Survey of Milk Production Practices and Facilities and Bacteriological Quality of Manufacturing-Grade Milk in the United States

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By ROGER DABBAH, formerly[1] *research assistant*, S. R. TATINI, formerly[2] *research assistant*, and J. C. OLSON, JR., formerly[3] *professor, Department of Food Science and Industries, University of Minnesota, St. Paul, Minn.*, and W. A. MOATS, *research chemist, Market Quality Research Division, Agricultural Research Service*

INTRODUCTION

Milk handling practices and facilities have changed tremendously since 1950. The evolution of milk cooling practices is an example of such changes. Since the practice of no cooling the cooling practices have included: (a) immersion of cans of milk in stock watering tanks, (b) immersion in tanks of water drawn from wells or springs (with no change of water or several changes during the storage period), (c) mechanical refrigerated "drop-in" or "spray" type coolers, and (d) refrigerated farm bulk tanks. All these cooling practices are in use on farms where milk is produced today.

Cleaning and sanitizing practices have changed, including the introduction and use of new chemicals and formulations. Methods of milk transport from farm to plant have also changed; these have evolved from transport in cans in uncovered, uninsulated trucks or other conveyances to transport in covered or insulated (or both) trucks, and to transport in insulated tank trucks.

As a consequence of these developments, as well as others, manufacturing-grade milk is handled in a more diversified manner today than in the past, and, presumably, such technological advances should have some effect on the quality of manufacturing-grade milk.

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[1] Present address: Research microbiologist, Market Quality Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Md. 20705.

[2] Present address: Assistant professor, Department of Food Science and Industries, University of Minnesota, St. Paul, Minn. 51101.

[3] Present address: Director, Division of Microbiology, Bureau of Science, Food and Drug Administration, U.S. Department of Health, Education, and Welfare, Washington, D.C. 20204.

This bulletin presents the results of an extensive survey of manufacturing-grade milk producing farms relative to their production facilities and practices and of a survey of the bacteriological quality of manufacturing-grade milk during the 1963–64 period.

Although in 1970, conditions presented here have probably changed, these data are presented as a frame of reference for the assessment of the evolution of conditions of manufacturing-grade milk production in the years to come.

LITERATURE REVIEW

An excellent review by Hartley and associates (*8*)[4] on the use of bacterial tests to evaluate production conditions on farms indicates that bacterial counts of manufacturing-grade milk are generally very high. This is not surprising for manufacturing-grade milk is generally thought to be produced under poorer conditions than Grade A milk. The extent to which developments such as milkhouses, milking machines, bulk tank cooling, and electrical can cooling have sifted down from Grade A milk producers to manufacturing-grade milk producers is not known. The effects of these developments on the quality of Grade A milk have not been overwhelming. In general, the quality of machine-milked supplies is much poorer than hand-milked supplies (*2,6,7,9,11,12,15*). Furthermore, the use of farm bulk tanks, which was hailed by many as the ultimate answer for the improvement of bacteriological quality of milk supplies, did not necessarily mean an improvement in quality of farm milk supplies (*3,10,12*).

During a study on methods for grading milk intended for manufacturing purposes (*4,5*), data relative to production facilities, production practices, and quality of milk were also collected.

EXPERIMENTAL METHODS AND PROCEDURES

Source of Samples

A total of 3,873 samples (can, 2,756; farm bulk tank, 1,117) from 970 producers were collected from the winter of 1963 to the fall of 1964.

Selection of geographical locations

In an attempt to obtain samples representative of several manufacturing-grade milk producing areas of the United States, seven States from three widely separated geographical locations were selected.

[4] Italic numbers in parentheses refer to Literature Cited, p. 18.

Selection of dairy plants

Twenty dairy plants, several in each geographical location, were selected. The milk supplies of these plants were felt to be representative of the manufacturing-milk supplies in each particular location.

Selection of producers

A random selection of producers delivering to each plant was made with the help of tables of 10,000 random digits (*13*). The number of samples to be analyzed per plant was determined by taking into consideration the following factors:

(1) Total number of producers delivering milk to the plant.

