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OREGON AGRICULTURAL EXPERIMENT STATION,

CORVALLIS, OREGON.

TESTING MILK AND CREAM.

BY F. L. KENT.

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TESTING MILK.

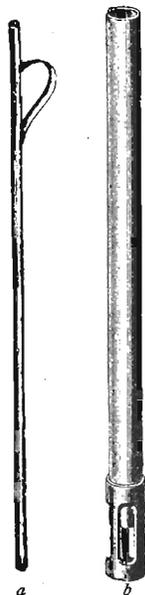
SHORTLY after the introduction of the Babcock Milk Test in 1890, Patrick, then of the Iowa Experiment Station, suggested the use of the composite sample as a means for greatly lessening the labor connected with the testing of milk at creameries and cheese factories, without materially affecting the accuracy of the results. The plan proved popular with the creamery men, and was quite generally adopted by those factories using the Babcock Test.

The composite sample is obtained by first providing a suitable vessel for each patron. This may be either a Mason fruit jar, a lightning top milk bottle, or a wide mouth glass-stoppered bottle of about a pint capacity. This bottle is labeled with the name or number of the patron, and each time he delivers milk, a small portion, an ounce or less, is put into the jar bearing his label. This continues during the test period which may cover a week, ten days, two weeks, or perhaps a month. Most of the factories in this state are in the habit of making two tests each month. The sample is kept from souring by the use of some preservative, most generally bi-chromate of potash; a quantity about the size of a pea being sufficient to preserve the two weeks' sample.

Considerable discussion has been given to the question of the proper manner of sampling the daily deliveries. Three methods are employed, viz: (1) Use of a small tin dipper; (2) the drip sample; and (3) sampling tubes. When all the milk of a day's delivery by a patron is poured into the weigh can and its weight taken it is ready for the sampling. Some operators use a large dipper to stir the milk before taking the sample, but this has been found to be unnecessary, the agitation due to transportation and pouring the milk into the weigh can being sufficient to mix it thoroughly. If the first named method is followed a small tin dipper holding from one-half an ounce to an ounce is used to take a sample from the weigh can. Some of these dippers are made with long handles so that they rest on the bottom of the weigh can when not in use but generally the handle is less than a foot in

length. This method of taking the composite sample is not strictly accurate unless the same amount of milk is delivered each time the sample is taken, or unless the milk should happen to contain the same percentage of butter fat each time. But the variation in amount delivered from day to day is usually so small that the dipper method is sufficiently-accurate for all practical purposes.

The drip sample is taken by collecting the milk that drips through a small hole in the conductor spout which conveys the milk from the weigh can to the receiving vat. This method is valuable where it is desired to secure a composite sample of all milk delivered, but it is not well adapted to the sampling of milk of each patron.



a—Milk Thief.
b—Scoville Sampling Tube.

Of the sampling tubes there are several forms but they all work on about the same principle. The two best known probably are the "Milk Thief" and the Scoville Sampling Tube. They both work on the same principle, hence a description of the latter only will be given. "It consists of a brass tube, one-half to one inch in diameter, and two to two and a half feet in length; it is open at both ends, the lower end sliding snugly into a cap provided with three elliptical openings at the side, through which the milk is admitted. The milk to be sampled is poured into a cylindrical pail, or the factory weigh can, and the tube with the cap set so that the apertures are left open, is lowered into the milk until it touches the bottom of the can.

The tube will be filled instantly to the level of the milk in the can, and is then pushed down, thereby closing the apertures of the cap and confining within the tube a column of milk representing exactly the quality of the milk in the can, and forming an aliquot part thereof. The milk is then emptied into the composite sample jar by turning the tube upside down."

In order to make a comparison between the dipper and the sampling tube methods, also to compare the results of the composite sample with the results obtained by daily tests, and incidentally to notice the variation in daily tests, the writer conducted a series of tests at the creamery in Corvallis during the first half of the month of May, 1901. The creamery operator was using the dipper method and took his samples as usual during the two weeks. Whenever he

placed a sample in a composite jar, the writer put a sample of the same milk in a corresponding jar, the latter sample being taken with a Scoville sampling tube. At the close of the test period both sets of composite samples were carefully tested and the results compared. In most cases the composite jars contained thirteen samples, the test period covering fifteen days, two of them being Sundays, on which no milk was received at the creamery.

Whenever a sample was placed in the composite jar, another sample, also taken with the Scoville sampler, was tested at once, and the average of these daily samples was compared with the test of the composite sample at the close of the test period. The milk of fifty two patrons was used in this work, the daily deliveries per patron ranging from fifteen pounds to four hundred fifty pounds. A record was kept of the number of pounds of milk from which each test was taken, and the amount of fat in each delivery was obtained by multiplying the number of pounds by the percentage of fat which the test indicated was present. The average of the daily tests was thus obtainable by two methods, viz: (1) By dividing the sum of any one patron's tests by the number of tests; (2) by dividing the total amount of fat delivered by the total amount of milk. These two averages were very nearly alike, in many cases being identical as will be seen by reference to Table I. Where a difference exists it is due to a variation in the amount of milk delivered from day to day. For instance: Suppose two deliveries were made, one of 325 pounds testing 3.6 per cent, and one of 430 pounds testing 3.9 per cent. The average of the two tests would be 3.75 per cent, but the average per cent obtained by dividing the total amount of fat by the total pounds of milk $[(11.70 + 16.27) \div 755]$ would be 3.77 per cent.

