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COMPARISON OF VARIOUS TYPES
OF MILK LINGUINI

William A. Hoskisson

thesis submitted in partial fulfillment of the requirements

for the degree of

Master of Science

in the

School of Agriculture

DEPARTMENT OF NUTRITION
& FOOD SCIENCES
Utah State University
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Logan Utah 84321-8700

Department of Dairy Manufacturing

Utah State Agricultural College •
1940

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by

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INTRODUCTION

The importance of an accurate measurement of fat in milk deliveries is fully appreciated by most producers and plant operators. Since milk is purchased on a fat basis, the accuracy of the procedure used in sampling and testing the milk has often been questioned by both the buyer and seller.

A composite sample to be theoretically correct, should consist of aliquot portions of the milk shipments represented. Where aliquot portions are to be taken, a milk thief is commonly suggested. This device takes a vertical column of milk from the weigh tank. The idea is that the height of the column will be proportional to the amount of milk. This will be true only if the weigh tank has a flat bottom and vertical sides. As a result, this device is not so well suited for this purpose, and besides, it is slow and cumbersome. For this reason, the principle of aliquot portions is usually ignored in sampling.*

The milk dipper is commonly used for sampling because of ease and speed with which samples are procured and the relatively small cost of the dipper. Since the dipper takes equal portions of milk regardless of the amount of milk delivered, there has been and still is considerable doubt as to the efficiency of the dipper as a method of sampling milk.

Accurate sampling is important not only from the standpoint of the producer who is interested in receiving payment for all of the butter fat he delivers to the creamery, but also from the standpoint of the creamery operator, who experiences considerable difficulty accounting for all the butter fat he purchases. Butter fat losses encountered in the operation of the creamery are far too high, according to dairy engineers. These and other similar problems connected with the sampling and testing of milk have led various institutions

*Sommer, H. H., Market Milk and Related Products, p. 272.

and individuals to devise methods of sampling milk that would help overcome these difficulties. Some of the sampling devices that have been developed for use with milk are shown in figure 1.

The procedure of sampling milk according to the Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists is:

In sampling bulk milk thoroly (sic) mix by pouring from one clean vessel into another 3 or 4 times. If this procedure is impracticable, thoroly (sic) stir the milk for at least 30 seconds with a suitable appliance long enough to reach to the bottom of the container. If cream has formed on the milk, continue the mixing until all cream is detached from the sides of the vessel and evenly emulsified throughout the liquid.*

The New Zealand proportional sampler is the outgrowth of a producer's attempt to take advantage of the sampling by equal portions.

To illustrate this let us assume that a producer has a daily production of 500 pounds of 4.0 per cent milk. In two days he would deliver $2 \times 500 \times 0.04$ or 40 pounds of fat. However by removing some skim milk on the first day and adding it to the second day's milk, this same production might result in deliveries of --

400 pounds of 4.9% milk containing 19.6 pounds of fat.
600/1000 pounds of 3.4% milk containing 20.4/40 pounds of fat.

When equal portions are taken in sampling, the composite sample of these two deliveries would test 4.15 per cent fat. Thus the producer would be credited with 1000×4.15 or 41.5 pounds of fat instead of the 40 pounds actually produced and delivered. Where producers' shipments vary greatly from day to day this possibility should not be ignored.†

The work undertaken in this study has been confined to the comparison of various types of sampling devices and to determine if there

*Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists, p. 264.

†Summer, op. cit., p. 276.

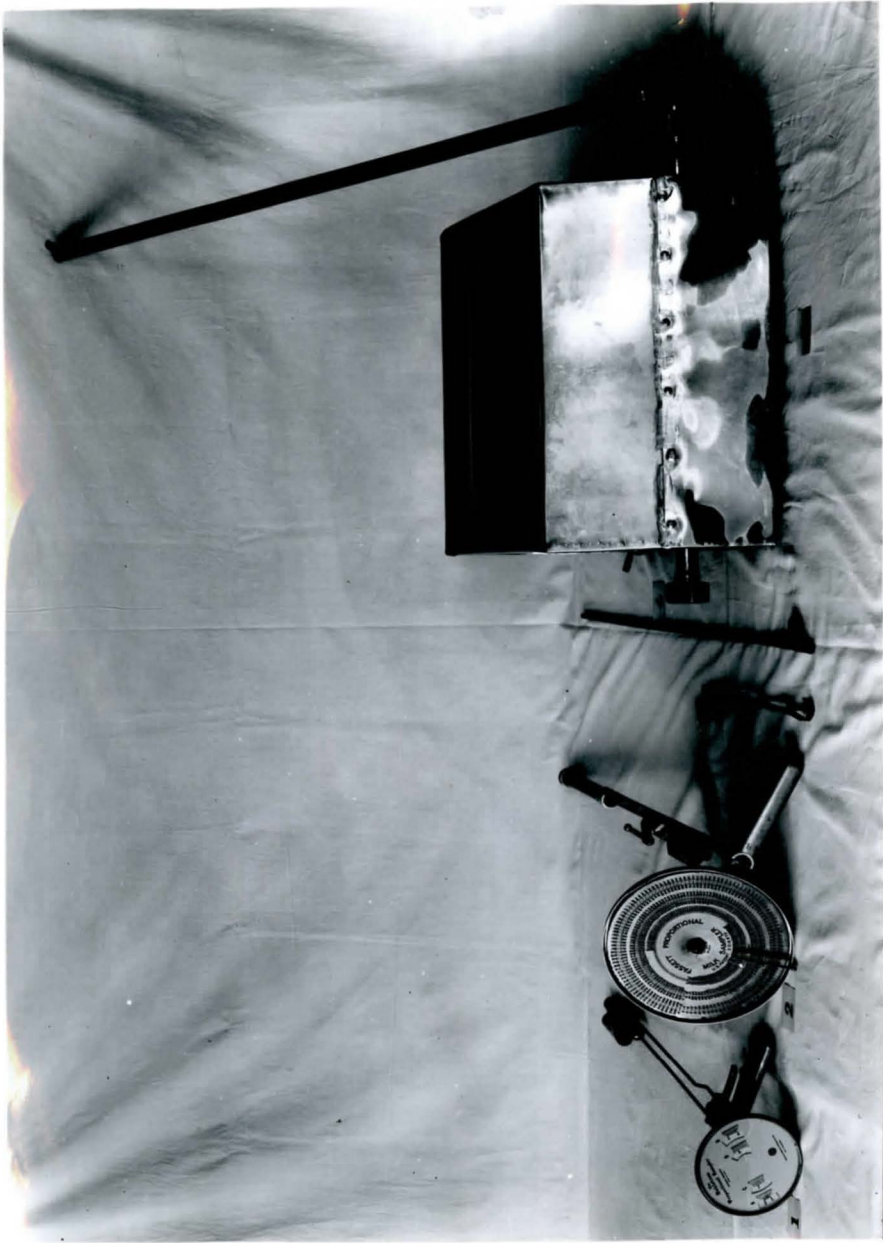


Figure 1. Various sampling devices used: (1) Dahlstrom sampler, (2) Fasset sampler, (3) dipper, (4) thief, and (5) New Zealand sampler.

is a significant difference between these samplers. Five different samplers were selected for this comparison (figure 1). These samplers are: (1) Dahlstrom proportional samplers; (2) Fassett proportional sampler; (3) the dipper; (4) the milk thief; and (5) the New Zealand proportional sampler.

