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Comparative Study of the Composition and Quality of Bulk Tank Milk

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COMPARATIVE STUDY OF THE COMPOSITION AND QUALITY OF BULK TANK MILK

by

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TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Importance of problem

During the past decade, many changes have taken place in the dairy industry. At the present time, the industry is endeavoring to improve the quality and handling of milk. This is being accomplished by new equipment and improved methods.

In recent years the handling and transporting of milk by means of the ten gallon can is being replaced by the bulk tank system. With improved farm and truck tanks, milk can be cooled rapidly and stored at a lower temperature.

There are a few problems pertaining to quality, fat tests and weights in handling milk in bulk tanks. Among the problems we may list the following: maintenance and improvement in the quality with reference to bacterial content and flavor, accurate composite fat tests and economy of investment and operation.

The dairy industry along with other industries are striving to improve the equipment and methods of handling milk. With each improvement, there are many problems that must be overcome before the system can be considered successful.

The tank system calls for every other day pick-up. The milk is pumped from the farm tank into the tank truck before being transported to the dairy plant. With this new development came the problem of gathering the samples of milk for the fat test at the farm rather than at the factory. This study compares the daily fat test with the 15 day composite of farm tank milk.

If milk is cooled and allowed to stand for any period of time a cream layer will form on the top of the milk. To mix the milk thoroughly for the cooling and sampling, installation of a mechanical agitator was necessary.

The milk is held on the farm two days before delivery. This may cause a problem in increased bacterial counts.

With the use of the bulk tank trucks came the problem of proper cleaning and sanitizing. Only a small amount of research has been made on cleaning and sanitizing tanks.

Along with this problem came the one of undesirable flavors in milk. The question of the effect of increased holding and agitation on the development of undesirable flavors becomes important. Without proper control a large tank of milk could very easily be contaminated with the milk from one patron.

As these problems, among others, are successfully solved, the bulk tank system of handling milk will flourish throughout the dairy industry.

Purpose of project

1. A comparison of daily fat tests (for 15 days) with the composite test for the same period.

2. The effects of agitation on the test of bulk tank milk.

3. The bacterial counts of bulk tank milk.

4. The bacterial counts of bulk tank milk for the period before and after installing mechanical cleaning.

5. The flavor score of bulk tank milk under varing conditions.

REVIEW OF LITERATURE

History of bulk tank milk

A report by Mojonnier (6) stated that the bulk tank system of producing milk was started on the larger farms in California about 15 years ago. Surface coolers were erected above the tanks where the milk was cooled to below 40° F., and held in the tank. The milk was agitated for sampling purposes only.

On smaller farms in the midwest and east, the pour in type tanks with elevated surface coolers, where the milk was discharged into a holding vat for storage. This did not appear to be the best answer to bulk handling. In 1948, the first bulk tank route in the eastern part of the country was established. Farm holding tanks were used with a cooler section suspended in the center of the tank. Milk was poured into a trough mounted on the tank which distributed the milk over this refrigerated section. An increase in the milk level in the tank had the effect of gradually submerging the cooler section and causing a decrease in cooling efficiency.

The first calibrated farm bulk cooling tank as reported by Noles and Wilkowsher (7) was introduced by the Lucerne Milk Company in November, 1941. Mojonnier reports (6) the first farm tank was installed in New York in April, 1948. The following year, 1949, Noles and Wilkowsher (7) reported that the bulk route with ice cold wall tanks was established out of Columbia, South Carolina. The first every other day pick-up system in New York was established in May, 1952.

A Milk Plant Monthly survey (1) estimated the number of tanks in

the United States as of May, 1955 to be about 19,000; May, 1956, about 54,000; and by May, 1957, there would be about 104,000 farm tanks.

Whereas a survey by Whitehead (12) from Republic Steel Corporation, published in March, 1955, some figures gathered from 30 states, showing an estimate of 15,432 tanks by July, 1955. Estimating the remaining 18 states, would come up to a total of 19,761. They estimated that 88,105 tanks would be in use in the 23 major states when the demand tapered off.

Whitehead reports (12) there are slightly more than 600,000 dairy farms in the United States with 15 cows or more and nearly everyone a tank prospect. It is estimated that in ten years 75% of the milk will be produced under the bulk tank system.

Fat tests of bulk tank milk

H. J. Preston (9) reported that a minimum of two minutes would completely blend the cream with the milk. Work completed by (3) reported that for proper blending, the agitation should run four minutes.

Preston (9) indicates that for a more accurate sample for testing purposes if it consisted of several small samples from different portions rather than one large sample from one position. Sample errors would be off-set by increasing the number of fresh samples tested throughout the month.

The American Milk Review made a comparative study (3) of the daily fat test with the composite fat tests. Three separate fat samples were gathered and analyzed. A composite sample carried on the truck at below 50° F., composite sample built up at the laboratory and held below 50° F., and daily sample.

The average fat test of the truck composite samples for the 19 patrons was 4.55%, for the laboratory composite sample 4.54% and for

the daily fresh sample 4.55%.

A comparison of the butterfat tests of composite samples carried on the truck, composite samples built-up at the city laboratory from fresh samples collected at the dairy farm, and the average of the daily fresh samples showed only 0.01% difference.

It was recommended that a storage compartment be built on the tank trucks and maintained at below 50° F. when samples are carried on the route. If the compartment on the bulk tank truck can be maintained at below 50° F. the samples will be satisfactory for testing.

Bacterial counts of bulk tank milk

There is some controbersy over the much publicized quality improvement of milk produced under the bulk tank system. Atherton (4) completed a study on 21 patrons on milk produced by using a ten gallon can and milk produced using the bulk tank system. Three individual plate counts were run, the standard plate count, heat resistant counts, and psychrophilic counts. The range for the standard plate count for the ten gallon can was 14 per ml. to 720 per ml. with an average count of 72 per ml., for the tank the range was 9 per ml. to 500 per ml. with an average count of 59 per ml. The range for the heat resistant counts was 150 per ml. to 16,000 per ml. with an average count of 1300 per ml. for the cans, and the range for the tank was 70 per ml. to 5000 per ml. with the average of 480 per ml. The range for the psychrophilic counts was 210 per ml. to 13,000 per ml. for the cans and the range for the tank was 92 per ml. to 15,000 per ml. with the average count of 780 per ml.

