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THE BABCOCK TEST

NOTES ON ITS USE IN DETERMINING THE PERCENTAGE OF FAT IN WHOLE MILK, SKIM-MILK, BUTTERMILK, CREAM AND WHEY.

BY

C. E. NEWLANDER, INSTRUCTOR IN DAIRYING

The Babcock test is a method for deterining the percentage of fat in milk and its products. It is the test generally used as a basis of payment for milk and cream. It has enabled milk producers to detect unprofitable cows, thus furnishing an intelligent guide in improving their herds. It has aided in detecting fraud by the watering or skimming of milk.

The apparatus necessary in making the test is as follows:

17.6 c.c. (cubic centimeter) pipette for measuring the milk,
17.5 c.c. acid measure,
Sulphuric acid, specific gravity 1.82 to 1.83,
Milk, cream, and skim-milk test bottles,
Babcock tester or centrifuge,
A pair of dividers,
Balance for weighing cream,
A thermometer.

TESTING MILK.

Mixing the Milk.—The sample to be tested should be at a temperature between 55° and 70° F. In testing whole milk it is very essential that the sample be thoroughly mixed to cause the fat to be evenly distributed

throughout, otherwise the test will not be accurate. Mixing is best accomplished by pouring from one vessel to another several times or by stirring thoroughly. In case the cream has hardened or sticks to the sides of the container, the sample should be thoroughly warmed, (not over 95° F.) and then mixed.

Taking the Sample.—Immediately after mixing, draw the milk up above the mark on the pipette and hold it there by quickly placing the soft part of the index finger over the top of the pipette. Have the finger dry. Then the column of milk can be easily controlled and allowed to flow until it is exactly even with the 17.6 c.c. mark. The pipette should always be held so that the 17.6 c.c. mark is on a level with the eye. The amount of milk taken weighs approximately 18 grams, which is the amount on which the test is based.

Transferring the Sample.—In transferring the sample to the test bottle, the bottle is held in a slanting position, so that the milk will run down the lower inside of the bottle neck in order to permit the air in the bottle to escape. Or drop the discharge end of the pipette into the neck of the test bottle until the bulb of the pipette rests on the neck of the bottle, then release the milk. Great care must be taken not to lose a drop of milk in the transference as that would lessen the accuracy of the test. Blow the last drop of milk out of the pipette before removing from the test bottle.

FIG. 1. Standard 8% Milk Test Bottle

Adding the Acid. Use commercial sulphuric acid, specific gravity 1.82 too 1.83. The temperature of the acid should be the same as that of the milk, 55° F. to 70° F. Add 17.5 c.c. of acid to the milk in the test bottles and mix by giving the bottles a rotary motion until the lumps of curd are completely dissolved and the mixture has a black color. The acid should pass down the side of the neck and the bottle should be turned slowly so that any milk adhering to the bottle neck will be carried down. Adding the acid in two or three installments and shaking after each addition will aid greatly in securing clear tests.

(NOTE.—Sulphuric acid has a great affinity for water, so it is absolutely necessary that the acid container be kept tightly closed, otherwise the acid will take up moisture from the air and thus be weakened. It should also be remembered that sulphuric acid is very corrosive and must be handled with great care. If it should get on the skin or clothing, wash off with water and then treat with dilute ammonia.)

