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Accuracy of Methods of Sampling Milk Deliveries at Milk Plants

By P. H. Tracy and S. L. Tuckey

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Accuracy of Methods of Sampling Milk Deliveries at Milk Plants

By P. H. Tracy and S. L. Tuckey[1]

THE IMPORTANCE of an accurate measurement of the fat contained in milk deliveries is fully appreciated by most producers and distributors. However, since the beginning of the present method of marketing milk according to fat content, the accuracy of the procedure used in sampling and testing the milk has often been questioned by either the buyer or the seller. At the suggestion of the Champaign County Milk Producers Association a study was begun in the fall of 1936 to determine the accuracy of the methods being employed to sample the milk delivered by members of the Association to each of four milk plants in Champaign and Urbana. This bulletin is a report of that study.

WORK OF OTHER INVESTIGATORS

Investigators began studying the relative merits of the daily (fresh), periodic (fresh), and composite milk samples almost immediately after the introduction of the Babcock test for determining the fat content of milk in 1890. This same year G. E. Patrick[8*] proposed a plan whereby an amount of milk proportionate to that delivered was kept and placed in a receptacle containing a certain amount of a preservative. Later such a sample was called a "composite sample." In a later publication Patrick[7*] stated that if a patron's deliveries ran fairly uniform in amount from the beginning to the end of a composite period, the taking of uniform-size samples was correct enough; but that if there were wide variations in the weight of milk delivered daily, the amount of the sample should be taken in proportion to the amount delivered.

In 1891 E. H. Farrington[2*] of the University of Illinois reported that testing composite milk samples once each week gave results practically as accurate as testing milk every day. He published the results

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*These numbers refer to literature citations on page 84.

of an experiment in which daily samples and composite samples of twenty patrons' milk were tested. The results were as follows:

	Average percent fat
7 daily tests for each patron	3.91
Composite (same amount)	3.96
Composite (aliquot sample taken each day)	3.93

Farrington further stated that a single sample and test of milk only once in a week might not be sufficiently accurate.

Hunziker[3*] in 1914 reported a remarkable uniformity of results when comparing the accuracy of different methods of sampling including daily samples, composite samples with aliquot portions, samples every fourth day and every fifth day. Tests were made on 4,900 samples taken by these methods over a 14-day period.

Sanmann and Overman[10*] in 1926 studied the importance of proper storage of composite samples. They found that nearly all the samples stored in the receiving room tested lower than the samples stored in the refrigerator, the differences being greater when the samples were held for two weeks than when they were held for only one week. The following data compiled from their publication involve milk deliveries by 21 patrons:

	Samples stored one week		*Samples stored two weeks*	
	Receiving room	*Refrigerator*	*Receiving room*	*Refrigerator*
Fat test, percent	3.6	3.81	3.57	3.84

In a continuation of this study Sanmann and Overman[9*] made a comparison of tests secured on periodic, composite, and fresh daily samples of the milk delivered by twenty patrons. The composite samples were prepared by taking one milliliter of milk for each pound of milk delivered. At the same time a sample was taken for the daily test. The composite samples were mixed carefully each day after adding the fresh portion. The samples were kept in one-quart fruit jars sealed and stored in a refrigerator at about 44° to 50° F. They were preserved by corrosive-sublimate tablets and extended over a month's time divided into four periods—7 days, 7 days, 8 days, and 8 days.

The following averages are compiled from their data:

	Percent fat
Average of daily tests of samples taken by aliquot	4.10
Average test of composite samples	4.08
Average test for 4 fresh milk samples[a]	4.19
Average test for 5 fresh milk samples[a]	4.12

([a]Taken at approximately equal intervals during the month.)

From these averages it is very evident that the fat test of composite samples properly taken and kept is comparable to the fat test of fresh daily samples. The data also indicate that under the conditions of the experiment the average of four or five periodic tests made on fresh samples taken at approximately equal intervals during the month is comparable to the average daily test, there being a slightly closer correlation when the averages were based on five tests than when they were based on four tests.

C. F. Monroe[6*] in 1930 reported that the average fat test of 290 seven-day composite samples averaged 5.13 percent, while the fresh daily samples averaged 5.22 percent.

Marquardt and Durham[4*] in 1932 studied the milk sampling at milk plants to find out whether or not milk is sufficiently agitated in dumping to make it possible to secure an accurate sample without further mixing. They concluded that stirring the milk before or after dumping did not improve the uniformity of the sample. They recommended, however, that each weigh tank be checked for its correctness for proper sampling, since such things as shape of the tank and type of strainer vary from plant to plant. They concluded that natural variations in the milk test cause some of the variations in tests obtained by the milk plant. The authors then explained the relation of certain factors to the fat content of milk. Among these factors the following were mentioned:

1. During the first part of the lactation period the milk tests higher.
2. The test is highest during the cold season of the year and lowest in midsummer.
3. Short intervals between milkings raise the fat test.
4. Omitting the foremilk raises the fat test of the milk, while omitting the stripping lowers the fat test.
5. Some breeds (as the Jersey) produce richer milk than other breeds (as the Holstein).
6. Night's milk will test higher than morning's milk.
7. Exercise increases the fat test.
8. Low temperatures cause the milk to test higher.
9. Underfeeding results in an increased fat test in the milk.
10. As cows grow older, their milk becomes lower in fat content.

Bailey[1*] in 1934 reported a two-year study of the accuracy of sampling of the milk delivered by 19 patrons. He found that the milk did not mix adequately when dumped into the weigh tank; and that, after such dumping, nine out of ten of the lowest testing samples were at the front end of the tank. He attributed the inadequate mixing to the dumping of milk that has creamed. The low-testing milk, being the last dumped, tends to remain on top. He also noted that low tests sometimes resulted from the adherence of thick cream to the strainer box until after the milk was allowed to run out of the weigh tank. It was found that the inadequate mixing could be eliminated by stirring the cans before dumping and that low-testing pools in the dump tank could be avoided by the use of a mechanical weigh tank agitator.

In 1936 Meade and Leckie[5*] compared composite and fresh samples taken from milk delivered by nine patrons during a 151-day period. The composite samples covered a period of 10 days, and one fresh milk sample was taken during each 10-day period. The periodic fresh samples had an average test of .09 percent higher than the average test of the composite samples. Considerable variation in the test of the milk delivered by the individual patron was also observed. The range by composite samples was .60 to 1.20 percent and the periodic fresh samples, .55 to 1.35 percent.

From the foregoing survey of past work, it may be concluded that:

1. Composite samples will give accurate results provided they are: *(a)* taken in proportion to the amount of milk delivered (this is particularly important when there is a wide variation in the amount of milk delivered daily); *(b)* placed in closed containers; *(c)* held in the refrigerator; *(d)* preserved by a germicidal agent, such as corrosive sublimate, and properly mixed after the addition of each fresh sample; *(e)* kept for a period of time not exceeding two weeks but preferably one week.

2. Composite tests and the average of daily tests on the fresh milk will check within the range of experimental error, altho the composite tests tend to average slightly lower.

3. Periodic samples taken at least four times a month will give average results that will check reasonably close to the average of daily tests.

4. Improper mixing of the milk in the weigh tank is sometimes responsible for discrepancies in tests.

5. Natural variations in the composition of the milk as produced will account for some of the variable tests reported by distributors.

PLAN OF PRESENT STUDY

The standard sampling procedure at each of the four dairies in this study was as follows: The plant employees dumping the milk took the composite milk samples daily either directly from the milk cans or from the dump tanks. These samples were kept in Mojonnier sample bottles stored either in the milk-receiving room or in the refrigerator. They were tested four times each month by an operator employed and paid jointly by the producers and distributors. This test is called the Association test. To study the accuracy of the sampling procedure at these plants, the following steps were taken:

1. The completeness of mixing of the milk at each of the four dairies was determined.

2. Comparisons were made of the tests made on fresh daily samples, regular plant composite samples, and laboratory composite samples over seven-day test periods. The procedure of the testing was as follows:

a. During the period of December 22 to January 4 inclusive samples were taken daily at each of the four plants from the milk delivered by each patron. These samples were obtained by a representative of the University, placed in half-pint bottles and taken to the University laboratory. In addition a composite sample was taken by the plant and tested by the Association tester in the regular manner. A test was later run on this plant composite at the University laboratory.

b. At the University laboratory composite samples were prepared from the fresh daily samples. The composites were kept in double-capped quart bottles stored at 60° F. Approximately 18 grams of milk were taken for the composite sample each day.

c. The fresh samples were tested daily in single tests at the University laboratory.

d. Owing to the large number of tests to be run, the labor was so divided that one man performed the same task each day. These tasks were: the preparation of composites, measuring of samples, adding of acid and mixing, operation of centrifuges and 130°-140° F. bath, reading and recording of results, and the washing of test bottles.

e. The standard Babcock method of testing was followed. The temperature of the acid and the amount used was such that the fat columns were free from charred fat or curd particles.

f. Additional studies were made later in the season, one in May and one in July. For these summer tests the same general procedure was followed as for the winter tests.

g. All glassware including test bottles (10 percent graduated to .1 percent) and pipets were checked for accuracy.

3. Tests were made to determine the importance of taking composite samples in aliquot portions.

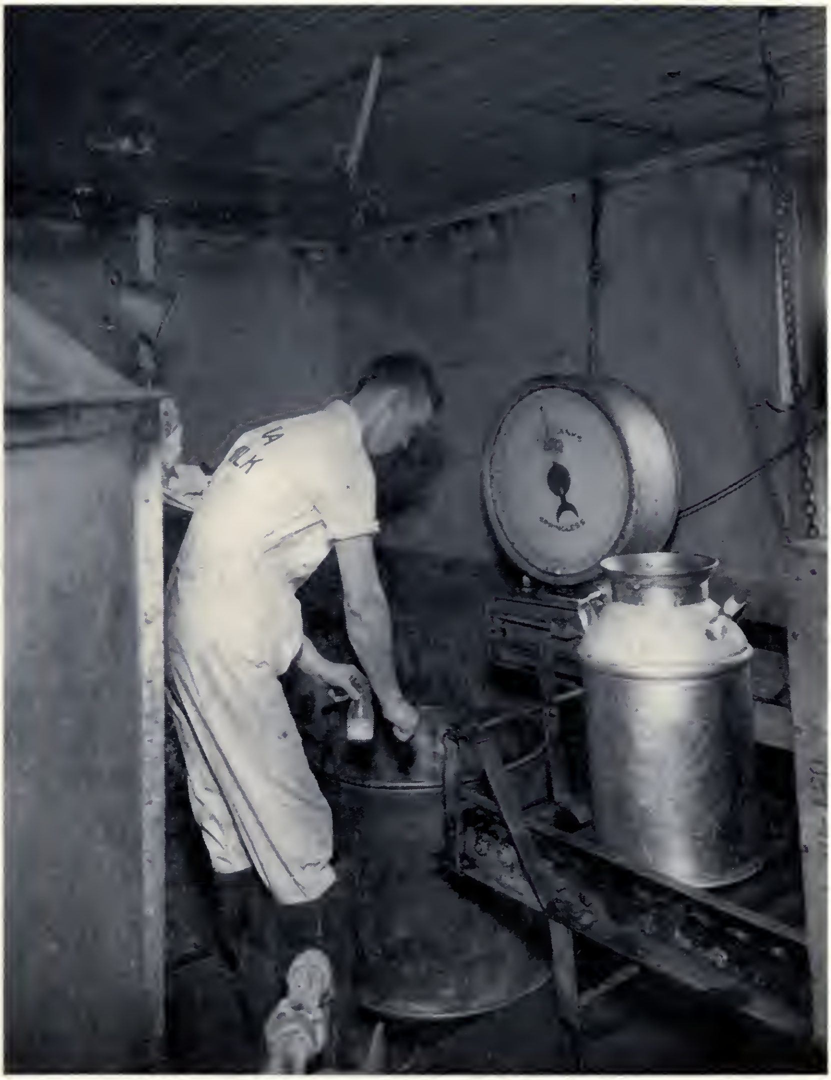

Fig. 1.—Receiving room, Plant A

COMPLETENESS OF MIXING AT THE FOUR PLANTS

To determine the completeness of the mixing of the milk sampled at the four dairies, tests were run on the milk delivered by a number of the patrons at each dairy. The number of patrons serving each dairy, together with the amount of milk delivered daily is shown in Table 1.