A report by Smith (9) reports that there is only a slight increase in the bacterial count of milk picked-up every other day from milk picked-up daily.

The range for the 12 month period for the daily samples was 3000 per ml. to 200,000 per ml., whereas the range for the 12 month period for the alternate day was 3000 per ml. to 290,000 per ml. The average for the daily sample was 6900 per ml. and the average for the alternate day was 7800 per ml., with a difference of only 900 per ml.

A study was made by Prouty (10) on the prevalence of facultative psychrophilic bacteria as determined by the plate count at 17° C., in raw milk produced under the bulk tank system, together with observations on the subsequent growth of these types during additional storage periods of 24 and 48 hours at 37° F. to 39° F. The percentage of facultative psychrophilic counts and the standard plate counts varied with the range of the total count.

At the time of sampling the facultative psychrophilic and standard plate counts paralleled one another rather closely. In the majority of the samples the standard plate count exceeded the facultative psychrophilic counts. At the initial plating period the facultative psychrophilic types were not present at high enough levels to induce the presence of abnormal flavors and odors.

As the samples were held in storage the facultative psychrophilic counts increased more rapidly than did the standard plate counts. In general, however, the facultative psychrophilic counts were not excessive after 24 hours of storage.

After 48 hours of storage 25.5% of the samples had facultative psychrophilic counts in excess of 100,000 per ml. In some of these samples the facultative psychrophilic count was in excess of 1,000,000 per ml.

Flavor score of bulk tank milk

A study from Atherton (4) reports on a comparative study of the flavor defects of milk produced by the bulk tank system and the ten gallon can. Approximately 175 flavor comparisons have been made between individual deliveries of 18 patrons under cooling conditions of 1952 and the delivery of these 18 patrons under bulk cooling system for the same month, 1954. Of the 175 comparisons made, there were 29 different undesirable flavors.

The results show that there were more perfect scores of 40 points by 10% when the milk was delivered in the ten gallon can than there was when the bulk tank was used. Feed flavors appeared in 51.4% of the milk produced under the bulk tank system, whereas only 29.7% appeared when the ten gallon can was used. There was a sharp decline in number of unclean flavors after the use of bulk tanks. The same holds true for the rancid, grass and high acid flavors. When the flavor scores were grouped for each patron on a good (38-40), fair (35-37), poor (less than 35) basis there was 105 samples scored good (38-40) for the can patrons, 67 scored fair (35-37) and three patrons scored poor (less than 35). The bulk tank scores were: 135 samples scored good (38-40), 37 samples scored fair (35-37), and three samples scored poor (less than 35).

Atherton (4) reported that rancidity does not appear to be a factor of improvement of the flavor of milk from bulk tanks. Likewise, milk criticized as having an unclean flavor has almost completely disappeared since the conversion of bulk milk cooling systems.

Kelley and Dunkley (5), Guthrie (11) and Calbert (2) reports that rancidity is the major undesirable flavor problem facing the bulk tank, pipeline milking system. They contribute the majority of rancid flavor to the pipeline milking system rather than the bulk tank itself. A few

of the causes were contributed to numerous risers and elbows in the lines. Defective connections in the pipeline, sways in the line and delay in changing the milking units from cow to cow. Air which gets into the pipeline is a contributing factor to rancid flavors. They recommend that when changing the units from cow to cow, first turn off the vacuum before pulling the teat cups off the cow, and do a quick job of putting them on the next cow.

There are (2) two main things to watch with bulk tanks to avoid the development of rancid milk. First, set the agitation so it will not stir warm milk to long before it is cooled and second, see that the temperature of the milk never gets above 65° F. after it has once been cooled. The addition of warm milk to cold milk below the level of the agitator, the warm milk should raise the temperature above 50° F. Pearson stated (8) that installation of a bulk tank should improve the quality of the milk bacteriologically, but unless care is taken, it will produce a lower quality milk flavor-wise.

PROCEDURE

A comparison of daily fat test (for 15 days) with the composite test for the same period

The samples for this portion of the research were gathered in co-operation with the Cache Valley Dairy Association. They were gathered by riding the bulk tank truck on one of the schedules routes. It was decided to use 14 customers who were using the same bulk tank system. The route was on an every other day schedule.

Samples were taken for a three-fold purpose. First, the sample was used for a bacterial count, then for a flavor score and finally for a daily fat analysis. The other sample jar would be used for the 15-day composite fat test.

The samples were gathered according to standard methods in the following manner. Before the samples were taken the agitator in each bulk tank was allowed to run at least two minutes. All samples were refrigerated as soon as taken and held at 35° to 40° F. until analyzed.

The effect of agitation on the fat test

The samples for this portion of the problem were taken from a C. E. Howard bulk milk tank, with a capacity of 300 gallons. They were taken after the milk had been completely cooled. The agitator was allowed to run for ten seconds, 20 seconds, 30 seconds, 60 seconds, one and one-half minutes, two minutes, two and one-half minutes, three minutes, four minutes, five minutes and ten minutes. Two samples were taken at the end of each period of agitation. One was taken from the center of the tank and the other was from the end of the tank.

The fat tests were made according to the Babcock method outlined in the Standard Methods.

The bacterial count of bulk tank milk

The samples for the bacterial counts were gathered with the fat test samples. The standard plate count was followed as outlined in the standard methods and swab technique according to standard methods, 1948.

The bacterial count of bulk tank truck milk before and after mechanical cleaning

For this portion of the problem, the samples were taken from a bulk tank truck. It was used for a considerable time before the mechanical cleaning system was installed. Samples were taken from the tanker in a similar manner before and after mechanical cleaning.

The bulk tanker was hand-cleaned in the following manner before the bacterial samples were taken. The tank was first rinsed with luke warm water. It was then hand scrubbed with an alkali cleaning compound using 120° F. water. Every third washing an acid cleaner was used. The tank was then rinsed with city water from the tap at about 45° to 50° F. There was no special sanitizing agent used after cleaning because a sanitizing agent was added directly to the cleaning compounds used.