Table No. I is designed to show for the test period of a half month the following for each patron: (1) the total number of pounds of milk delivered; (2) the average of the daily tests; (3) the average test computed by dividing the total fat by the total amount of milk; (4) the composite test obtained by the use of the Scoville sampling tube; (5) the test of the composite sample taken by the creamery operator with the little tin dipper.

TABLE I.

| NUMBER. | Lbs. Milk | Per ct. | | Composite | Creamery composite |
|---------|-----------|--------------|----------------------|-----------|--------------------|
| | | Av. of tests | Tests from total fat | | |
| 1 | 5912 | 3.86 | 3.86 | 3.85 | 3.90 |
| 2 | 964 | 4.16 | 4.18 | 4.15 | 4.10 |
| 3 | 3702 | 3.75 | 3.75 | 3.80 | 3.60 |
| 4 | 2430 | 3.98 | 3.96 | 4.10 | 3.85 |
| 5 | 4884 | 3.85 | 3.88 | 3.80 | 4.00 |
| 6 | 601 | 4.01 | 4.01 | 4.05 | 3.80 |
| 7 | 527 | 3.40 | 3.39 | 3.40 | 3.25 |
| 8 | 2595 | 3.62 | 3.62 | 3.50 | 3.50 |
| 9 | 459 | 3.89 | 3.88 | 4.00 | 3.80 |
| 10 | 1157 | 3.96 | 3.93 | 4.00 | 3.90 |
| 11 | 1317 | 3.60 | 3.59 | 3.60 | 3.45 |
| 12 | 1441 | 3.89 | 3.89 | 3.95 | 3.85 |
| 13 | 2618 | 3.69 | 3.72 | 3.75 | 3.65 |
| 14 | 1792 | 4.04 | 4.04 | 4.00 | 3.85 |
| 15 | 1981 | 4.60 | 4.59 | 4.45 | 4.50 |
| 16 | 2160 | 4.71 | 4.72 | 4.75 | 4.60 |
| 17 | 2970 | 3.84 | 3.85 | 3.90 | 3.90 |
| 18 | 912 | 4.36 | 4.36 | 4.25 | 4.40 |
| 19 | 301 | 3.33 | 3.34 | 3.30 | 3.20 |
| 20 | 825 | 3.81 | 3.79 | 3.85 | 3.75 |
| 21 | 1364 | 3.74 | 3.74 | 3.60 | 3.55 |
| 22 | 968 | 3.64 | 3.64 | 3.55 | 3.40 |
| 23 | 2571 | 3.73 | 3.72 | 3.85 | 3.80 |
| 24 | 213 | 4.78 | 4.79 | 4.85 | 4.80 |
| 25 | 746 | 3.75 | 3.73 | 3.60 | 3.60 |
| 26 | 571 | 4.14 | 4.15 | 4.00 | 4.20 |
| 27 | 1345 | 3.93 | 3.92 | 3.95 | 4.00 |
| 28 | 613 | 3.94 | 3.95 | 4.00 | 4.00 |
| 29 | 935 | 4.67 | 4.63 | 4.70 | 4.65 |
| 30 | 472 | 3.77 | 3.74 | 3.75 | 3.75 |
| 31 | 1161 | 4.04 | 4.05 | 4.00 | 4.10 |
| 32 | 307 | 4.35 | 4.38 | 4.40 | 4.20 |
| 33 | 736 | 3.45 | 3.47 | 3.50 | 3.35 |
| 34 | 864 | 4.28 | 4.27 | 4.20 | 4.35 |
| 35 | 907 | 3.49 | 3.48 | 3.50 | 3.50 |
| 36 | 990 | 3.83 | 3.85 | 3.80 | 3.70 |
| 37 | 2041 | 3.61 | 3.61 | 3.70 | 3.70 |
| 38 | 789 | 4.51 | 4.50 | 4.40 | 4.40 |
| 39 | 1550 | 4.24 | 4.24 | 4.20 | 4.00 |
| 40 | 868 | 3.61 | 3.63 | 3.60 | 3.65 |
| 41 | 503 | 3.72 | 3.68 | 3.80 | 3.85 |
| 42 | 949 | 4.20 | 4.18 | 4.05 | 4.05 |
| 43 | 951 | 4.58 | 4.58 | 4.60 | 4.40 |
| 44 | 572 | 3.48 | 3.50 | 3.50 | 3.35 |
| 45 | 518 | 5.06 | 5.03 | 5.00 | 4.80 |
| 46 | 236 | 4.81 | 4.81 | 4.85 | 4.85 |
| 47 | 301 | 5.03 | 5.02 | 5.00 | 5.00 |
| 48 | 470 | 4.20 | 4.18 | 4.20 | 4.10 |
| 49 | 647 | 3.47 | 3.46 | 3.40 | 3.40 |
| 50 | 669 | 3.61 | 3.61 | 3.60 | 3.60 |
| 51 | 243 | 4.40 | 4.41 | 4.40 | 4.30 |
| 52 | 428 | 4.08 | 4.08 | 4.15 | 3.95 |
| Average | | 4.01 | 4.01 | 4.00 | 3.93 |

By reference to table I it will be seen that in no case is there a difference of more than .04 between the two methods of computing the average of the daily tests, notwithstanding the fact that there was, in many cases, a wide variation in the daily tests, as will be shown in table II.