Plant A. At this plant samples were taken over a 3-hour period from a round weigh tank. The milk was poured from the cans at a height of about 30 inches. A sample was taken directly from the tank after the milk was poured in (the usual procedure). The milk was then stirred and as it flowed thru the discharge valve of the weigh tank, another sample was taken. The fat tests of the mixed and unmixed samples are given in Table 2.

From these data and a comparison of the averages of the tests on the unmixed and the mixed samples (4.77 percent fat and 4.76 percent), it is evident that the method of sampling at Plant A was satisfactory and that nothing would be gained by stirring the milk before sampling.

Plant B. Since this plant was not equipped with a weigh tank, the samples were taken directly from the cans after stirring. Comparisons were made between samples taken with a lipped stirring rod (the usual procedure) and those taken with a milk thief, which should give a more nearly aliquot portion, as it takes the sample in proportion to the volume of milk in the can. The use of the thief would seem particularly advisable when the farmer delivered his milk in two or more cans with milk varying in amount and test in each can. The results of the sampling at Plant B are given in Table 3.

The summary of the data in Table 3 shows very plainly that the method of securing the sample at Plant B was not in error and that under the conditions of the experiment, the use of the lipped stirring rod dipper gave as accurate results as the use of a milk thief.

TABLE 1.—AVERAGE AMOUNT OF MILK DELIVERED DAILY TO EACH PLANT

Plant	Number of producers	Average amount of milk delivered daily per producer	Average amount of milk delivered to plant daily by all producers
		lb.	*lb.*
A	136	78	10 608
B	64	77.1	4 934
C	63	81	5 103
D	170	79.8	13 566
Total	433	79	34 210

Fig. 2.—Receiving room, Plant B

TABLE 2.—TESTS OF MIXED AND UNMIXED SAMPLES: PLANT A

Sample No	Fat test of sample taken—		Approximate amount of milk delivered
	Before mixing	After mixing	
	perct.	*perct.*	*gal.*
1	4.2	4.1	20
2	5.0	5.05	25
3	4.55	4.5	5
4	5.7	5.7	11
5	5.1	5.1	15
6	5.5	5.6	10
7	4.4	4.4	20
8	4.3	4.4	10
9	5.0	4.8	10
10	4.9	4.9	20
11	5.8	5.9	8
12	4.6	4.5	20
13	5.0	5.0	12
14	5.05	5.1	6
15	4.5	4.5	10
16	3.3	3.3	5
17	4.8	4.9	13
18	4.9	4.9	14
19	4.75	4.75	8
20	5.0	5.0	12
21	4.8	4.85	8
22	4.9	4.9	22
23	4.25	4.1	10
24	4.4	4.4	18
25	5.25	5.0	8
26	4.6	4.6	8
27	4.6	4.7	5
28	4.2	4.15	20
29	4.3	4.3	15
30	5.4	5.4	10
Average	4.77	4.76	..

Summary

Number of times two tests were identical	13 (43.3 percent)
Number of times two tests checked within .1 percent	27 (90.0 percent)
Number of times two tests checked within .2 percent	29 (96.7 percent)
Number of times two tests checked within .25 percent	30 (100.0 percent)

Plant C. As in Plant B, the usual procedure was to take the samples from the milk cans after mixing with a lipped stirring rod. Here again, comparisons were made between the tests secured on samples taken in this manner and those taken with a milk thief.

As in the other two plants, the method of sampling followed in Plant C was found to be entirely satisfactory. The data are given in Table 4.

Plant D. This plant used a weigh tank. Ordinarily, the receiving man took the samples from the front end of the weigh tank, using a small sampling dipper. For the purpose of this study samples were taken at the front and rear before mixing. The milk was then mixed with a stirring rod and a third sample taken.

It is evident from the data in Table 5 that mixing resulting from

Fig. 3.—Receiving room, Plant C

the dumping of the milk into the weigh tank was not sufficient to make it possible to secure an accurate sample from either end of the tank without additional agitation. Whereas the average test of the samples

TABLE 3.—TESTS OF SAMPLES TAKEN WITH LIPPED STIRRING ROD AND WITH MILK THIEF: PLANT B

Sample No.	Fat test of sample taken—		Approximate amount of milk delivered
	With rod	With milk thief	
	perct.	*perct.*	*gal.*
1	5.5	5.4	Two 5-gal. cans ⅔ full
2	4.0	4.1	One 5-gal. can ⅔ full
3	5.0	5.0	Two 10-gal. cans ⅓ full
4	3.4	3.45	Three 8-gal. cans full
5	4.5	4.4	Two 10-gal. cans ⅔ full
6	4.9	5.0	One 8-gal. can full
7	4.7	4.7	One 8-gal. can ½ full
8	5.25	5.25	One 10-gal. can ⅔ full
9	4.5	4.5	Two 8-gal. cans ⅔ full
10	4.3	4.3	Two 10-gal. cans ⅔ full
11	4.65	4.6	One 10-gal. can full One 8-gal. can full One 5-gal. can full
12	4.1	4.3	Two 8-gal. cans ¾ full
13	4.5	4.4	Two 10-gal. cans ⅔ full
14	4.55	4.5	Two 10-gal. cans ¾ full One 5-gal. can full
15	5.2	5.2	Five 5-gal. cans full
16	4.7	4.6	Two 5-gal. cans full and ¾ full
17	3.8	3.8	Two 10-gal. cans full and ½ full
18	4.75	4.7	Two 5-gal. cans ⅔ full
19	4.35	4.3	Four 5-gal. cans ¾ full
20	4.6	4.6	One 8-gal. can ½ full Two 5-gal. cans full One 5-gal. can ½ full
21	3.4	3.4	One 10-gal. can full One 8-gal. can full One 5-gal. can ½ full
22	3.9	3.95	Two 8-gal. cans ⅔ full
23	4.6	4.4	One 10-gal. can full One 8-gal. can full One 5-gal. can ½ full
24	4.2	4.2	Two 8-gal. cans ⅔ full
25	4.3	4.3	One 10-gal. can ½ full One 8-gal. can ½ full
26	3.9	3.9	One 8-gal. can ¾ full One 5-gal. can ¾ full
27	4.75	4.7	One 10-gal. can ½ full One 8-gal. can ⅔ full
28	4.65	4.75	Three 10-gal. cans ⅔ full One 8-gal. can ⅔ full
29	4.2	4.2	One 10-gal. can ⅔ full Two 8-gal. cans full
30	4.4	4.5	One 10-gal. can ½ full One 5-gal. can ½ full One 5-gal. can ⅓ full
31	4.5	4.45	Two 5-gal. cans full
32	4.6	4.6	Two 8-gal. cans full
33	4.8	4.7	Two 8-gal. cans ½ full
Average	4.47	4.45	....

Summary

Number of times two tests were identical	14	(42.4 percent)
Number of times two tests checked within .1 percent	31	(93.9 percent)
Number of times two tests checked within .2 percent	33	(100.0 percent)

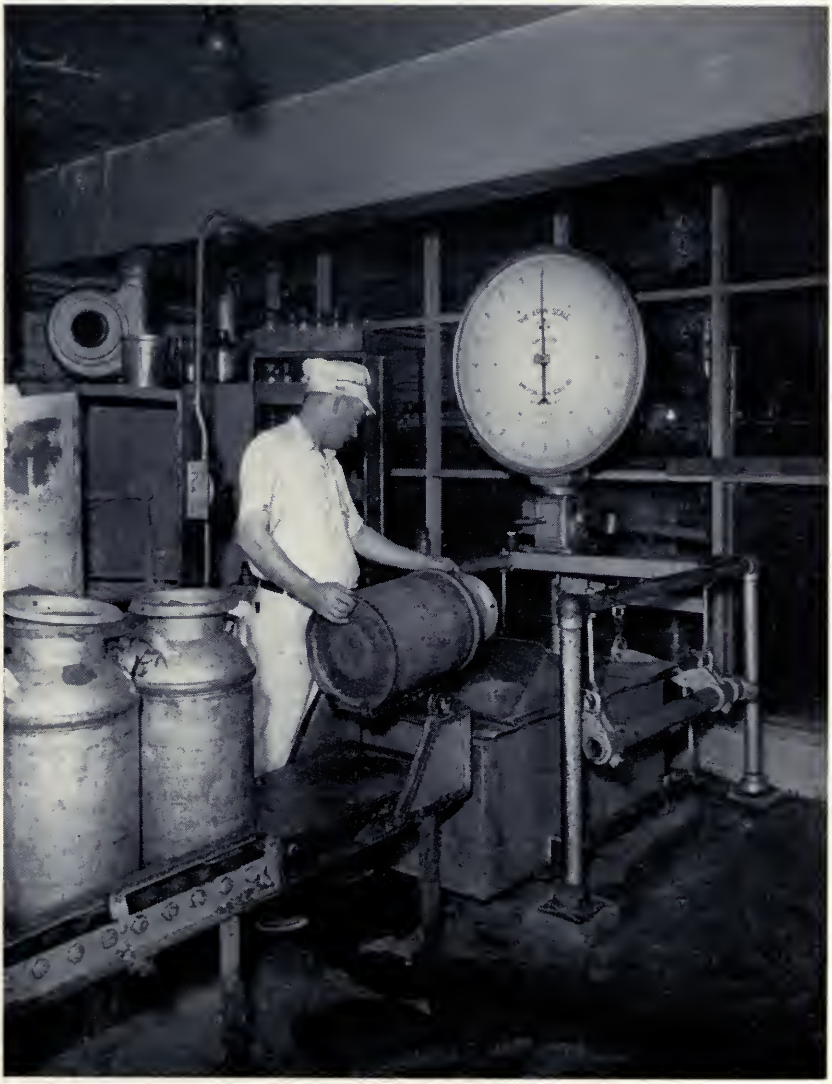

Fig. 4.—Receiving room, Plant D

taken from the front of the tank was only .11 percent lower than the average test of the sample taken after mixing, the discrepancy between certain samples was much greater, as shown by the distribution of differences in tests of unmixed and mixed samples (Table 6).

From these differences it is very apparent that there is a definite trend towards lower tests in the front end samples, particularly when variations higher than .2 percent are considered. Above .2 percent it will be noted that 27 front samples tested less than the rear samples,

TABLE 4.—TESTS OF SAMPLES TAKEN WITH LIPPED STIRRING ROD AND WITH MILK THIEF: PLANT C

Sample No.	Fat test of sample taken—		Approximate amount of milk delivered
	With rod	With milk thief	
	perct.	*perct.*	*gal.*
1	5.0	5.0	Two 5-gal. cans ⅔ full
2	3.6	3.7	Two 10-gal. cans ⅓ full
3	4.9	4.9	Three 5-gal. cans ⅓ and ½ full
4	4.2	4.2	Two 10-gal. cans ½ full
5	4.8	4.8	Two 5-gal. cans ½ full
6	4.4	4.4	Two 5-gal. cans ½ full
7	3.7	3.75	Two 5-gal. cans ⅓ and ½ full
8	4.4	4.4	One 8-gal. can full One 5-gal. can full
9	3.9	3.9	One 8-gal. can full One 5-gal. can ½ full
10	5.35	5.3	Two 8-gal. cans ½ full
11	5.5	5.55	One 5-gal. can full One 8-gal, can ⅔ full
12	4.4	4.45	Two 8-gal. cans full
13	3.9	3.9	One 10-gal. can ⅔ full
14	4.3	4.2	Two 10-gal. cans ½ and ⅔ full
15	5.35	5.4	Two 5-gal. cans full
16	4.2	4.2	Two 8-gal. cans full
17	5.2	5.2	One 10-gal. can full One 10-gal. can ½ full
18	4.6	4.6	One 10-gal. can ½ full One 5-gal. can full
19	4.3	4.3	Two 10-gal. cans full
20	4.6	4.6	One 10-gal. can full Two 5-gal. cans full
21	3.8	3.8	One 10-gal. can ½ full One 8-gal. can ½ full
22	4.5	4.5	Two 10-gal. cans full
23	3.45	3.45	Two 10-gal. cans full One 5-gal. can ⅔ full
24	5.3	5.3	One 10-gal. can full One 8-gal. can full
25	5.0	5.0	Two 10-gal. cans ⅔ full
26	4.1	4.0	Two 8-gal. cans ⅔ full
27	4.8	4.85	Two 5-gal. cans ⅔ full
28	4.5	4.5	Two 5-gal. cans full
Average	4.50	4.51	....

