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A Comparison Of

The Bulk and Can Systems For Handling Milk on Farms

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What It's All About

The milk can is the most commonly used container for holding milk on the dairy farm. It is also the stand-by container used for transporting milk from the farm to the processing plant. However, in recent years, many dairy farmers have installed holding tanks which allow them to handle milk in bulk, thereby eliminating the use of cans. When the bulk method of handling milk is used, milk is transported by tank truck.

This bulletin reports the results of a comparison of the two methods during a 15-month period.

Results show that:

- Raw milk handled in bulk had an average bacterial count of 17,400 as compared with a count of 54,700 for milk handled in cans. After pasteurization the bulk milk had a bacterial count of 107 as compared with 143 for the milk in cans.
- Less milk was lost through handling by the bulk method.
- It took less than one-fourth as much time to handle milk by the bulk method as it took to handle it by the can method.

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The use of the bulk system of handling milk has spread rapidly since the system was first introduced in California in 1939. As of February, 1954, there were approximately 7,000 farm holding tanks installed on dairy farms in 38 states, and the use of this system is continuing to spread rapidly. Although a considerable amount of research has been conducted on the practicability and economy of using the bulk system of handling milk, no research has been reported in which the two systems were compared directly by using them on alternate days.

The objects of the work reported herein were to determine:

The influence of the bulk and the can systems of handling milk on the bacterial counts on raw milk and on the same milk after pasteurization.

The influence of the two systems on the flavor and odor of pasteurized milk.

The extent of losses of fat and of total solids when the can system is used.

The degree of accuracy of measuring the milk in the vat as a means of calculating the weight.

The amount of labor required by each of the two systems.

WHAT OTHER STUDIES HAVE SHOWN

Most of the literaturs on the bulk system of handling milk is written in popular style and includes observations by various persons

on the advantage of using this system as compared to the can system. The advantages most commonly mentioned are: lower bacterial counts, reduced handling losses of milk, increased fat tests, attractive savings in transportation costs, reduction in the amount of labor, the elimination of lifting of heavy cans, and an improvement in the flavor score of the milk.

An economic study was made by Nelson (6)* in which a comparative analysis of costs was made on collection of milk by can and by tank in Oregon. This study showed that the average yearly overall cost on a 10-cow herd was about $400 for the can system as compared with about $250 for the bulk system. For a 100-cow herd, it was found that the average yearly cost was about $3,050 for the can system as compared with about $1,300 for the bulk system. Nelson further stated that Oregon farmers realized a labor saving of 25 minutes to an hour per day and 10 to 20 cents per hundred weight saving in transportation costs. In addition, plants realized a saving in receiving costs from a little less than two cents to more than 4 cents per 100 pounds of milk when the can system was replaced by the bulk system.

In bacteriological studies on the bulk system of handling milk, Marth, Hunter, and Frazier (4) concluded that neither every-other-day pick up nor tanker transport adversely affected the sanitary quality of the milk.

PROCEDURE

The work reported herein was conducted on operations at the Oklahoma A. & M. College dairy farm over a 15-month period from October, 1952 to December, 1953. The daily milk production ranged from about 2,700 pounds to about 4,400 pounds with an average of 3,733 pounds. The equipment consisted of a four-stanchion pipe line milking system, a direct expansion surface cooler, a 500-gallon cold-walled automatically controlled bulk storage tank, a 500-gallon insulated trailer tank, and a sufficient number of cans to handle each day's production when cans were used.

Comparisons were made by alternate operation of the two systems, using the can system on one day followed by the bulk system the next day. On the days when cans were used, the milk was allowed to flow from the vacuum releasing mechanism of the pipeline milking system over the surface cooler directly into the milk cans. This cooler was designed to fill four cans at a time and thus required less attention than the

* Numerals in parentheses refer to Literature Cited, page 15.

average surface cooler. The filled cans were stored in a walk-in cooler until delivery time. The milk was delivered to the college processing plant where it was dumped into the weigh tank and the weight recorded. Samples for bacteriological analysis and fat tests were taken at this time. After the cans were dumped, they were carefully rinsed with approximately one quart of hot water by inverting the cans over a mechanism which injected the hot water into the can through a spray nozzle. The rinsings were collected in a can and when all the cans had been rinsed, the rinsings were weighed and a sample taken for analysis.

On the days when the bulk system was used, the milk was allowed to flow from the vacuum releasing mechanism directly into the cold-walled bulk storage tank. At pickup time, the amount of milk was carefully measured by means of a calibrated rod and the calculated weight recorded. The agitator was then started and allowed to operate while preparations were made for pumping the milk from the tank through a Tygon hose into a 500-gallon tank trailer. The amount of time required for connecting the pump and hose was about 5 minutes in each case. After the connections were made, a sample for fat analysis was taken.