(2) Number of can shippers as compared with the number of bulk shippers, when both types of milk were handled at a plant.

(3) Accessibility of the milk supply at all seasons, especially for those producers with a bulk tank.

(4) Total numbers of samples to be analyzed per day—not to exceed 120 samples because of limitations of laboratory space, supplies, and personnel.

The selection of producers was done only once, and the selected producers were sampled once during each of the four seasons. Supplementary producers also were selected to serve as additional sources of samples if samples were unavailable from some producers owing to the drying up of herds, shifting in the schedule of delivery, and other conditions.

Location of Laboratories

The laboratory facilities of several different organizations were used during this study. With the exception of incubators needed for plate counts, materials and equipment were transported from one location to another.

Sampling Procedures

Producers delivering milk in cans

Sample containers were screw-capped test tubes (25 x 150 mm.). Samples were collected from the weigh tank at the plant intake. Sampling was done with a metal dipper. Before each use, the dipper was immersed in chlorinated water (250 p.p.m.), drained, and freed of chlorine by repeatedly filling it with milk from the weigh tank and emptying it. After the sample was obtained, the dipper was rinsed with clean flowing water. The weight and the temperature of each individual supply were recorded.

Producers with a bulk tank on the farm

Sampling was done on the farm either by one of the analysts, a fieldman, or a bulk tank truck driver. The proper procedure for sampling was demonstrated to the fieldman or the bulk tank truck driver. In most instances, one of the analysts went to each farm at least once. The sampling was done as follows:

(1) Weight of milk in the bulk tank was recorded.

(2) The milk was mixed mechanically (3 to 5 min.).

(3) A sample was obtained either with a sterile paper pipette or with a sanitized dipper when the bulk tank truck was so equipped.

(4) The temperature of the milk was recorded.

Handling of Samples

Samples were immediately cooled in a water bath containing liberal quantities of ice. After the initial cooling, the samples were transported in ice to the laboratory. On arrival, they were placed in a refrigerator maintaining the samples below 40° F. Samples were analyzed on the following day. In no instance was the interval between sampling and analysis greater than 24 hours.

Collection of Data on Individual Producers

Information relative to the selected producers was obtained through direct observation, conferences with fieldmen or other responsible personnel, and examination of records. The following data were included in the survey:

(1) Type of cooling facilities used on the farm (none, bulk tank, electrical or nonelectrical can cooler).

(2) Frequency of pickup of milk (every day, every other day, or less often).

(3) Size of the dairy herd.

(4) Presence or absence of a milkhouse.

(5) Use of cleaner, or sanitizer, or both.

(6) Type of milking (hand, machine).

Method of Bacteriological Analysis

An estimate of viable bacterial population in each sample was determined according to "Standard Methods for the Examination of Dairy Products" (*1*). The incubation temperature was 89.6° F. (32° C.). The medium used was plate count agar (Difco). Two lots of this medium (Difco Control No. 451711 and 463939) were used during the study. Lot 451711 had a productivity equal to or higher than a lot identified as Difco Control No. 445770. The latter had been previously certified during media certification studies sponsored by the Media Certification Commission and done at the Minneapolis-St. Paul Quality Control Laboratory. The second lot, Difco Control No. 463939, was compared in our laboratory with lot 451711 and was found to be equal in productivity.

Routinely, four dilutions of samples were made: 1:100; 1:1,000; 1:10,000; and 1:100,000. All samples were plated, and a standard plate count (SPC) was made. This was done by the same analyst to minimize variations.

Samples were classified according to the USDA recommended standards (*14*) as follows:

	SPC
No. 1 (acceptable)	not over 500,000/ml.
No. 2 (acceptable)	not over 3,000,000/ml.
No. 3 (undergrade)	over 3,000,000/ml.

RESULTS AND DISCUSSION

Survey of Milk Production Practices and Facilities

The results of the survey shown in tables 1 through 3 are self-explanatory. They are broken down according to geographical locations to indicate the range of variations encountered.