While there are a few cases in the foregoing table where a difference of more than .1 of one per cent exists between the results ob-

tained by the average of the daily tests and the composite sample test taken with the Scoville sampling tube, on an average this difference amounts to but .01 of one per cent.

When a comparison is made between the composite samples taken with the sampling tube and those taken by the little dipper method, it will be seen that in a few instances there is as great a difference as .2 of one per cent in the readings. But on the average the difference amounts to but .05 of one per cent, which difference can hardly be considered as being important in commercial work. The fact that the creamery composite samples were warmed to about 100° F. before measuring, while the others were measured at about 70° may partially account for the lower average test of the former.

Table II is a record of the daily tests of twenty of the fifty two patrons furnishing milk during the experiment. The first half of the table shows the tests of the ten patrons furnishing the largest amounts of milk, while the latter half shows tests of patrons delivering less than 100 pounds daily. They are thus arranged for the reason that we would naturally expect less variation where the milk came from a considerable number of cows than where only a few animals were kept, and the table shows that such is the case.

TABLE II.
Showing Variation in Daily Tests.

| Date | 1 | 2 | 3 | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 13 | 14 | 15 | Av. test | Variation | Av. milk |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|-----------|----------|
| No 1 | 3.8 | 4.1 | 4.0 | 4.0 | 3.9 | 3.9 | 4.0 | 3.8 | 3.8 | 3.9 | 3.8 | 3.6 | 3.7 | 3.86 | .5 | 455 lbs. |
| 3 | 3.9 | 3.8 | 3.8 | 3.9 | 4.0 | 3.7 | 3.7 | 3.6 | 3.8 | 3.6 | 3.6 | 3.8 | 3.6 | 3.75 | .4 | 285 |
| 4 | 3.9 | 4.1 | 4.2 | 4.2 | 3.9 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 3.8 | 3.9 | 3.8 | 3.98 | .3 | 187 |
| 5 | 4.1 | 4.1 | 3.8 | 3.9 | 3.7 | 4.0 | 3.7 | 3.4 | 3.9 | 3.8 | 3.6 | 4.2 | 3.9 | 3.85 | .8 | 338 |
| 8 | 3.4 | 3.8 | 3.8 | 3.8 | 3.5 | 3.6 | 3.6 | 3.6 | 3.8 | 3.5 | 3.8 | 3.4 | 3.6 | 3.62 | .4 | 200 |
| 13 | 3.8 | 3.9 | 3.8 | 3.5 | 4.0 | 3.5 | 3.6 | 3.6 | 3.4 | 3.8 | 4.2 | 3.5 | 3.4 | 3.69 | .8 | 201 |
| 14 | 4.0 | 4.0 | 4.0 | 4.2 | 4.1 | 4.2 | 4.0 | 4.1 | 4.1 | 4.0 | 4.0 | 3.9 | 4.0 | 4.04 | .3 | 138 |
| 15 | 4.6 | 4.7 | 4.5 | 4.6 | 4.6 | 4.6 | 4.6 | 4.7 | 4.5 | 4.8 | 4.4 | 4.6 | 4.6 | 4.60 | .4 | 148 |
| 16 | 4.8 | 4.5 | 4.8 | 4.5 | 4.8 | 4.5 | 5.0 | 5.0 | 4.4 | 4.5 | 5.0 | 4.4 | 5.0 | 4.71 | .6 | 166 |
| 17 | 3.9 | 4.0 | 4.1 | 3.9 | 4.2 | 3.8 | 3.9 | 3.8 | 3.6 | 3.8 | 4.0 | 3.4 | 3.6 | 3.84 | .8 | 228 |
| 2 | 3.9 | 4.2 | 4.2 | 4.4 | 4.6 | 4.0 | 4.1 | 3.8 | 4.0 | 4.6 | 4.0 | 4.5 | 4.0 | 4.16 | .8 | 74 |
| 7 | 3.7 | 3.4 | 3.4 | 3.4 | 3.1 | 3.5 | 3.6 | 3.0 | 3.4 | 3.7 | 3.3 | 3.4 | 3.3 | 3.40 | .7 | 42 |
| 10 | 4.0 | 3.9 | 4.0 | 3.6 | 3.6 | 3.8 | 3.6 | 3.7 | 5.1 | 4.0 | 3.6 | 5.1 | 3.6 | 3.96 | 1.5 | 89 |
| 31 | 3.8 | 4.2 | 4.0 | 3.8 | 4.1 | 4.0 | 4.0 | 3.9 | 4.6 | 4.0 | 4.1 | 4.1 | 4.0 | 4.64 | .8 | 89 |
| 33 | 3.6 | 3.4 | 3.2 | 3.5 | 3.6 | 3.1 | 3.3 | 3.7 | 3.2 | 3.8 | 3.7 | 3.6 | 3.2 | 3.45 | .7 | 56 |
| 34 | 4.5 | 4.4 | 4.2 | 4.3 | 3.9 | 4.5 | 4.4 | 4.4 | 4.4 | 4.1 | 3.9 | 4.3 | 4.3 | 4.28 | .6 | 66 |
| 35 | 3.4 | 3.2 | 3.3 | 3.8 | 4.1 | 3.2 | 3.2 | 3.5 | 3.4 | 3.7 | 3.6 | 3.2 | 3.8 | 3.49 | .9 | 70 |
| 38 | 4.4 | 3.8 | 5.3 | 4.6 | 4.9 | 4.6 | 4.5 | 4.7 | 4.9 | 4.2 | 4.0 | 4.5 | 4.2 | 4.51 | 1.3 | 61 |
| 45 | 4.7 | 4.8 | 4.8 | 5.2 | 5.3 | 5.1 | 4.9 | 5.1 | 6.0 | 5.4 | 4.8 | 5.1 | 4.5 | 5.06 | 1.5 | 40 |
| 47 | 5.0 | 5.1 | 5.0 | 5.6 | 5.0 | 4.6 | 5.4 | 5.0 | 5.0 | 4.8 | 4.7 | 4.8 | 5.5 | 5.03 | 1.0 | 23 |