At the processing plant, the milk was pumped into the receiving system where it was carefully weighed, and samples were taken for bacteriological analysis. With both the bulk and the can systems of handling, samples of the pasteurized milk were taken directly from the pasteurizing vat for bacteriological examination. Samples of the pasteurized bottled milk were also taken in many of the trials in order to determine the influence of the system of handling the milk on its flavor and keeping quality.

Fat tests on the milk were made by the Babcock method, and fat tests and total solids on the rinsings were made by the Mojonnier method (5). Standard plate counts and coliform counts were run according to the procedure given in the 9th edition of Standard Methods For the Examination of Dairy Products (1). Because of the very low counts on the pasteurized milk, 1.0 ml and 0.1 ml quantities of the milk were plated. The 0.1 ml quantity was obtained by diluting 1.0 ml with 9 ml of sterile water contained in a screw capped test tube. The standard plate counts were incubated at 32 degrees C. The coliform counts were determined by plating on desoxycholate agar and incubating at 35-37 degrees C.

The average standard plate counts and coliform counts were calculated as logarithmic averages, using a five-place log table.

RESULTS

The average standard plate counts and the coliform counts for each month of the experiment on the raw milk handled by each system are shown in Table I. Also included in Table I are the average standard plate counts on samples of milk taken from the pasteurizing vat after heating to 143 degrees F for 30 minutes. Fifty-one comparisons were run on the raw milk during the 15-month period in which the milk was handled with the bulk system and with the can system on alternate days.

The standard plate counts on the raw milk handled each day with the bulk system ranged from 5,000 to 200,000 and averaged 17,400, while those on the milk handled with the can system ranged from 7,600 to 390,000 and averaged 54,700. When the bulk system of handling was used, only six of the 51 counts were higher than 50,000; while when the can system was used, 25 of them were higher than 50,000. Also, none of the counts on the milk handled with the bulk system was over 200,000; while five of the counts on the milk handled with the can system were over this limit, which is commonly established as the maximum count for Grade A milk for pasteurization. For each month, the average standard plate count on the milk handled with the bulk system was lower than that on the milk handled with the can system.

There did not seem to be any general trend in counts due to the season of the year, except that the counts seemed to be higher during March and April than during any of the other months.

There did not appear to be any significant differences in the coliform counts on the raw milk handled with the two systems, although the milk handled with the bulk system had a slightly lower average count than the milk handled with the can system. There was no close relationship between the coliform counts and the standard plate counts, but the coliform counts were generally high when the standard plate counts were high.

In order to determine the influence of the two systems of handling the milk on the counts on the pasteurized milk, standard plate counts were run on samples of milk taken directly from the vat after pasteurization. In 23 comparisons, shown in Table I, the average count on the raw milk handled with the bulk system was 15,500 and on the same milk after pasteurization was 107, which is a pasteurization efficiency of 99.31 percent. The average count on the raw milk handled with the can system was 60,300 and on the same milk after pasteurization was 143, which is pasteurization efficiency of 99.76 percent.

Table I.—Bacterial Counts on Milk Handled with the Bulk and Can Systems.

Month	Number of trials	Raw milk: Standard plate counts, Bulk system	Raw milk: Standard plate counts, Can system	Raw milk: Coliform counts, Bulk system	Raw milk: Coliform counts, Can system	Number of trials	Standard plate counts on raw and pasteurized milk: Bulk system, Raw	Bulk system, Past	Can system, Raw	Can system, Past
November	5	17,300	91,200	41	784	--	-----	---	-----	---
December	6	12,400	37,100	15	220	--	-----	---	-----	---
January	4	11,100	53,800	98	281	2	10,300	57	72,800	244
February	6	13,300	22,400	290	115	6	13,300	118	22,400	93
March	5	27,700	112,000	337	410	4	26,700	107	60,400	164
April	6	31,100	88,400	147	52	5	21,800	135	80,600	148
May	6	10,900	81,700	47	209	6	10,900	99	120,000	163
June	3	12,100	18,800	164	25	--	-----	---	-----	---
July	7	31,100	50,700	257	283	--	-----	---	-----	---
August	3	15,400	55,000	705	51	--	-----	---	-----	---
Total	51					23				
Average		17,400	54,700	117	175		15,500	107	60,300	143
Pasteurization efficiency							99.31%		99.76%	

These results indicate that the system of handling the milk had no significant influence on the counts on the pasteurized milk or on the efficiency of pasteurization. This indication, coupled with the fact that there were no significant differences in the coliform counts between the lots of milk produced by the two systems, suggests that there was no significant difference in the degrees of contamination between the two systems, and that the differences in standard plate counts on the raw milk were largely due to the greater efficiency of cooling with the bulk system.

