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Abstract

Raw milk was obtained from the K-State Dairy Teaching and Research Center and evaluated for quality after being stored under various conditions. Results showed that as storage temperature increased from 35 to 45EF for 0 to 72 hr, total bacterial counts increased, whereas the titratable acidity and pH values remained fairly constant. Changing the cooling rate affected microbial numbers. Cooling to 40EF within 30 versus 120 min reduced microbial counts by 50%. Finally, the preincubation test was shown to be an effective method to document possible psychrotrophic contamination before the milk arrives at the processing facility.; Dairy Day, 1998, Kansas State University, Manhattan, KS, 1998;

Keywords

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COOLING RATE AND STORAGE TEMPERATURE AFFECT BACTERIAL COUNTS IN RAW MILK

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Summary

Raw milk was obtained from the K-State Dairy Teaching and Research Center and evaluated for quality after being stored under various conditions. Results showed that as storage temperature increased from 35 to 45EF for 0 to 72 hr, total bacterial counts increased, whereas the titratable acidity and pH values remained fairly constant. Changing the cooling rate affected microbial numbers. Cooling to 40EF within 30 versus 120 min reduced microbial counts by 50%. Finally, the preincubation test was shown to be an effective method to document possible psychrotrophic contamination before the milk arrives at the processing facility.

(Key Words: Raw Milk, Cooling Rate, Storage Temperature, Microbial Counts.)

Introduction

Cooling is an important step that can dramatically affect milk quality. The Pasteurized Milk Ordinance specifies that milk must be cooled to 45EF within 2 hr of milking and remain at that temperature or below throughout the distribution system. In some states, if raw milk reaches 50EF or above, it will be downgraded automatically to Grade B. Thus, raw milk temperature can affect the financial status of dairy producers.

In addition to temperature, the rate of cooling also affects milk quality. As the time increases, the milk is exposed to higher temperatures for longer periods. This condition will favor greater microbial growth. Thus, the cooling rate sets the environment that can affect microbial growth.

Several tests are done to evaluate the quality of raw milk. The most common tests include pH, titratable acidity (TA), and total plate counts or standard plate counts. The pH and titratable acidity tests are quick tests that can indicate microbial activity. The plate counts enumerate certain types of microbes that are in the milk but are time consuming. Processors may include a preincubation test on raw milk. This test is designed specifically to evaluate the psychrotrophic contamination level and generally is used to assess on-farm sanitation and hygienic transportation procedures. For the preincubation test, incoming raw milk is placed at 55EF for 18 hr and then plated to determine microbial numbers. Under these conditions, psychrotrophic growth is favored. Psychrotrophs are often the causes of fluid milk spoilage.

Assessing incoming raw milk quality is becoming more important. As milk processing facilities decrease in number, milk must be transported greater distances. This delay in raw milk processing allows microbial growth, which causes deterioration. Thus, this study was conducted to evaluate the effects of storage temperature and cooling rate on the quality of raw milk and to illustrate the use of a preincubation test for determining the acceptance/rejection criteria of raw milk at a fluid milk processing plant.

Procedures

Raw milk was obtained from the K-State Dairy Teaching and Research Center, kept cold (< 45EF), and transported immediately to the K-State Dairy Processing Plant. Milk samples were evaluated for total aerobic plate counts (TPC), pH, and TA. All tests were done in

duplicate, and at least three replications were done for each trial.

Trial 1. Storage temperature. Milk samples were incubated at 35, 40, or 45EF for 72 hr. Every 24 hr, samples were evaluated as described above.

Trial 2. Cooling rate. Milk samples were cooled to 45EF at each of the following times: within 30 min, within 2 hr, within 12 hr, and within 24 hr. After each test time, samples were evaluated as described above.

Trial 3. Preliminary incubation test. Milk was preincubated at 55EF for 18 hr and evaluated as described above.

Results and Discussion

Average values for pH, TA, and TPC were fairly consistent over the 72-hr period at all three temperatures. Slight changes occurred in the TPC. This is significant, because all three storage temperatures are considered "legal" temperatures for raw milk storage. A 72-hr "age" on raw milk before processing is highly likely. Table 3 illustrates that at the higher temperatures, more microbial growth occurs that potentially can spoil the milk. A dairy processing plant, in theory, should accept all three loads of milk. However, because longer shelf lives are desired, the 45EF stored milk would be the least desirable to process into a fluid milk product.

