A SURVEY OF TEMPERATURES INVOLVED IN BOTTLING MILK IN PAPER CONTAINERS

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SUMMARY

The temperature of milk during bottling in half-pint knock-down and preformed paper containers at ten dairy plants ranged from 43 to 56 F with an average of 47 F. The effects of these temperatures on the shelf life of the product are discussed.

The rise in the temperature of milk during bottling always has been the concern of industry personnel and regulatory authorities. The advent of knock-down paper containers increased this concern because of the high temperatures involved during their formation in the milk plant and the possibility that they might retain heat at time of filling. The transfer of this heat to the milk could result in a sufficient rise in temperature of the milk to affect its keeping quality.

The National Conference of Interstate Milk Shippers has a committee studying the practicability of a temperature requirement of not to exceed 45 F for bottled pasteurized milk. Some processors feel that they could not comply with this requirement using the present methods of bottling. A survey within the industry of the temperatures involved during bottling of milk and their effects on the keeping quality of the product would be of value to the industry.

The objective of this survey was to obtain information on the temperature rises involved during processing and bottling of milk in preformed and knock-down paper containers and the effects of these rises on the keeping quality of the milk during storage.

EXPERIMENTAL PROCEDURE

The survey included duplicate sampling on each of five dairy plants using knock-down plastic laminated and five

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Table 1. Temperatures Involved During Processing and Bottling of Milk in Paper Containers

<table>
<thead>
<tr>
<th>Source of temperature</th>
<th>Range</th>
<th>Mean*</th>
<th>Range</th>
<th>Mean*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(OF)</td>
<td>(OF)</td>
<td>(OF)</td>
<td>(OF)</td>
</tr>
<tr>
<td>Raw milk storage</td>
<td>37-41</td>
<td>39.6</td>
<td>40-43</td>
<td>41.0</td>
</tr>
<tr>
<td>Product during</td>
<td>167-172</td>
<td>169.8</td>
<td>165-174</td>
<td>169.0</td>
</tr>
<tr>
<td>Pasteurization</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product leaving press</td>
<td>37-41</td>
<td>38.6</td>
<td>36-43</td>
<td>38.8</td>
</tr>
<tr>
<td>Pasteurized surge tank</td>
<td>38-43</td>
<td>40.9</td>
<td>39-42</td>
<td>40.8</td>
</tr>
<tr>
<td>Container after filling</td>
<td>43-47.5</td>
<td>45.4</td>
<td>45-56</td>
<td>48.8</td>
</tr>
<tr>
<td>Container after 15 min</td>
<td>49-52</td>
<td>50.7</td>
<td>50-64</td>
<td>53.2</td>
</tr>
</tbody>
</table>

*Mean of two replicates on each of five milk plants.

using pre-formed waxed paper containers. State inspectors obtained the temperature data and collected the samples from the various milk plants. Temperatures recorded were (a) raw milk storage, (b) high temperature—short time pasteurization temperature, (c) product leaving the plate cooler of the pasteurizer, (d) milk in the pasteurized surge tank, (e) the product in the container within one min after filling, and (f) the milk in the container after holding at room temperature for 15 min. The half-pint milk samples collected at the time of filling were packed in ice in Styrofoam coolers and transported to the laboratory. Sufficient samples were collected from each dairy plant for storage at 35, 40, 45, 50, and 55 F for 0, 3, 6, 9, 12, and 15 days. At the conclusion of each storage period, the milk samples were analyzed for standard plate counts (SPC) using 32 C for incubation (1) and checked for flavor by two experienced judges.

RESULTS AND DISCUSSION

The temperatures involved during processing and bottling of milk in preformed and knock-down paper containers are presented in Table 1. The mean temperature of the milk in the pasteurized surge tank was practically the same for the two types of container using plants, but in the container it was 3.4 F.
higher in the knock-down than in the pre-formed containers. Although not a direct comparison of the same milks placed in each type of container under identical conditions, this observed mean difference suggested that, on the average, milk in knock-down containers retained more heat at the time of filling.

Nearly all of the containers contained milk that exceeded 45°F immediately after filling (Table 1). Only milk in two of the twenty containers representing ten dairy plants was below 45°F at the time of filling and the containers in these cases were pre-formed. The additional warm-up of the milk upon standing at room temperature (Table 1) indicated the importance of moving the filled containers into the cold room as quickly as possible. All of the plants but one moved the filled containers into the cold room by track within 2 min. In one plant filled cases were placed on dollies and 10 min elapsed before they reached the cold room.

The time required for milk which has warmed-up during filling to cool down in the cold room is also of prime importance. Milk in half-pint waxed pre-formed containers at temperatures of 45, 50 and 55°F required 75, 105 and 135 min, respectively, to reach 40°F when placed in a refrigerator maintained at 35°F. These times indicated that further study is warranted to determine the effect of slow cooling of milk in the container on keeping quality.

The effect of temperature of storage on the SPC of pasteurized milk stored in pre-formed and knock-down paper containers is shown in Figures 1 and 2, respectively. Each figure is an average of the data representing ten samples. A comparison of the two figures indicated that milk with the lower average temperature warm-up (pre-formed containers) had lower bacterial counts at nearly all temperatures during storage than milk with the higher average temperature warm-up (knock-down containers). Furthermore, the milk with the lower temperature in the containers met the State standard of not to exceed 25,000 per ml (SPC) (log\(_{10}\) = 4.4) for pas-
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Figure 4. Effect of temperature of storage on flavor scores of pasteurized milk in knock-down paper containers.

Figure 4. Effect of temperature of storage on flavor scores of pasteurized milk in knock-down paper containers.

teurized approved milk for longer periods of storage. This is exemplified by the milk in preformed containers meeting bacterial requirements for 6 and 12 days of storage at 40 and 35 F, respectively, whereas milk in knock-down containers met this requirement for only 3 and 9 days of storage at 40 and 35 F, respectively. The Figures 1 and 2 also demonstrated the well recognized fact that the lower the storage temperature, the longer the shelf life.

The flavor scores of the milk stored in pre-formed and knock-down paper containers at various temperatures of storage are presented in Figures 3 and 4. Each figure is an average of the data representing 10 samples. A comparison of the two Figures indicated that the advantage of the pre-formed container with its lower milk temperature over the knock-down container with its higher milk temperature at the time of filling is not as apparent when based on flavor scores of milk as it was for bacterial contents, particularly at the lower storage temperatures. If a score for milk of 36 and above is assumed to indicate a good product, then there does not appear to be a difference in the shelf-life of milk in the two containers. However, there is some evidence at temperatures of 45 and 55 F that milk with the greater warm-up (knock-down containers) deteriorated quicker than that with the lesser warm-up (pre-formed containers). It appeared that the higher temperature rise, when bottling milk in knock-down in comparison to pre-formed containers, did not have much affect on the final shelf life of the product when using flavor as a criteria.

The results of this survey seem to indicate the detrimental effect of the greater temperature rise of milk during bottling on the shelf life of the product when using bacterial counts as a standard of quality. The observations further show the inability of processors to maintain milk temperatures below 45 F during bottling operations. Suggestions for decreasing the temperature rise of milk include use of (a) lower temperatures and greater volume ratio of the coolant to product, (b) increased cooling surface, (c) improved methods for cooling knock-down paper containers after their formation, (d) minimum heating for forming of the containers, and (e) faster paper fillers and movement of the packaged product to the milk cooler.

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REFERENCES