About two-thirds of manufacturing-grade milk producers sampled were using some type of cooling for their milk cans for

TABLE 1.—*Frequency distribution, percentage, of 970 randomly selected producers from 3 geographical locations according to system of refrigeration, size of herd, quantity of milk delivered, and temperature at time of sampling*

Production variable	All locations	Location A[1]	Location B[1]	Location C[1]
Type of refrigeration:				
None	3.0	0.4	5.6	2.5
Farm bulk tank	29.3	42.1	19.1	29.0
Can cooling	67.7	57.5	75.3	68.5
Size of dairy herd:				
≦5 cows	16.6	6.5	22.4	18.7
6 to 25 cows	69.8	80.2	71.9	59.7
>25 cows	13.6	13.3	5.7	21.6
Pounds of milk delivered:				
≦150	26.5	12.8	35.7	28.2
151 to 750	48.5	58.1	47.7	41.8
>750	25.0	29.1	16.6	30.0
Temperature of milk at time of sampling, °F.:				
≦40	33.2	41.0	27.0	33.1
41 to 50	24.4	21.0	28.7	23.0
51 to 60	23.9	22.2	25.5	23.7
>60	18.5	15.8	18.8	20.2

[1] Values are percentages of samples within the location.

shipment to dairy plants, and about 30 percent were using farm bulk tanks on the premises and refrigerated tank trucks for shipment to the dairy plants (table 1). Three percent of all producers did not have, or did not use, any type of refrigeration. The majority of can producers had dairy herds in the 6- to 25-cow range and usually daily delivered 151 to 750 pounds to the dairy plant. In general, bulk producers had larger dairy herds and delivered more than 750 pounds every other day. Ninety percent of milk cans were picked up every day, and 95 percent of farm bulk tanks were picked up every other day.

The majority of milk samples had a temperature at delivery of 50° F. or less, but 18 percent of all samples had temperatures exceeding 60°. Of 280 farm bulk tanks sampled once every season, only once did we find a temperature above 50°—this was caused by malfunctioning of refrigeration system. Actually, 90 percent of all farm bulk tanks maintained a temperature of 40° or below. By contrast, 25 percent of milk shipped in cans had a temperature at delivery exceeding 60°, and only 10 percent had a temperature of 40° or below.

About two-thirds of can shippers had no milkhouses, but wide variations existed between geographical locations (table 2). The low percentage of electrical coolers in locations A and C, as compared with location B, may be due to the availability of cooler well and spring water on farms in locations A and C. Although 54.3 percent of producers were using electrical cooling for their cans, 58.1 percent of all samples were above 50° F. at time of sampling. Curiously, location C with the highest percentage of producers using nonelectrical coolers had the lowest percentage of samples over 50°.

Machine milking was practiced by over four-fifths of all can shippers. Less than 10 percent of can shippers in location A and C practiced hand milking, but about 35 percent of can shippers in location B practiced hand milking.

The interactions of various factors relative to milk production practices and facilities are worthy of comments.

Machine milking was more common on farms having a milkhouse than on farms without one. And among those producers with a milkhouse, machine milking was commonly associated with electrical cooling. In contrast, hand milking was associated almost exclusively with nonelectrical can cooling.

Electrical and nonelectrical can cooling were about equally used by producers without a milkhouse but practicing machine milking. However, considerable variation between geographical locations was evident.

Producers with facilities that might be considered optimum for proper handling of milk (milkhouse, machine milking, electrical

TABLE 2.—*Frequency distribution, percentage, of 690 randomly selected can producers from 3 geographical locations according to milk production practices and facilities*

