mental cheese had 41.9 percent in the 38.5 and over class (no criticizable off-flavor) and the Control 44.2 percent. In July and August, the Experimental cheese had 73.3 and 87.1 percent, respectively, in this class while the Control remained practically the same (44.3 and /49.9 percent). The cheese criticized for undesirable flavor and scoring less than 37 showed that in June the Experimental cheese had 25.8 percent to only 14.7 percent for the Control cheese. In July the cheese from both groups had practically the same number of vats in this undesirable flavor class. For August, September and October, there was no Experimental cheese scored with an undesirable flavor while the Control had 17.6 percent.

Acknowledgements

The authors wish to acknowledge the assistance given by Mr. A. M. Cheney, Jr., Mr. R. L. Oliver and Mr. G. M. Jones of Johnson & Johnson for helping with the sediment testing and supervision of the Experimental patron, also the filter Products Division of Johnson & Johnson for supporting and making this project possible.

References


Changes in the pH and the Reduced Ascorbic Acid Content of Milk Held for Every-Other-Day Pickup in Farm Bulk Milk Tanks

B. J. Liska and H. E. Calbert
Department of Dairy and Food Industries
University of Wisconsin

(Received for publication April 18, 1958)

Since the bulk system of handling milk was first introduced, a practice commonly referred to as every-other-day pick-up has been adopted in many producing areas. This is used primarily to reduce transportation costs by combining milk routes and increasing the pay load of tank trucks.

When this system of milk pick-up is used, the milk is held in the farm tank from 36 to 48 hours. During this time warm milk is mixed with cooled milk as the milk from each subsequent milking is added to the holding tank. Usually, the contents of the holding tank are agitated during the cooling period after each milking. These treatments may cause various physical and chemical changes in the milk.

Sommer (9) stated that sudden changes in holding temperatures of milk cause variations in the pH equilibrium. Rapp (7) reported that raw whole milk held at 5°C. for 48 hours showed a rise in pH from 6.54 to 6.76.

The changes in temperature and periods of agitation may have an effect on the ascorbic acid content of the milk. Holmes (4) found that raw whole milk stored in darkness in a closed container, at 10°C. for 96 hours showed a 64 percent loss of reduced ascorbic acid. Hand (3) showed that bottled whole milk stored in a refrigerator at 1°C. for a 6-day period lost 60 percent of the ascorbic acid originally present.

This study was undertaken to determine the changes in pH and reduced ascorbic acid content of milk held in farm milk tanks over a 36-hour period during which time the warm milk was added after each successive milking, stirred and cooled to the appropriate temperature.

Procedures

The studies were made with one 200-gallon and one 150-gallon direct expansion refrigerated farm bulk milk holding tank at the University of Wisconsin Dairy Farm. Both of these rectangular tanks were equipped with mechanical agitators mounted vertically in the center of the tank. The agitator motors were wired so that when the refrigeration compressor was operating during the cooling phase the agitator was in motion.

The agitator motors could be switched to manual control for independent operation. The agitator in the 200-gallon tank was designed with two 12-inch
propeller type blades and operated at 115 rpm. The 150-gallon tank had an agitator with 5 flat blades, 3 blades on the lower level, each 9 inches long, and two blades on the upper level, each 6½ inches long. This agitator operated at 36 rpm.

Representative milk samples were obtained from the tanks by using a 50-ml stainless steel dipper. This was inserted 3 inches below the surface of the milk during agitation and then drawn upward. Samples of milk were placed in closed glass jars and stored in ice water until analyzed. All samples were analyzed within one hour of collection. The reduced ascorbic acid content of the milk was measured by the method of Sharp (8). Observations on pH were made using a Beckman Model H2 pH meter with glass electrode.