Reference to table II shows a variation in the tests of the first half the table ranging from .3 to .8 during the two weeks covered by the test period, the average being .52. In the latter half of the

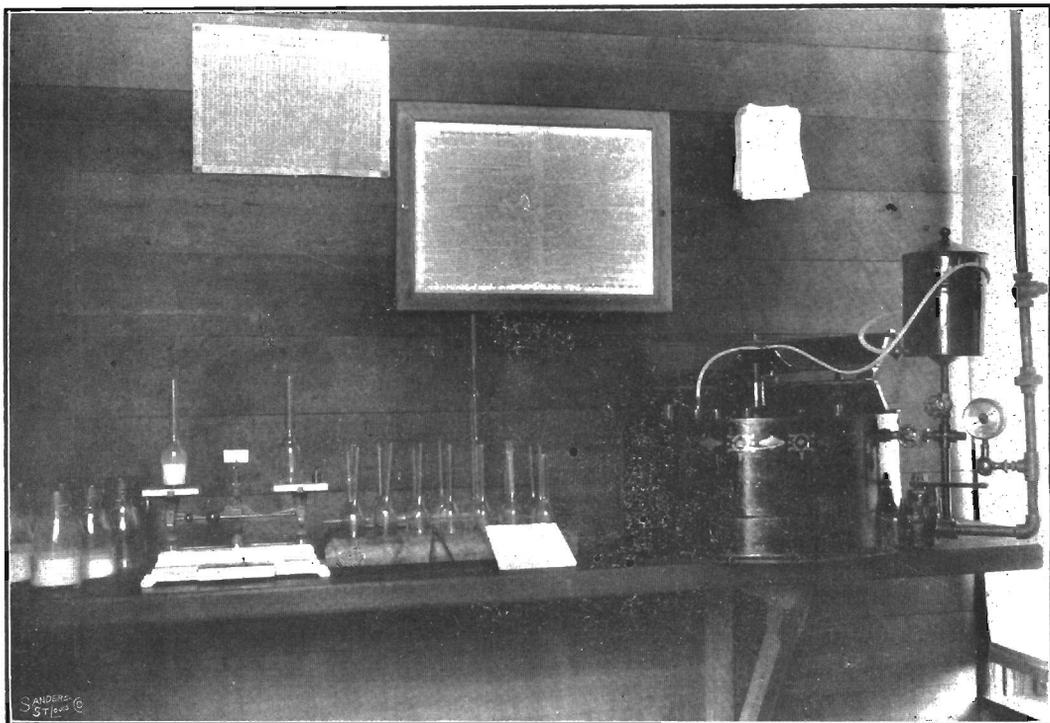
table the variation ranges from .6 to 1.5 per cent, the average being .98. It was known that some of the patrons whose tests appear in the latter part of the table occasionally did not send all their milk owing to lack of can capacity, but added cream from that which was retained to the milk sent to the factory. This doubtless accounts for the high tests, and the removal of a portion of the cream, when household necessity required it, probably accounts for most of the low tests.

Failure to get a clear fat column is probably the greatest difficulty encountered by Babcock test operators. This trouble usually comes from one or more of three sources:

First. Water containing foreign substances, usually carbonates, which upon addition to the test bottles causes the formation of gas bubbles at the top of the fat column. Remedy: Use rain or distilled water.

Second. Acid of improper strength. If the acid is too strong the fat column will present a charred or burned appearance, sometimes throughout its entire length, but usually in the lower part. If the acid is too weak there will be a cloudiness of the fat column, often with a grayish white substance at the lower end. In the first case the trouble, if not very bad, can be remedied by using a little less than the usual amount of acid. In the second case the use of a little more than the usual 17.5 c c of acid will generally produce desirable results. Satisfactory results can not be secured, however, if the acid is very far from the proper strength, which is acid having a specific gravity of 1.82 to 1.83, or as it is sometimes expressed, 90 to 92 per cent.