Summary

Number of times two tests were identical	19	(67.8 percent)
Number of times two tests checked within .1 percent	28	(100.0 percent)

TABLE 5.—TESTS OF SAMPLES TAKEN AT FRONT AND REAR OF WEIGH TANK BEFORE MIXING, AND TAKEN AFTER MIXING IN THE WEIGH TANK: PLANT D

Sample No.	Weight of milk	Fat test of sample before mixing taken—		Fat test of sample after mixing
		From front of tank	From rear of tank	
	lb.	*perct.*	*perct.*	*perct.*
1	110	4.0	4.4	4.2
2	167	4.8	4.95	4.85
3	137	3.9	3.95	3.95
4	308	3.6	3.75	3.8
5	165	4.3	4.35	4.4
6	100	3.9	3.8	3.85
7	185	4.2	4.15	4.2
8	...	4.5	4.55	4.55
9	66	4.95	5.5	5.4
10	30	4.4	4.75	4.8
11	140	4.3	5.0	4.7
12	50	3.6	3.5	3.5
13	170	3.35	3.8	3.6
14	80	3.75	3.7	3.7
15	75	4.8	4.85	4.9
16	95	4.4	4.35	4.35
17	60	4.7	5.1	5.0
18	97	4.2	4.95	4.6
19	84	3.25	4.1	3.7
20	100	3.6	4.6	4.2
21	100	5.05	5.85	5.4
22	48	6.5	6.3	6.3
23	101	4.8	4.4	4.55
24	85	3.3	3.3	3.3
25	130	4.6	5.1	4.95
26	95	4.65	5.3	5.1
27	95	5.1	4.9	5.1
28	170	4.4	4.8	4.6
29	35	3.75	4.1	3.9
30	40	4.3	5.0	4.8
31	25	4.7	4.8	4.7
32	80	3.7	4.2	3.9
33	130	3.95	3.9	3.9
34	140	4.7	5.0	4.85
35	190	3.85	4.2	4.3
36	55	5.2	5.2	5.2
37	60	4.8	4.75	4.8
38	90	4.3	4.3	4.45
39	60	4.4	4.45	4.3
40	140	4.0	4.0	4.0
41	100	5.1	5.2	5.5
42	...	5.2	5.2	5.1
43	50	5.2	5.3	5.35
44	65	3.9	3.85	3.7
45	60	5.4	5.6	5.5
46	190	4.0	3.9	3.95
47	215	3.35	3.2	3.5
48	60	3.6	3.6	3.6
49	150	4.2	4.6	4.45
50	70	3.95	4.8	4.3
51	80	3.85	4.4	4.0
52	90	3.15	3.3	3.2
53	95	4.4	4.5	4.4
54	125	3.1	3.7	3.2
55	60	5.0	5.1	5.0
56	75	5.0	5.4	5.15
57	60	4.4	4.4	4.4
58	40	5.1	5.1	5.1
59	110	5.0	4.8	5.0
60	160	4.35	4.45	4.3
61	60	4.5	4.5	4.5
62	45	5.8	5.9	5.9
63	60	4.75	5.0	5.0
64	75	4.6	4.9	4.4
65	140	4.0	4.1	4.1
66	65	5.2	5.3	5.3
67	60	5.0	5.3	5.1
68	100	4.95	5.2	4.95
69	65	5.0	5.3	5.1
70	15	4.5	4.45	4.45
71	110	4.5	4.4	4.0
72	90	4.4	4.5	4.4
Average	...	4.40	4.60	4.51

TABLE 6.—DISTRIBUTION OF DIFFERENCES IN FAT TESTS OF 72 SETS OF FRONT AND REAR SAMPLES, AND MIXED SAMPLES: PLANT D

Variation range	Times front sample tested *less* than—		Times front sample tested *more* than—	
	Rear sample	Mixed sample	Rear sample	Mixed sample
perct.				
0 – .1	15	13	11	9
.15– .2	4	11	5	3
.25– .3	6	4	0	1
.35– .4	8	6	1	0
.45– .5	3	6	0	1
.55– .6	3	1	0	0
.65– .7	3	0	0	1
.7 – .75	1	0	0	0
.8 – .85	2	0	0	0
.9 – .95	0	0	0	0
.95–1.00	1	0	0	0
Total	46	41	17	15

Summary

Times front and rear sample were the same	9
Times front and mixed sample were the same	16
Times rear and mixed sample were the same	19

while only one front sample tested more than the rear sample. In the same range, 17 of the front samples tested less than the well-mixed samples, while only 3 tested more. These results compare favorably with those of Bailey.[1*]

Examination of the weigh tank at Plant D (Fig. 5) revealed a possible explanation for the improper mixing of the milk when dumped. The shape of the tank was such that the first milk out of the can, which was often higher in test than the remainder, rushed to the rear and was held there to a certain extent by the last milk from the can, so that there was very little backwashing or mixing. The amount of milk dumped did not seem to be a factor of any consequence.

To further show that the discrepancies between tests on front and rear samples were due to improper mixing, a test was made on the milk from twenty patrons which was thoroly mixed in the can by stirring before it was dumped. The distribution of differences of the tests on front and rear samples is shown in Table 7. It is evident that when the milk was properly mixed, front and rear samples tested practically the same.

Change in Plant D sampling. Since the stirring of milk in the can or after dumping is not a practical procedure from the standpoint of plant costs, and since the results of the study of the accuracy of the weigh tank in Plant D had indicated the front end samples to test

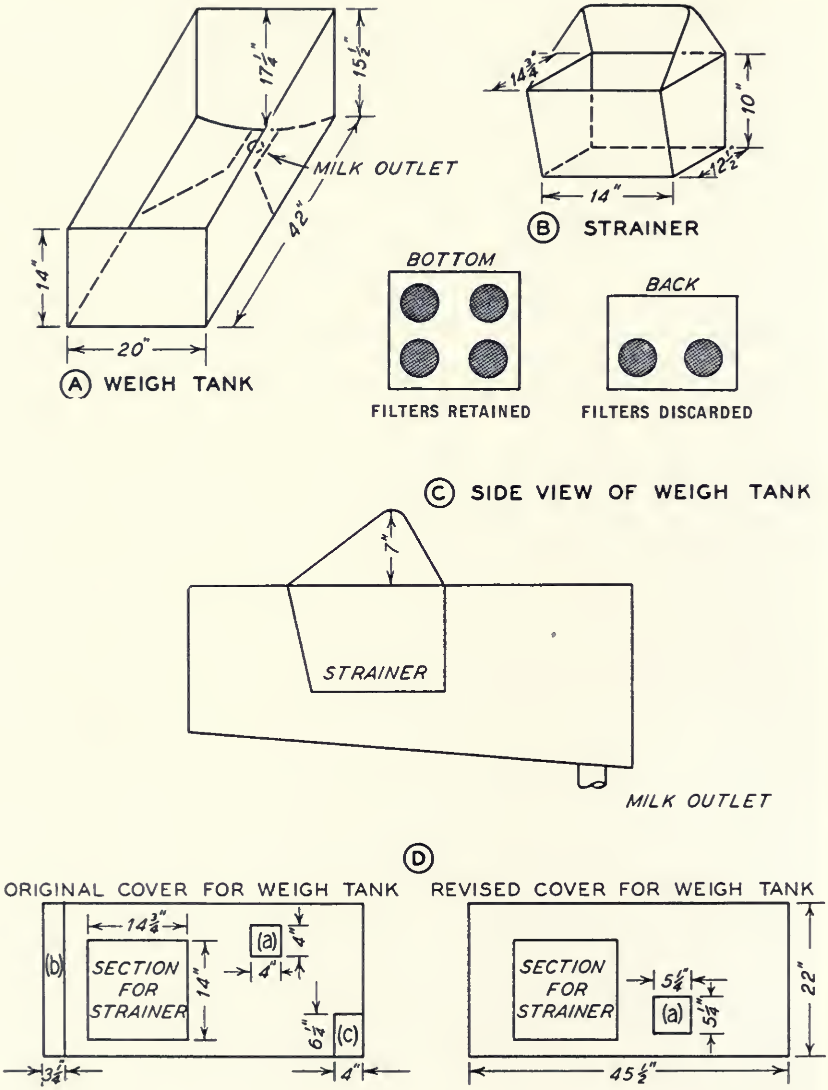

Fig. 5.—Construction details of weigh tank and strainer at Plant D

Dumping milk into this weigh tank (**A**) failed to mix the milk thoroly, and consequently the samples taken from the front of the tank differed from those taken from the rear by an average of .2 percent of butterfat. By changing the strainer (**B**) so that it had filters only on the bottom, and by changing the cover (**D**) so that all samples were taken thru one opening (*a*, revised cover) located at one side of the center in front of the strainer, more accurate sampling was obtained.

TABLE 7.—COMPARISON OF TESTS ON TWENTY SETS OF SAMPLES TAKEN FROM FRONT AND REAR OF VAT WHEN MILK WAS MIXED IN CAN BEFORE DUMPING: PLANT D

Variation range	Times front sample tested *less* than rear sample	Times front sample tested *more* than rear sample
perct.		
.01–.1	2	1
.15–.2	1	0
No difference	16	

rather consistently lower than the rear end samples, a new sampling opening was cut in the top of the weigh tank half way between the two ends, but still convenient to the operator. To check the accuracy of the samples taken from this location, the milk from one load was sampled daily for a period of one week.

A sample of each patron's milk was taken from the center of the weigh tank before and after mixing. These samples were tested daily and experimental composite samples were prepared. The plant also took its usual composite sample. The results of the daily tests on the fresh samples are shown in Table 8, while the averages of tests on daily and composite samples are given in Table 9. In this experiment the sampling and testing was all done by the same operator, the tests being performed in duplicate, the average test being reported in each

TABLE 8.—DAILY TESTS BEFORE AND AFTER MIXING, WHEN SAMPLES WERE TAKEN FROM CENTER OF DUMP TANK: PLANT D

Patron No.	Fat test of samples taken on dates indicated													
	5-17		5-18		5-19		5-20		5-21		5-22		5-23	
	perct.		*perct.*		*perct.*		*perct.*		*perct.*		*perct.*		*perct.*	
	(B)[a]	(A)[a]	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)
201	4.75	4.80	4.85	4.90	4.65	4.80	4.75	4.75	5.00	5.10	4.30	4.30	4.70	4.70
202	4.05	4.15	4.10	3.90	4.25	3.90	4.10	4.00	4.15	4.00	3.50	3.70	3.50	3.50
204	3.70	3.70	4.20	4.20	3.30	3.35	3.60	3.55	3.90	3.85	3.60	3.70	3.50	3.55
205	3.80	3.75	3.75	3.75	3.70	3.75	3.55	3.50	3.50	3.50	3.60	3.60	3.40	3.40
206	4.70	4.70	4.80	4.85	4.70	4.70	5.00	5.00	4.60	4.60	4.50	4.50	4.40	4.40
209	4.30	4.40	4.40	4.50	4.20	4.30	4.30	4.20	3.90	3.95	4.30	4.35	4.10	4.10
210	3.10	3.10	3.00	3.00	3.00	2.85	3.10	3.00	3.00	2.95	2.80	2.80	2.85	2.80
211	4.20	4.10	4.70	4.75	4.40	4.10	3.95	3.80	4.15	4.20	4.15	4.10	3.50	3.70
212	4.00	4.20	4.20	4.10	4.55	4.70	4.20	4.25	4.40	4.35	4.30	4.30	3.90	4.10
214	5.20	5.30	4.70	4.70	4.10	4.20	4.90	4.60	4.30	4.20	4.85	4.80	4.05	4.10
216	4.75	4.85	5.00	4.80	5.15	5.10	5.50	5.00	5.15	5.10	4.75	4.70	5.10	4.90
219	3.90	3.90	3.80	3.60	4.65	4.60	4.20	4.05	4.20	4.10	3.80	3.80	3.90	3.80
220	3.80	3.80	2.90	3.10	3.50	3.65	3.35	3.30	3.30	3.30	3.00	3.10	3.40	3.40
222	4.55	4.60	4.75	4.80	5.00	5.00	5.00	5.00	5.30	5.30	4.80	4.90	5.10	5.10
223	3.85	3.80	3.50	3.50	3.60	3.75	3.85	3.85	3.60	3.60	3.90	3.70	3.80	3.80

[a]B = before mixing, A = after mixing.

