TESTING MANUAL
BACTERIAL
CONTROL GUIDE

Borden's
Farm Products Co., Inc.

PREFACE

While a number of text books, experiment station bulletins, etc., give more or less complete directions for carrying out the Babcock test for butter fat, none of these works cover in detail the matter of conducting the test in quantities, as is the practice in country milk stations where composite samples are taken. This manual has been prepared after a careful study of the common irregularities that enter into this work and is designed for the purpose of aiding the Borden operators in their daily work, not only as to accuracy, but in saving of time and labor as well.

In the printed pages which follow, will be found the personal experience of the undersigned in visiting and instructing local testers in their work and in each and every case the suggestions outlined must be carefully followed in order that a standard practice of efficiency be maintained in this class of work.

BORDEN'S FARM PRODUCTS CO., Inc.

Wm. H. Marcussen.

April 28, 1917.

PREFACE TO REVISED EDITION

In order to keep abreast of the times in the testing of dairy products, several corrections and additions to the original text have appeared necessary and they have been incorporated in this revised edition of this little book.

The increasing importance of the subject of bacteria and their relation to the milk supply, as indicated by the interest shown along these lines by state and municipal Departments of Health and other sanitarians, together with a recognition on the part of progressive milk distributors that this problem must be successfully solved, has prompted including in this revised edition, standard directions for the collection and preparation of samples of milk for bacterial examination.

Wm. H. Marcussen.

September 17, 1919.

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COMPOSITE JARS

Composite jars should be of approximately one pint capacity. Any one type of the following three may be used; all the jars, however, in a single factory should be uniform.

1. Metal cap pint milk bottles. When these are used care should be taken to see that the metal caps are not bent. Paper caps should always be used under the metal cap, to prevent evaporation of the watery part of the milk and thus result in a higher test than actual when the milk was delivered.

2. Glass top pint preserve jars. The regulation rubber ring should always be used on this jar to check evaporation as pointed out under metal cap jars.

3. Ground glass stoppered pint bottles.

MARKING OF JARS

All jars should be permanently marked with the dairy number to which they are assigned. Brass tags with the number stamped upon the face and attached to the bottle by wire are the most satisfactory means of identification.

COMPOSITE JAR CABINET

Composite Jars should be kept in a cabinet convenient to the weigh tank, this cabinet being provided with a door that can be locked. **This cabinet should be locked** except during the time when patrons' milk is being delivered, for the following reasons:

1. Exposure to light has a tendency to harden butter fat.

2. To guard against any from handling composite samples other than duly licensed tester.

TAKING OF SAMPLES

Each factory should be provided with a long-handled dipper of approximately one ounce capacity for the taking of the daily sample. **Samples should be taken direct from the weigh tank, one dipperful** (1 oz.) constituting the daily sample from each dairy. Only in case of dairies delivering one can or less, may

sample be taken direct from can, provided the milk is thoroughly agitated with a stirrer. Stirring with composite sample dipper is not sufficient to thoroughly mix the milk.

In factories not equipped with a weighing tank the sample should be taken in the following manner:

Stir each can thoroughly. By means of a "milk sampler" (commonly called "milk thief") take a proportionate amount from each can by touching the bottom of the can with the "sampler." Transfer this to a metal cup of one pint size. Stir the milk in the cup and transfer a one ounce dipperful to composite jar.

PRESERVATIVE

During cold or moderate weather one No. 2 Corrosive Sublimate tablet is sufficient to preserve the composite sample. In mid-summer two No. 2 tablets should be used.

CARE OF COMPOSITE SAMPLES

Great care must be taken in handling composite samples, in order to keep the milk in as near the condition of fresh milk as possible, and to prevent the butter fat from adhering to and drying on the sides of the jar. This is best accomplished by **daily gentle whirling,** giving the milk a rotary motion, at the same time keeping it as low in the jar as possible. It is advisable that this be done the first thing in the morning, before the patrons begin delivering, and when sufficient time is at hand to do this work properly. A jar should never be handled so that the milk or butter fat is spattered up on the sides or top of the jar.

Carelessness in handling composite jars means extra labor on testing day and the possibility of an inaccurate result.

TESTING DAYS

Composite samples should be tested on the 7th, 14th, 21st, and last day of the month. **These dates must be strictly adhered to.**

EQUIPMENT

Bottles: The 8% milk bottle graduated at each .1% is the standard test bottle.

Pipettes: Either the ordinary 17.6 c.c. pipette or the 17.6 c.c. "Automatic" or "Up-to-Date" pipette may be used. The latter has the following advantages:

1. Insures a full 17.6 c.c. sample without manipulation of the fingers.

2. Delivers a solid column of milk as all foam passes over to overflow bulb.

Pipettes with broken tips should never be used.

MARK OF CERTIFICATION

All 8% test bottles and both plain and "Up-to-Date" pipettes should bear the **"Mark of Certification of Accuracy"** of the State Experiment Station of the state in which they are being used.

WARMING COMPOSITE SAMPLES

On testing day composite samples should be placed in a vat of warm water and brought to a temperature of approximately 100 degrees F., by **gentle shaking.**

Note:

1. Excessive shaking may churn out butter fat.

2. Temperature of sample should not exceed 100 degrees F. Above this temperature a part of the butter fat is converted to an oil which floats on the surface of the milk and is consequently lost in taking the pipette sample.

LOOSING BUTTER FAT ADHERING TO JAR

At this point the sample should be smooth with no signs of cream adhering to the sides of the jar. If an occasional jar shows cream adhering to the sides, this should be worked down into the milk by means of a soft wood stick or paddle. This is more satisfactory than the use of a brush and less dangerous in the possibilities it presents in carrying butter fat from one sample to another.

PIPETTE SAMPLE

When temperature of 100 degrees F. is attained the sample should be poured from one vessel to another several times to insure thoroughly mixing. The pipette sample of 17.6 c.c. is then taken, this being the equivalent of 18 grams of milk. In using the plain pipette the bottom of the meniscus should be on a level with the 17.6 c.c. mark on the pipette, this mark being on a level with the eye.

COOLING THE SAMPLE TO 60 DEGREES F.

The milk is then transferred from pipette to test bottle, the test bottle then being placed in water of about 58 degrees F., to cool the milk to approximately 60 degrees F. before the acid is added. Experience has shown that a 40 qt. can cover makes an ideal receptacle to cool and maintain a temperature of 60 degrees F. in the test bottles, the small hole on the side of the cover providing an overflow for the cooling water, at just the right height as more bottles are added. A can cover will in this way accommodate 12 bottles when arranged in a circle just inside the rim, thus two covers will accommodate 24 bottles for one run of the machine. Of course, the composite jars themselves may be cooled down to 60 degrees F., but this requires considerable time and much shaking of the jars which is undesirable, because continual shaking has a tendency to churn the butter fat in the sample. Also by the use of the can covers the measured sample can be held at exactly 60 degrees F. up to the moment the acid is added, even in very warm weather, which gives a decided advantage over the method of cooling the jars which always permits of the possibility of the measured sample rising in temperature before the acid is added.

RINSING PIPETTE IN SAMPLE

When measuring out a number of samples of milk in passing from one sample to another with the same pipette, the pipette should be rinsed by drawing it full of the milk to be sampled, this portion to be discarded. This eliminates the possibility of carrying butter fat from one sample to another and is more satisfactory than rinsing in water.

ACID

The sulphuric acid to be used in the test should be at a temperature of approximately 60 degrees F. Acid should be kept in glass stoppered bottles and not in open vessels, such as china pitchers, etc., or in metal top milk bottles as exposure to the air weakens it and leads to irregular results. The acid may be fairly dark colored and still be suitable for testing. It should, however, be free from particles as they have a tendency to come up in fat column of the completed test.

PURPOSE OF ACID

The purpose of adding the acid is to destroy all the milk solids except the fat, which it does by moist combustion. In this process great heat is produced. This is advantageous since the fat must be kept in a liquid condition in order to perform the test properly. The neck of the test bottle gives percentage readings only when the fat is in a liquid condition.