It was found that the (5) studied the importance of proper storage of cigarette samples, and these investigators proved that samples stored under refrigeration showed a higher tar than those stored at room temperature. Since this difference in tests was significant, it was decided that the samples to be used in this study should be stored under refrigeration of 40 to 45° F.

G. F. Harding in 1944 (6) reported very uniform results when comparing aliquot portions sampled with equal portion samples of milk for fat determination by the Babcock method. A report was prepared by Gray and Taylor in 1945 (7) in which these investigators concluded that "cigarette samples need not be taken in aliquot portions to give results that will be sufficiently accurate for practical purposes." This work was done by these authors with the milk thief, dipper and liquid measuring rod.

REVIEW OF LITERATURE

It has been demonstrated by Bailey in 1934 (1)* and Tracy and Tuckey in 1939 (2), that adequate stirring of the milk before sampling is necessary if a representative sample of milk is to be obtained. Sammann and Overman in 1926 (3) studied the importance of proper storage of composite samples, and these investigators proved that samples stored under refrigeration showed a higher test than those stored at room temperature. Since this difference in tests was significant, it was decided that the samples to be used in this study should be stored under refrigeration of 40 to 45° F.

O. F. Hunziker in 1914 (4) reported very uniform results when comparing aliquot portion samples with equal portion samples of milk for fat determination by the Babcock method. A report was prepared by Tracy and Tuckey in 1939 (2) in which these investigators concluded that "composite samples need not be taken in aliquot portions to give results that will be sufficiently accurate for practical purposes." This work was done by these authors with the milk thief, dipper and lipped stirring rod.

*References in Bibliography

PROCEDURE

Five samplers were used, as designated below.

Sampler 1, Dahlstrom proportional sampler, has a dial divided into four scales, A, B, C, and D. These are so arranged with the retaining or sample chamber (with which they are directly connected through the connecting rod) that when a patron's selected scale (on the dial) is set at the weights of the shipments as shown on the weighing scale, the individual sample taken will always be proportionate to the weight of the sampled shipment.

Sampler 2, Fassett proportional sampler, a dial type proportional sampler, consists of a tube in which a plunger is operated by crank and gear rack. A set of gears rotate a dial in exact relation to the movement of piston. Milk enters below the piston through a hole in a screw cap. The volume of milk entering is recorded by the position of the dial with relation to the index. The dial carries six scales, each calibrated in pounds of milk. Each scale represents a different ratio of volume of sample to weight of milk in the weigh vat.

Sampler 3, the dipper, is an ordinary long-handled dipper, holding seven ml. of milk.

Sampler 4, is the milk thief, having a bore of one-fourth inch and a length of 29 inches.

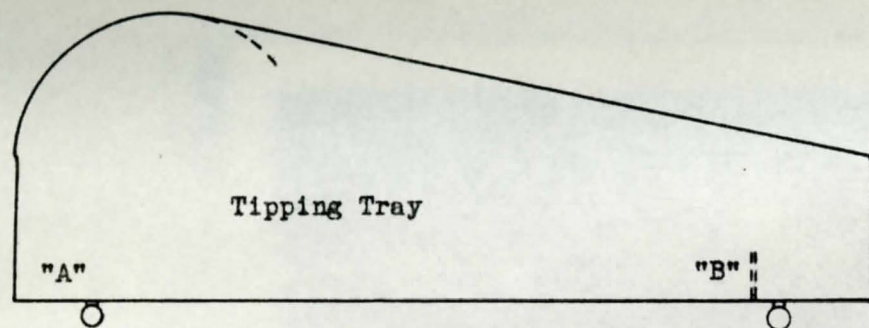
Sampler 5, the New Zealand sampler, is described in figure 2.

Sampler 5, because of its construction, had to be set up in the receiving room as part of the hopper (figure 3). The other four samplers were used at the weigh vat. After the milk had been poured into the weigh vat, it was vigorously agitated before any samples were taken. This agitation was continued while the samples were being

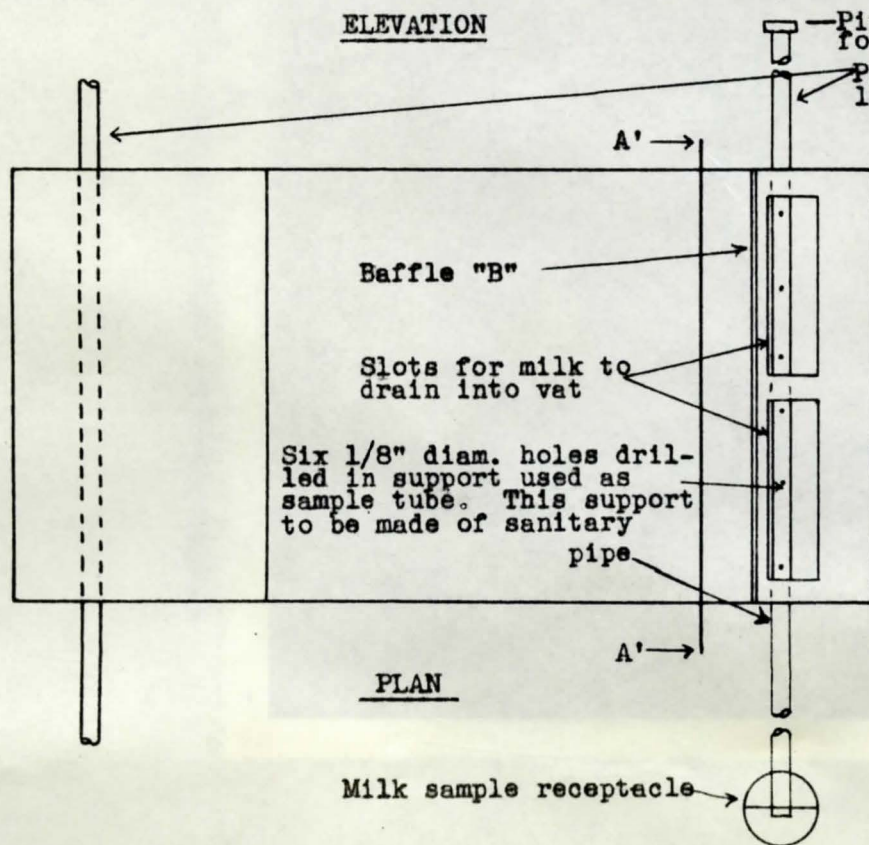
PROPORTIONATE MILK SAMPLER

As used in New Zealand Cheese
Factories

Jan., 1939 Scale: $1\frac{1}{2}"=1'$



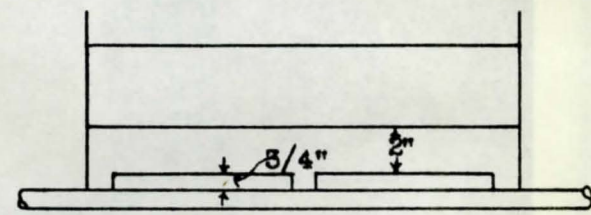
ELEVATION



PLAN

Pipe cap, removable for cleaning
Pipe supports to be of sufficient length to go across milk vat