Samples were taken at the following times: one sample from each tank was taken after the first milking had been introduced into the tank and had been cooled to the proper holding temperature. The milk in the 200-gallon tank was held at 48°F, and the milk in the 150-gallon tank at 38°F, for the first half of the study. For the second part of the study, the milk in the 200-gallon tank and the 150-gallon tank was held at 38°F and 49°F, respectively. The second sample from each holding tank was obtained just prior to the addition of the second milking. A third sample was taken after the second milking was added and cooled. This same procedure was followed for each tank for the third milking. A sample was taken just before the fourth milking, but no sample was taken after the fourth milking giving a total of six samples of milk from each tank over a 36-hour period.

A 40-qt. can of milk was taken when the first portion of milk was placed in the bulk tank cooler. This can was placed in a spray type cooler and was held at 40°F, for a 36-hr. period to compare it with the milk placed in the bulk tank. No additions of warm milk were made, but the samples were withdrawn, as previously described, at 12-hour intervals. The milk in the can was well mixed each time a sample was removed. The four samples taken over a 36-hr. period were analyzed in the same manner as the samples obtained from the farm holding tanks.

RESULTS AND DISCUSSION

The data on pH determinations for the milk from the two holding tanks and the 40-quart can are shown in Figure 1. The changes in pH are plotted against time in hours for each experimental unit. Each point on the graph represents an average of six determinations.

The milk stored in the 40-qt. can showed a constant increase in pH over the holding period. However, the milk stored in the two farm milk tanks showed uneven changes in pH as successive milkings were added to the tank. Sometimes, especially at the time of the first addition of warm to cold milk at the 12 hour level, a marked decrease in the pH of milk occurred in both holding tanks. The variations in pH of milk in the holding tanks usually did not exceed 0.05 pH units. The same was true for the milk held in the can.

The observations of the changes in reduced ascorbic acid are presented in Figure 2. Each point on the graph represents an average of three replicates for the milk from each bulk tank at the two different temperature levels. Results shown in Figure 2 represent per cent loss of reduced ascorbic acid as compared to the holding time of the milk. The milk stored in the 40-qt. can shows a loss of approximately 25% of its original ascorbic acid content, which is spread evenly throughout the 36-hr. holding time.

For the milk held in the two bulk milk tanks, the loss of reduced ascorbic acid is significantly higher. The milk held in the 200-gallon tank shows losses of reduced ascorbic acid of nearly 50% at 38°F, and 55% at 48°F, after 36 hours. Milk stored in the 150-gallon tank had the highest losses, about 70% at 38°F, and 78% at 49°F, after 36-hour holding time. Some of this variation between the two tanks may be due to a diff-
Changes in the pH and the Ascorbic Acid Content

Figure 2. Percent of reduced ascorbic acid lost during a 36-hour holding period.

Flavor development in milk. Second, several research workers have reported a loss in ascorbic acid content of milk during low temperature storage. Elvehjem (2) and Woesner, Weckel and Scheutte (11) reported that approximately 20 percent of the original ascorbic acid of milk was lost during pasteurization, homogenization, bottling and distribution to the consumer. Therefore, the lower the ascorbic acid content when milk processing begins the less will be retained for the consumer.

Summary

In this study, samples of milk from two different farm milk holding tanks were compared with samples obtained from a 40-qt. can of milk stored continuously at 42°F. for 36 hours, for changes in pH and ascorbic acid content. Milk stored in farm milk holding tanks lost between 50 and 75% of its reduced ascorbic acid content during a 36-hr. holding period as compared to only a 25% loss in milk stored in a 40-qt. can. A 10°F. increase in holding temperature of the bulk milk gave approximately a 10% increase in loss of ascorbic acid.

The difference in the type of agitation in the two holding tanks may be partially responsible for the large variations in ascorbic acid content between milk samples from the two tanks.

No significant difference was noted in pH changes among milk samples from two farm milk holding tanks and milk held in a 40-qt. can under the described conditions. However, from the results of this limited study, it appears that a significant loss of ascorbic acid occurs in milk stored in farm bulk milk tanks for a 36 to 48 hours as occurs when every-other-day pick-up is practiced.

References

10. Sommer, H. H. Dairy Chemistry Notes. (Unpublished)