TABLE 9.—AVERAGE TESTS OF DAILY SAMPLES BEFORE AND AFTER MIXING COMPARED WITH TESTS OF COMPOSITE SAMPLES: PLANT D

Patron No.	Average of daily tests		Test of experimental composite		Test of plant composite
	perct.		*perct.*		*perct.*
	(B)[a]	(A)[a]	(B)	(A)	
201	4.77	4.65	4.65	4.65	4.75
202	3.85	3.80	3.85	3.80	3.80
204	3.70	3.70	3.60	3.65	3.50
205	3.60	3.55	3.70	3.55	3.50
206	4.70	4.60	4.50	4.60	4.60
209	4.20	4.15	4.10	4.15	4.05
210	2.90	2.90	2.90	2.90	2.90
211	4.10	4.00	4.05	4.00	4.00
212	4.28	4.15	4.30	4.15	4.30
214	4.55	4.50	4.50	4.50	4.30
216	4.90	4.70	4.90	4.70	4.50
219	3.95	3.90	3.85	3.90	3.85
220	3.37	3.30	3.30	3.30	3.30
222	4.95	4.90	4.90	4.90	4.80
223	3.70	3.70	3.70	3.70	3.60
Average	4.10	4.03	4.05	4.03	3.98

[a]B = before mixing, A = after mixing.

case. In Table 10 will be found the distribution of differences between the tests on samples taken before and after mixing.

Tables 8, 9, and 10 show that sampling the milk from the center of the dump tank before mixing gave results comparable with those obtained after mixing. A close correlation between the average test of daily samples and that of the experimental composite was also obtained. While the average test of the plant composite was lower than that of the experimental composite taken before mixing, the difference was not great enough to be considered serious. A wide variation in the daily tests of the milk from the same farm is evident in several cases. For example, the milk delivered by patron 220 varied in fat content from 3.1 to 3.8 percent; that from patron 219 varied from 3.6 to 4.6

TABLE 10.—DISTRIBUTION OF DIFFERENCES BETWEEN TESTS OF FIFTEEN PAIRS OF DAILY SAMPLES AND FIFTEEN PAIRS OF COMPOSITE SAMPLES TAKEN BEFORE AND AFTER MIXING[a]

Variation range	Number of pairs of daily samples with tests in range indicated	Number of pairs of experimental composite samples with tests in range indicated
perct.		
None	3	6
.01–.05	6	5
.06–.10	3	1
.11–.15	2	2
.16–.20	1	1

[a]One sample of each pair was taken before mixing, the other sample, after mixing.

percent; that from patron 214 varied from 4.1 to 5.3 percent; and the milk delivered by patron 211 varied from 3.7 to 4.75 percent.

Decision concerning sampling technic. For the remainder of the study pertaining to a comparison of tests of daily and composite samples, it was decided that the usual procedure followed in Plants A, B, and C would be accepted, but that in Plant D the milk would be stirred thoroly in the cans before being dumped, in order to enable the plant operator to sample at the front end while one of the investigators was sampling at the rear end, each one thereby obtaining a sample the accuracy of which could not be questioned.

COMPARISON OF AVERAGES OF TESTS ON DAILY SAMPLES AND ON COMPOSITES

Winter samples. From December 22, 1936, to January 4, 1937, samples were taken daily from all the deliveries at four plants, as explained on page 51. The composite samples were tested at the end of each seven-day period. The milk delivered by about 425 patrons was included in this experiment. The information was not complete on the milk of some patrons, owing to such uncontrollable factors as loss of sample or failure of the farmer to make delivery each day. In such cases the available data were not included in the calculated averages.

TABLE 11.—AVERAGES OF FAT TESTS OF FRESH AND COMPOSITE MILK SAMPLES: WINTER SAMPLES, ALL PLANTS

	First period (348 samples)	Second period (343 samples)
	perct.	*perct.*
Daily tests of fresh samples	4.702	4.739
Tests of experimental composite	4.641	4.713
Laboratory tests of plant composites	4.571	4.601
Association tests of plant composites	4.539	4.564

A summary of the data obtained on the samples taken at the four plants is given in Tables 11 and 12. The results of the tests on the various samples are compared in such a way as to show the distribution of differences by .1-percent intervals. The extent to which the test of the milk delivered by each patron varied within a period of one week is shown in Table 13.

Summer samples. From July 8 to July 14, 1937, samples were taken daily from the milk delivered by 50 patrons at each of two dairies (A and D). The same general procedure was followed as in the experiments conducted December 22 to January 4. The composite samples taken by the University representatives as well as those taken by the plants, with the exception of Plant D, were stored at 40° F. In Plant D the samples were stored in the receiving room.

A summary of the results of the tests made on the samples taken at Plants A and D during the summer are given in Tables 14, 15, and 16. These data are presented in the same manner as those given in Tables 11, 12, and 13. Laboratory tests of the Plant A composites were not available for comparison, however.

TABLE 12.—DISTRIBUTION OF DIFFERENCES BETWEEN AVERAGES OF FAT TESTS ON DAILY SAMPLES AND ON COMPOSITE SAMPLES: WINTER SAMPLES, ALL PLANTS

Variation range	First period		Second period	
	Number of tests	Percent	Number of tests	Percent
Tests on daily samples and experimental composites				
perct.				
0–.09	244	65.410	292	83.670
.10–.19	102	27.340	52	14.900
.20–.29	16	4.300	5	1.430
.30–.39	6	1.600	...	.....
.40–.49	3	.800	...	.....
.50–.59	1	.270	...	.....
.60–.69	1	.270	...	.....
Total	373	.....	349	.....
Tests on daily samples and laboratory tests of plant composites				
0–.09	115	33.04	121	34.280
.10–.19	125	35.92	125	35.410
.20–.29	78	22.41	67	18.980
.30–.39	19	5.46	26	7.370
.40–.49	9	2.59	9	2.550
.50–.59	2	.58	1	.280
.60–.69	...	.....	1	.280
.70–over	...	.....	3	.850
Total	348	.....	353	.....
Tests on daily samples and association tests on plant composites				
0–.09	80	19.950	90	25.000
.10–.19	110	27.430	117	32.500
.20–.29	108	26.93	92	25.550
.30–.39	59	14.710	43	11.940
.40–.49	29	7.230	14	3.890
.50–.59	8	1.990	2	.550
.60–.69	4	.990	1	.270
.70–.79	2	.498	...	.....
.80–.89	1	.249	1	.270
Total	401	.....	360	.....

TABLE 12.—*Concluded*

Variation range	First period		Second period	
	Number of tests	Percent	Number of tests	Percent
Tests on experimental composites and association tests on plant composites				
perct.				
0– .09	58	12.16	75	21.490
.10– .19	141	29.56	120	34.380
.20– .29	86	18.03	88	25.210
.30– .39	50	10.48	42	12.030
.40– .49	131	27.46	17	4.870
.50– .59	4	.838	3	.850
.60– .69	3	.628	2	.570
.70– .79	1	.21	1	.280
.80– .89	...	.....	...	.....
.90– .99	1	.21	...	.....
1.00–1.09	...	.....	...	.....
1.10–1.19	1	.21	...	.....
1.20–1.29	1	.21	1	.280
Total	477	.....	349	.....
Laboratory tests on plant composites and association tests on plant composites				
0– .09	104	30.670	132	38.260
.10– .19	135	39.820	132	38.260
.20– .29	71	20.940	59	17.100
.30– .39	16	4.710	14	4.050
.40– .49	7	2.060	4	1.150
.50– .59	2	.590	2	.580
.60– .69	...	.....	1	.290
.70– .79	1	.290	...	.....
.80– .89	2	.590	...	.....
.90– .99	...	.....	...	.....
1.00–1.09	1	.290	1	.290
Total	339	.....	345	.....

TABLE 13.—VARIATION BETWEEN HIGHEST AND LOWEST DAILY TESTS OF MILK FROM SAME PATRON, WINTER SAMPLES, ALL PLANTS

Variation range	First period		Second period	
	Number of tests	Percent	Number of tests	Percent
perct.				
0– .25	29	7.160	6	1.670
.30– .50	143	35.310	75	20.890
.55– .75	109	26.910	108	30.080
.80–1.00	80	19.750	90	25.060
1.05–1.25	24	5.930	32	8.910
1.30–1.50	11	2.710	30	8.350
1.55–1.75	4	.990	10	2.780
1.80–2.00	4	.990	5	1.390
2.05–2.25	1	.250	1	.270
2.30–2.50	...	.....	2	.550
Total	405	.....	359	.....

TABLE 14.—DISTRIBUTION OF DIFFERENCES BETWEEN AVERAGES OF FAT TESTS OF FRESH AND COMPOSITE MILK SAMPLES: SUMMER SAMPLES, PLANTS A AND D

Variation range	Number of tests	Percent
Tests of daily samples and experimental composites		
perct.		
0–.09	90	90.90
.10–.19	8	8.08
.20–.29	1	1.01
Total	99	....
Tests of daily samples and laboratory tests of plant composites		
0–.09	29	90.62
.10–.19	3	9.38
Total	32	....
Tests of daily samples and association tests of plant composites		
0–.09	28	28.50
.10–.19	29	29.50
.20–.29	24	24.50
.30–.39	11	11.20
.40–.49	4	4.10
.50–.59	0	0
.60–.69	1	1.00
Total	97	....
Tests of experimental composites and association tests of plant composites		
0–.09	18	18.50
.10–.19	38	39.20
.20–.29	26	26.80
.30–.39	9	9.20
.40–.49	4	4.10
.50–.59	1	1.00
.60–.69	0	0
.70–.79	1	1.00
Total	97	....
Laboratory tests of plant composites and association tests of plant composites		
0–.09	8	16.33
.10–.19	22	44.90
.20–.29	12	24.49
.30–.39	3	6.12
.40–.49	3	6.12
.50–.59	1	2.04
Total	49	....

TABLE 15.—AVERAGES OF FAT TESTS OF FRESH AND COMPOSITE MILK SAMPLES: SUMMER SAMPLES, PLANTS A AND D

	Percent
Both plants	
Daily tests of fresh samples	4.15
Tests of experimental composites	4.13
Association tests of plant composites	3.99
Plant D	
Daily tests of fresh samples	4.10
Tests of experimental composites	4.07
Association tests of plant composites	3.92
Laboratory tests of plant composites	4.07

TABLE 16.—VARIATION BETWEEN HIGHEST AND LOWEST DAILY TESTS OF MILK FROM SAME PATRON: SUMMER SAMPLES, PLANTS A AND D

Variation range	Number of tests	Percent
perct.		
0– .25	2	2
.30– .50	24	24
.55– .75	21	21
.80–1.00	18	18
1.05–1.25	18	18
1.30–1.50	10	10
1.55–1.75	2	2
1.80–2.00	2	2
2.05–2.25	1	1
2.30–2.50	0	0
2.55–2.75	2	2
Total	100	...

COMPARISON OF TESTS ON DAILY SAMPLES AND CALCULATED TESTS ON TRUE COMPOSITES

As previously stated, a true composite sample is one taken in proportion to either the volume or the weight of milk delivered. However, the use of a dipper is so much simpler than the use of a milk thief or other means of taking a proportionate sample that many dairies use the dipper and take a sample of practically the same size from all deliveries regardless of variations in the amount of milk delivered. Since variations were apparent in both the weight and test of the daily deliveries, a comparison was made of the test of the true composite, as calculated from the weight and test of each daily delivery, with the mathematical average of the tests on daily samples taken with a dipper. Nearly 3,000 daily deliveries of milk were tested (Tables 17 and 18).