FIG. 2. The 17.6 c.c. Standard Pipette for Milk

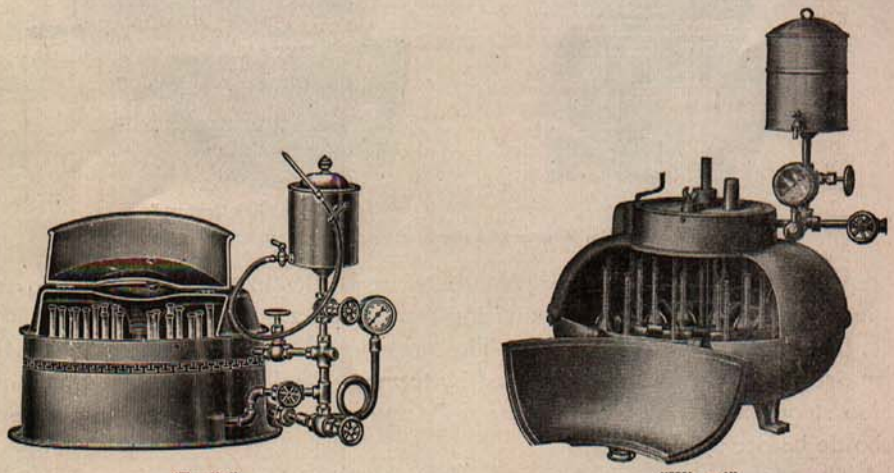
FIG. 3. The 17.5 c.c. Measure for Acid

Whirling the Test Bottles.—After the addition and mixing of the acid, the test bottles are placed in the centrifuge or tester and whirled. If the bottles are held over and allowed to become cool, they should be heated by setting in hot water at a temperature of 160° to 180° F. before whirling.

Steam turbine or electric driven testers with not less than twenty-four pockets are best adapted to factory use. They are constructed in two general sizes,—those having a twelve-inch diameter wheel and those having an eighteen-inch diameter wheel. The proper speed for the first is one thousand revolutions per minute, and for the second, eight hundred revolutions per minute.

FIG. 4.—The Combined Acid Bottle for rapid work

In testing milk on the farm it may not be feasible to make use of power testers, but hand testers will do the work just as well. In order to keep the bottles at the proper temperature during the



"Facile" "Wizard"

FIG. 5.—The large size steam or electric testers should be used in factories where considerable testing is done.

test, the pockets holding the bottles, or the jacket in the case of the enclosed tester, should be filled with hot water.

An even number of bottles should always be whirled at the same time. If there are not enough test bottles to fill all the pockets in the tseter, the bottles should be so arranged as to balance the machine.

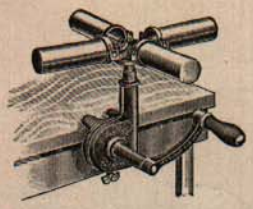
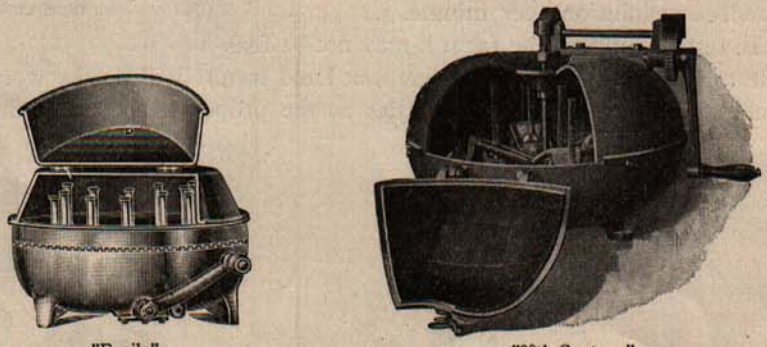


FIG. 6.—A hand tester suitable for a small sized dairy herd.

Whirl the bottles for five minutes at the proper speed. Then fill to the base of the neck with hot, soft water. Whirl again for two minutes and fill the bottles with hot, soft water to bring the fat *into the graduated portion of the bottle neck.* Whirl one minute. The temperature of the water added should be about 140° F. The best water to use is rain water or distilled water.

Reading the Test.—Read the test at a temperature of 135° F. to 140° F. In order to have the correct temperature, it is best to set the bottles in a water bath of that temperature. Measure the fat column with a pair of dividers, including the meniscus or curve, both at the bottom and at the top of the fat column. Then place one point of the dividers at the zero mark on the scale of the bottle used, and the other point will indicate the per cent. of fat in the milk tested. On the standard 8 per cent. bottle each main division represents 1 per cent., and each subdivision



"Facile" "20th Century"

FIG. 7.—Twelve-bottle hand testers for use where steam or electricity is not available.

represents .1 per cent. However, there are bottles in use which read to 10 per cent. On these each subdivision represents .2 per cent.