Third. An unfavorable temperature. Too high and too low temperatures of the milk and acid at the time of adding the latter, produce respectively, conditions similar to those existing when the acid is too strong or too weak. The proper temperature is between 60° and 70° F., which can be easily obtained by setting the measured sample in the test bottles in cold water or warm water as the case may require, also placing the acid bottle where it will come to the desired temperature before using.



Babcock Test Apparatus Showing Cream Scales.

PART II.

CREAM TESTING.

The growing popularity of the hand separator makes the testing of cream of more importance than the testing of milk in some localities. In fact there are several creameries in the state which receive no milk, and some that formerly handled milk only, are now receiving a large portion of their butter fat in the form of hand separator cream. The universal use of the Babcock test in the Oregon creameries has prevented the employment of any other means of determining the percentage of butter fat in cream, while in some of the older dairy states the old oil test churn which was in use in the days of the gathered cream system before the introduction of centrifugal separators, has come into use again in the testing of hand separator cream. The creamery operator who has fully mastered the use of the Babcock test as applied to milk, finds new questions arising when he comes to use the same method for testing cream. Among these questions the following are perhaps the most important: How should sampling be done? Can the composite method be followed? Does the 17.6 c.c. pipette give an accurate test sample? With a view to obtaining information on these points the writer spent over a month among three of the creameries located in Portland, making several hundred tests during that time, the results of which will be found in the following pages.

Sampling the Cream.

Cream is seldom poured into a weigh-can at the factory as milk is, but is weighed in the can in which it is transported. This difference in handling, with its greater viscosity, makes fair sampling more difficult than with milk. The Scoville tube, so valuable as a milk sampler, is not well adapted to sampling cream, unless it be a very thin sweet cream. But the milk thief can be used to very good advantage. However, it is advisable to stir the cream with a long handled dipper before taking the sample with the milk thief. The taking of the sample with the dipper is not to be recommended, particularly if the composite sample is used, because it will not give a proportionate amount in the quantity taken each time for the sample, and further, the contents of the can will probably not be thoroughly mixed by the stirring that will ordinarily be given. Out of 100 comparative tests (200 tests made) of samples taken by the

dipper and the thief methods, 58 were alike, 3 were higher, taken with the thief, and 39 were higher taken with the dipper, the variation ranging from 0.5 to 2.0 per cent. The samples were taken by first stirring the cream with a dipper holding about a half pint; then two or three times as much cream as would be required for a test was poured from the dipper into a sample jar. At the same time the thief was lowered into the can and the sample thus obtained placed in another sample jar. It is probable that the large number of higher tests with the dipper samples was due to the cream not being thoroughly mixed, and when a portion of the contents of the dipper was transferred to the sample jar it was composed of cream containing above the average percentage of butter fat for the contents of the can. The variations were fewer and smaller in size when the cream was sweet than in the case of sour samples.

Where the cream is collected from the farms where it is produced, by cream wagons, the method of sampling suggested in Bulletin 108 Conn. Exp. Sta., is to be recommended. The method, briefly, is as follows:

“The cream gatherer is provided with a spring balance for weighing, a pail for holding the cream while weighing, small wide necked bottles with numbers on the corks corresponding to the patron's numbers, and with a sampling tube. The cream is emptied into the pail, weighed, and after being poured two or three times from one vessel to another, a sample is taken and put into the bottle having the patron's number. When the driver returns to the creamery, the samples of cream in the wide necked bottles are emptied into a pint jar bearing the patron's number and containing some preservative. This gives a composite sample which may be tested as often as desired, at least once in two weeks.”

Measuring the Test Sample.

The Babcock test is based on the assumption that 18 grams (or a fractional part thereof) of the substance to be tested will be placed in the test bottles. In sampling milk the 17.6 c.c. pipette will deliver the required 18 grams, but in testing cream the same pipette delivers less than 18 grams, and the higher the percentage of fat in the cream the greater will be the deficiency in the amount delivered. As the percentage of fat in cream increases, its specific gravity decreases, or in other words, it becomes lighter for the same volume.

The following table shows the specific gravity of cream containing different percentages of fat, also the amount by volume required to weigh 18 grams, as computed from the specific gravity:

TABLE III.

| Per cent fat. | Specific gravity.* | Volume required to weigh 18 grams. |
|---------------|--------------------|------------------------------------|
| 10 | 1.023 | 17.60 c.c. |
| 15 | 1.012 | 17.79 |
| 20 | 1.008 | 17.86 |
| 25 | 1.002 | 17.96 |
| 30 | .996 | 18.07 |
| 35 | .980 | 18.36 |
| 40 | .966 | 18.63 |
| 45 | .950 | 18.95 |
| 50 | .947 | 19.01 |

* Farrington and Woll, "Testing Milk and its Products."

While the figures in the last column of the above table doubtless are correct for sweet cream, they are too low for cream that has become sour, thus containing more or less gas bubbles, or even for sweet cream that has been vigorously agitated and therefore containing more or less air bubbles.