Production facility and practice	Source of samples			
	All locations	Location A[1]	Location B[1]	Location C[1]
Milkhouse	37.9	60.4	27.7	34.9
No milkhouse	62.1	39.6	72.3	65.1
Machine milking	81.6	93.1	65.4	91.1
Hand milking	18.4	6.9	34.6	8.9
Electrical cooling	54.3	50.9	64.2	45.5
Nonelectrical cooling	45.7	49.1	35.8	54.5
Temperature at time of sampling, °F.				
<50	41.9	34.4	43.3	45.0
>50	58.1	65.6	56.7	55.0
Milkhouse:				
Machine milking	96.2	97.4	89.2	99.4
Hand milking	3.8	2.6	10.8	.6
No milkhouse:				
Machine milking	72.6	84.1	56.3	88.3
Hand milking	27.4	15.9	43.7	11.7
Milkhouse:				
Machine milking:				
Electrical cooling	72.5	61.9	95.5	66.0
Nonelectrical cooling	27.5	38.1	4.5	34.0
Hand milking:				
Electrical cooling	2.0	----------	----------	----------
Nonelectrical cooling	98.0	----------	----------	----------
No milkhouse:				
Machine milking:				
Electrical cooling	53.8	41.5	78.4	39.1
Nonelectrical cooling	46.2	58.5	21.6	60.9
Hand milking:				
Electrical cooling	22.2	2.5	28.1	5.3
Nonelectrical cooling	77.8	97.5	71.9	94.7

[1] Values are percentages of samples within the location.

cooler) delivered a little over 50 percent of their milk with temperatures greater than 50° F. (table 3). One might expect that this percentage would have been considerably lower. Possibly the reason for this high percentage was that morning milk may not

TABLE 3.—*Effect of various milk handling practices on the temperature at time of sampling of milk from 690 randomly selected can producers from 3 geographical areas*

Production facility and practice and temperature of milk	Source of sample			
	All locations	Location A [1]	Location B [1]	Location C [1]
Milkhouse:				
Machine milking:				
Electrical cooling:				
≦50° F	47.2	41.0	52.5	47.5
>50° F	52.8	59.0	47.5	52.5
Nonelectrical cooling:				
≦50° F	24.0	22.9	50.0	22.6
>50° F	76.0	77.1	50.0	77.4
Hand milking and non-electrical cooling:				
≦50° F	48.7	---	---	---
>50° F	51.3	---	---	---
No milkhouse:				
Machine milking:				
Electrical cooling:				
≦50° F	48.7	34.1	48.3	55.1
>50° F	51.3	65.9	51.7	44.9
Nonelectrical cooling:				
≦50° F	32.7	33.9	38.1	30.7
>50° F	67.3	66.1	61.9	69.3
Hand milking:				
Electrical cooling:				
≦50° F	47.0	---	51.1	---
>50° F	53.0	---	48.9	---
Nonelectrical cooling:				
≦50° F	33.4	37.5	36.7	22.4
>50° F	66.6	62.5	63.3	77.6

[1] Values are percentages of samples within the location.

have been cooled adequately before pickup. A somewhat higher percentage (about 67 percent) of samples from all producers having minimum facilities for milk handling (no milkhouse, hand milking, nonelectrical cooling) had a temperature greater than 50°. There was little variation among geographical locations.

One would expect that if a farmer invested a large amount of money in a bulk tank, he would provide adequate facilities, such as a milkhouse, to house the bulk tank. Approximately 7 percent of all producers with farm bulk tanks did not have a milkhouse (see table 4). Location A had the highest percentage of producers without a milkhouse; however, within location A, State I, which

TABLE 4.—*Frequency distribution, percentage, of 280 randomly selected producers with farm bulk tanks from various geographical locations according to the presence or absence of a milkhouse*

Milkhouse	All locations	Location A [1]	Location B [1]	Location C [1]
Present	93.1	87.2	96.5	97.6
Absent	6.9	12.8	3.5	2.4
	Location A			
	State I [2]	State II [3]	State III [3]	
Present	77.5	98.1	96.6	
Absent	22.5	1.9	3.4	

[1] Values are percentages of samples within the location.
[2] No State law requiring a milkhouse on farms producing manufacturing-grade milk.
[3] Compulsory State law requiring a milkhouse on farms producing manufacturing-grade milk.