Defects in the Fat Column.—The presence of charred and dark, curdy masses in the fat column is caused by too warm milk and acid, too much or too strong acid, or by letting the milk and acid stand too long in the test bottle before mixing.

The presence of whitish curd in or immediately below the fat column is due to very cold milk or acid, the use of too little or too weak acid, or incomplete mixing of milk and acid.

The appearance of foam on the surface of the fat column is due to the use of hard water. If it is impossible to obtain rain water or distilled water, the water may be softened by boiling or by the addition of a few drops of sulpuric acid before using.

Tests which have any of the above defects should be rejected as the readings are likely to be inaccurate.

KEEPING GLASSWARE CLEAN.

It is very essential that the test bottles and the pipettes used in the test be kept as clean as possible. If not the test is apt to be inaccurate, due to fat particles remaining in them.

As soon as a test is completed and the amount of fat read, the test bottle, while still warm, should be emptied into an earthen jar, never into anything

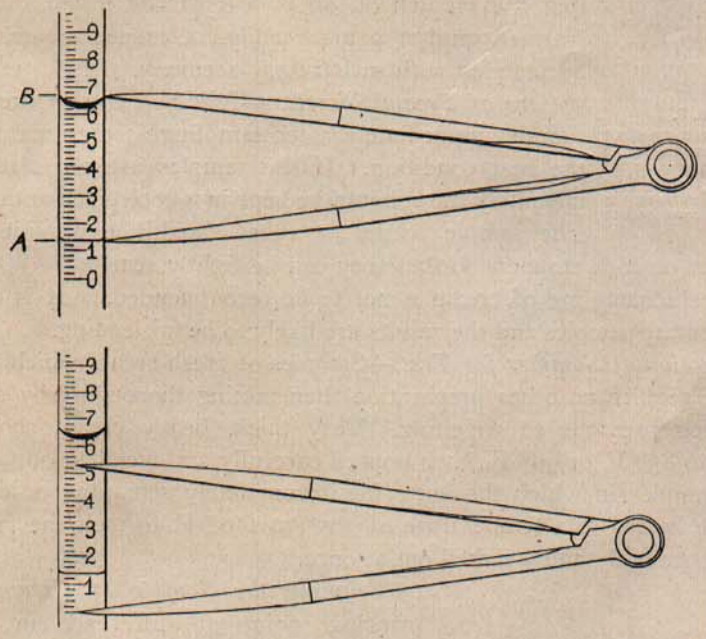


FIG. 8.—Dividers may be used in reading the fat column. Measure from A to B

metallic, because of the strong corrosive action of sulphuric acid on nearly all metals. Shake the bottle while emptying in order to remove the white calcium sulphate deposited on the bottom of the bottle during the test. Then they are easily cleaned by washing in a strong solution of some good washing powder and rinsing in clean, hot water.

Occasionally it is necessary to clean the bottles by rinsing with a potassium bichromate solution. This is made by dissolving one ounce of potassium bichromate crystals in one pint of sulphuric acid. Use 8 or 10 c.c. of this solution. Finish the cleaning by rinsing the bottles with hot water.

The potassium bichromate solution may be used over and over until its cleaning properties have been entirely used up.

TESTING CREAM.

FIG. 9.
A stirrer having a stout rod handle and a disc at least three inches in diameter should be used to thoroughly mix the cream before sampling.

Sampling the Cream.—One of the important steps in securing accurate tests of cream is to have accurate samples. The cream should be thoroughly mixed by pouring from one can to another or by agitating thoroughly from the bottom with an efficient stirrer. The stirring must be very complete before a sample is taken, otherwise the mixture will not be uniform in richness. (Caution: Do not heat to too high a temperature so that the fat will oil off.) Very thick cream should be warmed until it pours readily. Churned cream cannot be sampled with satisfactory accuracy.

Care of Cream Samples.—It is best to test the cream samples immediately after sampling as they are then in the best condition. If the samples are not tested immediately they should be kept in a cool place until ready. The sample bottles or tubes should be provided with screw tops or cork stoppers so that they can be tightly sealed.