Six 1/8" diam. holes drilled in support used as sample tube. This support to be made of sanitary pipe



SECTION A'-A'

As a can of milk is tipped it runs up to the far end of tray "A", as it flows back it strikes the baffle "B", runs under the baffle, over the perforated sample tube, and pours through the slots in the tray into the vat. As the milk passes over the perforated tube a percentage goes into the 1/8" holes, runs down the inside of the tube and is collected in a receptacle placed under

the open end. From this receptacle a correct sample is taken and bottled. The receptacle is then emptied after each supplier's milk has been tipped.

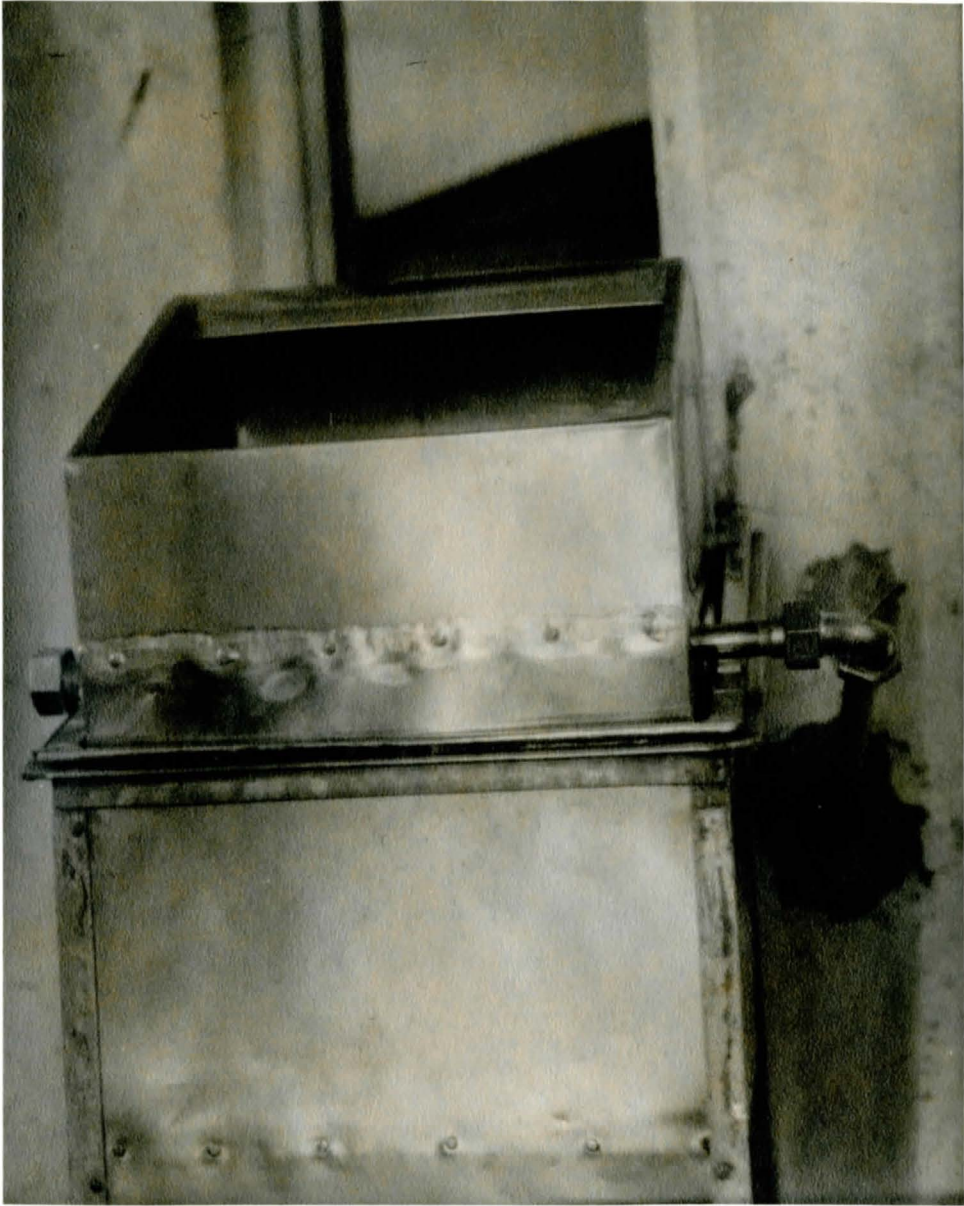


Figure 2. New Zealand sampler and milk receiving hopper.

taken. To facilitate the sampling, three men were used for this work, one man to agitate the milk and two men to handle the samplers. One man operated samplers 1 and 2, the other, samplers 3 and 4, sampler 5 being semi-automatic (figure 2).

Each patron's milk was sampled for a daily and a composite test in duplicate by each sampler except the New Zealand, which did not permit duplicate sampling. The samples were kept in Mojonnier sample bottles. The composite samples were kept under refrigeration from 40 to 45° F. preserved with corrosive sublimate tablets.

Since the Dahlstrom and Fassett samplers were of the dial type proportional samplers, the scale was set on the dial which corresponded to the weight of milk delivered by each patron.

The milk used in this study was furnished by four of the patrons of the Utah State Agricultural College Creamery. Patron A, during one composite period had daily deliveries ranging from 159 to 166 pounds of milk. The ranges for the other three patrons are as follows: Patron B, from 344 to 376 pounds; Patron C from 242 to 254 pounds; and Patron D from 318 to 340 pounds. The ranges of the daily milk deliveries for the other composite periods were comparable to those given above.