TABLE 5.—*Frequency distribution, percentage, of 3,873 samples from 970 randomly selected producers from 3 widely separated geographical sources according to bacterial estimates by Standard Plate Counts*

SPC range (per ml.)	All samples	Location A [1]	Location B [1]	Location C [1]
≤100,000	28.0	37.6	13.7	34.3
>100,000–≤200,000	7.6	11.5	6.3	5.7
>200,000–≤500,000	9.2	9.6	6.9	11.1
>500,000–≤1,000,000	13.9	14.0	13.3	14.4
>1,000,000–≤2,000,000	8.7	9.2	9.3	7.7
>2,000,000–≤3,000,000	2.2	4.2	1.9	.9
>3,000,000–≤5,000,000	5.8	4.4	7.2	5.4
>5,000,000–≤10,000,000	10.5	5.5	14.8	10.1
>10,000,000–≤15,000,000	3.8	1.8	6.0	3.3
>15,000,000–≤20,000,000	2.5	.5	4.8	1.8
>20,000,000	7.8	1.7	15.8	5.3

[1] Values are percentages of samples within the location.

at the time did not have a law requiring a milkhouse for housing bulk tanks, accounted for most of the producers with no milkhouse. Although such a law existed in States II and III, compliance did not appear to be complete.

Frequency Distribution of Milk Samples According to Bacterial Estimates by SPC

As shown in table 5, about 45 percent of all samples had an SPC of 500,000/ml. or less, and 30 percent of all samples had an SPC greater than 3,000,000/ml. Variations in quality of manufacturing-grade milk are obvious, with about 50 percent of the samples in location B well over 3,000,000/ml.

Table 6 shows the frequency distribution of can and farm bulk tank milk supplies. About 60 percent of all farm bulk tank milk and 40 percent of all can milk had an SPC of 500,000/ml. or less. Actually, over 40 percent of all farm bulk tank samples and 22 percent of all can samples had an SPC of 100,000/ml. or less. Locations A and C appeared to have milk of similar quality, with farm bulk tank milk being of better quality than can-cooled milk. However, in location B the percentage of can samples with 100,000/ml. or less was approximately double that of bulk tank samples (15 percent vs. 8 percent).

Quality of Milk as Affected by Various Handling Practices and Facilities

Samples were grouped into various categories according to one or more milk production and handling practices. Samples within each category were classified in three grades according to USDA recommended standards; the SPC was used as the grading test. Several observations may be made on data presented in table 7. The lack of a milkhouse generally resulted in milk of poorer bacteriological quality. Also, as the size of the dairy herd or the amount of milk delivered decreased, the percentage of samples classed as Grade 3 increased.

On farms where no cooling of milk was practiced, 60 percent of the samples were classed as Grade 3. This was about three times the number of Grade 3 samples from farms with bulk tanks and about two times the number of Grade 3 samples from farms using electrical or nonelectrical milk can cooling. Contrary to various reports cited in the literature review, hand-milked supplies were overall of poorer bacteriological quality than machine-milked supplies.

The can-milk data were broken down further between producers with a milkhouse and those without one. The following relations were apparent (table 8).

(1) *Milkhouse vs. no milkhouse.*—Within each grouping of samples, the absence of a milkhouse was associated with a higher percentage of Grade 3 samples. For example, when machine milking, electrical cooling, and a sample temperature of 50° F. or less were common factors, a higher percentage of Grade 3 samples occurred among those from producers without a milkhouse than with one.

TABLE 6.—*Frequency distribution, percentage, of two types of milk supplies from 3 widely separated geographical sources according to bacterial estimates by Standard Plate Count*