Composite sampling of cream is not to be recommended. It is difficult to get accurate samples and the results are likely to be misleading.

Preparation of Samples for Test.—Samples of fresh cream which are not too thick require no other preparation than mixing thoroughly by shaking or pouring previous to weighing. Very thick, heavy cream should be warmed to 85° F. or 90° F., then poured carefully and weighed out at once. Cream samples in which the butterfat is completely separated or churned should be heated to a temperature of 105° to 110° F. to melt the fat, then shaken thoroughly and weighed out at once.

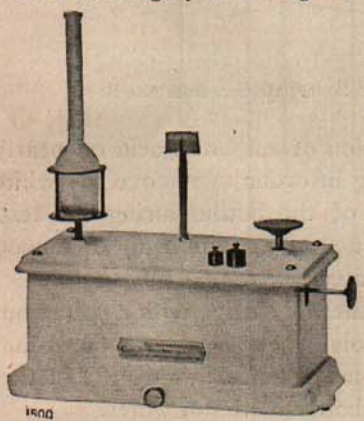


FIG. 10.—Cream should be weighed out on a pair of scales, not measured.

Weighing the Sample of Cream.—The principal point of difference in testing cream and whole milk is that the cream is always weighed, not measured. Cream varies in weight with its richness, it oftentimes holds large numbers of air bubbles or gases of fermentation, and much of it will adhere to the pipette. Hence, the use of the pipette instead of an accurate cream balance should never be practiced. The correct amount of cream by weight is nine grams. Great care should be taken to weigh the cream on accurate and sensitive scales. Cream scales should rest on a firm and level foundation and should at all times be

kept clean and free from dust. Furthermore they should be kept dry and protected from the corrosive influences of salt, sulphuric acid, etc.

The importance of keeping cream scales in first class condition cannot be too strongly emphasized, especially in the case of scales of large capacity and holding a large number of bottles, which are not as sensitive as balances of small capacity and holding but a few bottles. Although one-bottle scales are the most accurate, those holding more bottles, if properly constructed and operated carefully, will do the work satisfactorily.

The standard nine gram fifty per cent. cream test bottle is undoubtedly the best. The divisions represent .5 per cent., 1 per cent., and 5 per cent.

Adding the Acid.—The amount of commercial sulphuric acid to be used varies according to the richness and temperature of the cream. The richer the cream and the higher the temperature, the less the amount of acid

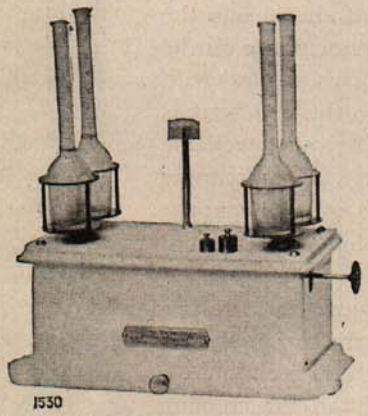


FIG. 11.—A four-bottle cream test balance which gives satisfactory results.

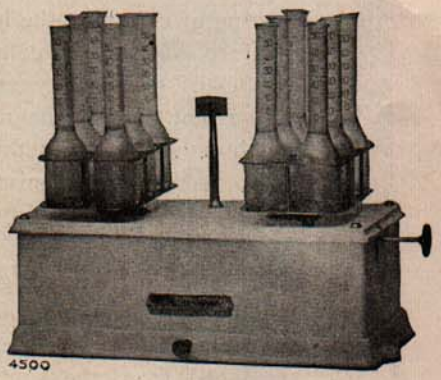


FIG. 12.—If much testing is done, balances that carry several bottles at a time help to simplify the work.

needed. The average amount required is about eight to twelve cubic centimeters. The safest guide to follow in deciding how much acid to use is the color of the cream and acid immediately after mixing. Acid can be added until the mixture, after proper shaking, shows no particles of white curd and has a coffee-brown color. A light brown color shows the need of more acid and a black color immediately after mixing shows that too much acid has been used.