ADDING THE ACID

In adding the sulphuric acid the bottle should be slanted and as the acid is poured in, the bottle should be revolved so that the acid will wash down any milk that adheres to the neck of the bottle. If this is not done, the milk dries on the neck of the bottle and is lost in the test; it also causes a cloudy bottle neck and obscures the fat column when the test is completed. **The acid and milk should be thoroughly mixed as soon as the acid is added to the bottle,** else portions of the sample might be charred and so lock up small particles of fat. It is well to mix the bottle for **at least half a minute** after all the milk has apparently been dissolved by the acid. The mixing is done by holding the bottle by the neck between the thumb and the index finger, giving it a rotary motion from the wrist. If an up and down motion is used the contents of the bottle are likely to be spilled.

COLOR FORMATION IN MIXTURE OF ACID AND MILK

With acid of the usual strength (1.820 to 1.830 specific gravity) and at a temperature of 60 degrees F. (milk in test bottles also at 60 degrees F.) 17.5 c.c. of acid should be used. This will provide just enough acid to **slowly destroy** the "milk-solids-not-fat" without too much heat and without charring them. In this reaction the characteristic color change is the best guide. As the milk and acid begin to mix the color of the solution becomes yellow at first, then passes through varying shades of yellow to violet, brown and finally dark brown. Too strong an acid or too high a temperature of either milk or acid produces a dense black color. The prompt formation of a black color will always give charred particles of milk solids in or under the fat column and this is a condition that leads to great inaccuracy in the test. Consequently, the **color formation and the appearance of the fat column of the completed test** (described later) are the best guides as to the amount of acid to be used.

HANDLING VERY STRONG ACID

Occasionally a carboy of acid may be encountered, in the use of which even when the temperature of milk and acid is held down to 60 degrees F., still such an intense reaction may be brought about so as to char rather than dissolve the milk solids. The specific gravity of such acid is probably 1.835 or above, and it may be handled in one of the two following ways:

1. By slightly reducing the amount of acid used. If black specks still appear in the fat column, resort to No. 2.

2. By reducing the strength of the acid with water as follows: Pour into empty bottle 30 c.c. (about 1 oz.) of cold water. Add slowly one quart of the strong acid. Mixture will rise to a temperature of approximately 100 degrees F. This should be cooled to 60 degrees F. before using. Occasionally with exceptionally strong acid it may be necessary to use 40 or 50 c.c. of water. A little experimenting will soon determine the exact amount necessary.

After the acid has been added and the solution of the milk solids is complete, the test bottle should be placed in the carrier cup of the machine so as to reduce the loss of heat to a minimum while the acid is being added to the other bottles. Just before centrifuging the bottles give each an **extra shaking to insure complete solution.**

Note: Bottles should never be allowed to stand any length of time before centrifuging after the acid has been added. If at any time it is necessary to divide the work, the test bottles may be set away in a cool place after the 17.6 c.c. of sample has been placed in them and **before** the acid is added. When the acid is once added the test must be carried through to completion.

CENTRIFUGING THE BOTTLES

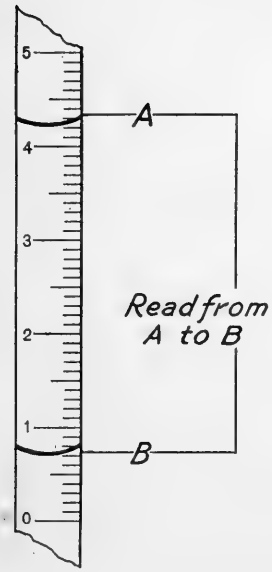
When less than 24 bottles are run at one time care must be taken to see that the machine is properly balanced. Centrifuge the bottles for **five minutes at a speed of 1,000 revolutions per minute.** Add hot water of a temperature of 150 degrees F. to the base of the neck of each bottle. Centrifuge for **two minutes** (*and*) again add hot water until the top of the fat column is a little below the 8% mark on the bottle. Centrifuge for **one minute** and begin taking readings immediately.

The above speed of 1,000 revolutions per minute applies to 12-inch diameter wheel (24 bottle) machine, this being the machine most commonly used. With the 18-inch diameter wheel (36 bottle) machine the speed should be 800 revolutions per minute.

TEMPERATURE OF BUTTER FAT

In taking the readings remove the bottles one at a time from the machine, replacing the cover each time a bottle is removed so that an even temperature is maintained. The **butter fat should be at a temperature of 135 to 140 degrees F. for at least three minutes before reading is taken,** and this condition will be fulfilled if the above directions are carefully followed out. This condition can also be fulfilled by placing the bottles in water at a temperature of 140 degrees F., having the water deep enough to surround the entire fat column.

READING THE FAT COLUMN



The fat column should be read by means of **sharp pointed dividers that permit of rapid adjustment** and that will retain their position when once adjusted. The one point of the dividers should be placed opposite the base of the column, which is nearly a straight line when the testing is properly performed, the other point of the dividers being placed **opposite the highest point** at the top of the fat column. The lower point is then rapidly dropped to the zero mark, the result being opposite the upper point of the dividers.

Emphasis is placed upon the fact that the highest point on the top of the column is the proper point to determine the upper limit.

REASON WHY FAT COLUMN IS READ AT EXTREME UPPER LIMIT

The objections may be raised that we get too high results by reading from the extreme top points of the fat column just as if the upper surface was straight at these points instead of concave. While there is such an apparent error the excessive reading thus caused is only enough to make up for the loss of fat which cannot be separated from the rest of the liquid by centrifugal force and brought into the fat column. The amount of fat thus left in the mixture of milk serum and acid is ordinarily about .2% and this is about the amount of excess obtained by the approved method of reading the upper limit of the fat column.

FAT COLUMN SHOULD BE WITHIN THE GRADUATED PORTION OF NECK

If the lower limit of the fat column is **below** the zero mark or the upper limit **above** the 8% mark the reading should not be taken with dividers as the volume of the neck has only been determined between these points and we have no positive assurance that the remainder of the neck is of like volume. When the fat columns extend below the zero mark a little water may be added and the bottle centrifuged for an additional minute and then read, but when the column extends above the 8% mark the only resort is to repeat the test.

CHECKING RESULTS

After obtaining the readings and before the composite jars are put away to be held ten days as provided by law, the results just obtained should be compared with the previous results on the same dairies and in those cases where the variation is **greater than .2 of one per cent** the test on these samples should be repeated to verify the results.

RECORD OF RESULTS

Neat and complete records of each testing date should be kept in special book provided for this purpose. This book should be available for inspection by the state or company officials at any time.

APPEARANCE OF COMPLETED TESTS

Color of fat column should be **straw yellow.** If very dark it indicates too strong acid or too high a temperature of milk or acid.

Black Specks

Absence of foreign matter. Fat column should contain nothing but butter fat. If black specks or particles of charred casein are gathered at the lower limit or are incorporated in the body of the column it is an indication that the acid is too strong or that the temperature of milk or acid was too high, thus bringing about a too violent reaction which charred the milk instead of slowly dissolving it.

Light Colored Specks

If greyish white specks are present—and this is usually accompanied by a very pale yellow color and cloudy condition of the column itself—it indicates a weak acid or too low a temperature of milk or acid. In this instance the reaction between the acid and milk has not been sufficient to entirely dissolve the milk solids.

Gas Bubbles

If bubbles of gas appear as foam on top of the fat column they are generally due to the use of hard water containing lime. Usually this condition can be overcome by adding to the hot water tank a few drops of sulphuric acid. If this condition still persists it is advisable to collect sufficient rain water for use in testing.

Too much importance cannot be placed upon the obtaining of a clear **straw yellow** colored fat column, absolutely free from all foreign matter. **The presence of particles of any kind in or below the fat column indicates the inaccuracy of the results.**

CLEANING BABCOCK GLASSWARE

Test bottles should be thoroughly washed between tests, **and this should be done immediately on completing the test.** If washing is delayed until fat has solidified it requires very much more labor to properly clean the bottles. When emptying bottles **shake them vigorously** as the contents run out. A

viscous sediment is formed by the action of the sulphuric acid on the milk and the hot acid helps to loosen this sediment if the bottles are well shaken. Prepare a pail of hot soap solution and a pail of hot water. Four to six bottles may easily be taken in each hand and immersed in the soap solution until about one-half full. Repeat this operation twice, shaking vigorously while the bottles are emptying. Rinse twice in a like manner in the hot water. If bottles are then inverted so as to drain they will be thoroughly clean and bright. No brush is necessary unless the bottles have been allowed to stand some time before cleaning.

