Testing Milk and Cream

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Abstract
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TESTING MILK AND CREAM

BY M. R. TOLSTRUP AND M. MORTENSEN

The Babcock test and the scales are in reality the foundation of profitable dairy farming. By the proper use of these utensils it is possible, not only to find the average production of the cows in general, but also to single out those which are not paying for their keep. By disposing of those animals and replacing them with better ones, it is possible to put dairy farming on a business-like and profitable basis.

UTENSILS FOR THE BABCOCK TEST

The utensils needed for the Babcock test are: a Babcock tester, a few test bottles, a pipette, an acid measure, some sulphuric acid ($\text{H}_2\text{SO}_4$), and a pair of dividers. All this can be procured from any creamery supply house for from $5.00 to $10.00, according to whether a four or an eight bottle tester is wanted.

TESTING WHOLE MILK FOR BUTTER FAT

Sampling — In testing milk, or any other product, it is necessary to secure a representative sample. If the sampling is wrong, the test cannot be accurate, no matter how skillfully the work may be carried out. When testing milk from individual cows the milk from a whole milking should be used, because the first drawn is not nearly as rich as the last. Before taking a sample for testing, the milk should be properly mixed, either by pouring from one vessel to another or by stirring it well by means of a dipper or ordinary stirring rod.

It should be mentioned that the richness of the milk differs with the individual cows within the same breed as well as with the different breeds. The same holds true with the different stages of the lactation or milking periods. Practically speaking, the milk increases in richness as the lactation period advances. This does not hold true the first few weeks when it is a little richer at the beginning and then decreases for a few weeks. Therefore in order to get an average test of a cow’s milk, it is well to test her milk at least once a month.

Transferring Milk to the Test Bottles — Having completed the mixing, 17.5 c.c. (cubic centimeters) of milk are transferred by means of a 17.6 c.c. pipette to the test bottle. This is done by inserting the lower stem of a pipette in the milk, placing the lips over the upper stem and sucking until the milk is well above the 17.5 c.c. mark, indicated on the upper stem of the pipette. Now quickly place the right forefinger over the opening of the pipette and retain the amount of milk required to fill it to the mark. Transfer to the bottle, being careful to avoid any losses during the process. If the neck of the bottle is wide enough so that it will allow the lower stem of the pipette to be inserted, this is the best method of emptying. If not, then the bottle and pipette should be slanted in opposite directions and the milk allowed to run slowly down on the inside of the bottle’s neck, as shown in fig. 2.

As mentioned, the 17.6 cubic centimeter (c.c.) pipette will deliver approximately 17.5 c.c. of milk, and this when multiplied by 1.032 (the average specific gravity of milk) gives a small fraction more than 18 grams, or the correct amount to use in the test.
Adding the Acid — Now add 17.5 c.c. commercial sulphuric acid ($\text{H}_2\text{SO}_4$) having a specific gravity of 1.82 to 1.83, which means that volume for volume it is 1.82 or 1.83 times as heavy at water. The temperature of both acid and milk should be between 60° and 70° F. The acid is generally poured into a small glass cylinder and from there into the test bottle. It is well to let it run slowly down on the inside of the slanted neck of the bottle, which is gradually rotated so as to give the acid a chance to rinse down any milk which may stick to the sides of the bottle neck. Due to its greater weight, the acid will locate below the milk at the bottom of the bottle. Acid and milk should then be rapidly and very thoroughly mixed by giving the bottle a rotary motion. Incomplete mixing invariably means a poorly made test.

In handling the sulphuric acid great care should be taken not to get it on hands, clothes, or utensils, because it will destroy them. For the same reasons the acid should never be left any place where the children have access to it.

Making the Test — The test bottles are best placed in the Babcock testing machine immediately after mixing, where they should be whirled for five minutes at the speed generally indicated on the crank or corner of the tester. The tester is then stopped and hot soft water at about 180° F. is added, by means of the pipette or acid measure, until the fat reaches the neck of the test bottles. They are then whirled for two minutes more. Hot water is now added until the fat column is brought up within the graduated scale on the neck of the bottle, after which they are given a final whirling of two minutes duration. The testing is best done in a warm room.

On removing from the tester, the test bottles are placed in hot water (130° F. or 140° F.) deep enough so that the fat column is submerged in the water, for from 5 to 10 minutes. This is done in order that the fat may be brought to that temperature at which the bottles are standardized. Fat, like other substances, expands and contracts with heat and cold; so in order to get a correct reading, the hot water bath is used.