The data show a remarkably close correlation between the tests

TABLE 17.—COMPARISON OF CALCULATED TRUE AVERAGE TEST AND MATHEMATICAL AVERAGE OF DAILY TESTS DURING 116 TEST PERIODS OF SEVEN DAYS EACH: PLANT B

Patron No.	First week				Second week			
	Daily test[a]	True test[b]	Difference		Daily test	True test	Difference	
			True test less	True test greater			True test less	True test greater
	perct.	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*
1	5.62	5.628	....	.008	5.35	5.352	....	.002
2	3.67	3.680	....	.010	3.50	3.502	....	.002
3	4.54	4.544	....	.004	4.71	4.707	.003	....
4	5.04	5.043	....	.003	5.10	5.090	.010	....
5	4.25	4.249	.001	....	4.10	4.081	.019	....
6	4.95	4.945	.005	....	5.19	5.186	.004	....
7	4.55	4.555	....	.005	4.83	4.813	.017	....
8	5.12	5.096	.024	....	5.11	5.101	.009	....
9	4.21	4.207	.003	....	4.13	4.158	....	.028
11	4.92	4.928	....	.008	4.61	4.614	....	.004
13	4.06	4.020	.040	....	3.58	3.575	.005	....
14	3.80	3.801	....	.001	3.93	3.922	.008	....
15	4.29	4.296	....	.006	4.16	4.164	....	.004
16	4.62	4.555	.065	....	4.74	4.713	.027	....
18	4.66	4.622	.038	....	4.82	4.826	....	.006
19	4.47	4.467	.003	....	4.25	4.248	.002	....
20	4.69	4.687	.003	....	4.53	4.492	.038	....
21	4.48	4.485	....	.005	4.85	4.790	.060	....
22	5.52	5.516	.004	....	5.24	5.202	.038	....
23	4.84	4.842	....	.002	5.01	5.015	....	.005
24	4.80	4.802	....	.002	4.91	4.903	.007	....
26	4.47	4.499	....	.029	4.46	4.457	.003	....
27	4.37	4.375	....	.005	4.64	4.641	....	.001
28	4.95	4.951	....	.001	5.04	5.036	.004	....
29	4.29	4.294	....	.004	4.30	4.277	.023	....
32	3.64	3.639	.001	....	3.56	3.563	....	.003
33	3.82	3.821	....	.001	4.17	4.162	.008	....
35	5.19	5.211	....	.021	5.15	5.142	.008	....
37	4.13	4.110	.020	....	4.42	4.415	.005	....
39	4.76	4.762	....	.002	4.99	4.990	0	0
41	4.50	4.470	.030	....	4.51	4.504	.006	....
42	4.46	4.502	....	.042	....	.....	....	....
43	....	.....	....	....	4.95	4.945	.005	....
45	4.63	4.618	.012	....	4.71	4.709	.001	....
46	5.74	5.730	.010	....	6.06	6.014	.046	....
47	4.41	4.447	....	.037	4.48	4.473	.007	....
48	4.10	4.096	.004	....	4.45	4.469	....	.019
49	5.02	5.028	....	.008	5.05	5.048	.002	....
50	4.83	4.837	....	.007	4.99	4.983	.007	....
52	4.42	4.406	.014	....	4.88	4.871	.009	....
53	4.71	4.680	.030	....	4.68	4.681	....	.001
54	5.08	5.072	.008	....	5.77	5.730	.040	....
57	4.40	4.316	.084	....	4.53	4.550	....	.020
61	4.70	4.687	.013	....	4.71	4.690	.020	....
63	4.60	4.611	....	.011	4.52	4.528	....	.008
64	4.82	4.812	.008	....	4.85	4.852	....	.002
H30	4.61	4.613	....	.003	4.54	4.536	.004	....
H31	5.43	5.437	....	.007	5.03	5.033	....	.003
H32	5.36	5.300	.060	....	5.45	5.394	.056	....
H33	4.25	4.243	.007	....	4.37	4.362	.008	....
H34	6.21	6.315	....	.105	5.52	5.502	.018	....
H35	5.82	5.805	.015	....	5.88	5.867	.013	....
H36	5.71	5.704	.006	....	5.78	5.791	....	.011
H37	5.20	5.178	.022	....	4.81	4.807	.003	....
H38	4.60	4.596	.004	....	4.24	4.235	.005	....
H39	5.35	5.353	....	.003	5.55	5.559	....	.009
H40	5.35	5.356	....	.006	4.98	4.978	.002	....
H41	4.53	4.551	....	.021	4.45	4.450	0	0
H42	5.00	5.002	....	.002	5.27	5.274	....	.004
Average	4.733	4.731	.002	....	4.761	4.775	....	.014

[a]Arithmetical average of daily percentages as determined by the Babcock test on daily deliveries.

[b]The true average test was determined by dividing the weight of the total amount of fat by the total weight of milk delivered and multiplying by 100.

TABLE 18.—COMPARISON OF THE CALCULATED TRUE AVERAGE TEST AND THE MATHEMATICAL AVERAGE OF DAILY TESTS DURING 310 TEST PERIODS OF SEVEN DAYS EACH:[a] PLANT D

Patron No.	First week				Second week			
	Daily test[b]	True test[c]	Difference		Daily test	True test	Difference	
			True test less	True test greater			True test less	True test greater
	perct.	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*
1	....	.....	....	....	4.95	4.948	.002	....
4	4.90	4.946	....	.046	5.00	5.008	....	.008
5	4.06	4.079	....	.019	3.82	3.825	....	.005
7	4.57	4.581	....	.011	4.59	4.581	.009	....
8	5.00	4.993	.007	....	4.99	4.998	....	.008
9	4.14	4.140	0	0	4.28	4.271	.009	....
11	4.25	4.266	....	.016	4.15	4.146	.004	....
12	4.06	4.062	....	.002	3.93	3.935	....	.005
13	4.62	4.612	.008	....	4.82	4.822	....	.002
19	4.24	4.250	....	.01	4.15	4.151	....	.001
20	4.18	4.198	....	.018	4.32	4.301	.019	....
22	3.68	3.691	....	.011	3.97	3.979	....	.009
200	3.09	3.091	....	.001	3.05	3.056	....	.006
201	4.92	4.915	.005	....	4.92	4.921	....	.001
202	5.00	5.000	0	0	4.88	4.900	....	.020
203	4.27	4.273	....	.003	4.45	4.425	.025	....
204	4.58	4.580	0	0	4.55	4.550	0	0
205	3.89	3.888	.002	....	3.88	3.869	.011	....
206	4.65	4.640	.01	....	4.74	4.761	....	.021
207	4.35	4.357	....	.007	4.54	4.471	.069	....
208	5.22	5.217	.003	....	5.31	5.301	.009	....
209	4.27	4.281	....	.011	4.31	4.326	....	.016
210	4.42	4.432	....	.012	4.66	4.663	....	.003
211	4.17	4.189	....	.019	3.99	3.962	.028	....
212	4.24	4.226	.014	....	4.44	4.441	....	.001
213	3.98	3.982	....	.002	4.37	4.367	.003	....
214	5.23	5.229	.001	....	5.23	5.232	....	.002
215	4.63	4.635	....	.005	4.95	4.967	....	.017
217	4.64	4.644	....	.004	4.68	4.688	....	.008
219	4.78	4.768	.012	....	5.05	5.049	.001	....
220	4.05	4.056	....	.006	4.09	4.070	.020	....
221	5.12	5.109	.011	....	4.90	4.891	.009	....
222	4.80	4.958	....	.158	4.76	4.769	....	.009
223	4.65	4.646	.004	....	4.65	4.650	0	0
226	3.78	3.783	....	.003	4.04	4.040	0	0
227	....	.....	....	....	5.02	5.013	.007	....
228	4.46	4.458	.002	....	4.45	4.487	....	.037
229	6.60	6.582	.018	....	6.52	6.454	.066	....
232	4.27	4.289	....	.019	4.61	4.588	.022	....
300	4.95	4.940	.010	....	4.73	4.727	.003	....
301	....	.....	....	....	4.86	4.858	.002	....
302	3.95	3.958	....	.008	4.28	4.290	....	.010
303	4.40	4.425	....	.025	4.34	4.348	....	.008
305	4.48	4.450	.030	....	4.60	4.580	.020	....
306	4.12	4.116	.004	....	3.97	3.973	....	.003
307	4.73	4.730	0	0	4.67	4.672	....	.002
308	4.59	4.566	.024	....	4.32	4.319	.001	....
309	3.79	3.790	0	0	3.79	3.800	....	.010
310	5.68	5.690	....	.010	5.25	5.246	.004	....
311	....	.....	....	....	4.30	4.322	....	.022
312	3.81	3.860	....	.050	4.05	4.056	....	.006
313	5.15	5.180	....	.030	4.94	4.909	.031	....
314	4.39	4.390	0	0	4.67	4.676	....	.006
315	6.06	6.050	.010	....	5.87	5.897	....	.027
316	4.59	4.580	.010	....	4.52	4.525	....	.005
318	4.33	4.330	0	0	4.46	4.465	....	.005
400	4.99	5.000	....	.010	5.09	5.085	.005	....
401	....	.....	....	....	5.95	5.945	.005	....
402	4.67	4.680	....	.010	4.70	4.726	....	.026
403	5.02	5.020	0	0	4.94	4.945	....	.005
404	5.05	5.050	0	0	5.09	5.084	.006	....
405	6.25	6.250	0	0	6.57	6.570	0	0
406	4.34	4.340	0	0	4.70	4.699	.001	....

(Table 18 continued on following page)

TABLE 18.—*Continued*

Patron No.	First week				Second week			
	Daily test[b]	True test[c]	Difference		Daily test	True test	Difference	
			True test less	True test greater			True test less	True test greater
	perct.	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*
408	3.90	3.905	....	.005	4.03	4.036	....	.006
409	4.97	4.974	....	.004	4.99	4.989	.001	....
411	4.85	4.857	....	.007	4.79	4.794	....	.004
412	4.22	4.205	.015	....	4.54	4.547	....	.007
413	5.07	4.959	.111	....	5.02	5.023	....	.003
414	5.70	5.697	.003	....	5.51	5.503	.007	....
415	4.56	4.568	....	.008	4.66	4.689	....	.029
416	4.75	4.752	....	.002	4.81	4.837	....	.027
417	....	.....	....	....	4.53	4.528	.002	....
418	5.05	5.048	.002	....	4.74	4.758	....	.018
419	4.32	4.331	....	.011	4.72	4.717	.003	....
424	5.40	5.421	....	.021	5.50	5.808	....	.308
426	....	.....	....	....	3.56	3.481	.079	....
427	4.28	4.297	....	.017	4.72	4.700	.020	....
428	4.12	4.127	....	.007	4.17	4.007	.163	....
429	3.85	3.848	.002	....	4.01	4.017	....	.007
430	4.54	4.535	.005	....	4.47	4.483	....	.013
431	4.30	4.297	.003	....	4.32	4.323	....	.003
432	4.82	4.834	....	.014	4.78	4.751	.029	....
434	3.97	3.971	....	.001	4.01	4.010	0	0
435	4.72	4.711	.009	....	4.69	4.691	....	.001
436	4.46	4.463	....	.003	4.68	4.675	.005	....
437	5.26	5.261	....	.001	4.97	4.980	....	.010
438	4.60	4.600	0	0	4.78	4.772	.008	....
439	5.39	5.392	....	.002	5.21	5.184	.026	....
440	3.69	3.678	.012	....	3.61	3.608	.002	....
441	4.96	4.968	....	.008	5.06	5.061	....	.001
442	5.21	5.213	....	.003	5.12	5.125	....	.005
443	5.49	5.524	....	.034	5.70	5.694	.006	....
444	5.79	5.807	....	.017	5.66	5.621	.039	....
445	5.70	5.710	....	.010	5.89	5.870	.020	....
446	5.39	5.391	....	.001	5.86	5.799	.061	....
503	4.80	4.832	....	.032	4.49	4.501	....	.011
504	4.98	4.980	0	0	4.83	4.846	....	.016
506	5.11	5.045	.065	....	5.27	5.280	....	.010
507	4.46	4.467	....	.007	4.30	4.296	.004	....
508	4.35	4.255	.095	....	4.86	4.892	....	.032
509	5.40	5.300	.010	....	5.14	5.140	0	0
510	4.47	4.483	....	.013	4.49	4.497	....	.007
511	4.46	4.403	.057	....	4.65	4.632	.018	....
513	4.92	4.886	.034	....	4.52	4.505	.015	....
514	5.42	5.464	....	.044	5.37	5.351	.019	....
515	5.20	5.212	....	.012	5.22	5.249	....	.029
516	5.05	5.045	.005	....	4.93	4.895	.035	....
517	5.75	5.770	....	.020	6.46	6.379	.081	....
518	4.75	4.747	.003	....	4.84	4.830	.010	....
519	4.79	4.798	....	.008	5.12	4.983	.137	....
520	5.33	5.340	....	.010	5.34	5.348	....	.008
521	5.20	5.193	.007	....	....	.....	....	....
523	3.90	3.970	....	.070	4.45	4.436	.014	....
600	5.94	5.942	....	.002	5.83	5.819	.011	....
601	4.45	4.445	.005	....	4.35	4.340	.010	....
602	5.35	5.350	0	0	5.41	5.410	0	0
604	3.98	3.993	....	.013	4.34	4.321	.019	....
607	4.34	4.347	....	.007	4.29	4.289	.001	....
608	4.51	4.500	.010	....	5.32	5.323	....	.003
609	4.86	4.855	.005	....	4.81	4.781	.029	....
610	4.64	4.620	.020	....	4.96	4.934	.026	....
612	4.89	4.920	....	.030	4.66	4.628	.032	....
613	....	.....	....	....	5.36	5.292	.068	....
615	4.53	4.530	0	0	4.99	4.989	.001	....
618	3.62	3.626	....	.006	3.63	3.665	....	.035
619	4.50	4.522	....	.022	4.21	4.193	.017	....
900	3.80	3.838	....	.038	3.74	3.735	.005	....
901	3.54	3.540	0	0	3.53	3.544	....	.014
903	....	.....	....	....	3.56	3.561	....	.001