The matter of keeping Babcock glassware absolutely clean at all times is not only one of personal pride on the part of the tester but it also insures more accurate results.

LEGISLATION REGARDING TESTING

In the spring of 1916, the legislature of New York State passed the Towner Act relative to taking composite samples in duplicate **when requested** by **patrons.**

In 1917 further legislation regarding milk testing was passed in the form of an act making it necessary for any person testing milk or cream by the Babcock method where the result of such test is used as a basis for payment or for public record to hold a state license empowering him to perform such tests.

On April 3, 1918, both of the above acts were amended so as to appear as one section of the Agricultural Law of the State of New York, to be known as Chap. 125, Section 35-a. In the amended law which is now in force provision was also made that composite samples must be resealed after test is completed and kept for at least ten days after making the test, for the purpose of permitting the Commissioner of Agriculture or his duly authorized representative to examine and test same.

The entire act in its present form follows:

CHAPTER 125

§ 35-a. **Fat tests of composite samples of milk.** Corporations, associations or persons hereafter buying milk from producers of milk to be paid for on the basis of the percentage of milk fat contained therein and for that purpose taking samples therefrom to form a composite sample to be tested periodically

to determine its value on such basis, shall, at the request of the producer, take such samples in duplicate and subject them to the same treatment. At the end of the period for which the composite sample is being taken such corporation, association or person shall tender same to the producer thereof or to his authorized agent and give such producer, or his said authorized agent, the choice of one of the two composite samples so taken. Such producer is hereby permitted to send such duplicate composite sample so received to the head of the department of dairy industry of the college of agriculture at Cornell University within ten days from the receipt thereof, properly marked for identification, and shall accompany same with his name and post office address. Such department head shall cause such sample to be tested for the per centum of milk fat and shall send a report of such test to the producer from whom it was received within ten days, or as soon thereafter as possible. Corporations, associations or persons hereafter testing samples of milk under the provisions of this section shall reseal the remaining portion of the composite sample from which the test was made, to determine the value of the milk bought from producers, and keep the same for at least ten days after the making of such test for the purpose of permitting the commissioner of agriculture or his duly authorized representative to examine and test the same.

Any person testing milk or cream by the Babcock method where the result of such test is used as a basis for payment, or for official inspection, or for public record, shall first obtain from the commissioner of agriculture a license to do such testing. Such license shall be granted upon satisfactory evidence of good moral character and the ability to make such tests based upon satisfactorily passing an examination set by the commissioner of agriculture. Such examination shall be based upon methods for making the Babcock test as outlined by the New York state college of agriculture and the commissioner of agriculture. Licenses granted under this section shall be revocable by the commissioner of agriculture upon evidence of dishonesty, incompetency or inaccuracy. Licenses shall be granted for one year renewable at the discretion of the commissioner of agriculture without further examination.

§ 2. This act shall take effect immediately.

TESTING FROZEN MILK

Partly frozen milk should never be sampled for testing since a sample of such milk will not be representative. Such milk should be melted and carefully remixed before any is removed for testing, but in melting the ice a temperature of not over 85 degrees F. should be used. Too high a temperature is likely to cause a separation of the fat in the form of an oil, and when the fat thus separates it is impossible to remix it evenly with the milk.

TESTING SOUR MILK

Sour milk should not be tested unless such testing is absolutely necessary. Composite samples will not turn sour if sufficient preservative is used and if the jars are thoroughly washed and the samples well cared for during the composite period. It is difficult to test sour milk because the casein has been precipitated and the fat is locked up in the particles of curd, making an even distribution of the fat impossible. The consistency of sour milk can be made more like that of normal milk by the addition of a strong alkali which drives or tends to drive the casein into suspension. The particles of fat are then released. Caustic soda and caustic potash are useful in restoring the consistency of sour milk and it is best to add them in the dry form.

TESTING CHURNED MILK

Churned milk should not be tested if it can be avoided. When it is absolutely necessary to test churned milk the milk should be heated to about 85 degrees F. and well shaken, and the pipette sample drawn quickly.

CONCLUSIONS

Carefulness and attention to details result in accuracy in Babcock test work.

The following very important features will bear repetition:

1. The daily samples should be taken in such a manner, and the composite sample in the jar should be so handled during the entire period, that on testing day when the 17.6 c.c. of milk

be transferred to the test bottle it will be an exact representation of the entire bulk of milk delivered during the entire period, by each individual patron.

2. The test should be so conducted that on completion it will give a clear fat column of straw yellow color with no evidence of either light or dark particles in or under the column.

3. An accurate reading should be made by means of sharp pointed dividers in which the extreme limits of the column are included.

CREAM

The Babcock test can be used in ascertaining the amount of fat in cream but certain precautions and modifications are necessary to insure correct results.

The four main factors to be considered are:

1. Taking the sample.

2. Getting the correct amount of cream into the test bottle.

3. Conducting the test so as to obtain a clear fat column absolutely free from foreign matter.

4. Reading the fat column correctly.

SAMPLING CREAM

The importance of thorough mixing of the cream in its original container is essentially important. If the sample is taken from a can the cream should be thoroughly mixed by stirring for at least a half minute. After thorough agitation it is necessary to take up but a very small sample (about 2 oz. being sufficient for one test and a duplicate). The taking of larger samples merely means a waste of cream.

WEIGHING THE CREAM

The sample should be warmed to a temperature of 85 to 100 degrees F., and it should then be poured several times from one bottle to another, care being taken to see that the sample is thoroughly smooth. Merely stirring a sample with a pipette or blowing air through it by means of a pipette is very poor practice and gives only indifferent mixing. The matter of thoroughly mixing samples by warming to 85 degrees F. and pouring several times back and forth is especially important after the samples have stood awhile at room temperatures before testing.

If small lumps are present the cream should be strained through a small sieve, at the same time working out the lumps so as to make the cream absolutely smooth before sample is weighed.

Cream should never be measured but should always be weighed for the following reasons:

1. More fat adheres to the inside of the pipette than in the case of milk.

2. The weight of cream decreases as the per cent of fat in cream increases, since the butter fat is lighter than the other constituents in cream.

3. Separator cream is more or less filled with bubbles of air and ripened cream contains gases produced by fermentation. These decrease the weight of a given volume of cream.

CREAM TEST BOTTLES

The 9 gram 50% bottle and the 18 gram 50% bottle are the standard bottles for testing cream. The 9 gram 50% bottle is considered the Borden standard. This bottle is more economical in the amount of cream it requires for a test, and since it is graduated in 0.5% it gives an accurate reading.

The old style 18 gram 15, 25 and 30% bottles should be discarded. With the latter bottles it would be necessary to weigh out an aliquot part of 18 grams (viz., 9 grams or 6 grams), the result then being multiplied by two or three as the case may be. The main objection to this method is that if a slight error be made in the test, it will be two or three times as great in the final result, because the reading must be multiplied by that factor representing the aliquot part of 18 grams used.

CONDUCTING THE CREAM TEST

The actual test on the weighed sample may be conducted in either of the following ways:

1. Babcock Test. To the weighed sample (9 grams of cream) 9 c.c. of water are added. This is to retard the action of the acid, and in this way a burned fat column may be avoided. The water should be warm enough to rinse into the body of the bottle all the cream that adheres to the neck.

Add 16 to 17.5 c.c. of sulphuric acid, specific gravity 1.82 to 1.83, at 60 degrees F. until mixture immediately after shaking resembles coffee with cream in it. Whirl in Babcock machine at proper speed five, two and one minutes respectively, filling the bottles with hot water (temperature 150 degrees F.) to the bottom of the neck after the first whirling, and to near the top of the graduation after the second whirling. Result as later described under "Flattening of Meniscus."

2. Modified Leffman and Beam Test or Amyl Alcohol Method. To the weighed sample of cream (9 grams) in the test bottle 1½ c.c. of a mixture of amyl alcohol and hydrochloric are added and thoroughly mixed by giving the bottle a rotary motion. (The mixture of amyl alcohol and hydrochloric acid consists of equal parts of each of these chemicals. This should be prepared in advance.) 4½ to 5 c.c. of sulphuric acid are then added, pouring a little of the acid at a time, meanwhile giving the bottle a rotary motion. After the acid has been added allow the bottle to stand about two minutes or until the mixture turns dark and the butter fat has risen to the top in a clear layer. Fill the bottle to the 50% mark with a hot and freshly made mixture of equal parts of water and sulphuric acid. (Caution—Always add the acid to the water.)