In adding the acid incline the bottle and turn it slowly so the acid will wash down any adhering cream or curd particles. Mix thoroughly by giving the bottle and contents a rotary motion, being careful not to spill any of the contents.

In the hands of the inexperienced operator it is best to add 9 c.c. of warm soft water and mix well before adding the acid. Then use about 15 c.c. to

17 c.c. of acid and mix thoroughly. The acid-cream mixture should have a dark chocolate color.

Whirling and Adding Water.—In whirling the test bottles and adding water the same directions should be followed as are given for testing milk. It is best to add the water in two portions after the first whirling, as in the case of testing milk. The practice of filling the test bottles with one addition of water only does not yield uniformly satisfactory tests.

FIG. 13.
Standard 9 in., 9 Gr. 50% Cream Test Bottle

Reading the Test.—The cream test should be read at a temperature of 135° to 140° F. In order to have control of the temperature the test bottles should be placed in a water bath for three minutes on removal from the centrifuge. The water should come as high as the top of the fat column.

Much inaccuracy has been introduced into the testing of cream by the meniscus or curve on the surface of the fat column. This varies with bottles of different types. Also the meniscus is often not clearly defined. The only reliable method of removing this source of inaccuracy is to remove the meniscus, changing the upper curved surface of the fat column into a flat surface.

If a few drops of glymol—one-half to one cubic centimeter—are added to the top of the fat column first before reading, the meniscus is removed from the surface of the fat column, leaving a straight and sharply defined line between the top of the fat column and the bottom of the glymol, making the fat column easily and accurately read. In adding the glymol it should be run down the side of the bottle neck, on top of the fat column. If dropped directly on the fat column it is likely to cause a ragged and indistinct surface. It can be conveniently added by means of a pipette.

FIG. 14.
6.5 inch, 18 Gram, 50% Cream Test Bottle

Glymol is a white mineral oil which is lighter than butter fat. It can be obtained at any drug store at a cost of about 75 cents per gallon. Glymol may be colored with alkanet root. Use one ounce of crushed alkanet root to one quart of glymol. Wrap the alkanet root in a piece of muslin and place it in the vessel containing the glymol for one or two days. This will give the glymol a bright cherry color.

Defects in Fat Column. Defects in the fat column of the cream are due to the same causes as given under milk testing.

TESTING SKIM-MILK, BUTTERMILK AND WHEY.

Skim-milk, buttermilk and whey are tested in bottles provided with double necks. The milk and acid are delivered through the larger neck

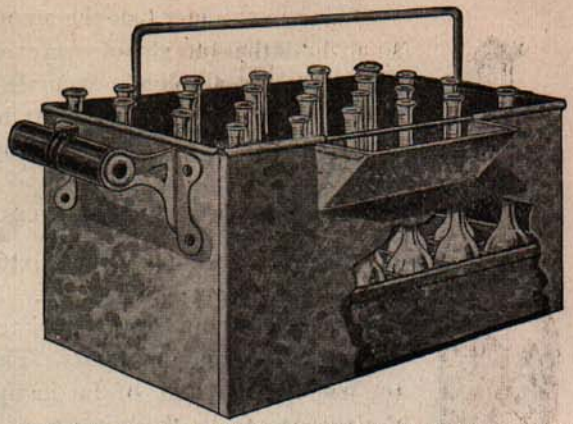


FIG. 15.—A water bath to insure easy control of the temperature for reading the test. The water should have a temperature of 135° to 140°F., and reach to the top of the fat column in the test bottle

FIG. 16. Glymol removes the meniscus and facilitates accurate reading of the fat column in the Cream Test.

while the smaller one is used for the per cent. of fat. There are two methods of graduation in these bottles. In some bottles the total graduation is .25 per cent. and the subdivisions represent .01 per cent. In others the total graduation is .5 per cent. and the subdivisions represent .05 per cent.

Mix the sample carefully, as described for the whole milk test. Then measure the sample into the test bottle with the 17.6 c.c. pipette. Add about 20 c.c. of acid instead of 17.5 c.c. If the acid is added in several portions, and the sample shaken after each addition, better results will be obtained than if the total amount is added at once. In the case of whey, use about 8 to 10 c.c. of acid.