RESULTS

①
From here

The data given in tables 1 and 2 show very close agreement between the average fat tests of the Dahlstrom and Fassett samplers, the dipper and the milk thief. The average fat tests of 4.011 and 4.010 of the New Zealand sampler varies somewhat more from the ranges of the other four samplers of 3.879 to 3.891 and 3.841 to 3.860. This difference might be due to the fact that we had to scale the New Zealand sampler down to fit the receiving apparatus of the creamery. This in turn affected the rate at which the milk was dumped into the hopper and flowed through holes in the sampling tube. Further study with the New Zealand sampler regarding this condition is needed to determine whether this is the case.

The data on tables 1 and 2 indicate that samples properly taken with the Dahlstrom or Fassett samplers, or the dipper or milk thief, will give results that are sufficiently accurate for practical purposes, especially where a uniform delivery from patrons is maintained from day to day. These results are in harmony with the findings of Tracy and Tuckey 1939 (2). These investigators concluded that "it was not necessary that composite milk samples be taken in aliquot portions, that either the dipper, thief, or lipped stirring rod gave results sufficiently accurate for practical purposes."

Table 3 shows the results of 1864 Babcock fat tests, originals and duplicates, of the milk received from patrons A, B, C, and D taken in duplicate with the Dahlstrom and Fassett samplers, the thief and dipper.

Table 1. Comparison of daily fat tests with various samplers

Name	No. of Tests	Total of Tests	Average Test
Dahlstrom	416	1614.5	3.881
Fassett	416	1615.5	3.883
Dipper	416	1618.9	3.891
Thief	416	1614.00	3.879
New Zealand	200	802.20	4.011

Table 2. Comparison of composite fat tests of samplers

Name	No. of Tests	Total of Tests	Average Test
Dahlstrom	96	372.00	3.875
Fassett	96	372.55	3.880
Dipper	96	371.15	3.866
Thief	96	369.75	3.851
New Zealand	46	184.50	4.010

The average fat test of the samples calculated from these data (table 3) was 3.897. If this average fat test is compared with the average fat test of each sampler, very comparable results are obtained, as shown in table 5.

There is no significant difference between the thief sampler, the Fassett sampler, the Dipper and the Dahlstrom. The difference necessary

Table 5. Comparison of the average of all daily tests with the average of all daily tests of samplers.

Average test of all samples	Dahlstrom	Fassett	Dipper	Milk Thief	New Zealand
3.897	3.881	3.883	3.891	3.879	4.011

The average fat test of the 430 composite samples, 3.883, is comparable to the average composite fat tests of the various samplers (table 6).

Table 6. Comparison of the average of all composite tests with the average of all composite tests of samplers

Average test of all composite samples	Dahlstrom	Fassett	Dipper	Milk Thief	New Zealand
3.883	3.875	3.880	3.886	3.851	4.010

The very fact that there is such close agreement between the average test for all samples taken with all five samplers and the average test of only one of the samplers, indicates that any one of these samplers, with the possible exception of the New Zealand, would give results that would be accurate enough for practical purposes.

According to the data of the two variance tables (tables 7 and 8) of the composite and daily samples, there is a significant difference between samplers. Upon examination of tables 1 and 2, it is evident there is no significant difference between the Dahlstrom sampler, the Fassett sampler, the dipper and the thief. The difference necessary

to be significant between any two of these samplers should exceed .111 at .04 and .146 at .01 for the daily samples. The actual difference between the dipper and the thief is .012 and this does not approach significance. This difference exceeds that of the four preceding samplers on table 1. There is, however, a significant difference between the first four samplers and the New Zealand sampler. The actual difference between these samplers, using the smallest difference, is .120; and the necessary difference at the .05 is .111, at the .01 is .146 (table 9), showing that the differences between the New Zealand sampler and the other four samplers approach significance. The composite samples show about the same type and magnitude of variation.

In the use of these various samplers, the dipper is the fastest, requiring an average time of six seconds to procure a sample. The thief is faster than the two dial type samplers, taking nine seconds to obtain a sample. The two proportional samplers took 15 seconds each. There is, however, sufficient time after the gate valve on the weigh vat is opened and the milk is draining from the vat, to sample the milk with dipper, the Dahlstrom, and Fassett samplers. The sample with milk thief must be taken before the gate valve is opened in order to secure an accurate sample. To secure a sample of milk from the receptacle at the end of the sampling tube of the New Zealand sampler requires nine seconds.

omit
Table 7. Variance table of daily samples of tested milk

Source		D/F	Sum of Squares	Mean	F	
Total	1864	1863	2695.98			
Patrons	4	3	1776.64	588.88	1192.06	
Testers	5	4	7.18	1.795	3.63	2.38
Samples	Original and Duplicate	1	5.04	5.04	10.20	3.34 3.85
Remainder		1855	917.12	.494		6.66

omit
Table 8. Variance table of composite samples of tested milk

Source		D/F	Sum of Squares	Mean	F	
Total	430	429	481.31			
Patrons	4	3	456.14	145.38	1453.00	
Testers	5	4	1.87	.467	4.67	2.40
Samples	Original and Duplicate	1	1.17	1.18	11.80	3.37 3.86
Remainder		421	48.12	.10		6.70

Table 9. Necessary differences among samplers to show significance

	Necessary difference between the Dahlstrom, Fassett, dipper, and thief088 at .05 probability	
Compo- site Samples	Necessary difference between the Dahlstrom, Fassett, dipper, and thief116 at .01	"
	Necessary difference between the Dahlstrom, Fassett, dipper thief, and New Zealand.111 at .15	"
	Necessary difference between the Dahlstrom, Fassett, dipper, thief, and New Zealand146 at .01	"
	Necessary difference between the Dahlstrom, Fassett, dipper, and thief095 at .05	"
Daily Samples	Necessary difference between the Dahlstrom, Fassett, dipper, thief125 at .01	"
	Necessary difference between the Dahlstrom, Fassett, dipper, thief, and New Zealand.111 at .05	"
	Necessary difference between the Dahlstrom, Fassett, dipper, thief, and New Zealand.146 at .01	"

CONCLUSIONS

1. From the standpoint of accuracy, the four samplers gave substantially the same results. This would seem to demonstrate that these four samplers could be used to sample milk shipments that do not vary greatly from day to day, and give results that are sufficiently accurate for practical purposes. Further work should be done with these samplers on milk deliveries that vary greatly from day to day.

2. With reference to accuracy, the New Zealand sampler did not give results agreeing very closely with those of the other four samplers. Further work with this sampler is recommended to determine the cause of this difference.