The samples were taken from the milk, and the rinse water that did not completely drain from the tanker. Swab tests were taken from the outlet of the tanker, the inside wall of the tanker, the air tube used for agitation inside the tanker, the thermometer inside tanker.

After the installation of the mechanical cleaner, the tanker was washed with a rotary jet cleaner. The tanker was rinsed with cold water for five minutes. The tanker was then cleaned with an alkali detergent solution of 1200 ppm. The water pressure was 200 pounds with a tempera-

ture of about 150° F. This operation continued for ten minutes. At this point the detergent valve is turned off and then the steam valve is turned off gradually allowing tanker to cool slowly. After about five minutes the steam is completely off and the tanker is rinsed with cold water at 45° F. until the discharge water is cold. The tanker is completely drained and sanitized by fogging with a mist of chlorine solution at one ounce per quart of water, or 2400 ppm. Every third day an acid cleaning compound is used in the same manner as the alkali compound.

Samples were taken from the milk, swab samples from the outlet of tanker, the inside wall of tanker, the air tube inside tanker used for agitation of the milk and the thermometer inside tanker. There was no rinse water left inside tanker due to the installation of a pump to draw the water out of the tanker.

The samples of milk and the drain water were run according to the standard plate count methods. The swab test samples were run according to standard methods.

The flavor score of bulk tank milk

The samples were taken at the same time the fat test and bacterial samples were gathered. Each sample was judged and scored according to American Dairy Science Association's score card.

RESULTS AND DISCUSSION

Fat tests

The experiment consisted of three separate fat analysis. The daily fat analysis was taken every day the milk was picked-up from the farm. The two composite fat analyses were taken for the same 15-day period. One composite sample was taken by the driver of the tank truck for the factory. The second composite sample was taken for research purposes.

The study makes a comparison of the two composite fat tests with the daily fat test.

Table 1 is a total of the pounds of milk, the average daily fat test, total pounds of fat, composite fat test, total pounds of fat, factory composite fat test, total pounds of fat, and the difference from the average daily fat test from the composite and factory composite fat test. The difference in the total and the average pounds of fat difference from the two composite fat tests.

The results indicate that for the 14 patrons on the test, there was a total of 161,289 pounds of milk produced. The average daily fat test was 3.61% for a total of 5,822 pounds of fat with a daily average of 416 pounds of fat. The average composite fat test was 3.57% with a total of 5,757 pounds of fat with a daily average of 411 pounds of fat. The average factory fat test was 3.55% with a total of 5,718 pounds of fat with a daily average of 408 pounds of fat. The average daily fat test was 0.04% higher than the composite fat tests, and 0.06% higher than the factory composite fat test. The average total daily pounds of fat was 65.1 pounds higher than the total composite pounds of fat and

104.0 pounds higher than the factory total pounds of fat. The average daily pounds of fat was 4.6 pounds more for the average composite pounds of fat and 7.4 pounds more for the average factory composite pounds of fat.

Table 1. Summary of daily fat tests, composite fat tests and factory composite fat tests.

Patron No.	Total Pounds Milk	Daily Fat Test	Total Pounds Fat	Composite Fat Test	Total Pounds Fat	Factory Composite Fat Test	Total Pounds Fat
1	14,304	3.44	492	3.40	487	3.40	487
2	9,928	3.59	357	3.45	343	3.40	338
3	7,649	3.49	267	3.45	264	3.50	268
4	9,584	3.76	361	3.65	350	3.60	345
5	16,309	3.59	586	3.55	579	3.50	571
6	7,649	3.69	283	3.65	279	3.70	283
7	10,223	3.59	367	3.60	368	3.50	358
8	14,802	3.71	549	3.70	548	3.70	548
9	13,932	3.75	522	3.70	516	3.70	516
10	12,030	3.48	426	3.50	421	3.40	409
11	12,403	3.66	454	3.70	459	3.70	458
12	16,645	3.59	588	3.50	583	3.50	583
13	9,809	3.58	351	3.50	343	3.50	343
14	6,022	3.64	219	3.60	217	3.50	211
Total	161,289		5,822		5,757		5,718
Ave.	11,516	3.61	416	3.57	397	3.55	408

Effect of agitation on bulk tank milk

There were ten separate trials completed for the agitation results. Table 17 through 26 gives the results for the different trials. The fat tests for Trial No. 1, Table 17, showed a slight decrease in the fat test for the ten seconds to 60 seconds agitation period and from 60 seconds to the ten minutes agitation period there was relatively little difference in fat tests.

Trial No. 2, Table 18, shows about the same results. From one and one-half minutes to the ten minute agitation period there was a uniform fat test. The fat test varied on trial from the one and one-half minute period and then only by 0.05%.

The general trend of the remaining trials were similar. It is indicated by the majority of the trials completed that the agitator should be allowed to run for at least two minutes before the sample of milk for the butterfat test is taken. At no time during the ten trials did the samples from the center of the tank vary more than 0.10% from the end of the tank. In the majority of the cases the sample of milk taken from the center of the tank had a more uniform fat test after the two minute agitation period than at the end of the tank.

The results have shown that in the majority of cases it is better to run the agitation at least two minutes and after three minutes there is no appreciable change.

Table 16. Summary table of the average fat test for the different agitation periods.

Time	Fat Test	
	Center	End
10 seconds	3.405	3.445
20 seconds	3.425	3.445
30 seconds	3.480	3.455
60 seconds	3.485	3.480
1.5 minutes	3.510	3.495
2.0 minutes	3.510	3.505
2.5 minutes	3.515	3.510
3.0 minutes	3.515	3.515
4.0 minutes	3.520	3.510
5.0 minutes	3.515	3.515
10.0 minutes	3.520	3.505

Bacterial counts of bulk tank milk

The results for the bacterial counts of the 14 different patrons milk is found on Table 2 through 15.