Weighing Cream Samples.

Uniformly accurate results in testing cream can be obtained only by weighing the sample to be tested. For this purpose there is probably nothing better than the Trohmer Cream Scale, shown at the left of the illustration opposite page 169. This scale is moderate in price, very durable as it has crystal bearings, and porcelain pans, and is very sensitive. For rapid work a bottle should be placed on each scale pan. Then the bottles are balanced by means of the sliding poises at the front of the scale. Next place the 18 gram weight on the right hand scale pan beside the bottle, and with a pipette run cream into the left hand bottle until the scales again balance, as shown in the illustration. Now remove the 18 gram weight and run cream into the bottle on the right hand scale pan until the scales are again in balance. Two samples can thus be weighed with one adjustment of the poises which effects a considerable saving of time. By following this method, twenty-four samples can easily be weighed out in an hour. The 9 gram weight is often used instead of the 18 gram, and the only objection to its use is that the readings obtained must be multiplied by 2, thus doubling any error in reading. But there are many points in favor of the practice. Only one-half the amount of both cream and acid is required which in time amounts to quite a considerable saving; the mixing can be done more quickly, and there is more room for the addition

of hot water, which is desirable where a hand whirling machine is used; and since cream bottles are commonly made to read not higher than 25 to 30 per cent, if the 9 gram plan is followed the richest sample one is liable to get can be tested in the usual manner.

The following table is designed to show the difference in readings obtained by measuring the sample with the 17.6 c.c. pipette, and by weighing it with the cream scales. The 17.6 c.c. pipette was rinsed with about 6 c.c. of warm water after measuring each sample, and the rinsings put into the test bottle, in order that the pipette should deliver its full capacity. The amount of cream adhering to the inner surface of the pipette varies greatly with the condition and fat content of the cream. If the cream is sweet and rather thin the amount left in the pipette will not make a difference of more than .2 or .3 of one per cent in the reading of the test, but when the cream is very thick by reason of containing 30 to 40 per cent of butter fat and also being sour, the error may amount to 3 or 4 per cent.

TABLE IV.

| Number of trials. | Test with 17.6 c.c. pipette. | Av. test with 18 grams. | Variations. |
|-------------------|------------------------------|-------------------------|---------------------|
| 3..... | 13.5 per cent. | 14.7 per cent. | 14.5—15.0 per cent. |
| 4..... | 14.0 | 15.0 | None. |
| 3..... | 14.5 | 15.3 | 15.0—16.0 |
| 3..... | 15.0 | 16.0 | None. |
| 3..... | 15.5 | 16.8 | 16.5—17.0 |
| 4..... | 16.0 | 17.1 | 17.0—17.5 |
| 7..... | 16.5 | 17.8 | 17.0—18.0 |
| 7..... | 17.0 | 18.1 | 17.5—18.5 |
| 9..... | 17.5 | 18.5 | 18.0—19.0 |
| 16..... | 18.0 | 19.1 | 18.5—19.5 |
| 15..... | 18.5 | 19.7 | 19.0—20.0 |
| 9..... | 19.0 | 20.0 | None. |
| 15..... | 19.5 | 20.7 | 20.0—21.0 |
| 20..... | 20.0 | 21.1 | 21.0—21.5 |
| 11..... | 20.5 | 21.7 | 21.5—22.0 |
| 21..... | 21.0 | 22.4 | 22.0—23.5 |
| 10..... | 21.5 | 23.0 | 22.5—24.0 |
| 17..... | 22.0 | 23.2 | 22.5—24.0 |
| 17..... | 22.5 | 23.7 | 23.0—24.0 |
| 13..... | 23.0 | 24.2 | 24.0—25.0 |
| 10..... | 23.5 | 24.9 | 24.5—26.0 |
| 15..... | 24.0 | 25.2 | 25.0—26.0 |
| 13..... | 24.5 | 26.0 | 25.5—26.5 |
| 10..... | 25.0 | 26.6 | 26.0—28.0 |
| 4..... | 25.5 | 27.2 | 27.0—28.5 |
| 8..... | 26.0 | 27.5 | 27.0—28.0 |
| 6..... | 26.5 | 27.7 | 27.0—28.0 |
| 17..... | 27.0 | 28.6 | 28.0—30.0 |
| 7..... | 27.5 | 28.9 | 28.5—29.0 |
| 5..... | 28.0 | 29.7 | 29.0—30.0 |
| 6..... | 28.5 | 30.5 | 30.0—31.0 |
| 2..... | 29.0 | 30.8 | 30.5—31.0 |
| 5..... | 29.5 | 31.4 | 31.0—32.5 |
| 2..... | 30.0 | 32.0 | None. |
| 2..... | 31.0 | 34.0 | None. |
| 2..... | 32.5 | 35.0 | None. |
| 5..... | 34.0 | 36.7 | 36.0—37.5 |
| 2..... | 37.0 | 42.0 | 40.0—44.0 |
| 2..... | 38.0 | 41.0 | None. |

