BY-PRODUCTS

V. D. FOLTZ,1 Ross MICKELSEN,2 W. H. MARTIN,3 and CHARLES A. HUNTER4

Kansas Agricultural Experiment Station, Manhattan
(Received for publication May 7, 1960)

Two hundred and seven samples of pasteurized dairy products obtained from consumer marketing channels were analyzed for the presence of staphylococci. Potentially virulent coagulase positive staphylococci were isolated from 3.4 percent of the samples examined. All of the various classes of products studied contained staphylococci; however, not all samples within a class contained the organism. The presence of coliform organisms and staphylococci did not correlate positively, leaving some question as to the source of contamination.

Research findings have shown a trend toward the development of antibiotic-resistant pathogenic staphylococci in dairy cattle undergoing mastitis therapy (11, 12, 13). McCoy (9) suggests the danger of the staphylococci developing resistance to some antibiotics and thereby limiting their use in treating human and animal infections. Numerous reports have indicated that antibiotic-resistant staphylococci have caused infections in hospital surgical patients and infants in nurseries throughout the country (4). Aside from this potential danger, is the ever-present menace of staphylococcal food poisoning. Increased incidence of staphylococci in the udder of dairy cattle has added significance to this problem (9). Recent reports incriminating dairy products in outbreaks of staphylococcal food poisoning have focused attention on the need for research in this area (2, 3, 7).

Increased importance of the problem and relatively little information available on it, prompted this survey of the incidence of potentially pathogenic staphylococci in dairy products at the consumer level. This paper reports results of studies on fluid milk and fluid milk by-products in original containers at the consumer level. Subsequent papers will report the results of similar examinations of powdered milk and a wide variety of cheese and frozen dairy products.

Experimental Procedure

Samples.

Two hundred and seven samples of pasteurized dairy products processed in 42 plants were obtained during June and July, 1959, from retail outlets throughout Kansas. The samples included the following products: milk, low-fat milk, chocolate drink or chocolate milk, cultured buttermilk, half and half, coffee cream, and whipping cream.

The samples were held under refrigeration (35°F).
from the time of collection until analyses were started. Total elapsed time never exceeded 12 hours.

**Bacteriological Examination.**

**Presumptive examination for staphylococci.** Both Tellurite-Glycine (TG) agar recommended by Zebovit et al. (15) and Staphylococcus Medium No. 110 (S-110) (5) were used for the initial isolation of staphylococci.

A 0.25-ml volume of each sample of dairy product was aseptically transferred to plates of TG and S-110 media. The surface plating technique of Snyder (14) was used to spread the sample over the plates. After inoculation, the TG plates were incubated at 37°C for 24 hours, and the S-110 plates were incubated at 37°C for 43 hours.

In addition, an enrichment procedure was used in which 1 ml. of each sample was transferred to 10 ml of enrichment broth consisting of Staphylococcus Medium No. 110 minus the gelatin and agar. The broth culture was incubated at 37°C for 24 hours after which aliquots were transferred to and incubated on TG and S-110 plates as described. After the TG and S-110 plates were inoculated with the broth culture, they were designated TGE and S-110E to differentiate between organisms obtained directly from the dairy product and organisms obtained from the product via the enrichment.

**Proof of isolation.** Isolates from the TG, S-110, TGE and S-110E plates were examined for morphological characteristics, Gram stain and anaerobic growth in the lower portion of a deep shake tube of glucose yeast extract agar.

**Determining potential pathogenicity.** Potential pathogenicity was determined on the basis of accepted criteria, that is, pigmentation, gelatinase activity, mannitol fermentation, coagulase production (citrated human plasma) and hemolysins on sheep blood agar.

**Antibiotic sensitivity.** Sensitivity to antibiotics was determined using antibiotics commonly used in mastitis therapy and antibiotics used in human therapy of staphylococcal infections (Antibiotic Sensitivity Disks, Difco).

**Bacteriophage typing.** Bacteriophage patterns were determined on coagulase positive cultures. All bacteriophage typing was done at the Regional Bacteriophage Typing Center, Kansas State Board of Health Laboratories, Topeka. This laboratory follows the recommendation for bacteriophage typing as established by the National Reference Laboratory, Laboratory Branch, Communicable Disease Center, U.S.P.H.S., Chamblee, Georgia.

**Coliform counts.** Coliform counts were made with Violet Red Bile agar (V.R.B.) (Difco) to establish whether a correlation existed between the number of coliform organisms in a dairy product and potentially pathogenic staphylococci.

**RESULTS**

The data showing incidence of staphylococci in the dairy products analyzed are presented in Table 1. All of the classes of products analyzed contained staphylococci. However, not all of the samples within each individual class contained the organisms.