SPC range (per ml.)	All samples		Location A[1]		Location B[1]		Location C[1]	
	Can	Bulk	Can	Bulk	Can	Bulk	Can	Bulk
≤100,000	22.3	41.5	33.3	43.5	15.1	7.7	23.4	68.8
>100,000–≤200,000	6.8	9.3	11.5	11.6	5.6	9.6	5.3	6.6
>200,000–≤500,000	9.6	8.4	10.4	8.6	6.5	8.8	12.5	7.8
>500,000–≤1,000,000	14.5	12.4	15.1	12.4	12.4	17.3	16.5	.9
>1,000,000–≤2,000,000	9.7	6.3	9.6	8.6	10.2	5.4	9.2	4.3
>2,000,000–≤3,000,000	1.4	4.0	1.4	7.7	1.8	2.3	1.0	.7
>3,000,000–≤5,000,000	6.7	3.5	7.1	.9	6.6	9.6	6.6	2.6
>5,000,000–≤10,000,000	11.9	7.0	6.9	3.9	14.1	17.7	12.8	4.0
>10,000,000–≤15,000,000	4.7	1.7	2.0	1.3	6.9	2.3	3.9	1.9
>15,000,000–≤20,000,000	2.9	1.5	.8	.2	4.7	5.0	2.2	.7
>20,000,000	9.5	4.4	1.9	1.3	16.1	14.3	6.6	1.7

[1] Values are percentages of samples within the location.

(2) *Hand milking vs. machine milking.*—Among the producers with a milkhouse, fewer Grade 3 and more Grade 1 samples were from producers practicing hand milking than from those practicing machine milking.

(3) *Electrical vs. nonelectrical cooling.*—Among producers practicing machine milking, the use of electrical can cooling was associated with more Grade 3 and less Grade 1 samples than the use of nonelectrical can cooling. This was true regardless of the presence or absence of a milkhouse and the temperature of the milk at time of sampling. However, among producers without a milkhouse and practicing hand milking, more Grade 3 and less Grade 1 samples were from those using nonelectrical can cooling than from those using electrical can cooling.

(4) *Temperature of milk at sampling.*—If the temperature of milk at time of sampling was above 50° F., more samples were Grade 3 and fewer were Grade 1 than if the temperature was 50° or less (table 8). This held true under various milk handling practices and facilities with the exception of samples from producers with a milkhouse and practicing hand milking and nonelectrical cooling.

The relations determined in 1, 2, and 3 above were not consistent when the samples were segregated on the basis of their geographical locations. However, within each of the geographical locations, regardless of the type of milking practiced, the type of can cooling used, or the presence or absence of a milkhouse, the bacteriological quality of milk was poorer when the temperature of milk at time of delivery to the plant was above 50° F. than when it was 50° or less.

Although all the relations presented in this bulletin between quality of milk and production practices and facilities have been observed, it is impossible to ascribe per se any direct cause and effect relation to the bacteriological quality of milk. Numerous other factors not shown here, such as cleanliness of milking equipment, rapidity of cooling, length of storage, cleanliness of the exterior teats and udder, may greatly affect the bacteriological quality of manufacturing-grade raw milk.

Quality of Milk as Affected by Geographical Sources of Supplies

Although, on the average, 30.8 percent of the manufacturing-grade milk was classified as undergrade (Class 3), percentages between geographical locations ranged from 14.9 percent in location A to 49.0 percent in location B (table 9).

The use of farm bulk tanks in locations A and B did not much improve the milk supplies, but it greatly improved the milk supplies

TABLE 7.—*Effect of various milk handling practices and facilities on the grade distribution of milk samples from 970 randomly selected producers, as determined by Standard Plate Count*

[Percentage distribution within each category]

USDA grade	Milk-house	No milk-house	Temperature of milk at time of sampling, °F.				Type of refrigeration			
			≦40	41–51	51–60	>60	None	Bulk tank	Electric can cooler	Non-electric can cooler
1	52.1	35.9	58.9	46.9	38.5	24.9	15.0	58.2	39.2	40.2
2	24.0	24.6	21.6	24.6	27.5	24.8	25.0	21.1	26.5	24.9
3	23.9	39.5	19.5	28.5	34.0	50.3	60.0	20.7	34.3	34.9

USDA grade	Number of cows in dairy herd			Pounds of milk picked up or delivered			Hand milking	Machine milking
	≦5	6–25	>25	≦150	151–750	>750		
1	36.8	42.1	67.8	35.7	41.2	60.7	34.4	46.1
2	23.7	25.7	17.0	24.3	27.2	18.7	22.6	24.5
3	39.5	32.2	15.2	40.0	31.6	20.6	42.0	29.4