The tests in the foregoing table were all made under factory conditions from samples taken from the daily shipments received by two Portland creameries. All weighed samples for testing were also measured with a pipette graduated to tenths of a cubic centimeter and it was found that, when the cream was sweet and contained from 18 to 25 per cent fat, there was but a small variation in the amount required to weigh 18 grams, the variations ordinarily ranging between 18.0 and 18.4 c.c. But for cream of the same fat content that had become nearly or quite sour enough for churning, the amount required to weigh 18 grams frequently exceeded 19.5 c.c. while creams testing over 30 per cent sometimes required, when sour, more than 20.5 c.c. to weigh the required 18 grams. The range of variation in tests recorded in the last column of Table IV, is due to this difference in the condition of the cream. Some samples were perfectly sweet while others were exceedingly sour. In every case the greatest difference between the test made by measure and by weight occurred when the cream was very sour.

The results obtained indicate that practically accurate tests can be secured, when the cream is sweet and contains not more than 25 per cent butter fat, by using a pipette of 18 c.c. capacity for measuring the sample. But if the cream is sour or contains more than 25 per cent fat, such measuring can not be relied upon and for accurate results weighing the sample must be practiced. It should be borne in mind that the bottles commonly used in testing cream are so graduated that operators do not attempt to make readings closer than .5 of one per cent as a rule, and some practice recording their tests only in the nearest whole per cent.

The following are a few of the tests made, showing amount required to weigh 18 grams.

TABLE V.

| Test 17.6 c.c. | Test 18 grams. | Volume required to weigh 18 grams. | Condition of sample. |
|---------------------|---------------------|------------------------------------|----------------------|
| 18.0 per cent. | 19.0 per cent. | 18.2 c.c. | Sweet. |
| 18.0 | 19.5 | 19.4 | Sour. |
| 20.0 | 21.0 | 18.2 | Sweet. |
| 20.0 | 21.5 | 19.6 | Sour. |
| 23.0 | 24.0 | 18.2 | Sweet. |
| 23.0 | 25.0 | 20.0 | Sour. |
| 25.0 | 26.0 | 18.4 | Sweet. |
| 25.0 | 28.0 | 20.2 | Sour. |
| 30.0 | 31.0 | 18.5 | Sweet. |
| 31. | 34.0 | 20.0 | Sour. |

NOTE.—The acidity of the sour samples was about .6 per cent.

Composite Sampling.

The adaptability of the composite sample to the testing of cream was a subject for investigation the results of which are found in the following table:

TABLE VI.

| Patron No. | Lbs. Cream. | Test from total fat. | Average of daily tests. | Composite. |
|------------|-------------|----------------------|-------------------------|------------|
| 1 | 1046 | 25.17 | 25.75 | 25.75 |
| 2 | 581 | 26.26 | 26.25 | 26.25 |
| 3 | 686 | 22.85 | 22.55 | 22.00 |
| 4 | 690 | 22.00 | 21.75 | 21.75 |
| 5 | 1339 | 25.15 | 25.55 | 25.25 |
| 6 | 1362 | 24.69 | 25.15 | 25.00 |
| 7 | 157 | 32.00 | 32.00 | 32.00 |
| 8 | 112 | 37.60 | 37.35 | 37.50 |
| 9 | 85 | 41.20 | 41.00 | 41.50 |
| 10 | 209 | 22.76 | 22.83 | 23.00 |
| 11 | 1123 | 20.21 | 20.25 | 20.00 |
| 12 | 978 | 22.87 | 23.00 | 22.50 |
| 13 | 202 | 24.86 | 24.37 | 24.00 |
| 14 | 1244 | 18.23 | 18.31 | 18.00 |
| 15 | 198 | 22.42 | 22.50 | 22.50 |
| 16 | 689 | 25.43 | 25.57 | 25.00 |
| 17 | 793 | 20.80 | 21.00 | 21.00 |
| 18 | 513 | 27.16 | 27.00 | 27.50 |
| 19 | 731 | 20.44 | 20.50 | 21.00 |
| 20 | 541 | 16.25 | 16.33 | 16.50 |
| 21 | 240 | 17.60 | 17.60 | 18.00 |
| 22 | 805 | 25.47 | 25.87 | 25.00 |
| 23 | 1241 | 21.50 | 21.62 | 21.50 |
| 24 | 862 | 23.55 | 23.50 | 23.50 |
| 25 | 490 | 15.00 | 15.00 | 15.00 |
| 26 | 561 | 29.50 | 29.63 | 29.00 |
| 27 | 515 | 22.21 | 22.21 | 21.50 |
| 28 | 780 | 22.70 | 22.20 | 22.00 |
| 29 | 866 | 24.16 | 24.14 | 24.00 |
| 30 | 747 | 20.67 | 20.35 | 20.00 |
| 31 | 422 | 28.35 | 28.75 | 28.50 |
| 32 | 1019 | 21.43 | 21.71 | 21.50 |
| 33 | 513 | 36.60 | 36.85 | 37.00 |
| 34 | 1641 | 28.55 | 28.55 | 28.50 |
| 35 | 334 | 28.90 | 28.75 | 28.50 |
| 36 | 214 | 28.70 | 29.00 | 28.50 |
| 37 | 1422 | 28.12 | 28.35 | 28.00 |
| 38 | 1113 | 19.02 | 19.27 | 19.00 |
| 39 | 379 | 22.50 | 22.50 | 23.00 |
| 40 | 100 | 23.30 | 23.50 | 23.00 |
| 41 | 214 | 23.98 | 24.00 | 24.00 |
| 42 | 226 | 26.00 | 26.00 | 25.00 |
| 43 | 240 | 17.34 | 17.42 | 18.00 |
| 44 | 529 | 23.77 | 23.77 | 24.00 |
| 45 | 319 | 42.54 | 43.00 | 44.00 |
| 46 | 382 | 41.10 | 41.66 | 41.00 |
| 47 | 1214 | 27.65 | 27.58 | 28.00 |
| 48 | 1322 | 29.44 | 29.54 | 29.50 |
| 49 | 1791 | 19.52 | 19.50 | 19.00 |
| 50 | 496 | 31.79 | 31.43 | 31.50 |
| Averages | | 25.37 | 25.42 | 25.34 |