Milk and Fat Losses with the Can System

When the can system was used, a certain amount of milk adhered to the cans and was lost. Table II shows the amounts of butterfat, total milk solids, and calculated pounds of milk lost in 20 trials. The average pounds of milk lost per can is shown in the last column of this table. These figures were obtained by dividing the equivalent pounds of milk based on the amount of fat in the can rinsings by the number of cans delivered on the particular day concerned.

The equivalent pounds of milk on a solids basis were obtained by dividing the pounds of total milk solids in the rinsings by the percent of total milk solids corresponding to that day's butterfat test as listed in the table compiled by Jacobson (3).

The amount of milk lost per can ranged from 0.287 pounds to 0.366 pounds and averaged 0.320 pounds. Using this average loss per can, a Grade A producer delivering 100 gallons of milk per day would lose 1,168 pounds of milk per year, which at current prices would mean a loss of between $50 and $60. The producer who uses the bulk system would eliminate this loss because the weight of his milk is determined at the farm.

Accuracy of Measuring the Weight of Milk

The accuracy of measuring, as compared to weighing, as a means of determining the weight of milk with the bulk system of handling was determined in 69 trials during the period from October 7, 1952 through December 17, 1953. In these trials, the depth of the milk in the storage tank was measured with a rod calibrated to give the weight. The milk was then pumped into a trailer tank, transported to the milk plant, and the weight of the milk determined by weighing with a receiving scale. The comparative accuracy of the calibrated measuring rod in determin-

Table II.—Amount of Fat, Total Solids, and Calculated Pounds of Milk Lost with the Can System of Handling Milk.

Date	Cans (No.)	Milk (pounds)	Fat (percent)	Rinsings (pounds)	Fat in rinsings (percent)	Fat in rinsings (pounds)	Solids in rinsings (percent)	Solids in rinsings (pounds)	Equiv. milk fat basis (pounds)	Equiv. milk solids basis (pounds)	Milk lost per can (pounds)
Nov. 1952											
15	45	3743	4.6	112	.57	.64	1.421	1.59	13.88	11.78	.308
18	40	3307	4.6	156	.43	.67	0.902	1.41	14.58	10.42	.365
20	43	3593	4.6	110	.544	.60	1.426	1.57	13.01	11.61	.303
22	40	3315	4.6	108	.599	.65	1.592	1.72	14.06	12.73	.352
25	43	3649	4.6	111	.587	.65	1.247	1.38	14.16	10.25	.329
Dec.											
2	48	3866	4.7	124	.531	.66	1.378	1.71	14.01	12.52	.292
4	41	3419	4.5	131	.472	.62	1.681	2.20	13.74	16.47	.335
6	41	3249	4.6	119	.510	.61	1.421	1.69	13.21	13.52	.322
9	42	3512	4.7	128	.508	.65	1.343	1.72	13.83	12.59	.329
11	41	3424	4.3	117	.551	.64	1.374	1.61	14.99	12.28	.366
16	42	3578	4.2	120	.486	.58	1.510	1.81	13.89	13.99	.331
Jan. 1953											
13	42	3474	4.3	119	.436	.52	1.461	1.74	12.07	13.28	.287
15	44	3711	4.3	127	.510	.65	1.380	1.75	15.06	13.39	.342
17	42	3500	4.4	121	.467	.57	1.243	1.50	12.84	11.37	.306
20	45	3750	4.2	124	.461	.57	1.271	1.58	13.61	12.17	.302
Feb.											
17	43	3644	4.3	117	.504	.59	1.472	1.72	13.71	13.16	.319
19	50	4156	4.3	146	.454	.66	1.296	1.89	15.41	14.46	.308
21	48	4007	4.4	136	.470	.65	1.410	1.92	14.53	14.49	.303
24	49	4063	4.3	98	.634	.62	1.761	1.73	14.45	13.18	295
26	50	4209	4.3	100	.675	.68	1.611	1.61	15.70	12.31	.314

ing the weight of milk is shown in Table III. The results show that in the first 46 trials, the average calculated weight was 4.35 pounds less than the average scale weight; while in the last 23 trials, the average calculated weight was 0.22 pounds more than the average scale weight. The difference for the entire period was 2.83 pounds less for the calculated weight. The average difference per day between the calculated weight and the scale weight was 24.35 pounds for the first 46 trials, 7.09 for the last 23 trials, and 18.59 for the entire period.

It is interesting to note that the calculated weights are much closer to the scale weights during the last 23 trials than they were during the first 46 trials, even though the same person did the weighing and measuring in every trial. The only explanation is that as this man became more experienced his readings became more accurate. These data demonstrate that the measuring rod is sufficiently accurate for determining the weight of the milk if the person doing the measuring is careful. The data show further that even when the person doing the measuring is not as accurate as he should be, the average weights as determined by the calibrated rod are very close to the average scale weights.