TABLE 8.—*Effect of various milk handling practices and facilities on the grade distribution of 2,760 milk samples from 690 randomly selected can producers, as determined by Standard Plate Count*

[Percentage distribution of samples within each category]

USDA grade	Machine milking	Hand milking	Sample temperature		Machine milking: Electric cooling		Machine milking: Nonelectric cooling		Hand milking: Electric cooling		Hand milking: Nonelectric cooling	
			$\leqq$50° F.	>50° F.	$\leqq$50° F.	>50° F.	$\leqq$50° F.	>50° F.	$\leqq$50° F.	>50° F.	$\leqq$50° F.	>50° F.
Producers with a milkhouse												
1	44.0	61.5	53.2	40.1	47.2	37.4	64.6	44.2	([1])	([1])	73.7	50.0
2	26.7	20.5	22.6	29.5	26.7	26.3	21.5	29.1	([1])	([1])	5.2	35.0
3	29.3	18.0	24.2	30.4	26.1	36.3	13.9	26.7	([1])	([1])	21.1	15.0
Producers without a milkhouse												
1	35.6	33.2	46.7	27.8	38.4	29.1	50.0	31.9	67.7	30.0	43.2	19.5
2	25.3	22.8	25.3	24.2	30.6	22.6	24.2	23.8	8.1	35.7	21.6	23.5
3	39.1	44.0	28.0	48.0	31.0	48.3	25.8	44.3	24.2	34.3	35.2	57.0

[1] The number of producers was too low to warrant a grade distribution.

of location C, where only about 11 percent of the farm bulk tank samples were classified as undergrade.

Quality of Milk as Affected by Seasons

As expected, summer samples were in general of poorer quality than during other seasons and winter samples were of the best quality (table 10). When farm bulk tanks were used, the quality of the milk was not affected by seasons. On the other hand, twice as many can samples were undergrade (Class 3) in summer as in winter.

Farm bulk tanks in location A gave milk supplies of basically the same quality throughout the year, but the use of cans resulted in approximately double the number of undergrade samples in summer that there were in winter. Farm bulk tank and can milk in location B were of poorer quality in summer than in winter. In location C, there were over three times as many undergrade can samples in summer as in winter. Curiously, in location C the number of undergrade farm bulk tank supplies in summer was one-fourth of those in winter; this indicates perhaps a laxity in sanitation during winter months in location C.

TABLE 9.—*Effect of geographical sources of milk supplies on class distribution, as determined by Standard Plate Count according to USDA recommended standards (14)*

[Percentage distribution of samples within each category]

Category of supply	Class		
	1	2	3
All samples:			
All locations	44.9	24.3	30.8
Location A	59.3	25.8	14.9
Location B	27.2	23.8	49.0
Location C	50.9	23.3	25.8
Bulk tank samples:			
All locations	58.2	21.2	20.6
Location A	60.7	26.0	13.3
Location B	27.6	23.9	48.5
Location C	74.8	14.3	10.9
Can samples:			
All locations	39.4	25.4	35.2
Location A	58.2	25.7	16.1
Location B	27.2	23.7	49.1
Location C	40.7	27.2	32.1

TABLE 10.—*Effect of seasons of sampling on class distribution of milk supplies, as determined by Standard Plate Count according to USDA recommended standards (14)*

[Percentage distribution of samples within each category]

