The rapidly increasing amounts of frozen foods of the so-called "heat and eat" variety and other available to the housewife have created possible potential public health hazards. Proper evaluation of such possibilities by health authorities involves the availability of accurate, complete bacteriological laboratory data. Presented in this survey, are the bacteriological results of 192 assorted frozen food samples purchased at the retail level in the Oklahoma City area, and tested during a 17 month period. The question is raised concerning the wisdom of using the coliform group bacteria as indicators of sanitation or contamination. The results tend to point up the need for federal authorities to determine a course of action which would best enable them to apply bacteriological standards in order that the consumer may be assured wholesome, high quality products at all times.

Approximately thirty years ago, the public was introduced to a new concept in out-of-season food purchase - quick frozen foods. Almost immediate and enthusiastic acceptance by the public occurred. In 1939, the industry packed 325 million pounds of frozen foods; in 1959, production reached approximately 6 billion pounds of food products valued at $3 billion. Additional new so-called convenience foods which the housewife needs only to "heat and eat" are constantly being added to the grocer's inventory. These products may be contaminated easily and they are highly perishable. Through faulty handling practices they may become thereby hazardous to public health. Procter (1) and Fitzgerald (2) in 1947, reported high bacterial counts of ready-to-eat frozen foods and pointed out the hazards. Health officials throughout the nation continue to be hard pressed attempting to keep up with these new ever-increasing products. They recognize a need for some broad overall evaluation as it affects public health, but lack sufficient laboratory information to logically approach the problem.

The study was undertaken (a) to determine whether a public health problem exists (b) to determine bacterial populations as a helpful guide in establishing reasonable bacterial standards, and (c) to supply health officials with additional information from the bacteriological standpoint.

### Table 1—Bacteriological Results of Frozen Pre-cooked Turkey Pies.

<table>
<thead>
<tr>
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<th>Coliform count/gm</th>
</tr>
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<td>60</td>
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<td>Apr 60</td>
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<tr>
<td></td>
<td>Sep 60</td>
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<td>60b</td>
</tr>
<tr>
<td></td>
<td>Sep 60</td>
<td>420,000</td>
<td>110a</td>
</tr>
<tr>
<td></td>
<td>Sep 60</td>
<td>370,000</td>
<td>180b</td>
</tr>
<tr>
<td>Brand &quot;G&quot;</td>
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<td>Feb 61</td>
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</tr>
<tr>
<td>Brand &quot;H&quot;</td>
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<td>85,000</td>
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</tr>
</tbody>
</table>

*aCoagulase-positive staphylococci isolated (1,000/gm)*
*bCoagulase-positive staphylococci isolated (11,000/gm)*
*cCoagulase-positive staphylococci isolated (10,000/gm)*
*dCoagulase-positive staphylococci isolated (18,000/gm)*
*eCoagulase-positive staphylococci isolated (11,000/gm)*
All samples were transported to the laboratory in an insulated carrying case containing dry ice. In the laboratory, they were immediately placed in the deep freeze and kept at a temperature of -25°C until tested. Before testing, the samples were thawed at room temperature, and 50 grams were removed aseptically into a sterile Waring blender jar containing 450 ml of sterile buffered distilled water and blended for 2 minutes. From this 1:10 dilution, further dilutions of 1:100, 1:1,000, 1:10,000 and 1:100,000 were made.

Standard plate counts were made of the above dilutions using a milk protein hydrolysate agar medium and an incubation period of 48 hrs ± 3 at 35°C.

For the coliform determinations (3), violet red bile agar was used and the plates incubated 18-24 hours at 35°C. All coliforms were confirmed as coliforms.