With the standards for raw grade A milk at 200,000 per ml., all the bacterial counts were below the above standard. Of the 14 patrons,

one had an average count of less than 10,000 bacteria per ml. One had an average count of less than 15,000 per ml. Three had an average bacterial count of less than 25,000 per ml. One had an average bacterial count of less than 30,000 per ml. Two had an average bacterial count of less than 40,000 per ml. One had an average bacterial count of less than 50,000 per ml. Two had an average bacterial count of less than 60,000 per ml. One had an average bacterial count of less than 65,000 per ml. The other two had average bacterial counts of 138,000 per ml. and 189,000 bacteria per ml. Nine of the 14 patrons produced milk with an average bacterial count of less than 50,000 per ml. Twelve of the 14 patrons produced milk with a bacterial count of less than 100,000 per ml, and only two of the 14 patrons produced milk with a bacterial count over 100,000 per ml. Table 27 indicates the average bacterial counts for the 14 patrons with a total bacterial count of 739,387 per ml. and an average bacterial count of 52,813 per ml.

Table 27. Summary of the bacterial counts of different patrons.

Patron Number	Average Plate Count
1	12,900
2	53,300
3	57,000
4	7,900
5	138,000
6	47,900
7	189,000
8	36,287
9	36,400
10	26,800
11	62,800
12	24,700
13	24,000
14	22,400
Average	52,813

Bacterial counts of bulk tank milk before and after mechanical cleaning

The bacterial counts for this portion of the study were taken on the milk, rinse water, outlet of the tanker, wall inside the tanker, air tube inside the tanker and the thermometer inside the tanker. Table 28 indicates the results before the mechanical cleaning was installed. Table 29 indicates the results after mechanical cleaning was installed.

The bacterial count of the milk before mechanical cleaning ranged from 3,000 bacteria per ml. to 6,000 bacteria per ml., with an average bacterial count of 4,375 per ml. There was only a slight decrease in the bacterial count of the milk after automation. The bacterial count ranged the same, but the average count was 4,000 per ml.

After the tanker was hand-cleaned, there was a small amount of rinse water that did not drain. This amounted to from one quart to one gallon. A sample of this rinse water indicated the presence of bacteria. There was from 3,000 per ml. to 21,000 per ml. After mechanical cleaning was installed, this rinse water was eliminated due to the installation of a pump to draw the water from the tanker.

The outlet of the tanker is the most difficult part to clean. It must be dissembled, cleaned and reassembled. The counts ranged from 14,000 to 180,000, with an average count of 76,625 per eight square inches. On Trial No. 1, 2, 5, and 8, the outlet was not dissembled and therefore a high count resulted. The bacterial count for the outlet of the tanker after the installation of mechanical cleaning ranged from 3,000 per eight square inches to 12,000 per eight square inches. It was dissembled, cleaned and fogged with chlorine water before reassembled. The average count was decreased to 7,937 per eight square inches.

There was an appreciable decrease in the bacterial count of the wall

inside the tanker. The average bacterial count before automation was 38,500 per eight square inches, whereas the average bacterial count after automation was 8,750 per eight square inches. This change could possibly be contributed to the fogging of the tanker with chlorine water after mechanical cleaning. Before mechanical cleaning, the tanker was sanitized during the cleaning process.

The air tube is a stainless steel tube inverted into the tank from the top. The air passes through the tube down into the milk which causes a gentle rotation during cooling. It must be removed from the tanker, hand-cleaned and then replaced back into the tanker. The bacterial counts ranged from 12,000 to 21,000, with the average count of 16,375 per eight square inches before mechanical cleaning. The bacterial count ranged from 10,000 to 17,000, with the average count of 14,500 per eight square inches after mechanical cleaning. The bacterial count on the thermometer ranged from 0 to 10,000 per eight square inches before automation. The bacterial counts ranged from 3,000 per eight square inches to 8,000 per eight square inches after automation. There was a slight increase in the bacterial count after automation. This could be due to the position of the thermometer in the tank. It cannot be removed and is in one end of the tanker about six inches from the bottom of the tank. From the position of the jet spray there is a possibility that the spray of cleaning compound does not make a direct hit on all the surface of the thermometer.

The time required to clean and sanitize the tanker by hand was two minutes for rinsing, 25 minutes for cleaning and three minutes for final rinse, for a total of 30 minutes. Two men were required to perform this operation.

When the mechanical cleaning system was installed, it took one man five minutes to rinse, ten minutes for spray cleaning, five minutes to

rinse, two minutes to fog with chlorine and eight minutes to assemble and take down, for a total of 30 minutes. With the mechanical cleaning system, the man was not required to get inside the tank.

Flavor score of bulk tank milk

There was a total of 73 flavor scores checked on this exercise. Of the 73 checked, 39 had a perfect score of 40 points, three had a score of 39.5 points with a slight feed flavor, 19 had a score of 39 with more pronounced feed flavor, four had a score of 38 with a very pronounced feed flavor, one had a flavor score of 37 with a chlorine flavor, two had a score of 36 with an unclean flavor and a chlorine flavor, one had a score of 35 with an oxidized flavor, one had a score of 34 with a rancid flavor and three had a score of 33 with a more pronounced rancid flavor.

Of the 14 patrons checked, two had a perfect average flavor score of 40 points, five had an average flavor score of 39.5 points or better, ten had an average flavor score of 39 points or better, 13 had an average flavor score of 38 points or better and one patron was under 38 points with an average flavor score of 33 points due to pronounced rancid flavor. Of the undesirable flavors present, excluding the feed flavor, there were four samples of rancid flavored milk and they all came from the same patron. This patron's milk for the 15-day period was picked-up on an every four day basis, except for two pick-ups when it was gathered every other day. There was a pronounced rancid flavor every time it was scored.

There were two samples with slight traces of chlorine, but they came from different patrons. There were two samples of unclean milk. They also came from two different patrons. One sample of malty flavored milk and one sample of oxidized milk. Of the 73 flavor samples analyzed, 89% had a flavor score of 38 points or better.