3. The dipper is the fastest method of sampling; the two dial proportional samplers are second. The New Zealand sampler is comparable in time to the thief. The dipper, or either of the dial type proportional samplers could be used in the creamery for sampling milk, and not interfere or slow down operations at the weigh tank. The thief is too cumbersome for use at the weigh tank.

where

Table 3. Daily yields of Volume 72' taken by various sampling devices

Day	Treat No.	Collator		Parade		Dipper		Slick		New Device
		Orig. Sample	Scale	Orig. Sample	Scale	Orig. Sample	Scale	Orig. Sample	Scale	
1st	1	4.0	4.8	4.0	4.7	4.7	4.8	4.7	4.7	4.7
	2	4.5	4.8	4.0	4.7	4.7	4.7	4.7	4.7	4.8
2nd	1	5.2	5.0	5.0	5.2	5.2	5.2	5.2	5.2	5.2
	2	5.25	5.2	5.15	5.25	5.2	5.2	5.2	5.2	5.2
3rd	1	4.2	4.15	4.2	4.15	4.2	4.2	4.2	4.2	4.1
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.15	4.1
4th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	4.0
5th	1	4.0	4.0	4.0	4.0	4.1	4.0	4.0	4.2	4.2
	2	4.7	4.2	4.2	4.2	4.1	4.0	4.0	4.0	4.1
6th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
7th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
8th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
9th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
10th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
11th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
12th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
13th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
14th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
15th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
16th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
17th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
18th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
19th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
20th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
21st	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
22nd	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
23rd	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
24th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
25th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
26th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
27th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
28th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
29th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
30th	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

APPENDIX

Table 3. Daily tests of Patron "A" taken by various sampling devices

Day	Test No.	Dahlstrom		Fassett		Dipper		Milk Thief		New Zealand
		Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal
1st	1	4.8	4.8	4.8	4.7	4.7	4.7	4.7	4.7	4.2
	2	4.8	4.8	4.8	4.7	4.7	4.7	4.7	4.7	4.2
2nd	1	3.3	3.0	3.2	3.2	3.2	3.3	3.25	3.2	3.2
	2	3.25	3.2	3.25	3.25	3.2	3.1	3.2	3.3	3.2
3rd	1	6.2	6.15	6.2	6.15	6.2	6.2	6.2	6.2	6.1
	2	6.2	6.2	6.2	6.2	6.2	6.3	6.2	6.15	6.1
4th	1	4.0	3.8	3.6	3.8	4.4	4.4	4.0	4.0	4.2
	2	3.9	3.8	3.6	3.8	4.4	4.4	4.0	4.0	4.2
5th	1	6.0	6.0	6.0	5.8	6.1	6.0	6.0	6.1	6.1
	2	6.0	6.1	6.1	5.9	6.1	6.0	6.0	6.0	6.1
6th	1	6.0	5.9	5.95	6.0	5.7	5.95	5.9	6.0	6.45
	2	5.9	5.9	6.0	5.95	5.8	6.0	5.9	5.95	6.45
7th	1	3.0	3.0	3.0	3.0	3.0	2.95	2.95	2.9	2.95
	2	3.0	2.95	3.0	2.95	2.95	2.95	2.9	2.9	3.0
8th	1	5.9	5.8	6.0	5.9	5.8	6.0	5.6	5.9	5.9
	2	5.9	5.9	6.0	5.9	5.8	6.0	5.6	5.9	5.9
9th	1	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.5	6.8
	2	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.5	6.8
10th	1	6.6	6.6	6.6	6.6	6.55	6.6	6.55	6.6	6.7
	2	6.6	6.6	6.6	6.6	6.55	6.6	6.55	6.6	6.7
11th	1	5.0	4.9	5.0	4.9	4.9	4.9	4.9	4.9	5.5
	2	5.0	4.9	5.0	4.9	4.9	4.8	4.9	4.9	5.5
12th	1	3.1	3.2	3.15	3.1	3.1	3.2	3.2	3.2	3.35
	2	3.1	3.2	3.2	3.15	3.2	3.25	3.25	3.2	3.3
13th	1	2.95	2.95	3.0	2.85	2.9	3.0	3.0	3.0	2.95
	2	2.95	3.0	3.0	2.9	2.95	3.0	3.0	3.0	2.9
14th	1	5.0	4.9	4.9	4.9	4.0	4.85	5.0	4.9	5.0
	2	4.95	4.9	4.9	4.9	5.0	4.85	5.0	4.9	5.0
15th	1	5.0	5.0	5.3	5.1	5.0	5.1	5.0	4.6	5.1
	2	5.0	5.0	5.3	5.1	5.0	5.1	5.0	4.6	5.1
16th	1	6.6	6.5	6.6	6.6	6.6	6.6	6.5	6.6	6.8
	2	6.6	6.5	6.6	6.6	6.6	6.6	6.5	6.6	6.8
17th	1	4.9	4.85	4.9	4.8	4.9	4.8	4.9	4.85	4.8
	2	4.9	4.85	4.85	4.85	4.9	4.8	4.95	4.85	4.85
18th	1	5.4	5.4	5.35	5.35	5.4	5.35	5.4	5.4	5.4
	2	5.35	5.3	5.35	5.35	5.4	5.35	5.4	5.4	5.4
19th	1	6.7	6.7	6.7	6.8	6.8	6.8	6.8	6.6	7.3
	2	6.7	6.7	6.7	6.8	6.8	6.8	6.8	6.6	7.3
20th	1	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	7.1
	2	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	7.1
21st	1	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	7.5
	2	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	7.5
22nd	1	6.8	6.8	6.8	6.8	6.7	6.8	6.7	6.75	7.8
	2	6.8	6.85	6.8	6.75	6.7	6.8	6.75	6.75	7.8
23rd	1	7.0	7.0	7.0	7.0	7.1	7.0	7.0	7.0	7.3
	2	7.0	7.0	7.0	7.0	7.1	7.0	7.0	7.0	7.3
24th	1	7.2	7.2	7.2	7.2	7.1	7.2	7.2	7.2	7.6
	2	7.2	7.2	7.2	7.2	7.1	7.2	7.2	7.2	7.6
25th	1	6.7	6.7	6.6	6.7	6.7	6.7	6.7	6.7	7.9
	2	6.7	6.7	6.6	6.7	6.7	6.7	6.7	6.65	7.9
26th	1	7.0	7.0	7.0	6.95	6.8	6.95	6.9	6.9	6.7
	2	6.95	7.0	6.95	6.9	6.9	6.95	6.9	6.8	6.7