Centrifuge the bottle at 1,000 revolutions per minute for five minutes. Only one whirling is necessary.

The Babcock method is considered by the New York State Department of Agriculture the official method of testing both milk and cream. Our experience has been that the Amyl Alcohol method is very useful in testing cream as it is very easily performed and gives a clear butter fat column that is easily read.

TEMPERATURE OF FAT COLUMN

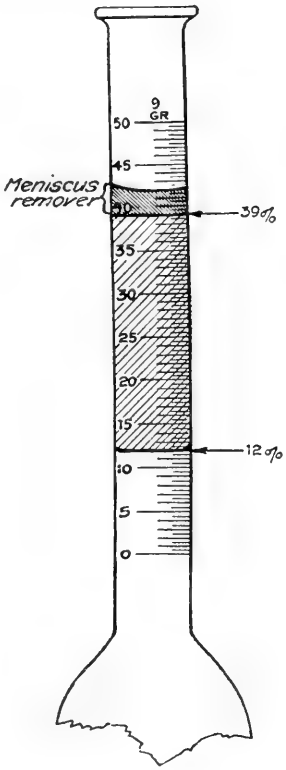
The fat column should be at a temperature of 135 to 140 degrees F. when read. In order to have the fat column at this temperature, the bottles should be immersed in a water bath at a temperature of 140 degrees F. for at least three minutes before reading the result, the water in the bath being deep enough to completely immerse the entire fat column. This adjustment of temperature of fat column is advisable in both Babcock and amyl alcohol methods.

FLATTENING THE MENISCUS

In order to obtain an accurate result when reading the fat column of the cream test, it is necessary to flatten the meniscus or curved upper end of the column so that a straight line may be obtained at this point. This is equally applicable in both Babcock and amyl alcohol methods. In this respect the reading of the cream test differs from that of whole milk. In the latter case the extreme limits of the column are included to make up for the residual amount of fat in the base of the bottle as pointed out in the manual under milk testing.

In order to accomplish this desired flattening of the meniscus a few drops of colored mineral oil or colored "Glymol" are added after the test bottle is taken from the water bath. The mineral oil should be added with a medicine dropper allowing the liquid to run down the inside of the neck of the test bottle until it reaches the fat column over which it will then spread giving a sharp line of demarcation. It should not be dropped directly into the fat for then it will mix with the fat and give a ragged line.

The reading should be made from the lower limit of the column to the sharp line of demarcation between the butter fat and mineral oil, as shown in opposite cut.



METHOD OF READING THE PERCENTAGE OF FAT IN CREAM

The arrows indicate the points on the scale at the ends of the fat column at which the readings should be taken.

TESTING SKIMMED MILK

Skimmed milk should be tested by the ordinary Babcock test. The regulation skimmed milk bottle should be used, this bottle having two necks, one having a very small bore in order to measure the small amount of butter fat accurately, the other being a funnel tube for conveniently adding the measured sample of 17.6 c.c. and the proper quota of acid. The Troy-Wagner bottle is well adapted for this test, this bottle having a small hole in the funnel tube to allow the escape of air when milk and acid are mixed and thus prevent the mixture of milk and acid being forced up into the graduated neck, and also to permit the more thorough washing of the fat when the water is added.

In the skimmed milk test 18 or 19 c.c. of acid should be used, the acid being added in two approximately equal portions with an intermediate shaking.

Skimmed milk bottles should be placed in the machine with the funnel tube to the outside.

The globules of fat in skimmed milk are very small and for this reason it is very difficult to bring them to the surface by centrifugal force. The bottles should therefore be whirled for periods of **ten minutes, two minutes, and one minute,** the hot water being added between these periods as in the case of whole milk.

Efficiently operated separators should never turn out a skimmed milk of more than .02 of 1% butter fat.

BUTTER

Preparation of Sample

A mass of butter is so variable in its composition, owing to the uneven distribution of water, that it is difficult to obtain a representative sample unless great care is exercised. A sample for testing should therefore be made up of parts selected from different places in the churn or package. The sample thus selected should be placed in a fruit jar or composite sample bottle and heated with constant agitation in water of about 110 degrees F., until the butter is of consistency of heavy cream. The sample should then be cooled, shaking the jar constantly to keep the moisture evenly distributed.

TESTING FOR BUTTER FAT

Weigh 3 grams of sample as prepared above into a 9 gram cream test bottle. Either the Babcock or Amyl Alcohol method (as described under cream testing) may be used. In using the Babcock method about 8 c.c. of sulphuric acid should be used, and in the amyl alcohol method 4 c.c. of sulphuric acid are sufficient. The reading should be multiplied by three to obtain the final result. Mineral oil should be used to flatten the meniscus.

TESTING FOR MOISTURE

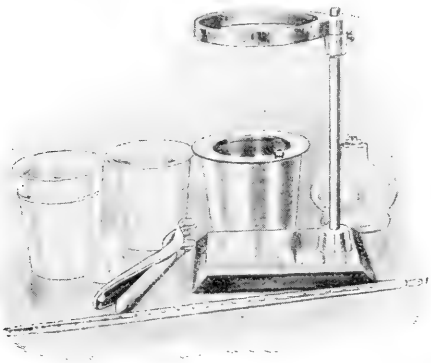
In the testing of butter for moisture special equipment is required. Among a number of tests on the market, our experience has been that the test known as the "Ames-Cherry" test gives very satisfactory results and is also very easily operated.

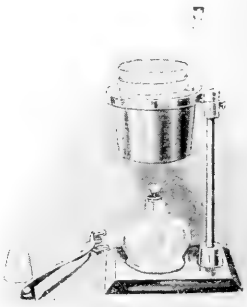
The equipment for this test consists of a tripod supporting a paraffine heating bath in which is inserted two aluminum cups so constructed that one cup fits tightly within the other. An alcohol lamp for heating the paraffine bath and an accurate thermometer complete the outfit. Direction for conducting this test follow:

1st. Start the paraffine to heating, using alcohol lamp that is furnished with the outfit, filling the copper container about one third full of paraffine.

2d. Place butter in an open container or vessel in which butter can be stirred and set in water at about 100 degrees F. until butter is soft and then stir until you have a thorough emulsion.

3d. Weigh out the 10 gram sample of butter into the inner or smaller aluminum cup.





4th. Set cup containing sample inside the larger aluminum cup and fit the outer aluminum cup into the copper paraffine kettle, pressing down so that the flange on the paraffine kettle will hold the outer aluminum cup in place. The time required to expel moisture will be from 5 to 7 minutes, depending on amount of moisture in butter. For testing creamery butter an even temperature of 175 degrees Centigrade is required. If you heat as high as 180 Centigrade you are liable to burn the sample.

5th. The cup and contents should be allowed to cool before weighing it back, as it is enough lighter when hot to make 2% to 4% difference in moisture reading.

In the copper paraffine kettle flange there is a small hole or opening into which special Centigrade thermometer is inserted. The end of the thermometer should be lowered to within about ½ inch of the bottom of the kettle by adjusting the wire clamp that is furnished with the thermometer.

By following the above directions carefully and heating the sample from 5 to 7 minutes, there is no danger of burning. The difference in weight before and after heating, that is, the loss in weight, divided by the original weight of the butter, and this result multiplied by 100, gives the percent of moisture.

For example:

Original weight of butter..... 10.00 grams
Weight after heating..... 8.54 "

Loss in weight..... 1.46 "

$$\frac{1.46 \times 100}{10} = 14.6\% \text{ moisture}$$

If a special butter moisture scale is used, the percent of moisture is given direct on the graduated beam of the scale, and the above calculation is then unnecessary.

COMPUTING OVERRUN IN BUTTER

Overrun is the increase in the amount of butter made from a given amount of fat, or it is the sum of the moisture, the salt, and the casein of the butter, minus the losses in manufacture.

For example:

Butter maker X has 1,000 pounds of cream testing 35% fat. From it he makes 400 pounds of butter. Compute the percentage of overrun and the value of the overrun at 50 cents per pound.

1,000 × .35 = 350, number of lbs. fat.
400 (lbs. butter)—350 (lbs. fat) = 50, weight in lbs. of overrun.
50 ÷ 350 = .142.
.142 × 100 = 14.2% overrun. (Answer.)
$.50 × 50 = $25.00, value of overrun. (Answer.)