TABLE 18.—*Concluded*

Patron No.	First week				Second week			
	Daily test[b]	True test[c]	Difference		Daily test	True test	Difference	
			True test less	True test greater			True test less	True test greater
	perct.	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*
904	3.43	3.430	0	0	3.87	3.869	.001	....
905	....	.....	....	....	5.67	5.660	.010	....
907	4.37	4.373	....	.003	4.18	4.182	....	.002
908	5.15	5.150	0	0	5.17	5.160	.010	....
909	4.04	4.043	....	.003	4.09	4.079	.011	....
910	5.00	5.009	....	.009	5.11	5.126	....	.016
911	5.02	5.019	.001	....	5.09	5.059	.031	....
912	5.57	5.566	.004	....	5.29	5.287	.003	....
913	4.07	4.072	....	.002	4.07	4.069	.001	....
914	4.80	4.793	.007	....	4.67	4.682	....	.012
917	4.29	4.309	....	.019	4.20	4.195	.005	....
920	3.92	3.925	....	.005	3.86	3.862	....	.002
921	4.55	4.552	....	.002	4.69	4.675	.015	....
922	3.83	3.837	....	.007	3.64	3.625	.015	....
1001	4.65	4.656	....	.006	4.83	4.826	.004	....
1002	4.28	4.302	....	.022	4.04	4.037	.003	....
1005	5.77	5.733	.037	....	5.64	5.675	....	.035
1006	....	.....	....	....	5.86	5.862	....	.002
1007	4.60	4.592	.008	....	4.34	4.330	.010	....
1009	4.92	4.911	.009	....	5.14	5.126	.014	....
1011	4.87	4.861	.009	....	5.09	5.080	.010	....
1012	4.84	4.833	.007	....	4.45	4.444	.006	....
1013	4.81	4.809	.001	....	4.54	4.528	.012	....
1014	4.49	4.497	....	.007	4.51	4.493	.017	....
1015	4.34	4.329	.011	....	4.61	4.598	.012	....
1016	4.22	4.233	....	.013	4.20	4.171	.029	....
1017	6.97	6.830	.140	....	6.83	6.736	.094	....
1018	4.70	4.705	....	.005	4.79	4.787	.003	....
1019	4.26	4.263	....	.003	4.15	4.148	.002	....
1020	4.67	4.585	.085	....	4.72	4.698	.022	....
1021	4.52	4.523	....	.003	4.51	4.519	....	.009
1022	4.38	4.431	....	.051	4.42	4.419	.001	....
Average	4.69	4.683	.007	....	4.70	4.704	....	.004

[a]Averages for the 426 test periods in Plants B and D, Tables 17 and 18. Daily test, 4.70 percent fat; true test, 4.6995 percent fat.
[b]Arithmetical average of daily percentages as determined by the Babcock test on daily deliveries.
[c]The true average test was determined by dividing the weight of the total amount of fat by the total weight of milk delivered and multiplying by 100.

calculated on the true composites and the mathematical average of the tests on the daily samples. For only seven samples did the difference between the tests amount to .10 percent fat or more. Naturally, some differences would be expected because of the wide variations in the weight of the milk delivered during the seven-day test periods (Tables 19 and 20). However, under the conditions of these experiments these differences are not of sufficient significance to seriously affect the accuracy of the test on the composite samples.

TABLE 19.—VARIATIONS IN WEIGHT OF MILK AND FAT DELIVERED BY PATRONS DURING EACH OF TWO SEVEN-DAY TEST PERIODS: PLANT B

Patron No.	First week				Second week			
	Milk		Fat		Milk		Fat	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
1.......	140	117	7.788	6.201	144	121	7.848	6.292
2.......	134	88	4.958	3.256	113	84	3.955	2.656
3.......	113	100	5.668	4.326	110	88	5.060	4.092
4.......	72	68	3.816	3.360	83	65	4.233	3.430
5.......	152	140	8.360	5.5825	152	118	6.192	5.428
6.......	150	100	7.200	4.950	137	72	7.260	3.852
7.......	121	107	5.616	4.905	137	82	6.371	4.018
8.......	119	97	5.950	5.044	156	98	8.112	5.096
9.......	175	151	7.216	6.3075	167	141	6.847	6.063
11.......	126	74	6.300	3.637	85	72	4.080	3.384
13.......	223	165	10.296	6.764	218	169	7.848	6.422
14.......	154	140	6.258	5.040	147	130	6.235	5.180
15.......	27	23	1.215	.966	26	23	1.092	.943
16.......	123	32	5.535	1.664	85	65	3.792	3.124
18.......	241	120	12.050	5.400	228	163	11.350	7.661
19.......	236	201	10.534	8.610	258	198	11.374	8.316
20.......	78	64	3.510	2.772	71	61	3.185	2.924
21.......	87	82	3.999	3.654	87	62	4.158	3.410
22.......	22	10	1.210	.550	50	21	2.800	1.145
23.......	142	139	7.089	6.526	143	140	7.722	6.816
24.......	85	72	4.165	3.384	80	49	3.760	2.401
26.......	168	42	6.888	1.890	172	95	7.912	5.935
27.......	47	38	2.068	1.539	48	37	2.208	1.517
28.......	70	62	3.432	2.8615	82	64	4.018	3.201
29.......	57	43	2.622	1.786	45	27	1.866	1.215
32.......	110	89	4.180	3.293	103	93	3.648	3.255
33.......	115	100	4.600	3.636	111	91	4.394	3.822
35.......	122	95	6.954	4.224	112	94	5.618	4.606
37.......	123	88	4.945	3.988	110	85	5.225	3.910
39.......	87	51	3.915	2.346	115	73	5.750	3.650
41.......	55	35	2.420	1.855	46	24	2.156	1.056
42.......	173	163	8.084	7.138	177	150	8.704	7.580
45.......	75	65	3.600	2.970	78	61	3.510	2.806
46.......	88	72	4.428	5.104	117	17	7.313	1.105
47.......	155	118	6.384	5.324	126	105	5.607	4.620
48.......	153	122	6.248	5.002	155	120	7.285	4.920
49.......	168	157	8.568	8.007	162	144	8.215	7.200
50.......	98	82	4.896	3.772	88	72	4.481	3.600
52.......	189	168	8.325	7.308	180	155	8.910	7.584
53.......	97	79	4.365	3.792	98	89	4.802	3.916
54.......	19	13	.936	.611	16	8	.856	.496
57.......	60	47	2.580	2.068	63	45	3.150	1.980
61.......	69	14	3.024	.742	54	21	2.322	.872
63.......	161	128	7.900	5.760	146	116	6.716	4.988
64.......	47	38	2.350	1.920	47	38	2.256	1.800
H30.....	82	76	3.772	3.465	79	73	3.950	3.198
H31.....	67	60	3.640	3.120	68	61	3.604	2.989
H32.....	29	23	1.426	1.352	37	25	1.776	1.550
H33.....	56	40	2.352	1.740	53	39	2.120	1.638
H34.....	67	17	4.355	.994	49	23	2.573	1.265
H35.....	54	45	3.036	2.655	58	40	3.625	2.480
H36.....	37	31	2.164	1.860	40	32	2.356	1.808
H37.....	51	32	2.703	1.728	56	46	2.800	2.254
H38.....	103	90	4.686	4.275	142	97	5.893	4.141
H39.....	61	54	3.355	2.912	58	47	3.219	2.444
H40.....	58	52	3.190	2.652	56	50	2.800	2.544
H41.....	50	37	2.350	1.615	52	13	2.344	.546
H42.....	48	39	2.400	1.911	50	46	2.675	2.346

TABLE 20.—VARIATIONS IN WEIGHT OF MILK AND FAT DELIVERED BY PATRONS DURING EACH OF TWO SEVEN-DAY TEST PERIODS: PLANT D

Patron No.	First week				Second week			
	Milk		Fat		Milk		Fat	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
1.....	194	162	9.118	8.415	183	155	9.516	7.968
4.....	135	105	7.020	5.145	126	110	6.300	5.390
5.....	70	52	3.010	2.028	50	42	2.072	1.596
7.....	202	156	8.9745	6.972	190	136	8.740	6.435
8.....	185	150	9.250	8.256	195	161	9.750	7.590
9.....	287	222	11.480	9.990	274	226	12.420	10.130
11.....	105	92	4.725	3.312	94	75	3.999	2.847
12.....	491	415	20.131	17.248	468	411	18.343	16.068
13.....	150	122	6.600	5.246	132	111	6.240	5.340
19.....	125	110	5.750	4.256	117	103	5.022	3.914
20.....	32	19	1.456	.7885	32	21	1.392	1.012
22.....	88	72	3.432	2.520	74	56	3.034	2.240
200.....	74	60	2.263	1.830	70	56	2.048	1.860
201.....	81	55	3.888	2.750	66	54	3.380	2.619
202.....	36	32	1.819	1.504	35	31	1.792	1.395
203.....	129	118	5.658	4.543	130	105	5.565	4.826
204.....	24	21	1.128	.924	21	18	9.660	7.200
205.....	210	178	8.151	7.030	203	183	7.503	7.030
206.....	77	63	3.542	3.072	70	54	3.500	2.241
207.....	144	98	6.336	4.214	195	50	8.385	2.450
208.....	96	76	4.814	3.948	91	78	5.185	4.056
209.....	55	44	2.530	1.665	58	43	2.494	1.763
210.....	83	45	3.652	1.935	68	63	3.150	2.880
211.....	56	43	2.436	1.505	50	32	2.256	1.344
212.....	84	63	3.696	2.8035	82	70	3.813	2.975
213.....	58	44	2.320	1.716	60	41	2.520	1.764
214.....	65	51	3.445	2.470	56	48	2.997	2.538
215.....	62	54	2.914	2.508	64	48	3.402	2.184
217.....	148	128	6.882	5.952	140	123	7.000	5.658
219.....	118	96	5.724	4.512	110	95	5.720	4.750
220.....	94	84	3.948	3.375	95	60	3.800	2.600
221.....	158	148	8.532	7.488	173	153	8.400	7.605
222.....	96	63	4.840	3.213	103	52	4.841	2.288
223.....	42	35	1.953	1.620	36	28	1.674	1.316
226.....	92	80	3.496	3.080	85	78	3.520	3.108
227.....	141	106	7.825	4.982	130	100	5.980	4.692
228.....	59	51	2.726	2.346	151	52	6.040	2.314
229.....	68	53	4.216	3.520	65	44	3.803	3.059
232.....	58	44	2.726	1.738	56	40	2.856	1.863
300.....	70	50	3.500	2.425	60	42	2.820	1.848
301.....	138	119	6.901	5.160	135	114	6.480	5.415
302.....	152	124	6.080	4.788	188	156	8.084	6.162
303.....	76	54	3.648	2.160	55	44	2.438	1.782
305.....	58	34	2.378	1.666	48	34	2.304	1.530
306.....	147	122	6.1625	5.104	153	114	6.579	4.526
307.....	74	63	3.848	2.479	71	52	3.536	2.418
308.....	56	38	2.430	1.653	49	36	2.136	1.548
309.....	123	99	5.0215	3.465	122	90	4.950	3.060
310.....	73	62	4.615	3.520	72	65	3.780	3.380
311.....	79	51	3.510	1.836	80	63	3.760	2.457
312.....	77	58	3.157	2.030	82	64	3.280	2.464
313.....	122	98	6.588	4.300	118	83	5.445	4.183
314.....	84	80	4.000	3.360	78	50	3.588	2.200
315.....	17	12	1.054	.708	17	10	1.088	.580
316.....	125	109	5.900	5.074	117	100	5.148	4.545
318.....	147	125	6.174	5.628	151	130	6.946	5.719
400.....	47	40	2.397	1.575	63	46	3.150	2.208
401.....	41	34	2.500	1.938	38	30	2.242	1.920
402.....	68	52	3.196	2.340	92	53	4.784	2.438
403.....	171	152	8.208	7.650	161	147	8.533	7.056
404.....	52	44	2.782	2.024	48	37	2.464	1.961
405.....	98	80	6.370	4.800	90	78	5.940	5.070
406.....	123	78	5.488	2.9625	80	78	4.212	3.200
408.....	205	183	8.5425	6.825	194	173	8.536	6.552
409.....	126	98	6.100	4.900	122	108	6.608	5.463
411.....	63	52	3.150	2.552	67	42	3.283	2.037
412.....	40	28	1.760	1.505	50	44	2.350	1.826