Six of the seven classes of products examined contained *Staphylococcus aureus* and all seven classes contained *Staphylococcus epidermidis*. Twenty-five potentially virulent coagulase positive cultures were isolated from four of the seven classes of products studied. These cultures were obtained from seven product samples produced in seven processing plants. A chi square test indicated (.50 < P < .70) that

---

**Table 1—Isolations of Staphylococci from Dairy Products in Consumer Marketing Channels**

<table>
<thead>
<tr>
<th>Product</th>
<th>No. samples examined</th>
<th>Samples containing staphylococci</th>
<th>Samples containing Staph. epid.</th>
<th>Samples containing Staph. aureus</th>
<th>Samples containing both Staph. epid. and Staph. aureus</th>
<th>Samples containing coagulase positive staph.</th>
<th>No. of coagulase positive cultures isolated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past. milk</td>
<td>86</td>
<td>23 (26.7)</td>
<td>17 (19.8)</td>
<td>12 (14.0)</td>
<td>6 (7.0)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Low fat</td>
<td>28</td>
<td>12 (42.9)</td>
<td>10 (35.7)</td>
<td>3 (10.7)</td>
<td>1 (3.6)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Choc. milk</td>
<td>10</td>
<td>1 (10.0)</td>
<td>1 (10.0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Buttermilk</td>
<td>15</td>
<td>3 (20.0)</td>
<td>1 (6.7)</td>
<td>2 (13.3)</td>
<td>0 (0)</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>35</td>
<td>10 (28.6)</td>
<td>5 (14.3)</td>
<td>6 (17.1)</td>
<td>1 (2.9)</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Coffee cream</td>
<td>6</td>
<td>2 (33.3)</td>
<td>1 (16.7)</td>
<td>2 (33.3)</td>
<td>1 (16.7)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Whipping cream</td>
<td>27</td>
<td>11 (40.7)</td>
<td>10 (37.0)</td>
<td>2 (7.4)</td>
<td>1 (3.7)</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

*Staphylococci differentiated from micrococi on the basis of anaerobic growth in glucose medium.

*Staphylococcus epidermidis* differentiated from *Staphylococcus aureus* on the basis of mannitol fermentation.
The level of staphylococcal contamination was essentially the same for all classes of dairy products analyzed. A chi square test also indicated (.20>P>.10) that the level of contamination was essentially the same in the products processed in the various plants.

The pigmentation, hemolysins, bacteriophage patterns and lytic groups of the coagulase positive organisms are presented in Table 2. None of the coagulase positive organisms was resistant to any of the eleven antibiotics tested. However, twelve of the coagulase negative Staphylococcus aureus and eight Staphylococcus epidermidis cultures showed resistance to one or more antibiotics. Seven cultures of coagulase negative Staphylococcus aureus and ten cultures of Staphylococcus epidermidis were hemolytic. Data on the antibiotic resistance and hemolytic patterns of the coagulase negative organisms are presented in Table 3.

In comparing the relationship between coliform organisms and staphylococci, contingency chi squares were nonsignificant, indicating that the presence of coliform organisms and staphylococci were the result of chance.

**DISCUSSION**

Coagulase positive staphylococci were isolated from 3.4 percent of the products examined. That potentially virulent organisms were present in even a low percentage of the products warrants the attention of the dairy industry. Improper refrigeration of the products before they were consumed could result in high populations of staphylococci with accompanying enterotoxin formation. There is no implication that enterotoxin was present in samples examined, but potentially pathogenic organisms were isolated and their virulence determined according to generally accepted criteria. Analysis for staphylococcus enterotoxin was not made because of the lack of an acceptable laboratory test.