Another example:

Butter maker Y is more careful in preventing leaks and wastes, and he understands butter making better than does X. From 1,000 lbs. of cream testing 35% fat he makes 420 lbs. of butter. Compute the percentages of overrun and its value at 50 cents per lb.

1,000 × .35 = 350, number of lbs. fat.
420 (lbs. butter)—350 (lbs. fat) = 70, weight in lbs. of overrun.
70 ÷ 350 = .20.
.20 × 100 = 20%, overrun. (Answer.)
$.50 × 70 = $35.00, value of overrun. (Answer.)

Butter maker Y has made from the same amount of fat $10 worth more butter than has X.

BUTTER FAT TEST ON BUTTER MILK

Tests for butter fat should be made on the buttermilk remaining to determine the completeness of the churning. This test may be performed as outlined under skim milk. When butter fat present in buttermilk is excessive, the 8% whole milk bottle should be used instead of the usual skim milk bottle.

COMPUTING LOSS OF BUTTER FAT IN CHURNING

In determining the approximate amount of buttermilk, subtract the weight of the butter—not the fat alone—from the weight of the cream.

For example, if 1,000 lbs. of cream were used for churning, and 400 lbs. of butter were made, the amount of buttermilk would be 1,000—400 = 600 lbs. If the buttermilk had a butter fat content of .5%, then:

600 × .005 = 3.0 lbs. butter fat.
3.0 × 1.20 = 3.6 lbs. butter (overrun.)
.50 × 3.6 = $1.80 value of butter fat lost in buttermilk.

CHEESE

In the sampling of cheese similar precautions must be used in order to obtain a representative sample as discussed in the sampling of butter. The most satisfactory method of obtaining a representative sample is to draw three plugs from the whole cheese, viz: one from center, one about one inch from the outer edge and one half way between these two. If only one plug can be drawn this should be taken at a point half way between the center and the margin. The plugs should be taken perpendicular to the end surface of the cheese and should reach either entirely through the cheese or just half way. The plugs should be carefully cut into small pieces and the sample for test bottle should be weighed promptly to prevent loss of moisture.

TESTING CHEESE FOR BUTTER FAT

As the normal amount of fat in American cheddar cheese will run from 33 to 38%, it is best to use the 9 gram 50% bottle in making the fat determination. Weigh 4.5 grams of the sample, prepared as above described, into the 9 gram 50% bottle. Then add 15 c.c. of hot water to the weighed sample and agitate until the water disintegrates the cheese. This may be hastened by adding a few drops of acid and keeping the bottle in slightly warm water until no more lumps are seen in the liquid.

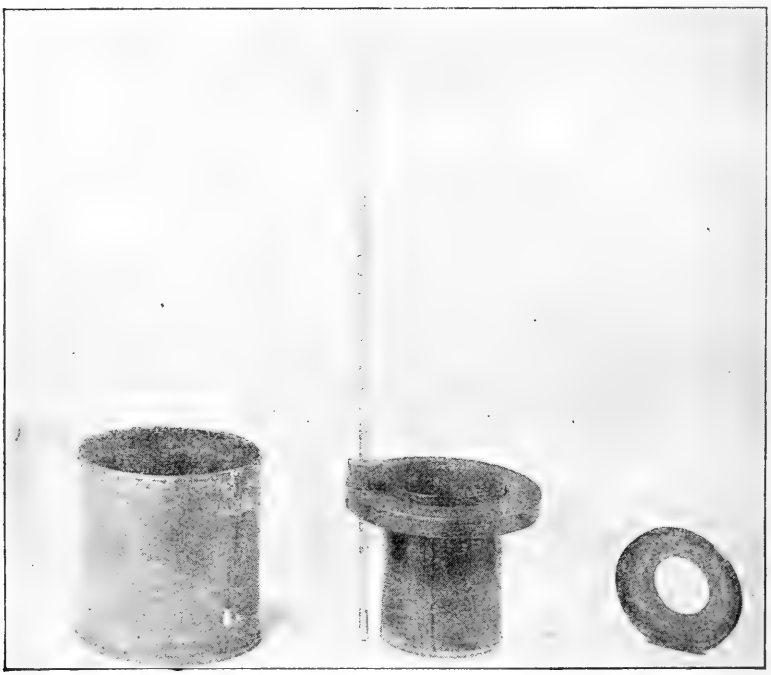
The test may be run by either the original Babcock method or the amyl alcohol method, in either case using a little more sulphuric acid than usual to completely dissolve the high percentage of solids—not—fat present in the cheese. Before reading the result mineral oil should be added to flatten the meniscus. Multiply the reading by two to obtain the final result.

TESTING CHEESE FOR MOISTURE

In testing cheese for moisture, the Ames-Cherry apparatus (described under testing butter for moisture) with slight modifications, may be used. These modifications consist in using a special glass flask instead of the inner aluminum cup of the Ames-Cherry apparatus, and a small cover for the outer cup, with a hole in it through which the neck of the flask may pass.

The directions for this test, which was originated by Prof. H. C. Troy of the New York State College of Agriculture, follow:

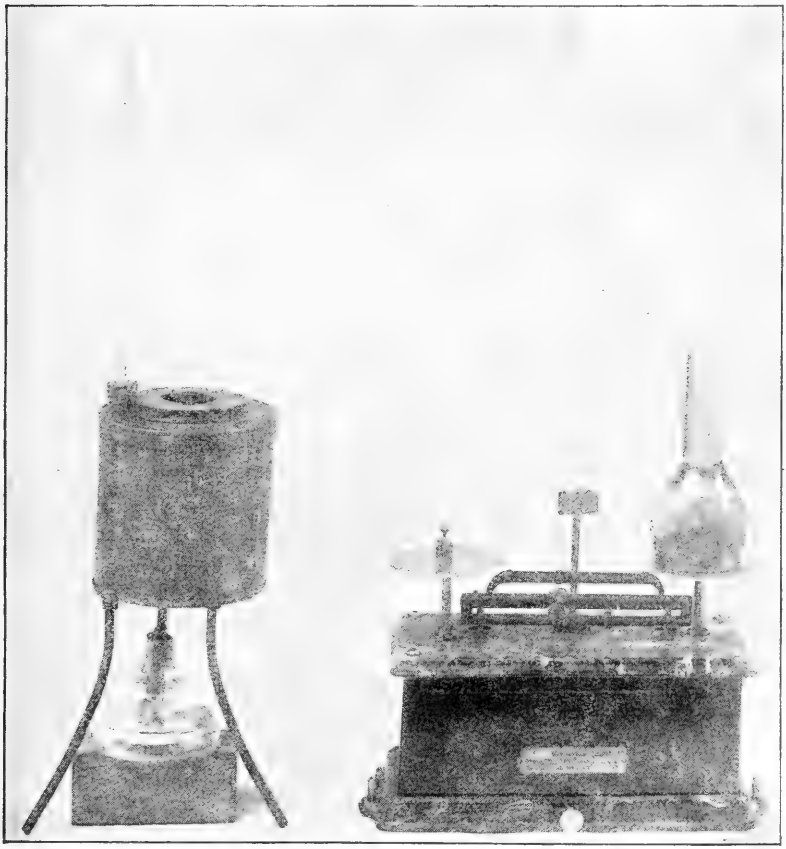
In operating the test, the alcohol lamp is first lighted, so that the parafin bath may be warming while the test sample is under preparation. A representative sample of the cheese, which may be taken with a cheese trier and held in a glass-stoppered sample jar, is then cut into particles about the size of kernels of wheat without removing it from the jar. This may be done



with an ordinary table knife that has had the end squared and sharpened. The clean dry flask is then accurately balanced on the scales and a 5-gram weight is placed in the opposite scale pan. Particles of cheese from the prepared sample are put into the flask until the scales comes to an exact balance. Great care should be taken to avoid loss of moisture from the cheese during the preparation of the sample.

With the thermometer in the parafin bath registering a temperature between 140 degrees and 145 degrees C. (or between 284

degrees and 293 degrees F.), the flask is placed in the cup of the parafin bath and the flat, disk-shaped cover is adjusted over the apparatus. The flask should remain in the bath for fifty minutes the temperature being kept between 140 degrees and 145 degrees C. all the time. The flask is then removed, covered, and al-



lowed to cool to room temperature in a dry place. It is then weighed, and the quotient obtained by dividing the loss in weight by the original weight, multiplied by 100, gives the percentage of water in the cheese. The following shows the method of computation.