SUMMARY

Fourteen patrons were included in this study. Daily fat tests and 15-day composite fat tests were taken. The daily fat tests were compared with the composite fat tests from the dairy plant. The daily fat tests were higher than the composite fat tests on 11 of the 14 patrons. The daily fat tests were also higher than the factory composite fat tests on 12 of the 14 patrons. There was a fat difference of 65.0 pounds for the 14 patrons from the daily fat test over the composite fat test, and a difference of 104.0 pounds of fat from the daily fat test over the factory fat test.

Ten trials were completed in which the time of agitation before sampling was varied from ten seconds to ten minutes. The fat tests obtained during the first 60 seconds of agitation ranged from 0.05% to 0.10% lower than the fat tests obtained after one and one-half minutes of agitation. The most uniform fat tests resulted after two minutes of agitation. There was very little difference in the fat tests after the two minute agitation period. The average fat test after ten seconds of agitation was 3.405% at the center of the tank and 3.445% at the end of the tank. The average fat test after one and one-half minutes of agitation was 3.510% for the center of the tank and 3.495% at the end of the tank. At two minutes the fat test was 3.510% for the center of the tank and 3.505% at the end of the tank.

The bacterial counts for the individual patrons milk ranged from 3,100 per ml. to 325,000 per ml. The average bacterial counts was

7,900 per ml. to 189,000 per ml. for the different patrons for the low bacterial count milk

The bacterial counts of the milk and the swab counts per eight square inches of surface for the different portions of the bulk milk tanker were as follows: There was only a slight difference in the bacterial count of the raw milk before and after mechanical cleaning was installed. Of the eight trials completed the average bacterial count was 4,375 per ml. before mechanical cleaning and 4,000 per ml. after mechanical cleaning. The outlet of the tanker was the most difficult to clean and therefore the swab counts were higher. The average swab count was 75,625 during hand cleaning and 7,937 after mechanical cleaning was installed. The wall inside the tanker had an average swab count of 38,500 before and 8,750 after mechanical cleaning. There was little difference in the swab bacterial count of the air tube inside the tank. The average swab count before mechanical cleaning was 16,375 per ml. and 14,500 per ml. after mechanical cleaning. The same holds true for the thermometer inside the tank. The average swab count being 4,750 per ml. before automation and 5,125 after automation.

The time required to clean the tanker by hand was 30 minutes for two men. The same job was performed after the installation of the mechanical cleaner by one man in 30 minutes.

Seventy-three samples were checked for flavor. Thirty-nine of the 73 had a perfect score of 40 points, three had a score of 39.5 points with a slight feed flavor, 19 had a score of 39 points with a more pronounced feed flavor, four had a score of 38 points with a pronounced feed flavor, one had a score of 37 with a chlorine flavor, two had a score of 36 with a pronounced chlorine flavor and an unclean flavor, one had a

score of 35 with an oxidized flavor, one had a score of 34 with a rancid flavor and three had a score of 33 with a very pronounced rancid flavor. Of the samples scored 83.5% had a flavor score of 39 points or better, 89% had a flavor score of 38 points or better, with only 11% having a flavor score of below 38 points.

CONCLUSION

The average difference between the daily fat test and the 15-day composite fat test varied from -0.04% to a +0.14% and for the 15-day factory composite fat test from 0.01% to 0.15%. The total pounds of fat based upon the daily fat test was 65.0 pounds more than the total pounds of fat based upon the 15-day composite fat test and 104.0 pounds more than that based upon the 15-day factory composite fat test. The total pounds of fat for the 15-day composite fat test was 1.1% less than the total pounds of fat from the daily fat test, whereas the total pounds of fat from the 15-day factory composite fat test was 1.8% less than the total pounds of fat from the daily fat test.

It is recommended that the milk be tested for butterfat and purchased on every tank of milk shipped to the plant.

To get the most accurate fat test from bulk tank milk, the agitator should be allowed to run for a minimum of two minutes.

Milk of low bacterial count can be produced with the bulk tank system if proper temperature, cleaning and sanitizing.

The decrease in the bacterial count of the milk after mechanical cleaning was installed, appeared insignificant. This could have been due to the extremely low bacterial count before the installation of the mechanical cleaning system.

It required two men 30 minutes to clean the tanker by hand, whereas it required only one man 30 minutes after mechanical cleaning was installed. With the mechanical cleaning system, the man was not required

to get into the tank.

The only serious off-flavor which appears in succession was rancidity. It appeared in one of the patrons milk continuously throughout the study.

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APPENDIX

Table 2. Individual farm tank test.
Patron No. 1

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	5,500	40	40	1,991	3.30	65.7
2	11,000	40	40	1,931	3.50	67.6
3	9,000	40	40	2,042	3.55	72.5
4	31,000	40	43	2,038	3.55	72.4
5	11,000	40	34	2,138	3.45	73.8
6	9,100	40	42	2,144	3.30	70.8
7	14,000	40	41	2,020	3.40	68.7
Total				14,304		492
Ave.	12,900	40	40	2,043	3.44	70.3

1. Pounds of milk - 14,304.
2. Pounds of fat using composite test (3.4) - 487.
3. Pounds of fat using daily fat test (3.44) - 492.
4. Pounds of fat using factory composite test (3.4) - 487.

Table 3. Individual farm tank test.
Patron No. 2

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	19,700			1,477	3.60	53.2
2	19,400	38 Malty	42	1,502	3.65	54.8
3	97,000	40	46	1,358	3.65	49.6
4	58,000		46	1,452	3.55	51.6
5	8,000	39.5 Feed	46	1,449	3.50	50.7
6	70,000	40	45	1,364	3.55	48.4
7	101,000	40	48	1,326	3.65	48.4
Total				9,928		357
Ave.	53,300	39.5	45.5	1,433	3.59	51.4

1. Pounds of milk - 9,928.
2. Pounds of fat using composite fat test (3.45) - 343.
3. Pounds of fat using daily fat test (3.59) - 357.
4. Pounds of fat using factory composite fat test (3.4) - 338.