(Table 20 continued on following page)

TABLE 20.—Continued

Patron No.	First week				Second week			
	Milk		Fat		Milk		Fat	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
413.....	70	51	3.536	2.703	62	45	3.120	2.273
414.....	87	73	4.8025	4.028	77	68	4.477	3.536
415.....	59	48	2.8615	2.093	56	46	2.915	1.833
416.....	87	73	4.176	3.525	75	56	3.723	2.550
417.....	30	10	1.290	.465	21	16	.935	.720
418.....	58	50	2.900	2.400	54	45	2.754	1.845
419.....	107	98	4.8685	3.360	100	80	4.680	3.740
424.....	15	11	.854	.520	20	7	1.044	.445
426.....	28	22	1.026	.770	32	20	1.104	.780
427.....	115	48	5.060	2.1725	70	34	3.150	1.598
428.....	363	335	15.4275	14.070	360	330	15.225	10.562
429.....	150	125	6.000	4.9375	150	128	6.300	4.800
430.....	213	160	10.011	7.600	247	190	11.609	8.360
431.....	82	59	3.731	2.655	84	73	3.744	2.993
432.....	77	68	3.8625	3.134	67	42	3.015	2.226
434.....	103	91	4.116	3.720	105	90	4.242	3.690
435.....	83	63	3.818	3.096	80	54	4.134	2.646
436.....	150	127	6.750	5.461	134	111	6.200	5.332
437.....	73	63	3.9195	2.925	87	73	4.698	3.285
438.....	94	83	4.324	3.320	90	70	4.200	3.360
439.....	143	123	7.865	6.765	155	97	7.776	5.626
440.....	59	42	2.124	1.734	50	40	1.838	1.440
441.....	110	98	5.830	4.606	110	92	5.720	4.830
442.....	155	143	8.208	7.007	165	145	8.498	6.536
443.....	83	47	4.9385	2.809	55	40	3.108	2.240
444.....	46	29	2.576	1.590	31	15	1.798	.983
445.....	132	86	7.524	4.730	132	96	7.590	6.144
446.....	83	71	4.482	3.763	93	60	5.208	3.600
503.....	127	96	6.096	4.800	141	107	6.839	4.565
504.....	32	28	1.568	1.248	30	24	1.470	1.008
506.....	68	48	3.060	2.514	54	35	2.754	1.820
507.....	169	144	7.943	6.336	224	137	9.408	5.880
508.....	80	21	2.960	1.008	55	45	3.025	1.688
509.....	150	25	7.650	1.475	100	78	5.843	4.067
510.....	111	78	5.232	3.354	93	80	4.263	3.120
511.....	58	22	2.262	1.056	40	28	1.760	1.428
513.....	76	30	3.724	1.605	72	60	3.402	2.560
514.....	32	24	1.824	1.236	30	18	1.530	.999
515.....	170	130	9.435	6.175	175	97	9.625	5.044
516.....	100	30	5.000	1.455	61	20	2.928	.980
517.....	89	28	5.518	1.650	75	20	4.350	1.170
518.....	55	43	2.420	1.980	53	37	2.491	1.684
519.....	76	62	3.800	2.816	67	53	3.250	2.727
520.....	94	30	5.076	1.800	70	45	3.675	2.115
521.....	22	10	1.166	.515	24	17	1.416	.901
523.....	76	37	3.306	1.326	76	54	3.572	2.106
600.....	79	65	4.7795	3.795	90	64	5.040	3.610
601.....	122	97	5.551	4.312	102	80	4.464	3.480
602.....	69	52	3.657	2.756	61	52	3.294	2.886
604.....	82	67	3.773	2.345	89	75	3.838	2.880
607.....	63	53	3.024	2.226	58	42	2.622	1.857
608.....	148	93	6.216	4.350	122	102	7.320	5.457
609.....	173	147	8.131	7.252	196	147	9.300	7.350
610.....	112	72	5.152	3.312	85	65	4.234	2.860
612.....	118	58	6.018	2.8125	75	45	3.230	2.205
613.....	...	...	.....	.....	83	47	3.901	2.820
615.....	85	70	3.818	2.993	75	67	3.863	3.162
618.....	120	100	4.200	3.400	104	82	3.811	3.116
619.....	34	19	1.716	.798	25	16	1.088	.741
900.....	84	73	3.360	2.916	74	64	2.680	2.278
901.....	271	260	9.756	8.942	276	250	10.212	8.514
903.....	159	110	6.123	3.905	158	144	5.846	4.884
904.....	116	103	3.811	3.5535	121	100	4.780	4.000
905.....	63	39	3.480	2.436	71	50	4.114	2.950
907.....	120	104	5.452	4.368	110	97	5.040	3.800
908.....	85	76	4.293	3.800	78	64	4.017	3.520
909.....	173	153	7.093	6.314	165	133	6.765	5.476
910.....	150	94	7.650	4.888	103	74	5.044	3.552

TABLE 20.—*Concluded*

Patron No.	First week				Second week			
	Milk		Fat		Milk		Fat	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
911.....	120	100	5.880	5.100	113	92	5.511	4.935
912.....	116	98	6.322	5.562	112	94	6.380	5.194
913.....	97	73	4.0255	2.9565	104	60	4.160	2.220
914.....	58	36	2.697	1.773	65	46	3.016	2.001
917.....	90	65	4.200	2.520	86	70	3.825	2.870
920.....	83	65	3.311	2.665	82	68	3.239	2.698
921.....	116	101	5.432	4.242	112	85	5.100	4.123
922.....	106	80	4.028	2.880	120	51	4.380	1.913
1001.....	70	65	3.536	2.665	68	60	3.283	2.790
1002.....	51	40	2.275	1.560	51	40	2.040	1.554
1005.....	55	18	3.245	1.121	46	25	2.737	1.428
1006.....	41	33	2.394	1.716	40	30	2.379	1.705
1007.....	118	102	5.100	4.664	134	97	5.786	4.268
1009.....	53	42	2.544	2.058	48	35	2.668	1.920
1011.....	62	39	2.976	2.050	59	43	3.233	2.376
1012.....	148	50	6.882	2.400	105	90	4.656	3.870
1013.....	96	89	4.806	4.042	102	90	4.500	3.999
1014.....	76	70	3.496	2.992	80	68	3.520	3.280
1015.....	170	126	7.682	5.796	160	127	7.040	5.720
1016.....	144	120	6.681	4.736	152	105	6.384	5.040
1017.....	36	11	2.304	.897	40	10	2.620	.750
1018.....	49	37	2.254	1.640	46	42	2.208	1.932
1019.....	82	79	3.840	3.081	83	76	3.510	3.081
1020.....	127	50	5.3975	2.650	86	30	3.913	1.485
1021.....	64	45	2.880	2.040	52	44	2.525	1.890
1022.....	38	23	2.090	.989	35	19	1.820	.836

GENERAL DISCUSSION OF RESULTS

The data obtained in this study confirm the findings of Sanmann and Overman[9*] and others that seven-day composites when properly taken and stored will test about the same as fresh milk samples. While the tests on fresh milk samples averaged somewhat higher than the average test of the laboratory composites, the difference was slight, being .061 percent the first period of the winter series; .026 percent the second period of the winter series; and .020 percent for the summer series. Comparing all the samples, 75.64 percent of the daily and laboratory composite samples checked within .09 percent of each other, and 95.98 percent were within .20 percent of each other. The greatest variations were in the first period of the winter series.

In comparing the daily tests with the Association tests on the plant composites, it will be noted that agreement between tests is not so close as it is between the laboratory composite tests and the daily tests. The average variation for the first period of the winter series was .163 percent, for the second period .175 percent, and for the summer series .205 percent. However, 22.78 percent of the 708 comparisons show a difference of .3 percent or more.

In comparing the laboratory tests on the plant composites with the Association tests on these same samples, it will be found that only 7.4 percent of the samples show a difference of .3 percent or more. In the comparison of the average of daily tests and the laboratory tests of plant composites, 18.3 percent of the samples differ .3 percent or more in fat content. It would seem, therefore, that there were more variations traceable to the plant composite samples themselves than to the testing of these composites. Possible causes for inaccurate plant composites are improper mixing in the bottle each day, improper refrigerating of the samples, and failure to take samples each day. It has been observed that sometimes composite samples are not taken by the plants on holidays, Sundays, or on days the regular receiving-room man is off duty. The occasional omission of a daily sample would not be serious except when the tests on daily deliveries varied widely. Since 67.71 percent of 864 seven-day delivery periods were found to have variations over .5 percent between the highest and lowest daily tests on the milk delivered within the period, failures to include samples from all deliveries likely affected the accuracy of the composite samples of such deliveries.

In general, the tests reported by the Association representative seem to have been accurately performed. As it is not humanly possible to prevent all errors, the question rises as to what degree of tolerance should be allowed. Examination of the data indicates errors either in the testing or in the recording of the Association tests on several of the plant composites. In such cases the tendency was for these tests to be low. With the average daily tests, laboratory composite tests, and the laboratory tests of the plant composites as a check, an attempt was made to select the Association tests of the plant composites that seemed in error.

The laboratory tests of the plant composites might be subject to some criticism because of the fact that by the time some of these samples reached the laboratory, they were churned, and occasionally there was only a small portion of sample left. However, whenever the average daily tests and the laboratory composite test agreed reasonably well with the laboratory test of the plant composite and all three tests were .2 percent or more higher than the Association test of the plant composite, it was assumed that there was some error in the performing of the test by the Association representative either thru faulty tests, incorrect reading of the fat column, or incorrect recording of the test. How best to prevent such errors, however, is rather difficult to determine.

It is very likely that errors of this nature will occur wherever many tests are being performed at one time, and probably the only way in which the number could be held to a minimum would be by some system of checks. The person doing the testing should realize that his tests are likely to be checked at any time. Duplication of all tests is probably unnecessary, yet there is ample evidence in this study to support the belief that a retest of at least part of the samples would be justified and practical. In milk delivered by a selected group of 117 patrons the errors evident in the test for fat totaled 31.30 percent (Table 21). Assuming the average weekly delivery was 600 pounds, the total loss to the producers of this group was the value of 187.8 pounds of fat. At 40 cents a pound this amount of fat would have a value of $75.12, a value that would take care of the extra cost of double-checking most of the composite milk samples on this market.