Reading the Test — As indicated on the figure, it will be noted that the neck of a Babcock milk test bottle is graduated or marked in 8 or 10 large divisions, each of which is again subdivided in 5 or 10 smaller divisions, thus making these count 0.1 or 0.2 per cent respectively. The reading of the test is best done with a pair of dividers. With them measure the full length of the fat column, starting with the top of the upper curve, or meniscus, as it is called, and down to the lower part of the bottom curve, placing a point of the dividers at each extreme as indicated in fig. 9. This done, remove the dividers without changing their angle, and place the lower point at the zero mark, while the upper point will fall on the mark of the bottle, indicating the amount of fat present directly in per cent. For example, if the upper point falls on a spot three large and two smaller divisions above the zero mark it means that this particular sample contains 3.4% fat (each smaller division representing .2% on the 10% bottle), or 3.4 pounds of fat in each 100 pounds of that kind of milk.

To compute the amount of butter fat, multiply the fat percentage by the number of pounds of milk and divide by 100; for example: if 255 lbs. milk tests 3.8% butter fat, the amount of butter fat is found as follows:

\[
\text{255} \times 3.8 = 9.69 \text{ pounds butter fat.}
\]

Cleaning of Glassware — It is very important that the glassware be kept properly cleaned. This can best be done by emptying the utensils while they are still warm and washing them with hot water and washing-powder to remove all fat, and then giving them a final rinsing in clean water.
Fig. 1. A 17.6 c. c. pipette
Fig. 2. Emptying pipette into test tube
Fig. 3. Acid measure
Fig. 4. Four bottle Babcock tester
Fig. 5. Twelve bottle Babcock tester
Fig. 6. Tank for holding test bottles at proper temperature
Fig. 7. Babcock test milk bottles
Fig. 8. Dividers for measuring
Fig. 9. Reading milk test; read from A to B
Fig. 10. Cream balance
Fig. 11. Cream balance
Fig. 12. Babcock test cream bottle
Fig. 13. Reading cream test; read from A to C
Fig. 14. Babcock skim milk bottle
BRIEF DIRECTIONS FOR TESTING MILK FOR FAT

1. Secure a representative and well-mixed sample of the milk.
2. With a 17.6 c.c. pipette measure 17.5 c.c. (18 grams) into a Babcock Milk Test Bottle.
3. Add 17.5 c.c. sulphuric acid (H₂SO₄) and mix milk and acid very thoroughly.
4. Put the test bottles in Babcock Tester and whirl for five minutes at proper speed.
5. Add hot water (180 degrees) until fat column reaches neck of bottle.
6. Whirl in tester for two minutes.
7. Add hot water until fat column is within the graduated scale on neck of test bottle.
8. Whirl in tester for two minutes.
9. Put test bottles in hot water bath (130-140 degrees F.) for three to ten minutes.
10. Read and record the test in percents and tenths.
11. Clean all utensils.

TESTING CREAM FOR BUTTER FAT

Sampling — Cream is tested in practically the same manner as milk, but owing to the greater variation in its fat content the cream must be weighed out in order to obtain accurate results. The reason is that the richer cream, besides being of a lower weight, volume for volume, than the thinner cream, is more viscous (sticky), containing often larger amounts of air; therefore more of it will adhere to the sides of the pipette, thereby making the amount used for the testing too small and the test too low.

Larger sized pipettes might be used to overcome this trouble, but difficulties are encountered because the test of the cream is not known beforehand and consequently one is at a loss to know which pipette to use. For these reasons it has been found more convenient and more accurate to weigh out the cream. The following table will show why this is so:

<table>
<thead>
<tr>
<th>Percent of fat in cream</th>
<th>Specific gravity at 63.5 degrees F.</th>
<th>Weight of cream delivered in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.023</td>
<td>17.9</td>
</tr>
<tr>
<td>15</td>
<td>1.012</td>
<td>17.7</td>
</tr>
<tr>
<td>20</td>
<td>1.008</td>
<td>17.3</td>
</tr>
<tr>
<td>25</td>
<td>1.002</td>
<td>17.2</td>
</tr>
<tr>
<td>30</td>
<td>.996</td>
<td>17.2</td>
</tr>
<tr>
<td>35</td>
<td>.980</td>
<td>16.4</td>
</tr>
<tr>
<td>40</td>
<td>.966</td>
<td>16.3</td>
</tr>
<tr>
<td>45</td>
<td>.950</td>
<td>16.2</td>
</tr>
<tr>
<td>50</td>
<td>.947</td>
<td>15.8</td>
</tr>
</tbody>
</table>

Weighing the Sample — A sensitive balance is used for weighing out the cream. One bottle is balanced on the scale, which should be placed on a level and solid table. After balancing the bottles, a 9 gram or 18 gram weight (according to whether 18 gram, 30 or 50 per cent bottles, or 9 gram, 50 per cent bottles are used) is placed on the opposite scale pan, and by means of a pipette, enough cream is let into the test bottle to balance the weight.