Table 3. (Cont'd) Daily tests of Patron "B" taken by various sampling devices

Day	Test No.	Dahlstrom		Fassett		Dipper		Milk Thief		New Zealand
		Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	
1st	1	3.3	3.4	3.4	3.55	3.45	3.45	3.4	3.4	3.6
	2	3.4	3.45	3.4	3.4	3.45	3.45	3.4	3.4	3.6
2nd	1	3.9	3.9	3.95	3.9	3.8	4.0	3.9	3.95	3.9
	2	3.9	3.95	4.0	3.9	3.8	4.0	3.9	3.95	3.9
3rd	1	3.55	3.5	3.55	3.6	3.55	3.6	3.6	3.6	3.55
	2	3.55	3.6	3.6	3.55	3.6	3.6	3.55	3.6	3.6
4th	1	3.3	3.45	3.5	3.5	3.7	3.6	3.6	3.5	3.5
	2	3.4	3.45	3.5	3.5	3.7	3.6	3.6	3.6	3.5
5th	1	3.5	3.6	3.7	3.5	3.5	3.5	3.5	3.6	3.6
	2	3.5	3.6	3.7	3.5	3.6	3.5	3.6	3.6	3.6
6th	1	3.8	3.75	3.8	3.75	3.8	3.75	3.8	3.8	3.8
	2	3.8	3.8	3.8	3.8	3.8	3.75	3.8	3.8	3.8
7th	1	3.4	3.4	3.5	3.4	3.4	3.4	3.4	3.45	3.45
	2	3.4	3.35	3.4	3.45	3.4	3.4	3.4	3.4	3.45
8th	1	3.6	3.5	3.6	3.6	3.6	3.6	3.6	3.5	3.6
	2	3.6	3.5	3.55	3.6	3.6	3.6	3.6	3.6	3.6
9th	1	3.55	3.5	3.6	3.6	3.5	3.6	3.6	3.6	3.65
	2	3.5	3.5	3.6	3.55	3.5	3.5	3.6	3.5	3.6
10th	1	3.45	3.5	3.4	3.5	3.5	3.5	3.5	3.5	3.5
	2	3.45	3.5	3.4	3.5	3.5	3.5	3.5	3.5	3.5
11th	1	3.1	3.1	3.05	3.1	3.2	3.1	3.2	3.1	3.2
	2	3.1	3.15	3.05	3.1	3.2	3.1	3.1	3.1	3.2
12th	1	3.5	3.5	3.5	3.6	3.4	3.4	3.4	3.5	3.4
	2	3.5	3.5	3.5	3.55	3.4	3.4	3.6	3.5	3.35
13th	1	3.65	3.5	3.65	3.7	3.6	3.6	3.55	3.6	3.6
	2	3.7	3.65	3.7	3.7	3.6	3.6	3.55	3.65	3.65
14th	1	3.55	3.3	3.3	3.3	3.4	3.2	3.4	3.2	3.2
	2	3.35	3.3	3.3	3.5	3.4	3.2	3.3	3.2	3.2
15th	1	3.35	3.3	3.4	3.35	3.35	3.4	3.35	3.4	3.35
	2	3.3	3.4	3.35	3.5	3.4	3.35	3.35	3.4	3.4
16th	1	3.15	3.1	3.1	3.1	3.1	3.3	3.1	3.2	3.3
	2	3.1	3.1	3.1	3.1	3.1	3.3	3.1	3.2	3.3
17th	1	3.3	3.2	3.2	3.30	3.1	3.2	3.15	3.1	3.2
	2	3.1	3.2	3.2	3.25	3.1	3.2	3.15	3.1	3.2
18th	1	3.1	3.1	3.1	3.15	3.1	3.0	3.1	3.1	3.2
	2	3.1	3.1	3.1	3.15	3.1	3.05	3.1	3.05	3.15
19th	1	3.6	3.6	3.7	3.7	3.7	3.7	3.6	3.6	3.7
	2	3.6	3.6	3.7	3.7	3.7	3.65	3.6	3.6	3.7
20th	1	3.6	3.5	3.6	3.6	3.6	3.5	3.5	3.6	3.6
	2	3.6	3.5	3.6	3.6	3.5	3.6	3.6	3.5	3.6
21st	1	3.5	3.6	3.6	3.6	3.6	3.5	3.6	3.5	3.5
	2	3.5	3.6	3.6	3.6	3.6	3.5	3.6	3.5	3.5
22nd	1	3.4	3.3	3.35	3.4	3.4	3.4	3.4	3.3	3.35
	2	3.4	3.3	3.35	3.35	3.4	3.35	3.4	3.3	3.35
23rd	1	3.5	3.4	3.4	3.4	3.5	3.4	3.5	3.4	3.5
	2	3.5	3.4	3.4	3.4	3.5	3.4	3.5	3.4	3.5
24th	1	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	2	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.5
25th	1	3.4	3.4	3.4	3.4	3.4	3.5	3.4	3.4	3.4
	2	3.4	3.4	3.4	3.4	3.4	3.5	3.4	3.4	3.3
26th	1	3.3	3.4	3.3	3.35	3.4	3.3	3.35	3.3	3.3
	2	3.35	3.4	3.3	3.4	3.4	3.3	3.3	3.35	3.3

