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Comparison of Code Date Reliability for Freshly Bottled Whole, Lowfat and Nonfat Fluid Milk

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ABSTRACT

Whole, lowfat, and nonfat fluid milk samples were collected from dairy plants on the day of bottling and each set of the three types of milk was processed from the same raw milk supply. Bacterial analyses for total aerobic count and for specific degradative types were made immediately after collection. Samples were also stored at 1.7, 5.6 and 10.0 C to test for flavor deterioration. Total count of aerobic bacteria and of specific degradative types did not differ significantly among the three types of milk. Organoleptic analysis was made periodically to determine milk quality (flavor score) and defect (flavor). At any of the storage temperatures the keeping quality (days required from bottling to reach a flavor score of < 36) was unrelated to the length of time between bottling and last day of sale (code date) assigned by the processor. At 5.6- and 10.0-C storage, more whole milk samples were criticized for more serious flavor defects (e.g. putrid) than for the less serious ones (e.g. lacking freshness) found in the lower fat milks. Keeping quality of all three types of milks at 1.7- and 5.6-C storage could be predicted from keeping quality determined at 10.0 C with equations previously developed for whole milk.

Recently we reported on the keeping quality of milk offered for retail sale in Connecticut (*2,3*). These studies were made on whole milk, i.e., milk with at least 3.25% of milkfat, no added solids but fortified with vitamin D. The samples were collected both at retail stores and directly from processing plants. We showed that the keeping quality (organoleptic acceptability) of the product at any storage temperature was unrelated to the processor's code date (last day product is to be sold). There was a significant correlation between keeping quality at 10.0-C storage and keeping quality at 1.7- and 5.6-C storage, suggesting a practical test to measure keeping quality at the lower storage temperatures.

Processors, at least in Connecticut, use the same code period (time between date of bottling and code date) for all three types of fluid milk, whole, lowfat and nonfat. Since our previous studies had shown the code date to be unrelated to actual keeping quality we investigated whether this same situation existed for the two lowfat milks. This study also allowed us to determine what flavor defects developed in these products and to assess the types of bacterial contaminants present.

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MATERIALS AND METHODS

Sampling

At eight intervals from January, 1977 through October, 1978, 42 samples of pasteurized whole, lowfat and nonfat milk were collected from six large dairies in Connecticut. All three products were collected at each dairy at the same time, reflecting that all the products were processed from the same supply of raw milk contained in a single storage tank and bottled on the same day. If samples were collected from the filler, all samples were taken from the same filling valve. No samples were collected on Mondays since such milk could have been stored over a weekend. Both actual inspection and close questioning assured that all milk was processed from the same raw supply. Each lot consisted of four samples collected in original containers which were placed in ice during transport to the laboratory. One subsample was used for microbiological analysis and the other three subsamples for organoleptic analysis.

Organoleptic analysis

Subsamples were stored at 1.7, 5.6 and 10.0 C. Organoleptic analysis was made as described previously (*1,2,3*) by at least two trained persons according to procedures recommended by the American Dairy Science Association as modified for use in the Connecticut Milk Flavor Improvement Program.

Microbial analysis

Microbial tests were made initially on each sample as it arrived in the laboratory. The method of plating and the media used have been described (*2,3,4*).

Statistical analysis

All data were analyzed statistically using SPSS computer programs (*5*).

Definitions

"Code date" is the date marked on the container designating the last day on which the product may be sold or offered for sale. "Code period" is the number of days between bottling and the code date. "Days to go bad" is the number of days from bottling until the flavor score dropped below 36. "Keeping quality" is the number of days from bottling that a sample remained organoleptically acceptable, i.e., with a flavor score of 36 or higher.

RESULTS AND DISCUSSION

Keeping quality in relation to code date and storage temperature

Shown in Table 1 are data for actual keeping quality of 42 samples of whole, lowfat and nonfat milk collected at processing plants and all processed from the same supply of raw milk. The samples were stored at 1.7, 5.6 and 10.0 C. The average code period for all samples was 11.1 days. Thus at 1.7-C storage all samples exceeded the code period and at 5.6 C storage only the nonfat milk failed to retain a satisfactory flavor to the end of the code period. At 10.0-C storage none of the milk retained an acceptable flavor to the time designated by the processor. There was no statistically significant difference between the keeping quality of the three types of milk at any of the storage temperatures. Further, for all three types of milk no significant correlation was found between the number of days for a sample to become unacceptable (reach a flavor score of less than 36) and the code period assigned by the processor, when the sample was stored at either 1.7, 5.6 or 10.0 C.