Nos. 1 to 9 were secured from the Hazlewood Cream Co., and are the results of a ten days' composite test period, July 20-30. The samples were practically all sweet when placed in the composite jar, and were in excellent condition when the composite test was made.

Nos. 10 to 32 are the results of daily tests of the regular shipments, with a few exceptions, received by the Weatherly Creamery Co., and also cover a test period of ten days, Aug. 1-10. About one-half of these composite samples were made up from daily samples of sweet cream, the other half being from deliveries that were always sour. Satisfactory tests were obtained from each of these composite samples.

Nos. 33 to 50 represent the results of two composite test periods of fifteen days each, July 2-16, and July 17-31, the samples being taken from the regular shipments received by the Townsend Creamery Co. With the exception of Nos. 34, 38, 44, and 49, these samples were always sour when received. However, but three composite samples were in bad condition at the close of the test period.

It will be observed from the averages in table VI that the composite sample test is more nearly correct than the average of the daily tests, that is, it comes nearer being equal to the "test from total fat," which was obtained in the manner explained in the introduction to table I.

It will also be observed that in only one instance, No. 45, is there a difference between the composite test and the test from total fat, exceeding 1.00 per cent, and only comparatively few in which there is a difference greater than .5 per cent, while the average of the fifty comparisons shows a difference of but .03 per cent. This is really a less variation than was found in milk samples according to Table I if the relative fat content of milk and cream is considered.

It should be borne in mind that the test bottles used in making these cream tests were of the form most commonly used for that purpose viz., straight, wide-necked bottles, graduated to 30 per cent, the subdivisions of the scale representing .5 per cent so that readings closer than .5 per cent would be only approximations.

TABLE VII.

| Patron No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Variation. |
|------------|------|------|------|------|------|------|------|------------|
| 1 | 20.5 | 27.0 | 26.0 | 25.0 | 27.0 | 28.0 | 27.0 | 7.5 |
| 6 | 31.0 | 28.0 | 24.5 | 23.0 | 22.0 | 24.0 | 23.5 | 9.0 |
| 11 | 23.0 | 20.0 | 20.5 | 19.5 | 20.0 | 19.0 | 20.0 | 4.0 |
| 20 | 15.0 | 14.5 | 18.5 | 18.5 | 14.5 | 17.0 | | 4.0 |
| 22 | 27.0 | 25.0 | 23.0 | 30.5 | 26.0 | 24.0 | 25.5 | 7.5 |
| 28 | 28.0 | 25.0 | 23.0 | 22.5 | 22.0 | 19.0 | 20.0 | 9.0 |
| 33 | 38.0 | 41.0 | 37.0 | 37.0 | 35.0 | 33.0 | | 8.0 |
| 38 | 18.0 | 18.5 | 19.0 | 18.5 | 19.5 | 21.0 | 20.0 | 3.0 |
| 39 | 22.0 | 22.5 | 22.5 | 22.0 | 23.0 | 23.0 | | 1.0 |
| 49 | 20.0 | 19.0 | 21.0 | 19.5 | 20.0 | 18.5 | 18.5 | 2.5 |

Table VII shows variations in daily tests. It is composed of successive tests of a portion of the deliveries from which the averages were made in table VI. It will be noticed that the least variation occurred with patron No. 39, and amounted to only 1.0 per cent, while patrons No. 6 and No. 28 showed a variation of 9.0 per cent.

SUMMARY.

The milk thief or some similar appliance should be used in preference to the little dipper method in taking cream test samples.

For all practical purposes, a pipette holding 18 c.c. can be used in measuring test samples of sweet cream containing between 18 and 25 per cent fat. If the cream is sour or contains more than 25 per cent fat, the test sample should be weighed.

Considerable variation will be found in the tests of daily deliveries during a composite test period. A variation of 9.0 per cent or more may be expected.

The composite sample can be applied to the testing of cream quite as successfully as in milk testing. Fifty comparisons of composite tests with "tests from total fat" showed an average difference of but .03 of one per cent.

Composite test periods for cream should not exceed ten days in hot weather. At other seasons of the year semi-monthly periods will prove satisfactory.