Three of the seven products containing coagulase

---

**Table 2—Characterization of Coagulase Positive Staphylococci Isolated From Marketed Dairy Products**

<table>
<thead>
<tr>
<th>Type product</th>
<th>Product sample No.</th>
<th>Culture number(s)</th>
<th>Isolation medium</th>
<th>Pigmentation</th>
<th>Hemolysins</th>
<th>Bacteriophage pattern</th>
<th>Concentrated</th>
<th>Lytic group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>194</td>
<td>229*</td>
<td>TGE, 110E, TG</td>
<td>white</td>
<td>a</td>
<td>42D, 81</td>
<td>N.T.*</td>
<td>IV. and Uncl</td>
</tr>
<tr>
<td>Buttermilk</td>
<td>35</td>
<td>72, 63, 71</td>
<td>TGE, 110E, TG</td>
<td>orange</td>
<td>a</td>
<td>42D, 81</td>
<td>IV. and Uncl</td>
<td></td>
</tr>
<tr>
<td>Buttermilk</td>
<td>35</td>
<td>64</td>
<td>TGE</td>
<td>white</td>
<td>a</td>
<td>42D, 81</td>
<td>IV. and Uncl</td>
<td></td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>75</td>
<td>25</td>
<td>TG</td>
<td>orange</td>
<td>a &amp; β</td>
<td>42D, 81</td>
<td>N. T.</td>
<td>IV. and Uncl</td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>75</td>
<td>78, 80, 90, 110, 96, 103</td>
<td>orange</td>
<td>a</td>
<td>44A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>179</td>
<td>94</td>
<td>TG</td>
<td>orange</td>
<td>a</td>
<td>79, 7, 44A</td>
<td>I, III. and Uncl</td>
<td></td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>179</td>
<td>236</td>
<td>110E</td>
<td>white</td>
<td>a &amp; β</td>
<td>42D</td>
<td>IV.</td>
<td></td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>179</td>
<td>196</td>
<td>TG</td>
<td>orange</td>
<td>a &amp; β</td>
<td>42D</td>
<td>IV.</td>
<td></td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>179</td>
<td>190, 239</td>
<td>110, 110E</td>
<td>orange</td>
<td>a &amp; β</td>
<td>44A</td>
<td>Uncl</td>
<td></td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>179</td>
<td>188, 189</td>
<td>TG</td>
<td>orange</td>
<td>a &amp; β</td>
<td>44A</td>
<td>Uncl</td>
<td></td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>179</td>
<td>224</td>
<td>TGE</td>
<td>orange</td>
<td>β</td>
<td>42D</td>
<td>IV.</td>
<td></td>
</tr>
<tr>
<td>Half &amp; Half</td>
<td>179</td>
<td>225</td>
<td>TGE</td>
<td>orange</td>
<td>β</td>
<td>7, 42E, 83(VA4)</td>
<td>III. and Uncl</td>
<td></td>
</tr>
<tr>
<td>Whipping cream</td>
<td>201</td>
<td>231</td>
<td>110E</td>
<td>orange</td>
<td>β</td>
<td>7, 42E, 83(VA4)</td>
<td>III. and Uncl</td>
<td></td>
</tr>
<tr>
<td>Whipping cream</td>
<td>201</td>
<td>201</td>
<td>TG</td>
<td>white</td>
<td>—</td>
<td>N. T.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whipping cream</td>
<td>201</td>
<td>202</td>
<td>TG</td>
<td>orange</td>
<td>—</td>
<td>N. T.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whipping cream</td>
<td>201</td>
<td>212</td>
<td>110</td>
<td>orange</td>
<td>a &amp; β</td>
<td>3B, 42E</td>
<td>II., III.</td>
<td></td>
</tr>
<tr>
<td>Whipping cream</td>
<td>207</td>
<td>193</td>
<td>TG</td>
<td>orange</td>
<td>—</td>
<td>N. T.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Critical Test Dilution
*Critical Test Dilution x 1,000

**Staph. epidermidis**

a = Alpha hemolysins
β = Beta hemolysins
positive staphylococci, yielded organisms which had bacteriophage patterns falling within lytic group III where virtually all of the food poisoning strains have been found (1). Also of significance were organisms having bacteriophage pattern 81, isolated from samples of buttermilk and half and half. Organisms having bacteriophage pattern 81 deserve special consideration because they have been predominant in outbreaks of staphylococcal infections arising in hospital nurseries (8).

That staphylococci were present in a rather high percentage of the samples examined is significant. Since all of the samples were taken at the consumer level, the source of contamination can only be postulated. Post-pasteurization contamination should not be overlooked as a source of staphylococci. This problem needs additional research.

It is generally recognized that, except for pyogenic infections, the most important reservoir of Staphylo-

coccus aureus is the nose and upper respiratory tract of normal humans and some animals (6, 10). It is known that these organisms are normally discharged from the nose and transferred from person to person to contaminate the environment and to establish clinical infections where susceptible tissues are available. This suggests that dairy plant workers might be a reservoir of contamination.

REFERENCES


3. Armijo, R., Henderson, D. A., Timothee, R., and Robin-

Make Your Plans Now To Bring Your Wife And —— If Possible—— Give Us Some Indication That You Expect To Bring Her So That We May Know How Much Of An Entertainment Program To Plan.

While Chicago Has Many Activities—A Bus Trip To Hagger Potteries Should Be A Must —— And— I Am Sure Many Of Your Wives Will Enjoy Don McNeill’s Breakfast Club Which Is Going On Every Morning They Are Here.

THE 47TH ANNUAL MEETING
HOTEL MORRISON, CHICAGO, ILL.
OCTOBER 26, 27, 28, 29.