Previously we had calculated two regression equations to predict the keeping quality of whole milk stored at 1.7 and 5.6 C based on keeping quality at storage at 10.0 C (3). The formulae were:

$$\hat{Y}_{5.6C} = 0.44 + 1.68X_{10.0C} \text{ and } \hat{Y}_{1.7C} = 5.01 + 1.8X_{10.0C}$$

where X is the number of days required at 10.0-C storage until the flavor score dropped below 36 and $\hat{Y}$ is the predicted number of days to go bad at the other designated storage temperatures.

Using these equations estimated for whole milk, a prediction was made on the keeping quality of the whole, lowfat and nonfat milk tested in the present study (Table 1). In no instance was the mean prediction in error by more than 1 day. Thus the prediction equations based on whole milk appear from a practical standpoint to be satisfactory for milk with a lower fat content.

From the present data, equations were developed predicting days to go bad for each of the lowfat products. They differed little in overall predictive ability from the original equations developed for whole milk (3).

Bacterial groups found in whole, lowfat, and nonfat milk

The number of bacteria found in the freshly pasteurized milk is shown in Table 2. The number of aerobic bacteria is quite low as are the numbers of the other bacterial groups. No significant differences were found among populations of any bacterial group in the three types of milk. Further, data on the percentage of the total count for any bacterial group among the three types of milk examined show no trend in the destruction of any specific bacterial group able to excrete a specific degradative enzyme. Thus the amount of fat in the milk evidently has little effect on destruction by pasteurization of the types of degradative bacteria present in the raw milk.

Flavor of milk after storage

The flavor defect of each sample of whole, lowfat and nonfat milk was determined when it was no longer organoleptically acceptable (flavor score of below 36) (Table 3). On initial testing many of the lowfat and nonfat milks were criticized as having a vitamin-like flavor although the number of samples having a cooked flavor was also high. The vitamin-like flavor is attributable to the vitamin A fortification used in the lower fat milks but not used in the whole milk. The "burnt" flavor criticism of the milk is attributed to paper cartons overheated during sealing.

Most of the samples stored at 1.7 C were rejected for the generally non-specific criticism of lacking freshness. At the higher storage temperatures of 5.6 and 10.0 C, where mesophilic bacteria are more likely to grow, the more serious flavor defects such as putrid or curdled were evident, especially in the whole milk. The lower fat milks had the less serious defect of lacking freshness. No general pattern of flavor criticism among the three types of milk was noted. A comparison of the present data with observations of milk samples collected directly from processing plants in 1977 (3) showed similar results.

TABLE 1. *Actual and predicted keeping quality[1] of whole, lowfat and nonfat milk stored at 1.7, 5.6, and 10.0 C.*

	Keeping quality				
	Actual[2] no. days			Predicted no. days from 10.0-C storage	
Type of milk	1.7 C	5.6 C	10.0 C	1.7 C	5.6 C
Nonfat	16.7 ± 0.6[3]	10.9 ± 0.5	6.8 ± 0.3	17.3 ± 0.5	11.8 ± 0.5
Lowfat	17.4 ± 0.5	12.8 ± 0.7	6.9 ± 0.3	17.6 ± 0.6	12.1 ± 0.5
Whole	16.8 ± 0.4	12.9 ± 0.6	7.1 ± 0.4	17.8 ± 0.6	12.3 ± 0.6

[1]Based on the prediction equations for whole milk (3.25% fat minimum); $\hat{Y}_{1.7C} = 5.01 + 1.81X_{10.0C}$ and $\hat{Y}_{5.6C} = 0.44 + 1.68X_{10.0C}$ (see ref. 3).
[2]Average code period for all samples was 11.1 days.
[3]Standard error of the mean.

TABLE 2. *Number of percentage of various types of bacteria in freshly bottled whole, lowfat and nonfat milk.*[1,2]

Bacterial group	Whole milk		Lowfat milk		Nonfat milk	
	No.[3]	%[4]	No.	%	No.	%
Total aerobic count	617	—	688	—	466	—
Protease producers	97	15.7	147	21.4	96	20.6
Lipase producers	266	43.1	392	57.0	285	61.2
Pseudomonads	99	16.0	135	19.6	102	21.9
Protease-producing pseudomonads	51	8.3	85	12.4	59	12.7
Lipase-producing pseudomonads	89	14.4	119	17.3	88	18.8
Acid producers	14	2.3	29	4.2	14	3.0

[1]14 samples of each type represented; samples collected from processing plant on day of bottling and all milk processed from same raw supply.
[2]t-test shows no significant difference between types of milk for the different bacterial groups shown.
[3]Number of colony forming units per ml of milk.
[4]Percent of total aerobic count.