Table 3. (Cont'd) Daily tests of Patron "C" taken by various sampling devices

Day	Test No.	Dahlstrom		Fassett		Dipper		Milk Thief		New Zealand
		Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal
1st	1	3.4	3.45	3.4	3.40	3.4	3.4	3.4	3.4	3.4
	2	3.4	3.4	3.4	3.50	3.4	3.4	3.4	3.4	3.45
2nd	1	3.1	3.1	3.05	3.05	3.1	3.05	3.05	3.05	3.05
	2	3.1	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.1
3rd	1	3.15	3.15	3.2	3.15	3.2	3.45	3.15	3.15	3.2
	2	3.2	3.2	3.2	3.2	3.2	3.15	3.2	3.15	3.2
4th	1	3.7	3.7	3.55	3.55	3.55	3.7	3.6	3.7	3.6
	2	3.7	3.65	3.6	3.5	3.5	3.6	3.6	3.6	3.6
5th	1	3.4	3.4	3.4	3.4	3.4	3.5	3.5	3.5	3.7
	2	3.4	3.4	3.4	3.4	3.4	3.5	3.5	3.5	3.6
6th	1	3.45	3.5	3.5	3.5	3.5	3.5	3.5	3.45	3.5
	2	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
7th	1	3.55	3.6	3.5	3.5	3.6	3.55	3.55	3.55	3.6
	2	3.4	3.5	3.55	3.5	3.6	3.55	3.55	3.55	3.55
8th	1	3.3	3.3	3.3	3.3	3.2	3.1	3.2	3.2	3.4
	2	3.3	3.3	3.3	3.3	3.2	3.1	3.2	3.1	3.3
9th	1	3.45	3.45	3.45	3.45	3.5	3.4	3.45	3.4	3.6
	2	3.5	3.5	3.45	3.45	3.5	3.4	3.45	3.4	3.6
10th	1	3.4	3.4	3.4	3.4	3.45	3.45	3.55	3.5	3.5
	2	3.35	3.35	3.4	3.4	3.45	3.45	3.55	3.5	3.5
11th	1	3.3	3.35	3.4	3.5	3.6	3.5	3.3	3.5	3.8
	2	3.4	3.5	3.4	3.5	3.5	3.5	3.4	3.5	3.8
12th	1	3.0	2.95	3.4	3.3	3.0	3.3	3.0	3.3	3.5
	2	3.3	3.2	3.34	3.2	3.0	3.3	3.0	3.3	3.5
13th	1	3.3	3.3	3.3	3.45	3.4	3.5	3.35	3.5	3.5
	2	3.4	3.5	3.45	3.4	3.35	3.5	3.3	3.5	3.5
14th	1	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.5
	2	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.5
15th	1	3.4	3.4	3.4	3.45	3.5	3.4	3.4	3.4	-
	2	3.4	3.4	3.45	3.45	3.5	3.45	3.4	3.4	-
16th	1	3.55	3.35	3.5	3.5	3.6	3.5	3.6	3.5	-
	2	3.5	3.5	3.5	3.5	3.6	3.5	3.6	3.4	-
17th	1	3.4	3.4	3.4	3.5	3.4	3.5	3.3	3.5	-
	2	3.5	3.5	3.4	3.5	3.4	3.5	3.3	3.6	-
18th	1	3.4	3.45	3.45	3.4	3.4	3.4	3.4	3.4	-
	2	3.4	3.4	3.45	3.4	3.4	3.45	3.45	3.4	-
19th	1	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.6
	2	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.6
20th	1	3.6	3.6	3.7	3.6	3.6	3.6	3.6	3.7	3.7
	2	3.7	3.7	3.7	3.7	3.6	3.6	3.6	3.7	3.7
21st	1	3.5	3.5	3.4	3.4	3.5	3.4	3.5	3.4	3.5
	2	3.4	3.4	3.4	3.4	3.5	3.4	3.5	3.4	3.5
22nd	1	3.35	3.3	3.3	3.3	3.3	3.4	3.3	3.4	3.5
	2	3.4	3.4	3.35	3.3	3.3	3.4	3.3	3.35	3.5
23rd	1	3.4	3.4	3.4	3.4	3.5	3.3	3.4	3.4	3.7
	2	3.3	3.3	3.4	3.4	3.5	3.3	3.4	3.4	3.7
24th	1	3.3	3.3	3.4	3.3	3.3	3.3	3.4	3.4	3.5
	2	3.3	3.3	3.4	3.3	3.3	3.3	3.4	3.4	3.5
25th	1	3.3	3.3	3.3	3.3	3.3	3.3	3.4	3.3	3.5
	2	3.3	3.3	3.3	3.3	3.3	3.3	3.4	3.3	3.5
26th	1	3.2	3.2	3.2	3.15	3.2	3.15	3.2	3.2	3.2
	2	3.2	3.2	3.2	3.15	3.2	3.2	3.2	3.2	3.2

Table 3. (Cont'd) Daily tests of Patron "D" taken by various sampling devices

Day	Test No.	Dahlstrom		Fassett		Dipper		Milk Thief		New Zealand
		Orig-inal	Dupli-ate	Orig-inal	Dupli-ate	Orig-inal	Dupli-ate	Orig-inal	Dupli-ate	
1st	1	3.5	3.45	3.5	3.5	3.4	3.45	3.5	3.5	3.2
	2	3.5	3.45	3.45	3.4	3.4	3.5	3.45	3.5	3.3
2nd	1	3.05	3.0	3.1	3.0	3.0	3.0	3.0	3.0	3.0
	2	3.05	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.95
3rd	1	3.3	3.3	3.25	3.3	3.3	3.35	3.3	3.3	3.3
	2	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
4th	1	3.15	3.15	3.2	3.15	3.2	3.15	3.15	3.1	3.05
	2	3.15	3.15	3.2	3.15	3.2	3.15	3.15	3.1	3.05
5th	1	3.5	3.4	3.4	3.4	3.5	3.5	3.5	3.5	3.7
	2	3.5	3.5	3.4	3.4	3.4	3.4	3.5	3.5	3.7
6th	1	3.35	3.35	3.35	3.35	3.35	3.4	3.35	3.35	3.5
	2	3.35	3.4	3.35	3.35	3.35	3.35	3.35	3.35	3.5
7th	1	3.45	3.45	3.45	3.4	3.45	3.5	3.4	3.4	3.55
	2	3.45	3.5	3.45	3.4	3.5	3.45	3.4	3.45	3.5
8th	1	3.5	3.5	3.5	3.5	3.6	3.5	3.6	3.5	3.5
	2	3.5	3.5	3.5	3.5	3.6	3.5	3.5	3.5	3.6
9th	1	3.5	3.5	3.5	3.5	3.5	3.6	3.5	3.55	3.7
	2	3.6	3.55	3.5	3.5	3.5	3.6	3.5	3.55	3.7
10th	1	3.2	3.2	3.35	3.25	3.2	3.2	3.2	3.2	3.2
	2	3.2	3.2	3.3	3.2	3.2	3.2	3.2	3.2	3.2
11th	1	3.3	3.3	3.3	3.4	3.3	3.6	3.3	3.5	3.5
	2	3.3	3.5	3.45	3.45	3.3	3.5	3.3	3.5	3.5
12th	1	3.3	3.4	3.4	3.3	3.34	3.4	3.4	3.4	3.5
	2	3.45	3.35	3.4	3.25	3.4	3.4	3.35	3.4	3.5
13th	1	3.3	3.4	3.4	3.4	3.4	3.5	3.4	3.45	3.3
	2	3.45	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.3
14th	1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	2	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
15th	1	2.95	2.95	3.0	2.7	3.0	2.9	2.95	3.0	3.0
	2	2.95	3.0	3.0	2.6	2.95	2.9	2.95	2.95	3.0
16th	1	3.1	3.2	3.2	3.2	3.1	3.2	3.1	3.2	3.2
	2	3.1	3.2	3.2	3.1	3.1	3.2	3.1	3.2	3.2
17th	1	2.8	2.8	2.75	2.8	2.8	2.7	2.75	2.7	2.95
	2	2.8	2.8	2.75	2.8	2.8	2.75	2.75	2.75	2.95
18th	1	2.6	2.65	2.6	2.6	2.6	2.65	2.6	2.7	2.7
	2	2.6	2.65	2.6	2.6	2.15	2.7	2.6	2.7	2.7
19th	1	3.1	3.0	3.0	3.0	3.0	3.0	3.1	3.0	3.1
	2	3.1	3.0	3.0	3.0	3.0	3.0	3.1	3.0	3.1
20th	1	2.8	2.8	2.8	2.8	2.8	2.9	2.8	2.8	2.9
	2	2.8	2.8	2.8	2.8	2.8	2.85	2.8	2.8	2.85
21st	1	2.4	2.4	2.5	2.4	2.4	2.5	2.4	2.4	2.5
	2	2.4	2.4	2.5	2.4	2.4	2.5	2.4	2.4	2.5
22nd	1	2.8	2.85	2.8	2.8	2.9	2.8	2.8	2.8	2.9
	2	2.85	2.8	2.8	2.8	2.85	2.8	2.8	2.8	2.9
23rd	1	3.1	3.1	3.1	3.1	3.1	3.2	3.1	3.2	3.2
	2	3.1	3.1	3.1	3.1	3.1	3.2	3.1	3.2	3.2
24th	1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
	2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
25th	1	2.9	3.0	2.9	2.9	3.0	2.9	2.9	2.9	3.0
	2	2.9	3.0	2.9	2.9	3.0	2.9	2.9	2.9	3.0
26th	1	3.4	3.4	3.4	3.4	3.3	3.4	3.3	3.4	3.6
	2	3.4	3.4	3.4	3.4	3.3	3.4	3.35	3.4	3.6