### Table 2—Bacteriological Results of Frozen Pre-cooked Chicken Pies

<table>
<thead>
<tr>
<th>Source</th>
<th>Date purchased</th>
<th>Total plate count/gm</th>
<th>Coliform count/gm</th>
</tr>
</thead>
<tbody>
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<td>110</td>
</tr>
<tr>
<td></td>
<td>Feb 60</td>
<td>1,100,000</td>
<td>170</td>
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<tr>
<td></td>
<td>Mar 60</td>
<td>28,000</td>
<td>0</td>
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<td></td>
<td>Mar 60</td>
<td>1,100,000</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Nov 60</td>
<td>22,000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Nov 60</td>
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</tr>
<tr>
<td>Brand “B”</td>
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<td>1,000,000</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Feb 60</td>
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</tr>
<tr>
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<td>Jul 60</td>
<td>8,400</td>
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<td></td>
<td>Jul 60</td>
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<tr>
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<tr>
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<td>Aug 60</td>
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<td>Brand “C”</td>
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<td>Oct 59</td>
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<td></td>
<td>Jul 60</td>
<td>97,000</td>
<td>10</td>
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<td>Jul 60</td>
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</tr>
<tr>
<td>Brand “D”</td>
<td>Dec 59</td>
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</tr>
<tr>
<td></td>
<td>Dec 59</td>
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</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>Jul 60</td>
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</tr>
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<td>970</td>
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</tr>
<tr>
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<td>Jan 60</td>
<td>880</td>
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</tr>
<tr>
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<td>Jun 60</td>
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<td>Jul 60</td>
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<tr>
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<tr>
<td>Brand “F”</td>
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<td>Jul 60</td>
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### Table 3—Bacteriological Results of Frozen Pre-cooked Beef Pies

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<th>Coliform count/gm</th>
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</thead>
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<tr>
<td></td>
<td>Mar 60</td>
<td>60,000</td>
<td>420</td>
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<tr>
<td></td>
<td>Mar 60</td>
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</tr>
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<td>Apr 60</td>
<td>500</td>
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<td>Apr 60</td>
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<td>760</td>
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<td>Apr 60</td>
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<td>Apr 60</td>
<td>4,900</td>
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<td></td>
<td>Jul 60</td>
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<td></td>
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### Methods and Results

Funds for this study were furnished by the Research Grants Committee of the Oklahoma Public Health Association and were used solely for the purchase of the frozen foods at the retail level. Work began on October 1959, and continued until available funds were exhausted in March 1961. A total of 192 samples were purchased and tested. Not more than 12 samples were purchased at any one time, and not more than 6 were tested in any one week period during the entire 17 month period of the project.
A Bacteriological Investigation of Frozen Foods

by inoculation of resulting colonies into a 2% brilliant green lactose bile broth. This was done to eliminate the possibility of false positive coliform counts due to the presence of sucrose and/or other substances present in the frozen food product which might be carried over into the dilutions in sufficient amounts for bacteria other than coliforms to act biochemically as coliforms.

Mannitol salt agar plates, incubated for 48 hours at 35°C, were used to determine the presence of possible food-poisoning staphylococci, and if found, the usual coagulase tests were performed. Blood agar plates were used to determine the presence of beta hemolytic organisms.

The search for species of Salmonella was conducted using an enrichment medium of selenite broth followed by transfer to SS agar. All suspicious colonies found on this medium were transferred to TSI agar tubes and the usual biochemical procedures followed to determine their presence or absence as well as that of other enteric pathogens.

The tested products consisted of all available brands (including nationally-known brands) from as many different retail establishments as it was possible to visit in the Oklahoma City area. Initially, the main effort was directed toward obtaining a significant number of beef, and poultry pot pies; later, selection of samples became more varied in order that a rather general bacteriological picture could be obtained of most frozen food products which would be of interest to the health official. An attempt also was made to divide the purchasing of samples equally among the fall, winter, spring and summer in order to determine the effect, if any, of the extremes of weather on the bacteriologic populations of frozen foods.

A total of 192 samples were examined. Of this number, 135 consisted of turkey, chicken, and beef pot pies and the so-called TV dinners involving 9 brands of approximately 6 samples each.

Table 4—Bacteriological Results of Frozen TV Dinners.

<table>
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<th>Source</th>
<th>Date purchased</th>
<th>Total plate count/gm</th>
<th>Coliform count/gm</th>
</tr>
</thead>
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<td></td>
<td></td>
</tr>
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<td>(turkey)</td>
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</tr>
<tr>
<td></td>
<td>Feb 60</td>
<td>10,000</td>
<td>10</td>
</tr>
<tr>
<td>(chicken)</td>
<td>Feb 60</td>
<td>17,000,000</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Feb 60</td>
<td>1,700,000</td>
<td>130</td>
</tr>
<tr>
<td>(beef)</td>
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<td>8,100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Feb 60</td>
<td>11,000</td>
<td>0</td>
</tr>
<tr>
<td>Brand “C”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(beef)</td>
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<td>10</td>
</tr>
<tr>
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<td>40</td>
</tr>
<tr>
<td>(turkey)</td>
<td>Apr 60</td>
<td>7,900</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 5—Bacteriological Results of Frozen Sea Foods.