Table 4. Individual farm tank test.
Patron No. 3

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	28,500			1,013	3.50	35.5
2	28,800	36 Chlorine	42	1,231	3.55	43.7
3	43,000	39 Feed	38	1,094	3.55	38.8
4	66,000		40	1,112	3.50	38.9
5	10,500	39 Feed	39	1,106	3.50	38.7
6	100,000	39 Feed	38	1,059	3.45	36.5
7	122,000	40	36	1,034	3.40	35.2
Total				7,649		267
Ave.	57,000	38.6	38.8	1,093	3.49	38.2

1. Pounds of milk - 7,649.
2. Pounds of fat using composite fat test (3.45) - 264.
3. Pounds of fat using daily fat test (3.49) - 267.
4. Pounds of fat using factory composite fat test (3.5) - 268.

Table 5. Individual farm tank test.
Patron No. 4

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	7,700			1,426	4.00	57.0
2	5,200	40	36	1,451	3.75	54.4
3	10,000	39 Feed	36	1,419	3.65	51.8
4	13,000		36	1,388	3.60	50.0
5	10,000	40	36	1,352	3.90	52.7
6	3,100	40	36	1,289	3.60	46.4
7	6,400	40	36	1,259	3.85	48.5
Total				9,584		361
Ave.	7,900	39.8	36	1,369	3.76	51.5

1. Pounds of milk - 9,584.
2. Pounds of fat using composite fat test (3.65) - 350.
3. Pounds of fat using daily fat test (3.76) - 361.
4. Pounds of fat using factory composite fat test (3.6) - 345.

Table 6. Individual farm tank test.
Patron No. 5

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	96,000			2,558	3.55	90.8
2	60,000	39 Feed	36	2,222	3.55	78.9
3	150,000	40	36	2,340	3.70	86.6
4	61,000		49	2,349	3.55	83.4
5	325,000	39 Feed	33	2,279	3.60	82.0
6	192,000	39 Feed	37	2,312	3.60	83.2
7	84,000	39 Feed	37	2,249	3.60	81.0
Total				16,309		586
Ave.	138,000	39.2	38	2,329	3.59	83.7

1. Pounds of milk - 16,309.
2. Pounds of fat using composite fat test (3.55) - 579.
3. Pounds of fat using daily fat test (3.59) - 586.
4. Pounds of fat using factory composite fat test (3.5) - 571.

Table 7. Individual farm tank test.
Patron No. 6

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	18,500			1,118	3.75	41.9
2	30,000	36 Unclean	48	1,096	3.95	43.3
3	50,000	40	38	1,094	3.60	39.4
4	25,000		37	1,016	3.60	36.6
5	150,000	35 Oxidized	37	1,083	3.60	39.0
6	31,800	40	37	1,065	3.70	39.4
7	40,000	39.5 Feed	33	1,177	3.70	43.6
Total				7,649		282
Ave.	47,900	38	38.3	1,093	3.69	40.5

1. Pounds of milk - 7,649.
2. Pounds of fat using composite fat test (3.65) - 279.
3. Pounds of fat using daily fat test (3.69) - 282.
4. Pounds of fat using factory composite fat test (3.7) - 283.

Table 8. Individual farm tank test.
Patron No. 7

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	141,000			1,331	3.60	47.9
2	247,000	40	39	1,364	3.65	49.8
3	242,000	39 Feed	42	1,237	3.70	45.8
4	260,000		42	1,240	3.60	44.6
5	170,000	39 Feed	39	1,292	3.50	45.2
6	130,000	40	38	1,284	3.60	46.2
7	194,000	40	32	1,253	3.60	45.1
8	128,000	39 Feed	44	1,222	3.45	42.2
Total				10,223		367
Ave.	189,000	39.5	39.4	1,255	3.59	45.9

1. Pounds of milk - 10,223.
2. Pounds of fat using composite fat test (3.6) - 368.
3. Pounds of fat using daily fat test (3.59) - 367.
4. Pounds of fat using factory composite fat test (3.5) - 358.

Table 9. Individual farm tank test.
Patron No. 8

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	17,800			1,622	3.80	61.6
2	21,000	38 Feed	41	1,649	3.80	62.7
3	22,500	39 Feed	35	1,709	3.70	63.2
4	38,000		41	1,989	3.70	73.6
5	49,000	40	41	2,103	3.80	79.9
6	41,000	39 Feed	41	2,078	3.70	76.9
7	54,000	40	40	1,826	3.60	65.7
8	47,000	39 Feed	46	1,826	3.60	65.7
Total				14,802		549
Ave.	36,287	39.1	40.7	1,850	3.71	68.7

1. Pounds of milk - 14,802.
2. Pounds of fat using composite fat test (3.7) - 548.
3. Pounds of fat using daily fat test (3.71) - 549.
4. Pounds of fat using factory composite fat test (3.7) - 548.

Table 10. Individual farm tank test.
Patron No. 9

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	108,000			1,794	3.80	68.2
2	32,000	39 Feed	35	1,859	3.70	68.8
3	20,000	38 Unclean	36	1,648	3.90	64.3
4	39,000		34	1,613	3.80	61.3
5	13,000	40	42	1,800	3.70	66.6
6	21,200	39.5 Feed	36	1,825	3.70	67.5
7	39,000	40	37	1,749	3.70	64.7
8	19,300	40	38	1,644	3.70	60.8
Total				13,932		522
Ave.	36,400	39.3	36.8	1,741	3.75	65.2

1. Pounds of milk - 13,932.
2. Pounds of fat using composite fat test (3.7) - 516.
3. Pounds of fat using daily fat test (3.75) - 522.
4. Pounds of fat using factory composite fat test (3.7) - 516.

Table 11. Individual farm tank test.
Patron No. 10

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	58,000			1,502	3.60	54.1
2	41,000	40	36	1,484	3.40	50.5
3	60,000	39 Feed	37	1,440	3.60	51.8
4	21,000		36	1,509	3.45	52.1
5	6 ,000	38 Feed	36	1,559	3.60	56.1
6	8,800	40	37	1,509	3.60	54.3
7	10,100	39 Feed	37	1,493	3.55	53.0
8	9,200	39 Feed	37	1,534	3.50	53.7
Total				12,030		419
Ave.	26,800	39.1	36.6	1,533	3.48	53.3

1. Pounds of milk - 12,030.
2. Pounds of fat using composite fat test (3.5) - 421.
3. Pounds of fat using daily fat test (3.48) - 426.
4. Pounds of fat using factory composite fat test (3.4) - 409.