Problem. Five grams of cheese was heated until the water contained in it was evaporated. The remaining substance weighed 3.15 grams. What percentage of water did the cheese contain?

Answer:

5.00—3.15 = 1.85
1.85 ÷ 5 = 0.37
0.37 × 100 = 37 (percentage of water in cheese)

A butter moisture scales with an extra 5-gram weight may be used for weighing out the 5 grams of cheese. If the scales indicates the amount of moisture in 10 grams of butter by percentage graduations on its beam or by percentage weights, then it will be necessary to multiply by two the percentage indicated by such scales when only 5 grams of cheese is used.

Caution:

In operating either the cheese or butter moisture tests, the temperature of the parafin bath should be carefully watched, so as not to over heat it. If over heated it may take fire. If a bath should ever take fire, smother out the flame. Do not throw water on it, since water would spread and intensify the flame. If the indicated temperatures are not greatly exceeded, there is no danger of fire.

CHEESE YIELD

In computing the cheese yield of milk, using the fat content as a basis of calculation, the results of careful experiments conducted by state experiment stations, show that within reasonable limits, the yield of cheese increases with the percentage of fat in the milk.

Percentage of fat in milk	Lbs. of Cheese from 100 lbs. of milk	Lbs. of Cheese for 1 lb. of butter fat in milk
3.0	8.28	2.76
3.5	9.41	2.68
4.0	10.56	2.64
4.8	12.51	2.60

Actual Cheese Yield

In order to obtain the actual yield of cheese, divide the number of pounds of cheese made by the number of pounds of milk used. Multiply the result by 100 to get the yield of cheese per 100 pounds of milk. For example, if 480 pounds of cheese are obtained from 5,180 pounds of milk, what is the yield?

480 ÷ 5,180 = .0927
.0927 × 100 = 9.27 lbs. cheese per 100 lbs. milk

Yield per pound butter fat

To obtain the yield of cheese per pound butter fat, samples should be taken of the thoroughly mixed milk, and tested by the Babcock method. For example, using the same batch of cheese given above (under "Actual Cheese Yield"), let us assume that the butter fat test on the whole milk was 3.5. Then:

5,180 × .035 = 180.30 lbs. butter fat
480 (lbs. cheese) ÷ 180.30 = 2.66 lbs. cheese per lb. butter fat

TESTING PLAIN CONDENSED OR EVAPORATED MILK

Weigh carefully 9 grams of well mixed plain condensed milk into a 10% (old style) milk test bottle. The 10% bottle is specified because of its larger neck, which permits the weighing of plain condensed milk more readily than the present 8% milk bottle. Add 9 c.c. of water. Mix condensed milk and water thoroughly. Add 3 c.c. of a mixture made from equal parts of hydrochloric acid and amyl alcohol. Again mix thoroughly. Add slowly and a little at a time 12 to 14 c.c. sulphuric acid. Allow to stand until fat has risen to surface and mixture has turned dark. Fill to just below 10% mark with a hot and freshly made mixture of half sulphuric acid and half water. Whirl for 5 minutes in Babcock tester. Add colored mineral oil to flatten meniscus. Read with dividers. Multiply reading by two for final result.

ACIDITY TEST

To determine the percent of acidity in either milk or cream, special apparatus is required. All acidity tests are based upon the principle of neutralizing the acid present in a definite volume of milk by a solution containing a known amount of alkali, the common alkali solution being what is commonly known among chemists as a deci-normal $\left(\frac{N}{10}\right)$ sodium hydrate solution. An indicator called "phenolphthalein" is also used. This indicator gives a pink color in the presence of alkali, and is colorless in the presence of acid.

The following apparatus is necessary for performing the acidity test:

1—25 c.c. burette graduated at each $\frac{1}{10}$ c.c.
1—burette stand
1—white cup or casserole
1—stirring rod
1—17.6 c.c. milk pipette
$\frac{N}{10}$—sodium hydrate (alkali) solution
Indicator (phemolphthalein)

Performing of Test

Measure 17.6 c.c. of milk into the white cup. Rinse the pipette by drawing clean water to the 17.6 c.c. mark, and add this rinse water to the cup. Then add 4 or 5 drops of the indicator to the mixture of milk and water.

Fill the burette with the $\frac{N}{10}$ alkali solution. Draw off the $\frac{N}{10}$ alkali **into another vessel,** through the stop cock of the burette until the solution stands at exactly the zero mark on the burette.

Now place the cup containing the milk to be tested under the stop-cock of the burette, and add the $\frac{N}{10}$ alkali solution **very slowly,** meanwhile stirring the milk thoroughly with the stirring rod. When the mixture assumes a **very light permanent pink color,** stop adding the alkali solution. At this part of the test, the alkali should be added drop by drop.

Calculating the Result

Read from the burette the number of c.c. of alkali required to produce the light permanent pink color. Divide this number

by two and the answer will represent the percent of acidity of the milk in terms of one-hundredths percent.

For example, if it required 2.8 c.c. of alkali, then 28 divided by 2 equals 14, or .14% acidity.

Standards for Milk

Fresh milk will give acidity tests between the limits of .12% to .15%. If the acidity is higher than .18%, it indicates that lactic acid fermentation has been going on, and that the milk can no longer be considered fresh.

Precautions

Precautions to be observed in running the acidity test:

1. All apparatus used in running this test must be **absolutely clean,** and it must be kept apart from other testing glassware. A small trace of sulphuric acid will affect the test very markedly, making the result unreliable.

2. Alkali solution should never remain in the burette after the test is completed. It should be immediately drawn back in the alkali bottle.

3. Alkali bottle should be tightly stoppered at all times. This solution loses its strength rapidly when exposed to the air. When weakened, it gives results that indicate too high acidity in the milk.

4. No more alkali should be added when a **light permanent pink** color is obtained. Do not add alkali until the deep pink color is obtained. This will give too high acidity.

5. Finally, it should be borne in mind that the acidity test is a very delicate one, and that the results obtained are very apt to be worthless if the test is not properly performed, or if the alkali solution is not properly protected from the air.

LACTOMETER

Lactometer readings are regularly obtained in the Eastern and Middle States by means of the New York Board of Health Lactometer.

In using the Lactometer the following procedure is recommended: Fill the cylinder with the carefully mixed milk at a temperature of 50 to 70 degrees F. Insert the lactometer and note the point at which it comes to equilibrium on the scale at the surface of the milk. The lactometer is graduated on the basis that all examinations are to be made at 60 degrees F. It is therefore necessary to take the temperature of the milk and to correct the reading by adding three tenths of a point for each degree of temperature above 60 degrees F., or to subtract .3 point for each degree below 60 degrees F. This rule holds good only when the range of temperature is within the limits of 50 degrees F. and 70 degrees F.

The best practice is to bring the sample to a temperature of exactly 60 degrees, F, and then take the lactometer reading.

PRECAUTIONS IN USING LACTOMETER

The following precautions should be observed in obtaining lactometer readings:

1. Milk should not be examined until about one to two hours after milking as the lactometer reading is lower for a while after being drawn than it is later, due to the presence of gases in the freshly drawn milk.

2. The sample must be thoroughly mixed.

3. The lactometer must be kept clean.

4. The lactometer cylinder must be large enough to allow the instrument to float freely without the possibility of friction between the lactometer and sides of cylinder.

5. Composite samples containing preservatives always give a higher reading than fresh milk. Accurate lactometer determinations can only be obtained from fresh milk.

QUEVENE LACTOMETER

In some dairy sections the Quevene lactometer is used in place of the N. Y. Board of Health lactometer. The readings on the Quevene scale differ from those on the Board of Health scale; for example, a reading of 29 on the Quevene is equivalent to 100 on the B. of H.

To convert Quevene reading to the equivalent B. of H. reading:

Divide the Quevene reading by .29.

Example: What is the equivalent B. of H. reading of 30.5 Quevene?

Answer: 30.5 divided by .29 equals 105.2 B. of H.

To convert B. of H. reading to Quevene reading:

Multiply the B. of H. reading by .29.

Example: What is the equivalent Quevene reading of 108 B. of H.?

Answer: 108 × .29 equals 31.32 Quevene.