In order that all the fat may gather in the calibrated neck, place the bottles in the tester so that the large filling tube faces the center. Whirl the bottles and add water as in the test for whole milk, but run the centrifuge about five minutes longer and keep the temperature as near 140° F. as possible.

FIG. 17.
A skim-milk test bottle on which each subdivision represents .01 of one per cent.

Owing to the fact that the amount of fat is so small and the fat globules are so minute it is difficult to get absolutely accurate tests of skim-milk, buttermilk and whey. At best the results should be considered only as approximations.

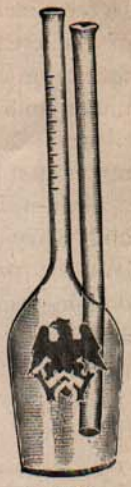


FIG. 18.
A skim-milk test bottle on which each subdivison represents .05 of one percent.

COMPOSITE SAMPLES.

A composite sample is a mixture of samples of milk taken from day to day. The purpose of the composite sample is to obviate the labor and expense of making daily tests. The fat test gives the average per cent. of fat in the milk for the period covered by the mixture of daily samples.

For composite sampling it is necessary to use jars which can be tightly sealed to prevent evaporation. Pint jars with glass stoppers, cork stoppers, metal or screw tops, should be used for this purpose. A separate jar is used for each patron or for individual cows as the case may be. Each jar must be marked in some distinctive way, either with the name or number of the individual.

Taking Samples.—In order to get correct composite samples, care should be exercised that the small samples taken are an accurate and an aliquot part of the whole. To be so the milk should be thoroughly mixed and a milk thief or graduated pipette used in taking the sample. If a milk thief be used, it is inserted in the weigh can of the entire delivery of a patron. The milk rises in the tube to the same level as that of the milk in the weigh can. When the tube is filled it is drawn out and the contents emptied into the sample jar. The milk thief gets a uniform proportion of the milk as it takes a sample corresponding to the amount of milk in the weigh can.

FIG. 19.
Glass-stoppered milk sample bottle. Stopper fits tight and prevents evaporation.

If the quantity of milk varies but little from day to day, a small dipper may be used in taking the sample. A dipper holding about half an ounce or an ounce is generally used. Where there is considerable variation in the quantity of milk, the sampling tube is much more accurate.

Care of Composite Samples.—Composite samples should be kept covered tightly to prevent evaporation of water which tends to increase the per cent. of fat. Evaporation also tends to cause the formation of a tough, leathery cream which

FIG. 20.
The metal top milk sample bottle is easily and quickly opened.

makes it difficult to secure an accurate sample for the test.

Shaking the sample jar with a gentle rotary motion after each addition of milk will prevent undue separation of the cream and prevent its drying fast to the sides of the jar.

Use of Preservatives.—In order to prevent spoiling of the sample by fermentation it is necessary to use a small amount of preservative, such as corrosive sublimate, formalin, or potassium bichromate. Of these, corrosive sublimate is the most satisfactory for general use, being a more powerful antiseptic than either of the others. It is put up in convenient tablet form and being a violent poison, it is colored to warn people against using any of the milk in which it is put. One tablet will preserve one pint of milk about two weeks. The preservative tablet should be placed in the sample bottle at the time the first portion of the composite sample is taken. Shake the bottle until the tablet is dissolved. Then shake the bottle after each addition of milk in order to get the contents thoroughly mixed. This also helps to prevent the formation of a tough cream layer and keeps the sample in good condition for the test.

When to Test.—In order to get reliable and satisfactory results from composite samples, they should not be kept longer than one week and tested at the end of that period.

How to Test.—When the composite sample is to be tested it is treated according to directions for testing whole milk, great care being taken to get all the cream into solution.

ACKNOWLEDGEMENT.

Acknowledgement is here made to The Ceamery Package Manufacturing Company, The Wagner Glass Works, The Torsion Balance Company, and D. H. Burrell and Company for their kindness in furnishing most of the electrotypes for this circular.