Table 12. Individual farm tank test.
Patron No. 11

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	58,000			1,522	3.70	56.3
2	61,000	39 Feed	40	1,488	3.70	55.1
3	105,000	40	41	1,513	3.70	56.0
4	55,000		41	1,553	3.70	57.5
5	75,000	40	37	1,679	3.65	61.3
6	52,000	40	41	1,541	3.70	57.0
7	50,000	40	39	1,532	3.60	55.2
8	47,000	40	40	1,575	3.55	55.9
Total				12,403		454
Ave.	62,800		39.9	1,550	3.66	56.7

1. Pounds of milk - 12,403.
2. Pounds of fat using composite fat test (3.7) - 459.
3. Pounds of fat using daily fat test (3.66) - 454.
4. Pounds of fat using factory composite fat test (3.7) - 459.

Table 13. Individual farm tank test.
Patron No. 12

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	46,000			2,126	3.55	75.5
2	39,000	40	Frozen	1,788	3.50	62.6
3	9,900	40	38	2,458	3.40	83.6
4	12,000		38	2,049	3.60	73.8
5	3,000	40	41	2,161	3.60	77.8
6	72,000	37 Chlorine	41	2,013	3.60	72.5
7	7,300	39 Feed	38	1,983	3.50	69.4
8	8,400	40	38	2,067	3.50	72.4
Total				16,645		588
Ave.	24,700	39.3	39	2,080	3.59	73.5

1. Pounds of milk - 16,645.
2. Pounds of fat using composite fat test (3.5) - 583.
3. Pounds of fat using daily fat test (3.59) - 588.
4. Pounds of fat using factory composite fat test (3.5) - 583.

Table 14. Individual farm tank test.
Patron No. 13

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1	19,000			1,462	3.70	54.1
2	7,200	40	40	1,499	3.50	52.5
3	21,000	40	43	1,515	3.55	53.8
4	31,000		43	810	3.45	28.0
5	23,000	40	39	1,586	3.60	57.1
6	16,000	40	43	1,497	3.50	52.4
7	75,000	40	41	1,440	3.65	52.6
Total				9,809		351
Ave.	24,000	40	41.5	1,226	3.58	43.8

1. Pounds of milk - 9,809.
2. Pounds of fat using composite fat test (3.5) - 343.
3. Pounds of fat using daily fat test (3.58) - 351.
4. Pounds of fat using factory composite fat test (3.5) - 343.

Table 15. Individual farm tank test.
Patron No. 14

Trial No.	Standard Plate Count	Flavor Score	Temperature of Milk	Pounds of Milk	Daily Fat Test	Pounds of Fat
1						
2	12,900	33 Rancid	42	1,461	3.70	54.1
3						
4	19,000		42	1,517	3.50	53.1
5	45,000	33 Rancid	42	756	3.60	27.2
6						
7	16,400	34 Rancid	42	1,498	3.70	55.4
8	18,600	33 Rancid	42	790	3.70	29.2
Total				6,022		219
Ave.	22,400	33	42		3.64	43.8

1. Pounds of milk - 6,022.
2. Pounds of fat using composite fat test (3.6) - 217.
3. Pounds of fat using daily fat test (3.64) - 219.
4. Pounds of fat using factory composite fat test (3.5) - 211.

Table 17. Fat tests for different agitation periods.
Trial No. 1

Sample No.	Time Agitated	Fat Test Center	Fat Test End	Difference in Fat Tests
1	10 seconds	3.70	3.75	.05
2	20 seconds	3.70	3.80	.10
3	30 seconds	3.75	3.80	.05
4	60 seconds	3.75	3.80	.05
5	1.5 minutes	3.80	3.75	- .05
6	2.0 minutes	3.75	3.80	.05
7	2.5 minutes	3.80	3.80	---
8	3.0 minutes	3.80	3.80	---
9	4.0 minutes	3.80	3.75	- .05
10	5.0 minutes	3.80	3.80	---
11	10.0 minutes	3.80	3.80	---

Table 18. Fat test for different agitation periods.
Trial No. 2

Sample No.	Time Agitated	Fat Test Center	Fat Test End	Difference in Fat Tests
1	10 seconds	3.70	3.70	---
2	20 seconds	3.70	3.75	.05
3	30 seconds	3.75	3.75	---
4	60 seconds	3.75	3.70	- .05
5	1.5 minutes	3.80	3.80	---
6	2.0 minutes	3.80	3.80	---
7	2.5 minutes	3.75	3.80	.05
8	3.0 minutes	3.80	3.80	---
9	4.0 minutes	3.80	3.85	-.05
10	5.0 minutes	3.80	3.80	---
11	10.0 minutes	3.80	3.80	---

Table 19. Fat tests for different agitation periods.
Trial No. 3

Sample No.	Time Agitated	Fat Test Center	Fat Test End	Difference in Fat Tests
1	10 seconds	3.60	3.60	---
2	20 seconds	3.60	3.60	---
3	30 seconds	3.65	3.60	- .05
4	60 seconds	3.65	3.65	---
5	1.5 minutes	3.70	3.65	- .05
6	2.0 minutes	3.70	3.70	---
7	2.5 minutes	3.70	3.70	---
8	3.0 minutes	3.65	3.70	.05
9	4.0 minutes	3.70	3.70	---
10	5.0 minutes	3.70	3.70	---
11	10.0 minutes	3.70	3.70	---

Table 20. Fat tests for different agitation periods.
Trial No. 4

Sample No.	Time Agitated	Fat Tests Center	Fat Tests End	Difference in Fat Tests
1	10 seconds	3.55	3.60	.05
2	20 seconds	3.60	3.55	- .05
3	30 seconds	3.60	3.60	---
4	60 seconds	3.60	3.65	.05
5	1.5 minutes	3.60	3.65	.05
6	2.0 minutes	3.70	3.70	---
7	2.5 minutes	3.70	3.70	---
8	3.0 minutes	3.70	3.70	---
9	4.0 minutes	3.65	3.70	.05
10	5.0 minutes	3.70	3.70	---
11	10.0 mimutes	3.70	3.65	- .05