CALCULATION OF TOTAL SOLIDS

When the butter fat content and the B. of H. lactometer reading of a sample of milk are known, the total solids may be readily calculated by the following formula:

$$\frac{L \times .29}{4} \times 1.2\ F = T.\ S.$$

L representing the B. of H. lactometer reading, F the butter fat content, and T. S. the total solids.

Example: What are the total solids in sample of milk having 3.6% butter fat and 108 B. of H. lactometer reading at 60 degrees F.?

Answer:

$$\frac{108 \times .29}{4} \times (1.2 \times 3.6) = T.\ S.$$

or

$$\frac{31.32}{4} \times 4.32 = T.\ S.$$

or

$$7.83 \times 4.32 = 12.15 \text{ Total Solids.}$$

TESTING EQUIPMENT

A stock of carefully selected and accurate glassware and supplies for testing milk and its products is maintained at the laboratory headquarters of our Company to meet the requirements of our country branches. When a factory wishes testing material a requisition should be made on Purchasing Department (Form No. O-1). The Purchasing Department will then authorize the laboratory to make shipment. **All orders for testing supplies should be sent to the Purchasing Department and not to the laboratory.**

While it is the aim of the Company to promptly supply all necessary equipment it should be borne in mind that these articles are costly and they should be handled carefully in order to keep breakage down to a minimum; and each factory should order supplies only in accordance with its actual requirements.

The articles that are regularly carried in stock follow:

Acidometer (for determing specific gravity of acid)
" jars
Acid measures (17.5 c.c.)
Acid-alcohol mixture for cream test
Bottles—6 inch milk test bottles (8%)
" " cream test bottles (50%)
" " skim milk test bottles
" glass stoppered (1,000 c.c.) for acid
Corrosive sublimate tablets (No. 2)
Cylinders—graduated (10 c.c.) for cream test
" " (8 oz.) for handling acid
Dividers—for reading butter fat columns
Lactometers (N. Y. Board of Health scale)
Lactometer jars
Milk Samplers
Pipettes—Milk (17.6 c.c.)
" to be used when weighing cream (9 c.c.)
Thermometers—floating dairy
" platform.

STANDARDIZING

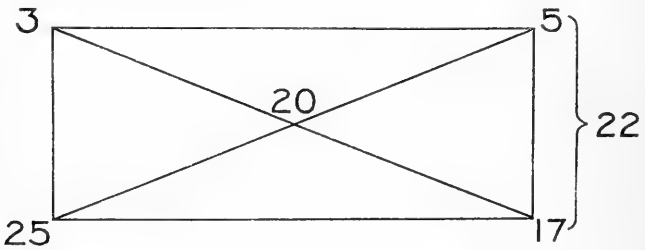
Standardizing milk or cream consists in raising or lowering the fat content to a fixed standard. This is done by adding to the material to be standardized, milk or cream of a higher or lower percentage of fat. Naturally the quantities of material of two different butter fat contents that should be mixed in order to obtain the desired result, is the first problem that presents itself.

The original method of computing problems in standardization is long and difficult, but a method suggested by Prof. R. A. Pearson of Cornell University is comparatively simple and is herewith described:

Draw a rectangle and write in the center the desired test. Write opposite the upper and lower left hand corners the tests of the materials you have on hand.

Determine the difference between figure in the **upper left hand corner** and that in the **center,** and write this result in the **lower right corner**—that is, subtract diagonally. Now determine the difference diagonally between the figure in the **lower left hand corner** and that in the **center,** and write the result in the **upper right hand corner.**

For example: If you have 3% milk and 25% cream, and wish to make 20% cream:



That is, 5 parts of 3% milk, when mixed with 17 parts of 25% cream, will give 22 parts of 20% cream.

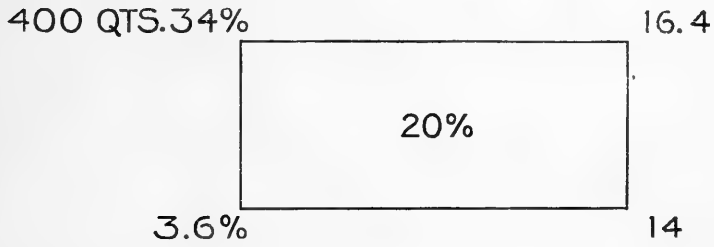
If the number of quarts of each of the two to be mixed, per 40 quart can, is desired, the following calculation may be used:

$5/22 \times 40 = 9.08$ qts. of 3% milk.

$17/22 \times 40 = 30.92$ qts. of 25% cream.

Another problem that often presents itself is when we have a definite amount of cream of a high test and we wish to know how many quarts it will make of a certain lower test, and how much milk should be added to make the proper mixture.

For example: if we have ten cans (400 quarts) of 34% cream, and we wish to know how many cans of 20% cream can be made, by adding 3.6% milk to it:



This shows that for every 16.4 quarts of 34% cream, 14 quarts of 3.6% milk should be used; so divide the 400 qts. by 16.4, and multiply this figure by 14, which gives 341.4 quarts of 3.6% milk to use. By adding 400 qts. to 341.4 qts., we will get 741.4 qts. of 20% cream; or,

$\frac{400}{16.4} \times 14 = 341.4$ qts. of 3.6% milk.
$400 + 341.4 = 741.4$ qts. of 20% cream.

The usual grades of cream marketed by our Company are the 20% butter fat, or "Route Cream," and the 38% and 40% butter fat, or "Extra Heavy Cream." Cream as it comes from the separators will very seldom meet with these requirements as to butter fat content. Accordingly it becomes necessary to standardize it by adding the proper amount of whole milk. In order to assist the cream operator, tables are herewith given, covering the possible range of separator creams, in which are set forth the number of quarts of cream and the number of quarts of milk (testing 3.6%) which, when mixed, will give 40 quarts of cream of the desired test. Milk testing 3.6% is a fair average that will apply to all plants.

These tables are given on the following pages:

TABLE NO. 1

To Make 20% Cream

When cream tests	To make 40 qts., use	
	qts. cream	qts. milk
21%	37.7	2.3
22%	35.6	4.4
23%	33.8	6.2
24%	32.2	7.8
25%	30.7	9.3
26%	29.3	10.7
27%	28.0	12.0
28%	26.9	13.1
29%	25.8	14.2
30%	24.8	15.2
31%	23.9	16.1
32%	23.1	16.9
33%	22.3	17.7
34%	21.6	18.4
35%	20.9	19.1
36%	20.2	19.8
37%	19.6	20.4
38%	19.1	20.9
39%	18.5	21.5
40%	18.0	22.0
41%	17.5	22.5
42%	17.1	22.9
43%	16.6	23.4
44%	16.2	23.8
45%	15.8	24.2

TABLE NO. 2

To Make 38% Cream

When cream tests	To make 40 qts., use	
	qts. cream	qts. milk
39%	38.9	1.1
40%	37.8	2.2
41%	36.8	3.2
42%	35.8	4.2
43%	34.9	5.1
44%	34.1	5.9
45%	33.2	6.8
46%	32.4	7.6
47%	31.7	8.3
48%	31.0	9.0
49%	30.3	9.7
50%	29.7	10.3

TABLE NO. 3

To Make 40% Cream

When cream tests	To make 40 qts., use	
	qts. cream	qts. milk
41%	39.0	1.0
42%	37.9	2.1
43%	37.0	3.0
44%	36.0	4.0
45%	35.1	4.9
46%	34.3	5.7
47%	33.5	6.5
48%	32.8	7.2
49%	32.0	8.0
50%	31.4	8.6

Before standardizing operations are attempted, an accurate test must be obtained on the cream that is to be used. This can be best obtained by thoroughly mixing the cream on hand in a vat pasteurizer, or in a regulation cream vat. Samples should then be taken and run **in duplicate** by the Babcock or Amyl Alcohol method. Let us assume that these tests show that the butter fat content is 48%, and that twenty (20) cans of cream testing 38% are desired.

By consulting Table No. 2, we find that when 48% cream is reduced to 38% that 31 qts. of this cream and 9 qts. of milk will give 40 qts. of 38%. Hence, to make 20 cans:

$$31.0 \times 20 = 620 \text{ quarts } 48\% \text{ cream}$$
$$9.0 \times 20 = 180 \text{ quarts } 3.6\% \text{ milk}$$

when mixed will give 800 qts. (20 cans) of 38% cream.