<table>
<thead>
<tr>
<th>Product</th>
<th>Date purchased</th>
<th>Total plate count/gm</th>
<th>Coliform count/gm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halibut steaks</td>
<td>Nov 59</td>
<td>7,600</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Nov 59</td>
<td>6,200</td>
<td>20</td>
</tr>
<tr>
<td>Sole fillets</td>
<td>Mar 61</td>
<td>9,400</td>
<td>0</td>
</tr>
<tr>
<td>Ocean perch</td>
<td>Mar 61</td>
<td>550,000</td>
<td>0</td>
</tr>
<tr>
<td>Fillet of cod</td>
<td>Feb 61</td>
<td>12,000</td>
<td>0</td>
</tr>
<tr>
<td>Haddock</td>
<td>Feb 61</td>
<td>13,000,000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(French-fried)</td>
<td>194,000</td>
<td>30</td>
</tr>
<tr>
<td>Catfish sticks</td>
<td>Nov 59</td>
<td>88,000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Nov 59</td>
<td>96,000</td>
<td>0</td>
</tr>
<tr>
<td>Fish sticks</td>
<td>Jan 61</td>
<td>270,000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Feb 61</td>
<td>6,900</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Feb 61</td>
<td>4,300</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mar 61</td>
<td>6,000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mar 61</td>
<td>27,000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mar 61</td>
<td>38,000</td>
<td>0</td>
</tr>
<tr>
<td>Shrimp creole</td>
<td>Jan 61</td>
<td>390,000</td>
<td>0</td>
</tr>
<tr>
<td>Fish cakes</td>
<td>Feb 61</td>
<td>8,600</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Feb 61</td>
<td>1,800</td>
<td>0</td>
</tr>
<tr>
<td>Tuna pie</td>
<td>Jan 61</td>
<td>240</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Jan 61</td>
<td>400</td>
<td>0</td>
</tr>
<tr>
<td>Breaded shrimp</td>
<td>Mar 61</td>
<td>290,000</td>
<td>0</td>
</tr>
<tr>
<td>Stuffed shrimp</td>
<td>Jan 61</td>
<td>2,300,000</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Jan 61</td>
<td>5,400,000</td>
<td>500</td>
</tr>
<tr>
<td>Crab sticks</td>
<td>Jan 61</td>
<td>23,000</td>
<td>30</td>
</tr>
<tr>
<td>Lobster newburg</td>
<td>Feb 61</td>
<td>34,000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mar 61</td>
<td>18,000</td>
<td>0</td>
</tr>
<tr>
<td>Breaded oysters</td>
<td>Feb 61</td>
<td>110,000</td>
<td>290</td>
</tr>
<tr>
<td></td>
<td>Feb 61</td>
<td>100,000</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Feb 61</td>
<td>85,000</td>
<td>160</td>
</tr>
<tr>
<td>Scallops</td>
<td>Nov 60</td>
<td>800</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Feb 61</td>
<td>2,000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mar 61</td>
<td>190,000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mar 61</td>
<td>510</td>
<td>0</td>
</tr>
<tr>
<td>Crab meat</td>
<td>Jan 61</td>
<td>1,200</td>
<td>0</td>
</tr>
<tr>
<td>Crab legs</td>
<td>Mar 61</td>
<td>620</td>
<td>0</td>
</tr>
<tr>
<td>Devilish</td>
<td>Nov 60</td>
<td>430,000</td>
<td>0</td>
</tr>
<tr>
<td>Crab cakes</td>
<td>Feb 61</td>
<td>35,000</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 1 shows the total bacteria counts and coliform counts for turkey pies of all brands tested. Fourteen or 35% of the 40 samples had total plate counts of over 100,000 per gram. If the standard of less than 10 coliforms is used as required by the Quartermaster Food and Container Institute, 19 or 47% did not meet these requirements. Brands “D” and “E” had total counts well below the 100,000 level and indicated that some of the manufacturers have no difficulty meeting this requirement.

One sample of brand “B” showed 1,000 coagulase-positive staphylococci per gm and 4 of the 6 samples of brand “F” had coagulase-positive staphylococcal counts ranging from 10,000 to 18,000 per gram. Products such as these are potentially hazardous.