Table 21. Fat tests for different agitation periods.
Trial No. 5

Sample No.	Time Agitated	Fat Test Center	Fat Test End	Difference in Fat Tests
1	10 seconds	3.60	3.60	---
2	20 seconds	3.60	3.60	---
3	30 seconds	3.65	3.60	- .05
4	60 seconds	3.60	3.70	.10
5	1.5 minutes	3.70	3.70	---
6	2.0 minutes	3.65	3.70	.05
7	2.5 minutes	3.70	3.70	---
8	3.0 minutes	3.70	3.70	---
9	4.0 minutes	3.70	3.70	---
10	5.0 minutes	3.70	3.70	---
11	10.00 minutes	3.70	3.70	---

Table 22. Fat tests for different agitation periods.
Trial No. 6

Sample No.	Time Agitated	Fat Test Center	Fat Test End	Difference in Fat Tests
1	10 seconds	3.60	3.65	.05
2	20 seconds	3.60	3.60	---
3	30 seconds	3.65	3.65	---
4	60 seconds	3.70	3.70	---
5	1.5 minutes	3.70	3.65	- .05
6	2.0 minutes	3.70	3.70	---
7	2.5 minutes	3.75	3.70	- .05
8	3.0 minutes	3.70	3.75	.05
9	4.0 minutes	3.70	3.70	---
10	5.0 minutes	3.70	3.70	---
11	10.0 minutes	3.75	3.70	- .05

Table 23. Fat tests for different agitation periods.
Trial No. 7

Sample No.	Time Agitated	Fat Test		Difference in Fat Tests
		Center	End	
1	10 seconds	3.10	3.15	.05
2	20 seconds	3.10	3.15	.05
3	30 seconds	3.20	3.15	- .05
4	60 seconds	3.20	3.20	---
5	1.5 minutes	3.20	3.15	- .05
6	2.0 minutes	3.20	3.15	- .05
7	2.5 minutes	3.20	3.15	- .05
8	3.0 minutes	3.20	3.20	---
9	4.0 minutes	3.20	3.20	---
10	5.0 minutes	3.15	3.20	.05
11	10.0 minutes	3.20	3.20	---

Table 24. Fat tests for different agitation periods.
Trial No. 8

Sample No.	Time Agitated	Fat Test		Difference in Fat Tests
		Center	End	
1	10 seconds	3.10	3.20	.10
2	20 seconds	3.15	3.20	.05
3	30 seconds	3.20	3.20	---
4	60 seconds	3.20	3.20	---
5	1.5 minutes	3.20	3.20	---
6	2.0 minutes	3.20	3.15	- .05
7	2.5 minutes	3.15	3.15	---
8	3.0 minutes	3.20	3.15	- .05
9	4.0 minutes	3.20	3.20	---
10	5.0 minutes	3.20	3.20	---
11	10.0 minutes	3.20	3.20	---

Table 25. Fat tests for different agitation periods.
Trial No. 9

Sample No.	Time Agitated	Fat Test Center	Fat Test End	Difference in Fat Tests
1	10 seconds	3.10	3.10	---
2	20 seconds	3.10	3.10	---
3	30 seconds	3.20	3.10	- .10
4	60 seconds	3.20	3.10	- .10
5	1.5 minutes	3.20	3.20	---
6	2.0 minutes	3.20	3.20	---
7	2.5 minutes	3.20	3.20	---
8	3.0 minutes	3.20	3.20	---
9	4.0 minutes	3.20	3.20	---
10	5.0 minutes	3.20	3.20	---
11	10.0 minutes	3.20	3.10	- .10

Table 26. Fat tests for different agitation periods.
Trial No. 10

Sample No.	Time Agitated	Fat Test Center	Fat Test End	Difference in Fat Tests
1	10 seconds	3.10	3.10	---
2	20 seconds	3.10	3.10	---
3	30 seconds	3.15	3.10	- .05
4	60 seconds	3.20	3.10	- .10
5	1.5 minutes	3.20	3.20	---
6	2.0 minutes	3.20	3.15	- .05
7	2.5 minutes	3.20	3.20	---
8	3.0 minutes	3.20	3.15	- .05
9	4.0 minutes	3.20	3.20	---
10	5.0 minutes	3.20	3.15	- .05
11	10.0 minutes	3.20	3.20	---

Table 28. Bacterial count before mechanical cleaning.

Trial No.	Milk	Rinse Water	Bacteria per 8 sq. inches Outlet	Wall	Air Tube	Thermometer
1	4,000	21,000	90,000	30,000	14,000	6,000
2	5,000	7,000	120,000	24,000	20,000	5,000
3	3,000	4,000	70,000	49,000	17,000	6,000
4	3,000	16,000	40,000	13,000	12,000	10,000
5	5,000	3,000	180,000	68,000	14,000	4,000
6	5,000	9,000	32,000	19,000	21,000	3,000
7	6,000	10,000	14,000	90,000	16,000	-----
8	4,000	8,000	67,000	15,000	17,000	4,000
Ave.	4,375	9,750	76,625	38,500	16,375	4,750

Table 29. Bacterial count after mechanical cleaning.

Trial No.	Milk	Rinse Water	Outlet	Wall	Air Tube	Thermometer
			Bacterial per 8 square inches			
1	3,000		12,000	10,000	17,000	3,000
2	7,000		10,000	9,000	17,000	6,000
3	3,000		8,500	12,000	12,000	6,000
4	4,000		4,000	8,000	16,000	8,000
5	4,000		3,000	7,000	13,000	7,000
6	6,000		9,000	10,000	15,000	4,000
7	5,000		10,000	7,000	16,000	4,000
8	3,000		7,000	7,000	10,000	3,000
Ave.	4,000		7,937	8,750	14,500	5,125