Cream test bottles vary in size from 30 per cent to 50 per cent 18 gram bottles, reading in .5 per cent (1 per cent as the smallest reading) to a 9 gram 50 per cent bottle, reading in .5 per cent. The latter is the most desirable and perhaps most commonly used bottle.
Mixing with Acid — After weighing it is best to add 9 c.c. cold water (one-half pipette full) to each test bottle, and then add acid as with milk, that is, 17.5 c.c. for each test, and mix well, after which the test is completed as directed for milk.

Sometimes the acid is added directly into the cream and no water is used. In this case it will take about 10 or 12 c.c. of acid, which is gradually added under constant shaking until a light brown chocolate color appears. This color should turn dark brown when the sample is left standing a little while. Nine c.c. hot water are then added before the samples are put into the tester and finished as directed for milk. This latter method, while it requires less acid, is not quite as desirable for farm use as the former because it is more difficult to secure a good test. The extra acid used is almost a negligible factor where testing is done on a small scale.

Finishing the Test — From this point the test is completed in absolutely the same manner as for milk with the exception of the reading. In milk we read from the extremes of both curves on the fat column, in whole per cents and tenths; but in cream we read from the lower point of the bottom and to the lower point of the upper meniscus or curve of the fat column. Note the difference in reading milk and cream tests as indicated in figs. 9 and 13.

If a sample measures 33% it simply means that each 100 pounds of that kind of cream contains 33 pounds of butter fat. In reading the cream tests a little oil (Glymol is good) put on top of the fat column will level out the curve and make the reading easier.

BRIEF DIRECTIONS FOR TESTING CREAM

1. Secure a well-mixed sample of cream.
2. On a sensitive balance weigh 9 grams or 18 grams into each cream bottle.
3. Add 9 c.c. (½ pipette full) of cold water to each test bottle and mix.
4. Add 17.5 c.c. H₂SO₄ and mix cream and acid well.
5. Put in tester and whirl 5 minutes at proper speed.
6. Add hot water (180 degrees F.) until fat reaches neck of bottle.
7. Whirl in tester for 2 minutes.
8. Add hot water until fat is within graduated scale on neck of bottle.
9. Whirl in tester for 2 minutes.
10. Put test bottles in hot water bath for 5 to 10 minutes.
11. Read and record test in per cents and halves.
12. Clean utensils and glassware.

TESTING SKIMMED MILK

Sometimes it is desirable to know the amount of fat contained in skimmed milk because it indicates whether or not the separator is doing good work. If separated milk from a hand separator contains more than 0.10 per cent of fat, it is quite safe to assume that the machine is not working as well as it should.

The method used for testing of skimmed milk differs but very little from that of whole milk. A specially constructed double-necked bottle with a very narrow bore is used in order to read or measure correctly the small amount of fat contained in the skimmed milk. The graduation is made in hundredths of one per cent. On account of the comparatively large amount of casein and the small fat globules which separate with greater difficulty in the skimmed milk, we use 20 c.c. of sulphuric acid (H₂SO₄) in place of 17.5 c.c. for the whole milk. For the same reasons it is well also to whirl at a higher speed for the skimmed than for the whole milk. The fat is
measured to both extremes of the column and read in hundredths of one per cent.

COMMON CAUSES FOR POOR TESTS

1. Insufficient mixing of milk and acid, which may cause either a burned test or leave some of the curd undissolved.
2. Too much or too little acid, the former giving a dark fat column containing charred matter and the latter a very light one with some undissolved curd at the bottom of the fat column.
3. Too strong or too weak acid, the former leaving a dark fat column while the latter will give a very light-colored fat and some undissolved curd.
4. Too high temperature of either acid or milk or both. The result will always be a dark fat column containing charred matter and unclean test. Try to have acid and milk between 60° F. and 70° F.
5. Running the tester at too low speed generally results in too low a test.
6. Hard water, which is apt to give a white foam on top of fat column.
7. Inaccuracy in reading of fat column.

COMMON REASONS FOR VARIATION IN TEST OF CREAM

1. Change in the position of the cream screw. If it is turned toward the center the cream will be richer and if turned away from the center it will be thinner.
2. Change in speed of the machine. Low speed means thinner and high speed richer cream, therefore admitting milk to separator before speed is up means thin cream.
3. Vibrating bowl, caused either by the separator not being level or not standing on a solid foundation. This always means thin cream and rich skim milk.
4. Dirty separator. This generally means a poor quality of thin cream.
5. Too much rinse water, which always gives a thinner cream.
6. Incorrect rate of inflow. If too much milk is admitted to the separator the cream will be thin; if not enough, the cream will be richer than is desirable.
7. Temperature of milk. Warmer milk produces thinner cream. It is profitable however to skim the milk while warm as the separator will do cleaner skimming.