Table 2 lists the results of tests on 45 chicken pies; 10 or 22% exceeded 100,000 per gram and 21 or 46% of the pies had 10 or more coliforms per gram.
Table 6—Bacteriological Results of Frozen Miscellaneous Foods.

<table>
<thead>
<tr>
<th>Product</th>
<th>Date purchased</th>
<th>Total plate count/gm</th>
<th>Coliform count/gm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pig in blanket</td>
<td>Oct 59</td>
<td>36,000</td>
<td>0</td>
</tr>
<tr>
<td>Meat loaf</td>
<td>Oct 59</td>
<td>52,000</td>
<td>0</td>
</tr>
<tr>
<td>Beef steaks</td>
<td>Jan 60</td>
<td>1,300,000</td>
<td>430</td>
</tr>
<tr>
<td>Roast beef hash</td>
<td>Jan 61</td>
<td>1,800,000</td>
<td>1,300*</td>
</tr>
<tr>
<td>Spaghetti dinner</td>
<td>Feb 61</td>
<td>360,000</td>
<td>0</td>
</tr>
<tr>
<td>Hot tamales</td>
<td>Mar 61</td>
<td>1,200</td>
<td>0</td>
</tr>
<tr>
<td>Sausage pizza</td>
<td>Aug 60</td>
<td>5,000</td>
<td>0</td>
</tr>
<tr>
<td>Chicken</td>
<td>Aug 60</td>
<td>850,000</td>
<td>0</td>
</tr>
<tr>
<td>Chow mein</td>
<td>Jan 61</td>
<td>400,000</td>
<td>0</td>
</tr>
<tr>
<td>Creamed chicken &amp; biscuits</td>
<td>Jan 60</td>
<td>1,500</td>
<td>0</td>
</tr>
<tr>
<td>Tenderoni &amp; beef in tomato sauce</td>
<td>Jan 60</td>
<td>690</td>
<td>0</td>
</tr>
<tr>
<td>Macaroni &amp; cheese casserole</td>
<td>Jan 61</td>
<td>40,000</td>
<td>0</td>
</tr>
<tr>
<td>Spaghetti &amp; meat sauce</td>
<td>Jan 61</td>
<td>760</td>
<td>0</td>
</tr>
<tr>
<td>Escalloped chicken &amp; noodles</td>
<td>Feb 61</td>
<td>790</td>
<td>0</td>
</tr>
</tbody>
</table>

*Coagulase-positive staphylococci isolated (12,000 col. per gram)

Table 3 lists 39 beef pie samples of which only 6 or 15% exceeded 100,000 per gram; however, 18 or 46% had coliform counts of 10 or more per gram.

November so-called TV dinners listed in table 4 consisted of two brands. Two chicken dinners purchased in February 1960 showed total counts of 1,700,000 and 17,000,000.

Thirty-nine assorted sea foods consisting of 10 brands were also examined and the results are listed in Table 5. Thirty-three percent exceeded a total plate count of 100,000 per gram, while 28% did not meet the coliform requirement.

In Table 6 are listed 18 samples consisting of 9 brands of assorted miscellaneous foods.

Discussion

Fifty of the 192 samples or 26% had total plate counts exceeding 100,000 per gram. One of the samples (sausage pizza pie) presented an interesting observation. It is a well-known fact that starter cultures are used in cheese manufacture, also, one or more types of cheese are normal ingredients in most frozen pizza pies. These cheese usually are placed on top of the pies last and then the pies are frozen. Any laboratory examination of such a product would normally include portions of such cheese in the natural, unmelted state. High total counts would be expected. To verify this, a package of cheese sold primarily for use with pizza pies was purchased and tested. The total viable bacteria count was 120,000,000 per gram. Obviously, pizza pies manufactured in this manner should not and cannot be included with those products for which total bacterial standards apply.

No doubt there are other ingredients in frozen food products which reach the consumer in the raw state, and therefore, should be taken into consideration when determining bacterial populations and applying standards. However, this study does show that the suggested maximum level of 100,000 per gram is more than a reasonable standard as evidenced by many manufacturers having no difficulty producing such products with total plate counts far below this level.

Six of the samples examined showed the presence of coagulase-positive staphylococci with counts ranging from 1,000 to 18,000,000 per gram. There were no species of Salmonella or other enteric pathogens isolated from any of the 192 samples.

The Quartermaster Food and Container Institute standard of less than 10 coliforms per gram brings up the wisdom of using the coliform group bacteria as indicators of sanitation or contamination. Approximately 40% of the samples in this study would not have been able to meet these requirements.