An analysis of the data for each trial showed that during the first 46 trials, the greatest variation between the calculated weight and the scale weight was 59 pounds, while the least difference was 2 pounds. During the last 23 trials, the greatest difference was 21 pounds, while in two instances the calculated weights and the scale weights were the same.

Labor Required for Handling Milk On the Farm

The amount of labor required to handle milk on the farm by the bulk and by the can system was determined by using a stop watch to time all operations connected with the cooling and handling

Table III.—Comparative Accuracy of Measuring As a Means of Determining the Weight of Milk.

Duration of period	Number of trials	Average calculated weight	Average scale weight	Difference	Average difference per day
		(pounds)	(pounds)	(pounds)	(pounds)
Oct. 7, 1952 to April 13, 1953	46	3,883.91	3,888.26	—4.35	24.35
April 15, 1953 to Dec. 17, 1953	23	3,432.48	3,432.26	+0.22	7.09
Entire period	69	3,733.43	3,736.26	—2.83	18.59

Table IV.—Labor Required per Day for Handling Milk on the Farm by the Bulk and Can Systems.

Time in minutes per day to handle milk on the farm			
Bulk system		Can system	
Date	Time	Date	Time
February 23	31.0	February 26	167.0
February 27	30.0	February 28	141.5
March 17	35.0	March 21	206.0
April 17	26.5	April 16	145.0
April 22	24.5	April 18	179.5
April 24	28.5	April 23	127.0
August 10	39.5	August 12	114.0
August 14	20.5	August 13	112.0
August 19	23.0	August 15	97.0
August 21	21.0	August 18	42.0
Average	28.0	Average	137.0

of the milk. These time studies were made when milk was handled by the two systems on alternate days in order that the conditions under which the milk was handled would be as nearly the same as possible.

The amount of labor required in 10 trials with each of the two systems are shown in Table IV. The labor required to handle the milk by the bulk system ranged from 20.5 to 35 minutes and averaged 28 minutes per day, while the labor required to handle the milk by the can system ranged from 97 to 206 minutes and averaged 137 minutes per day. The difference in time saved per day with this rather large operation amounted to 109 minutes, the equivalent of over 600 hours per year. It should be mentioned in this connection that the surface cooler used in these trials was one that filled four cans at a time so that it required considerably less frequent attention than would one that would fill only one can at a time.

Influence of the System of Handling On the Flavor of the Milk

Observations were made on numerous occasions on the flavor and keeping quality of the pasteurized milk processed from the raw milk handled with the two systems. No detectable differences in flavor or in keeping quality were observed, although it would appear that the milk handled with the bulk system would have less metal contamination and would therefore be less vulnerable to oxidation than the milk handled by the can system.

SUMMARY AND CONCLUSIONS

This study was limited to the operations on only one dairy farm, and in some respects it may not be representative of a commercial operation where the milk from several farms is collected by one tank truck. It does, however, reveal that there are certain advantages of the bulk system over the can system for handling milk. Perhaps the most attractive of these advantages are the savings in labor, and the fact that the farmer sells his milk while it is still on his own premises. Also, the labor involved in the bulk system is less toilsome.

The results indicate that the standard plate counts on the milk handled by the bulk system were lower than those on the milk handled by the can system. There appeared to be no significant differences in the coliform counts on the raw milk or in the standard plate counts on the pasteurized milk attributable to the system of handling the milk.

With the can system there was an average calculated loss of 0.32 pounds of milk per can, while with the bulk system this loss was eliminated since the weight of the milk was taken on the farm.

There appeared to be no difference in the flavor of the pasteurized milk processed from raw milk produced by the two systems. However under less favorable conditions of production the chances for metal contamination would probably be much less with the bulk system than with the can system.

LITERATURE CITED

1. American Public Health Association. *Standard Methods for the Examination of Dairy Products.* 9th ed. American Public Health Association, New York, N. Y. 1948.

2. Dahlberg, A. C., J. C. Henning, and H. L. Durham. Reduction of milk losses in milk plants. *J. Milk Tech.* 2:96-99. 1939.

3. Jacobson, M. S. Butterfat and total solids in New England farmers' milk as delivered to processing plants. *J. Dairy Sci.* 19:171-176. 1936.

4. Marth, E. H., J. E. Hunter, and W. C. Frazier. Bacteriological studies of a farm bulk milk handling system. *J. Milk and Food Tech.* 17:86-90. 1953.

5. Mojonnier, Timothy, and H. C. Troy. *The technical control of dairy products.* 2nd ed. Mojonnier Bros. Chicago, Ill. 1925.

6. Nelson, G. T. Report on bulk handling. *Milk Plant Monthly.* 42: (3) 23-24. March, 1953.