One of the most striking things brought out in this study was the wide variation between the highest and lowest test of the milk delivered by a large number of the patrons during a seven-day period. A total of 432 patrons made deliveries which were tested over two weeks time. Each week during which each patron's milk was tested was considered a separate period, so that there were 432 patrons and 864 test periods. Data on these 864 periods show that only 37 of them do not exceed .25 percent between the highest and lowest test. Considering .5 percent as a normal variation, 67.71 percent of the test periods would indicate an abnormal variation in the fat content of the milk. That 18.4 percent of the seven-day periods showed variations over one percent (some over 2.5 percent) is sufficient evidence that mechanical manipulation of the fat content of the milk took place in a number of cases. A possible explanation for this may be found in the plan followed in paying the farmers for their milk. Each patron had a base, which approximated 60 percent of the *amount* of milk he delivered from September 15 thru December 15. For this base, in December, 1936, he was paid a net price of $2.05 per hundred pounds. The price differential was 3.5 cents a point. Since the only restriction on his base allotment was its weight, a farmer may have considered it good business to skim a reasonable amount of his surplus milk, place the cream he did not need for table purposes in with the remaining whole milk and utilize the skimmilk for feeding. For example, a farmer may have delivered 2,000 pounds of 3.8-percent milk in a seven-day period. With a base of 1,200 pounds, if he did not skim the milk, he would have

TABLE 21.—TESTS OF DAILY AND COMPOSITE SAMPLES SHOWING PROBABLE ERROR IN ASSOCIATION TEST OF PLANT COMPOSITE

Patron No.	Average test of daily samples	Test of experimental composite	Laboratory test of plant composite	Association test of plant composite	Evident error
		Plant A			
	perct.	*perct.*	*perct.*	*perct.*	*perct.*
First period					
9	4.19	4.2	4.2	4.00	.20
12	5.56	5.6	5.6	5.35	.25
56	5.12	5.0	4.9	4.70	.20
63	4.72	4.6	4.6	4.40	.20
58a	4.30	4.3	4.4	4.10	.20
Second period					
142	3.87	3.80	3.85	3.60	.20
		Plant B			
First period					
3	4.54	4.50	4.50	4.30	.20
4	5.04	5.10	5.10	4.80	.20
6	4.95	4.90	4.80	4.60	.20
9	4.21	4.20	4.05	3.80	.20
20	4.69	4.60	4.60	4.40	.20
22	5.52	5.40	5.40	5.20	.20
23	4.84	4.80	4.90	4.60	.20
37	4.13	4.10	4.20	3.90	.20
41	4.50	4.50	4.50	4.30	.20
52	4.42	4.45	4.40	4.20	.20
54	5.08	5.00	4.80	4.60	.20
61	4.70	4.80	4.50	4.30	.20
64	4.82	4.95	4.80	4.00	.80
31	5.43	5.40	5.40	5.10	.30
Second period					
3	4.71	4.70	4.60	4.30	.30
7	4.83	4.80	5.00	4.60	.20
		Plant C			
First period					
H26	5.80	5.80	5.80	5.60	.20
Second period					
3	4.27	4.30	4.20	4.00	.20
		Plant D (winter)			
First period					
1	4.77	4.80	4.75	4.60	.15
7	4.57	4.50	4.60	4.40	.20
19	4.24	4.20	4.20	3.80	.40
204	4.58	4.60	4.70	4.40	.20
205	3.89	3.90	3.90	3.50	.40
214	5.23	5.30	5.30	4.90	.40
228	4.46	4.60	4.55	4.20	.30
229	6.60	6.50	6.35	6.10	.25
302	3.95	3.90	3.80	3.50	.30
305	4.48	4.50	4.50	4.20	.30
312	3.81	3.95	3.90	3.50	.40
313	5.15	5.20	5.10	4.80	.30
315	6.06	6.00	6.10	5.70	.40
405	6.25	6.30	6.20	6.00	.20

TABLE 21.—*Continued*

Patron No.	Average test of daily samples	Test of experimental composite	Laboratory test of plant composite	Association test of plant composite	Evident error
Plant D (winter, first period, *concluded*)					
First period	*perct.*	*perct.*	*perct.*	*perct.*	*perct.*
406	4.34	4.40	4.35	4.10	.25
408	3.90	4.00	3.95	3.50	.45
429	3.85	3.85	3.75	3.40	.35
432	4.82	4.65	4.70	4.40	.30
441	4.96	4.90	4.90	4.60	.30
444	5.79	5.70	5.65	5.40	.25
445	5.70	5.70	5.60	5.30	.30
516	5.05	5.00	5.00	4.80	.20
600	5.94	5.80	5.70	5.50	.20
602	5.35	5.30	5.30	5.00	.20
609	4.86	4.90	4.70	4.50	.20
901	3.54	3.50	3.50	3.30	.20
912	5.57	5.50	5.50	5.30	.20
914	4.80	4.75	4.80	4.60	.20
920	3.92	3.80	3.80	3.60	.20
1009	4.92	4.90	4.90	4.70	.20
401	5.80	5.70	5.90	5.40	.50
Second period					
12	3.93	4.00	3.90	3.70	.20
13	4.82	4.75	4.70	4.50	.20
22	3.97	3.95	3.80	3.60	.20
200	3.05	3.10	3.00	2.80	.20
201	4.92	4.90	4.90	4.70	.20
202	4.88	4.80	4.80	4.60	.20
203	4.45	4.40	4.25	4.00	.25
206	4.74	4.70	4.60	4.30	.30
207	4.54	4.55	4.50	4.20	.30
208	5.31	5.30	5.10	4.70	.40
209	4.31	4.25	4.10	3.90	.20
210	4.66	4.60	4.60	4.30	.30
228	4.45	4.40	4.30	4.10	.20
301	4.86	4.70	4.70	4.40	.30
308	4.32	4.30	4.30	4.10	.20
313	4.67	4.70	4.50	4.30	.20
315	5.87	5.75	5.70	5.50	.20
405	6.57	6.55	6.40	5.30	.10
406	4.70	4.80	4.60	4.40	.20
408	4.03	4.15	3.90	3.70	.20
411	4.79	4.90	4.80	4.50	.30
412	4.54	4.70	4.70	4.30	.40
414	5.51	5.60	5.40	5.10	.30
415	4.66	4.75	4.60	4.20	.40
443	5.70	5.70	5.60	5.40	.20
506	5.27	5.20	5.30	5.10	.20
507	4.30	4.30	4.30	4.10	.20
516	4.93	4.85	4.70	4.50	.20
517	6.46	6.40	6.25	6.00	.25
520	5.34	5.35	5.40	5.20	.20
523	4.45	4.40	4.20	4.00	.20
601	4.35	4.35	4.30	4.10	.20
612	4.66	4.65	4.70	4.40	.30
613	5.36	5.45	5.40	5.00	.40
618	3.63	3.60	3.75	3.40	.35
619	4.21	4.15	4.10	3.90	.20
900	3.74	3.65	3.60	3.40	.20
905	5.67	5.60	5.60	5.40	.20
909	4.09	4.00	3.95	3.60	.35
910	5.11	4.90	4.90	4.70	.20
920	3.86	3.90	3.75	3.50	.25
922	3.64	3.60	3.55	3.30	.25
1005	5.64	5.60	5.50	5.30	.20
1006	5.86	5.90	5.90	5.40	.50
1020	4.72	4.65	4.70	4.50	.20

(Table 21 concluded on following page)

TABLE 21.—*Concluded*

Patron No.	Average test of daily samples	Test of experimental composite	Laboratory test of plant composite	Association test of plant composite	Evident error
Plant D (summer)					
	perct.	*perct.*	*perct.*	*perct.*	*perct.*
201	5.28	5.20	5.20	4.80	.40
212	4.39	4.40	4.40	4.20	.20
213	4.33	4.30	4.25	4.00	.25
214	4.59	4.50	4.50	4.30	.20
216	4.52	4.45	4.40	4.20	.20
244	3.79	3.70	3.70	3.50	.20
601	3.75	3.70	3.75	3.40	.35
1002	3.41	3.40	3.40	3.20	.20
1005	4.20	4.10	4.10	3.90	.20
1012	4.13	4.20	4.20	3.70	.50
1013	4.32	4.30	4.40	4.00	.40
1014	4.94	4.95	4.90	4.70	.20
1015	4.59	4.60	4.60	4.40	.20
1017	4.25	4.20	4.15	3.80	.35
1019	4.61	4.60	4.70	4.30	.40
1020	3.85	3.80	3.80	3.60	.20
1022	3.61	3.60	3.60	3.30	.30

received under the conditions of the Champaign-Urbana market in December, 1936, $36.50 calculated as follows:

Base allotment: 1200 lb. at $2.05 per cwt. 3.8%.............. = $24.60
Surplus: 800 lb. at $1.50 per cwt. 3.8%........................ = 12.00
Total.. = 36.60

If the farmer had skimmed half his surplus milk, he would have received $36.05 for the milk he sold and would have had about 339 pounds of skimmilk left for feeding. Further, he would have saved the shipping cost on 339 pounds of milk. The method of arriving at these values is shown by the following calculations:

400 × 3.8% = 15.2 pounds of fat in milk skimmed

Assuming that a 25-percent cream was skimmed, the weight of the cream skimmed would be equal to 60.8 pounds:

1600 + 60.8 = pounds of milk delivered
1600 × 3.8% = 60.8 pounds of fat in unskimmed milk
60.8 × 25% = 15.2 pounds of fat in added cream

Thus the 1660.8 pounds of milk delivered contained 76 pounds of fat. As it tested 4.58 percent, its value would be figured as follows:

Value of 1200 lb. of 4.58% base milk at $2.323 per cwt......... = $27.88
Value of 460.8 lb. surplus milk at $1.773 per cwt............... = 8.17
Total value of 1600.8 lb. milk testing 4.58%............... = 36.05

Assuming the skimmilk has a feeding value of 25 cents a hundred pounds and that hauling charges are 25 cents a hundred pounds, the farmer would gain $1.70 by not marketing the 339 pounds of skimmilk.

His *net* gain, however, would be $1.70 minus $.55 ($36.60 minus $36.05) or $1.15.

Apparently the advantage to the farmer of skimming a portion of his surplus milk will depend upon:

1. Relative value of price differential used in determining the value of the milk produced in excess of the base test (3.8 percent in this case) per pound of fat, and the market price of butter (which is used as basis for determining the value of the surplus milk).

2. Value of skimmilk for feeding.

3. Hauling costs.

It seems hardly logical that all the evident skimming mentioned above can be explained by a desire on the part of the farmer to secure the slight financial gain that would result from such a practice. Since the majority of these farmers are small producers, it seems more logical to assume that they use a certain amount of their milk, cream or skimmilk for table purposes, and so the milk varies in test from day to day.

The wide variation in daily milk tests that were found would make the use of periodic tests undesirable. Under such conditions composite milk samples would be most satisfactory.

SUMMARY AND CONCLUSIONS

This study of the sampling procedure followed on the Champaign-Urbana milk market was made to determine the accuracy of the methods used. The completeness of mixing before sampling was determined at each of the four milk plants purchasing milk from more than 400 members of Champaign Milk Producers Association. Comparisons were made between the daily tests on fresh milk samples, the weekly tests on laboratory composites, and weekly tests on plant composites, as well as between the laboratory tests and the Association tests on the plant composites. Comparisons were also made between the tests of composite samples taken in aliquot portions and the mathematical average of the tests on daily samples taken with a dipper. From the data secured the following conclusions are drawn:

1. Inaccurate tests may result from improper mixing of the milk when dumped in the weigh tanks.

2. To determine the accuracy of sampling from the weigh tanks, samples taken from each tank without previous stirring of the milk should be checked against samples taken when the milk has been thoroly stirred.

3. Tests on composite samples properly taken and kept will give an accurate measurement of the fat content of the milk.

4. Periodic testing would not be satisfactory on a market where variations in daily tests are as wide as those on the Champaign-Urbana market.

5. Variation in daily tests on milk from the same patron was sufficiently great to indicate mechanical manipulation of the fat content.

6. The tendency for plant composite samples to test less than laboratory composite samples is thought to be due to variations from the accepted practice in the care of the samples.

7. A system of double-checking the Association tests of the plant composites would be desirable and possibly profitable to the milk producers. It should not be necessary, however, to recheck each patron's samples in each test period.

8. Composite samples need not be taken in aliquot portions to give results that will be sufficiently accurate for practical purposes.

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