Category of supply	Class		
	1	2	3
All samples:			
Fall	46.3	23.3	30.4
Winter	51.3	26.5	22.2
Spring	48.9	21.2	29.9
Summer	32.2	26.7	41.1
Farm bulk tank samples:			
Fall	67.0	15.7	17.3
Winter	58.1	20.6	21.3
Spring	60.3	20.6	19.1
Summer	53.3	25.1	21.6
Can samples:			
Fall	38.7	26.1	35.2
Winter	48.6	28.2	23.2
Spring	44.1	21.5	34.4
Summer	21.7	27.5	50.8
All samples:			
Location A:			
Fall	64.3	23.2	12.5
Winter	62.6	22.6	14.8
Spring	58.4	26.3	15.3
Summer	44.8	35.6	19.6
Location B:			
Fall	22.3	22.9	54.8
Winter	36.4	27.8	35.8
Spring	35.3	19.3	45.4
Summer	16.2	24.9	58.9
Location C:			
Fall	54.4	23.8	21.8
Winter	55.6	27.4	17.0
Spring	54.7	19.3	26.0
Summer	40.0	22.8	37.2
Farm bulk samples:			
Location A:			
Fall	69.0	20.7	10.3
Winter	67.6	19.6	12.8
Spring	61.8	26.3	11.9
Summer	53.0	34.2	12.8
Location B:			
Fall	42.6	14.8	42.6
Winter	30.0	30.0	40.0
Spring	17.3	26.9	55.8
Summer	20.9	23.1	56.0

TABLE 10.—*Effect of seasons of sampling on class distribution of milk supplies, as determined by Standard Plate Count according to USDA recommended standards (14)*—Continued

Category of supply	Class		
	1	2	3
Location C:			
Fall	79.8	9.5	10.7
Winter	63.8	16.2	20.0
Spring	80.4	10.8	8.8
Summer	76.1	18.5	5.4
Can samples:			
Location A:			
Fall	61.0	25.0	14.0
Winter	59.7	24.4	15.9
Spring	55.5	26.3	18.2
Summer	37.6	36.8	25.6
Location B:			
Fall	18.3	24.5	57.2
Winter	37.7	27.4	34.9
Spring	38.7	17.9	43.4
Summer	14.8	25.4	59.8
Location C:			
Fall	46.1	28.5	25.4
Winter	52.1	32.2	15.7
Spring	43.8	22.9	33.3
Summer	21.4	25.0	53.6

SUMMARY

The random selection of producers, coupled with the diverse geographical locations sampled, permits nationwide projection of the results found in this 1963–64 survey.

The profile of most producers of manufacturing-grade milk during 1963–64 is as follows:

He is most likely to ship his milk in cans, with either electrical or nonelectrical can cooling. His dairy herd is most likely between 6 and 25 cows, and he is most likely to deliver 151 to 750 pounds of milk per day. He is more likely not to have a milkhouse than to have one; and he is more likely to machine milk his cows than to hand milk them. The temperature of his delivered milk is as likely to be above as under 50° F. The bacterial content of the delivered milk is most likely to be higher than 500,000/ml. The bacteriological quality of his can milk supply will depend on various factors which are reflected in this study as the geographical location of

his farm and on the season of the year, with summer milk being generally of lower quality than that of any other season.

If he has a bulk tank on the farm, he is more likely to have a milkhouse, to have a dairy herd of more than 25 cows, and to use milking machines. Pickup of his milk is most likely every other day with more than 750 pounds per delivery. The temperature of milk at delivery is most likely to be 40° F. or lower. The bacterial content of his milk is most likely to be less than 500,000/ml. or it may be even less than 100,000/ml. The bacteriological quality of his farm bulk milk will depend on various factors which are reflected in this study as the geographical location of his farm, but it will be more uniform during the year than if he was shipping his milk in cans.

CONCLUSION

The paucity of nationwide data on the practices and facilities available on farms producing manufacturing-grade milk, as well as on the bacterial quality of such supplies, is evident. We have tried as best we could to fill this gap, but we realize that this data may not be sufficient. It may be necessary to establish some kind of mechanism under which data such as this would be evaluated and kept current.

The conditions of production and bacteriological quality of manufacturing-grade milk in 1963–64 cannot and should not be projected in the 1970's for changes, especially in the trend toward larger herd size, shifts to bulk tanks, and a drop in the number of producers, are bound to occur. Nevertheless, such data collected in 1963–64 should serve as a frame of reference for the assessment of improvements in the conditions of milk production in the years to come.

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