Table 4 illustrates the effect of cooling rate on the quality of raw milk. As the cooling rate increased, pH values decreased, TA values increased, and microbial counts increased. The raw milk that was cooled fastest had lower TPC counts. The TPC count in the quickly cooled milk was half that of the milk cooled within 120 min. Thus, the importance of quick cooling can be easily seen. Although our results suggest that raw milk cooled to 40EF within 12 hr is acceptable from a legal standpoint, it did not meet the cooling criterion of 45EF within 2 hr. Table 4 clearly illustrates the need to cool milk *quickly*, and once it is cooled, to maintain those

cooler temperatures (Tables 1, 2, and 3) to preserve the high quality of the fluid milk.

The K-State Dairy Processing Plant uses the following criteria to accept raw milk for fluid milk products: antibiotic negative, pH 6.6 - 6.8, TA .14 - .17%, and TPC < 80,000 cfu/mL. Over the past few years, all incoming raw milk has been accepted. The records from K-State Dairy Processing Plant show that the plant produced high quality fluid milk with a satisfactory shelf life. However, to better evaluate the K-State raw milk, a preincubation test would provide information about possible psychrotrophic contamination.

The test results for three loads of milk clearly show the value of the preincubation test. Incoming milk (before incubation) had acceptable TA and pH values and very low microbial counts. As expected, the preincubation results showed higher TA values, indicating that microbial growth had occurred, which was verified by TPC results. These data indicate that some improvements may need to be made with the on-farm sanitation practices or in the sanitary hauling of milk to the plant.

The preincubation information is invaluable and can strengthen the supplier-buyer relationship. From the preincubation data, a producer can determine where improvements in sanitation, milking practices, or employee actions may be warranted. To make high quality processed milk, high quality raw milk is necessary. Thus, providing direction for possible improvements in raw milk quality benefits everyone -- the producer, the processor, and the final consumer.

Conclusions

The quality of raw milk is affected greatly by handling conditions on the farm and throughout the distribution cycle. This study shows that as storage temperature increases, microbial activity will increase and the quality of milk will decrease. As cooling time increases, raw milk quality will decrease. Thus, it is important to cool milk quickly and to as low a temperature as possible. The preincubation test is an effective

method to determine psychrotophic contamination, which is generally the cause of pasteurized milk spoilage.

Table 1. Average pH Values of Raw Milk Stored at Different Temperatures[1]

	Incubation Time, hr			
Temperature	0	24	48	72
35EF	6.70 ± .03	6.77 ± .04	6.81 ± .03	6.80 ± .02
40EF		6.76 ± .04	6.81 ± .04	6.80 ± .01
45EF		6.77 ± .04	6.81 ± .02	6.80 ± .02

[1]Mean ± SD.

Table 2. Average Titratable Acidity (TA) Values of Raw Milk Stored at Different Temperatures[1]

	Incubation Time, hr			
Temperature	0	24	48	72
35EF	.15 ± .01	.14 ± .01	.14 ± .02	.14 ± .01
40EF		.14 ± .01	.14 ± .02	.14 ± .01
45EF		.14 ± .01	.15 ± .01	.15 ± .01

[1]Mean ± SD.

Table 3. Average Total Plate Counts (TPC) of Raw Milk Stored at Different Temperatures[1]

	Incubation Time, hr			
Temperature	0	24	48	72
35EF	1.6 ± .49	2.0 ± 1.04	1.8 ± .89	1.4 ± .19
40EF		1.6 ± .83	1.5 ± .45	1.9 ± .93
45EF		2.1 ± 1.16	2.0 ± .75	3.2 ± 2.27

[1]Multiplied by 1,000; results are reported in cfu/ml.
[2]Mean ± SD.

Table 4. Average pH and Titratable Acidity (TA) Values and Total Plate Counts[1] (TPC) for Raw Milk Cooled to 40°F at Different Time Intervals[1]

Item	Interval to Cooling, hr			
	0.5	2	12	24
pH	6.82 ± .04	6.81 ± .08	6.78 ± .03	6.64 ± .01
TA	.13 ± .01	.14 ± .01	.15 ± .01	.19 ± .02
TPC[1]	2.8 ± 2.4	6.6 ± 4.1	190 ± 140	88,000 ± 8190

[1]Multiplied by 1,000; results are reported in cfu/ml.
[2]Mean ± SD.

Table 5. Evaluation of Milk for K-State Dairy Processing Plant

Item	Before Incubation	After Incubation
pH	6.76 ± .07	6.74 ± .01
TA	.16 ± 0	.18 ± 0
TPC[1]	6.3 ± 3.8	62 ± 32

[1]Multiplied by 1,000; results are reported in cfu/ml.