TABLE 3. *Initial flavor at sampling (I) and flavor of three types of milk when no longer organoleptically acceptable after storage at 1.7, 5.6, or 10.0 C.*

Flavor	Whole milk				Lowfat milk				Nonfat milk			
	I	10.0 C	5.6 C	1.7 C	I	10.0 C	5.6 C	1.7 C	I	10.0 C	5.6 C	1.7 C
	(% of samples)				(% of samples)				(% of samples)			
Cooked	7.1											
Cooked & unclean	28.6											
Feed & unclean	64.3											
Feed					28.6				7.1			
Vitamin-like					49.9				78.6			
Cooked & feed					14.3				—			
Burnt					7.1				14.3			
Lacks freshness	—	35.7	28.6	100	—	78.6	42.9	100	—	71.4	50.0	85.7
Putrid/curdled	—	50.0	57.1	—	—	7.1	35.7	—	—	7.1	21.4	7.1
Unclean	—	7.1	—	—	—	—	—	—	—	—	—	—
Bitter	—	7.1	7.1	—	—	7.1	—	—	—	—	21.4	7.1
Fruity	—	—	7.1	—	—	7.1	14.3	—	—	—	—	—
Rancid	—	—	—	—	—	—	7.1	—	—	—	—	—
Avg. no. of days to become unacceptable	—	7.1	12.9	16.8	—	6.9	12.8	17.4	—	6.8	10.9	16.7

Samples collected in 1976 from retail stores (*2*), however, had more serious flavor defects.

The keeping quality of whole, lowfat and nonfat milk does not differ significantly at a given storage temperature. As we had shown previously for whole milk, the code period for lowfat and nonfat milk was also unrelated to the actual keeping quality. Bacterial populations in all three types of milk were as low as we had found in whole milk collected at processing plants. Clearly, high storage temperatures damaged keeping quality of all three kinds of milk. At 5.6 C whole and lowfat milk, on the average, remained acceptable approximately 1 day beyond the average code period for all samples, 11.1 days. However, nonfat milk stored at 5.6 C did not remain acceptable to the end of the code period. Since storage temperature in retail stores frequently exceeds 5.6 C (*2*), it is easy to see why milk would not retain an acceptable flavor through the last date of sale.

Most investigations of microbial quality and flavor quality or flavor deterioration have examined whole milk collected at dairies or at retail outlets. Few studies report on quality of lower fat milks. In the present study we have compared milk of different fat contents, all from the same dairy and all processed from the same raw milk supply and found no evidence that separate code periods need be used for different types of milk, nor did we find changes in the character of the microbial contaminants.

ACKNOWLEDGMENTS

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are described in the following paragraphs.

1. *Recovery of Injured Coliforms.* Procedures for allowing recovery of injured cells have involved overlay techniques and use of modifications of the bile agar medium. Collaborative studies are needed as well as comparative studies between the methods. (Dr. E. H. Marth, Department of Food Science, Babcock Hall, University of Wisconsin, Madison, WI 53706; phone: 608-263-2004).

2. *Rose Bengal-Chlortetracycline Hydrochloride Agar.* This medium has been shown to encourage growth of some yeasts and molds which are inhibited by acidified potato dextrose agar. The medium also limits colony spreading. A collaborative study is needed to confirm the advantages of this medium for recovery of yeasts and molds in dairy foods. (Dr. E. H. Marth, Department of Food Science, Babcock Hall, University of Wisconsin, Madison, WI 53706; phone: 608-263-2004).

3. *Hydrophobic Grid Membrane Filter Methods.* Recent improvements in membrane filter methods for microbiological examination of foods prevent colony spread and allow enumeration of a wider range of colony forming units. Coliform tests on dairy foods containing sucrose are possible and up to 5 g of dairy foods can be filtered through such membranes. Technique development and collaborative studies are suggested. (Dr. Gary H. Richardson, Department of Nutrition and Food Science, Utah State University, Logan, UT 84322; phone: 801-750-2120).

4. *Rapid Psychrotrophic Methods.* There is need for review, refinement, and miniaturization of

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