Table 4. Composite tests of Patron "A" taken by various sampling devices

Day	Test No.	Dahlstrom		Fassett		Dipper		Milk Thief		New Zealand
		Orig: inal	Dupli: cate	Orig: inal	Dupli: cate	Orig: inal	Dupli: cate	Orig: inal	Dupli: cate	Orig: inal
1st	1	4.7	4.8	4.7	4.6	4.8	4.7	4.75	4.75	4.8
	2	4.7	4.8	4.8	4.7	4.7	4.8	4.8	4.75	4.8
2nd	1	5.6	5.6	5.8	6.0	5.5	5.4	5.6	5.4	6.15
	2	5.6	5.6	5.8	6.0	5.55	5.5	5.6	5.4	6.15
3rd	1	4.4	4.4	4.1	4.1	4.2	4.1	4.2	4.1	5.2
	2	4.4	4.4	4.1	4.1	4.2	4.1	4.2	4.1	5.2
4th	1	5.4	5.35	5.35	5.3	5.25	5.4	5.2	5.4	5.5
	2	5.4	5.2	5.4	5.3	5.3	5.35	5.2	5.4	5.5
5th	1	6.7	6.65	6.65	6.6	6.6	6.6	6.6	6.6	7.3
	2	6.7	6.65	6.6	6.6	6.6	6.6	6.6	6.6	7.3
6th	1	6.95	6.85	7.0	6.85	6.95	7.0	6.7	6.8	6.7
	2	7.0	6.85	7.0	6.85	6.95	6.9	6.7	7.0	6.7

Table 4. (Cont'd) Composite tests of Patron "B" taken by various sampling devices

Day	Test No.	Dahlstrom		Fassett		Dipper		Milk Thief		New Zealand
		Orig: inal	Dupli: cate	Orig: inal	Dupli: cate	Orig: inal	Dupli: cate	Orig: inal	Dupli: cate	Orig: inal
1st	1	3.7	3.7	3.75	3.7	3.75	3.7	3.75	3.75	3.75
	2	3.7	3.7	3.75	3.7	3.7	3.7	3.7	3.75	3.75
2nd	1	3.6	3.6	3.65	3.65	3.6	3.6	3.6	3.6	3.65
	2	3.6	3.6	3.65	3.65	3.6	3.6	3.6	3.6	3.6
3rd	1	3.4	3.4	3.4	3.4	3.4	3.3	3.4	3.2	3.3
	2	3.4	3.4	3.4	3.4	3.4	3.3	3.4	3.2	3.3
4th	1	3.2	3.15	3.15	3.15	3.2	3.2	3.15	3.1	3.15
	2	3.2	3.15	3.15	3.15	3.2	3.2	3.15	3.1	3.1
5th	1	3.45	3.5	3.4	3.5	3.5	3.4	3.5	3.5	3.25
	2	3.4	3.45	3.4	3.45	3.5	3.4	3.5	3.5	3.4
6th	1	3.4	3.3	3.3	3.4	3.4	3.4	3.4	3.3	3.4
	2	3.4	3.3	3.3	3.4	3.35	3.4	3.4	3.35	3.4

Table 4 (Cont'd) Composite tests of Patron "C" taken by various sampling devices

Day	Test No.	Dahlstrom		Fassett		Dipper		Milk Thief		New Zealand
		Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	
1st	1	3.2	3.2	3.2	3.15	3.2	3.15	3.2	3.15	3.3
	2	3.2	3.15	3.2	3.15	3.2	3.2	3.2	3.1	3.3
2nd	1	3.5	3.5	3.6	3.6	3.5	3.5	3.5	3.5	3.55
	2	3.5	3.5	3.6	3.6	3.55	3.5	3.5	3.5	3.55
3rd	1	3.2	3.4	3.5	3.4	3.4	3.2	3.3	3.2	3.3
	2	3.2	3.4	3.5	3.4	3.4	3.2	3.3	3.2	3.3
4th	1	3.3	3.3	3.35	3.3	3.4	3.4	3.35	3.35	-
	2	3.3	3.3	3.35	3.3	3.4	3.4	3.35	3.4	-
5th	1	3.25	3.35	3.35	3.35	3.4	3.4	3.3	3.5	3.5
	2	3.3	3.4	3.3	3.35	3.4	3.4	3.35	3.4	3.5
6th	1	3.25	3.3	3.3	3.3	3.4	3.2	3.3	3.25	3.3
	2	3.3	3.3	3.3	3.3	3.3	3.2	3.3	3.3	3.3

Table 4. (Cont'd) Composite tests of Patron "D" taken by various sampling devices

Day	Test No.	Dahlstrom		Fassett		Dipper		Milk Thief		New Zealand
		Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	Orig-inal	Dupli-cate	
1st	1	3.4	3.3	3.4	3.35	3.3	3.3	3.3	3.5	3.5
	2	3.5	3.35	3.4	3.35	3.3	3.35	3.3	3.3	3.45
2nd	1	3.5	3.5	3.4	3.45	3.5	3.5	3.5	3.5	3.5
	2	3.5	3.5	3.4	3.4	3.5	3.5	3.5	3.5	3.5
3rd	1	3.2	3.2	3.3	3.2	3.2	3.2	3.25	3.2	3.2
	2	3.2	3.2	3.25	3.2	3.2	3.2	3.3	3.2	3.2
4th	1	2.85	2.8	2.85	2.8	2.85	2.9	2.8	2.8	2.85
	2	2.85	2.8	2.85	2.8	2.8	2.85	2.8	2.8	2.9
5th	1	2.7	2.75	2.65	2.8	2.75	2.75	2.7	2.8	2.75
	2	2.75	2.75	2.65	2.8	2.7	2.75	2.7	2.8	2.7
6th	1	3.1	3.1	3.1	3.1	3.2	3.1	3.2	3.1	3.3
	2	3.1	3.1	3.1	3.1	3.1	3.15	3.2	3.15	3.3

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