Kereluk and Anderson (4), in a study on the bacteriological quality of frozen meat pies, showed that the predominant source of coliforms was of non-fecal origin and that these coliforms were identified as members of the genus Aerobacter.

All of the pot pies studied in this project had pie shells made of raw dough. Obviously this dough could contain bacteria of the coliform group not necessarily associated with a fecal source. Hartman (5), in a study of coliforms in frozen food products, recently stated, "Until non-fecal coliforms are shown to indicate contamination from a "dangerous source" there is no reason to believe that these types of coliform bacteria, just because they form a colony on violet red bile agar, should be considered any less desirable in pot pies than other innocuous microorganisms." Other workers have commented on some of the inadequate aspects of using coliforms as indicators of pollution.

It would appear that the presence of coliform organisms not of fecal origin does not necessarily indicate that the foods were cooked insufficiently or that they were contaminated after cooking or during processing prior to freezing. As previously mentioned, these coliforms may be only natural inhabitants of the various ingredients used in the manufacture of the frozen food products. The entire coli...
form problem relating to frozen foods may need to be re-studied and re-evaluated. Certainly, it would appear, that to set standards of so many coliforms per gram, would necessitate proof of their fecal origin or of their originating from some other source considered “dangerous.”

No significant trend in bacterial population was associated with any of the spring, summer, fall or winter seasons.

NEWS AND EVENTS

ADSA COMMITTEE TO ADVISE DSI ON TECHNICAL MATTERS

Dr. R. F. Holland of Cornell University was named Chairman of a newly formed American Dairy Science Association Advisory Committee to Dairy Society International, it was announced by Dr. E. L. Jack, ADSA President and George W. Weigold, DSI’s Managing Director.

A wide range of technical questions come to the Society from its members in some 45 countries, in its capacity as the official Cooperator with the Foreign Agricultural Service (USDA) in market development programs under Public Law 480, as the industry focal point for dairy-industry-interested visitors to the United States and as a result of its liaison and consultative status with United Nations agencies such as the Food and Agriculture Organization and UNICEF. The Committee has been established by ADSA, as a public service, to make available in answer to these queries the latest scientific data concerning a wide range of dairy techniques. The Committee also will advise on selection of personnel for overseas assignments and on programs for overseas trainees and dairy visitors.

In asking the ADSA Executive Board to establish such a Committee, Mr. Weigold said: “We believe that such a close association not only would greatly strengthen and enrich the Society’s technical assistance program, but would give the rest of the world a chance to savor the competence and depth of knowledge of the U. S. scientific community.”

“The Executive Board”, Dr. Jack said, “feels that ADSA has a professional responsibility to assist in advancing international dairy relations and I hope that this cooperation will prove to be one effective way to meet this responsibility.”

Other members of the Committee are: Dr. A. O. Shaw, Dairy Science Department, Washington State College, Pullman, Washington; Dr. H. E. Calbert, Dairy and Food Industries, University of Wisconsin, Madison, Wisconsin; Dr. Dwight Seath, Dairy Section, University of Kentucky, Lexington, Kentucky; Dr. C. D. McGrew, Dairy Science Department, Ohio State University, Columbus, Ohio; and Dr. Fred Behel, Dairy Department, Purdue University, Lafayette, Indiana.

MARYLAND DAIRY TECHNOLOGY COURSES SCHEDULED

A number of dairy technology courses and conferences will be held on the following dates under the sponsorship of the Dairy Department, University of Maryland.

November 8, 1961 - Dairy Technology Conference, Continental Hotel, Washington, D. C.

January 22-31, 1962 - Ice Cream Short Course, Dairy Department of the University.

February 1, 1962 - Ice Cream Conference, Student Union Building at the University.

March 14, 1962 - Cottage Cheese Conference, Student Union Building, at the University.

Those desiring additional information should communicate with Professor Wendell S. Arbuckle of the Dairy Department, College Park, Md.

BOSSY GETS WASHED ALL OVER WITH NEW DEVICE

The “COWASH,” invented and manufactured by Teo Albers of Artesia, California, is fully automatic and somewhat resembles the familiar 5-minute car wash. Cows are herded into one end of a chute, each turns on and off her own supply of water and as they walk out the opposite end, they are clean and ready for milking.

The “COWASH” consists of two units, (see picture) both similar in design and each equipped with