Other cream standardizing problems may be worked out in like manner.

In each case, after the proper proportions are thoroughly mixed, samples should again be taken and tested to confirm the result.

QUESTIONS AND ANSWERS ON TESTING

At regular intervals, the officials of the various State Departments of Agriculture conduct examinations for those wishing to obtain licenses to act as milk testers at places where milk is purchased on a butter fat basis. At these examinations, correct answers in writing to a set of questions are usually required.

The following questions are representative of those that may be asked at such an examination. Each question has been answered by Mr. Harold W. Gray of the Borden's Farm Products Co. (Inc.), Laboratory Staff. These answers amply serve as models of proper answers for the prospective candidate at an examination:

1.

Ques. Name the principal substances and the percent of each in milk of average composition.

Ans: The principal substances and the percent of each in milk of average composition are as follows:

Water	87.0%
Sugar	5.0%
Fat	4.0%
Casein	2.6%
Albumen	0.7%
Ash	0.7%
	100.0%

2.

Ques: Describe briefly how the Babcock test for fat in milk is made.

Ans: The milk to be tested is very carefully mixed by pouring from one dish to another. If the tester is dealing with a composite sample, the milk must be warmed to approximately 90 degrees F. previous to mixing. 17.6 c.c. of the sample are then taken and discarded to rinse out the pipette. The second amount is kept, and placed in an 8% milk bottle. This bottle is then placed in a water bath having a temperature of 60 degrees F, and left until the milk has assumed the temperature of the water. The sulphuric acid to be used should be cooled in like

manner to the same temperature as the milk. Then 17.5 c.c. of the acid are measured and added to the milk. The sample is carefully agitated with a rotary motion until all the solids—not —fat are destroyed. The test bottle is then placed in the machine and whirled for five minutes at the proper speed. Water at 150 to 160 degrees F. is then added to the base of the neck; the sample is again whirled for two minutes and additional water at the same temperature as before is added until the fat has risen so as to be measured. The machine is then run for one minute. After this, the test bottle is immersed in a water bath at a temperature of 135 to 140 degrees F. for three minutes, care being taken to completely surround the fat column. The result is then quickly read by means of dividers or calipers.

3.

Ques: What changes in the milk are brought about when the sulphuric acid is mixed with the milk in the Babcock test?

Ans: When sulphuric acid is mixed with milk in the Babcock test, the following changes take place:

(a) All the solids—not—fat are destroyed.

(b) In accomplishing this, much heat is generated, which keeps the butter fat in a liquid state.

(c) The specific gravity of the liquid surrounding the butter fat is increased, which makes it much easier for the fat to rise.

4.

Ques: What special precautions are necessary in preparing composite samples for testing?

Answer:

(a) Care in handling composite sample jars.

(b) Place jars in a vat or tub containing water between 90 and 100 degrees F. (**Do not exceed 100 degrees F.**) Allow the jars to remain in this bath until the milk has assumed the temperature of the water. The tester should be careful not to have too much water in the container, thus causing the jars to overturn.

(c) Shake gently until all the cream is washed down, being careful not to churn the milk.

(d) Mix well the milk by pouring from one dish to another.

(e) Draw up the first pipette of milk and let the contents run back into the jar. This is done to rinse the pipette. Keep the second amount—18 grams (17.6 c.c.).

(f) Hold the test bottle and pipette at an angle and let the milk run into the test bottle. This bottle should be carefully marked to identify the dairyman's sample.

(g) Next, place the test bottle containing the sample in a water bath of about 60 degrees F., and allow it to stand for several minutes before adding the acid.

5.

Ques: How does the fat in a completed Babcock test indicate:

(a) that the acid was too strong.

(b) that the temperature of the milk and acid were too high when they were mixed together.

(c) that the acid was too weak.

Ans: (a) Black specks and charred particles at the bottom of the fat column indicate too strong an acid or too little agitation.

(b) A cloudy fat column is caused by high temperature of acid and milk when mixed.

(c) Too weak acid will give a very pale-colored fat column.

6.

Ques: At what points in making a Babcock fat test is temperature of importance, and why?

Ans: Proper temperature is very essential to secure accurate readings in the Babcock fat test. Acid and milk should always be mixed at an approximate temperature of 60 degrees F., because the re-action at this point will give the proper colored fat column and the destruction of all solids—not —fat, providing acid is at the proper strength. In the next place, water should be added during the running of the test at a temperature of 150 to 160 degrees F., to properly wash down the fat and enable it to rise. Water at a lower temperature will give a thick, muddy-colored column, and will tend to harden the fat, which must be kept in a liquid condition. Again, before

reading the results, the test bottles should be taken from the machine and immersed for three minutes in a water bath at a temperature between 135 and 140 degrees F. This is done for the reason that the graduated portion of an 8% milk test bottle holds 1.6 c.c. Melted butter at 140 degrees F. has a specific gravity of .9, giving 1.44 grams (1.6 × .9 equals 1.44), which is 8% of 18 grams (18 × .08 equals 1.44), the amount of the milk taken. If a 10% milk test bottle is used, the same results are obtained as follows: The graduated portion holds 2 c.c.; the specific gravity of melted butter at 140 degrees F. is .9. 2 × .9 equals 1.8 grams. 10% of 18 grams equals 1.8 grams.

7.

Ques: Describe briefly the method of taking, preparing, and testing a sample of cream.

Ans: The cream in a can or vat should be thoroughly agitated by stirring before selecting the sample. If a composite from several cans is to be secured, take an equal amount from each can and place this in a receptacle. Warm the sample to approximately 80 degrees, and mix again by pouring. Weigh into a 50% cream test bottle, 9 grams of the liquid. Then cool this amount to 60 degrees. Add an equal amount of water at the same temperature. To the sample, add about 15 c.c. of sulphuric acid (temperature 60 degrees F.) Shake thoroughly with a rotary motion. After this, at once place the test bottle in the machine and run at the proper speed for five minutes, two minutes, and one minute, adding water (150 to 160 degrees F.) as in a whole milk sample. Then place the test bottle in a water bath (135 to 140 degrees F.) for three minutes, taking care to completely surround the fat column. Before reading the results, add about three drops of glymol to flatten the meniscus. This should be allowed to trickle down the sides of the bottle. Do not drop the glymol directly on the fat.

8.

Ques: At what points at the upper and lower ends of the fat column should the percentage reading be taken,

(a) for milk (b) for cream

Ans: (a) The fat column for milk should be read from the lowest point of the bottom curve to the extreme upper point of the top curve.

(b) Use glymol to flatten the curve and read from the lowest point of the bottom curve to the line of demarkation between the glymol and the fat column. In other words, read to the **bottom** of the red line.

9.

Ques: If you were given a set of Babcock test glassware, how would you know that you could legally use it for testing milk, where the milk was sold on the basis of the fat percentage that you found?

Ans: If a person or concern buys or sells milk on the basis of the fat therein contained, all glassware used in the Babcock test must be calibrated by the New York State authorities at the Geneva Experimental Station, Geneva, N. Y. Such glassware is marked "S. B." (State brand). The use of un-calibrated glassware is illegal. (Note: Most states have similar regulations regarding the calibration of glassware.)

10.

Ques: Name the precautions necessary for taking and keeping composite samples in good condition.

Ans: Composite samples should be taken from the weigh tank. After the supply has been dumped into the weigh tank, take a 1-oz. dipperful and place the contents into a jar, well stoppered and carefully labeled to identify the patron. One corrosive sublimate tablet (two in summer) should be used for a preservative. Carefully shake with a rotary motion. This should be done twice daily before and after delivery. The samples should be kept in a cupboard away from the light, in a cool place, and locked, except at the time of receiving the milk. As each additional amount is added from day to day, great care should be used not to wash up the cream on the sides of the jar. Never pull over a composite jar, but lift it straight from the shelf. Shake well, unstopper, add the sample, shake again, and place the jar in its proper place. If a weigh tank is not in use, thoroughly mix the milk with a stirrer or agitator and, by means of a "milk thief," take a proportionate amount from each can of the individual dairy by touching the bottom of the can with the thief. Transfer from each can such a sample to a small pail. From this pail, take one 1-oz. dipperful, and place the contents into the test jar.

Samples should be kept for a period of ten days after running. These should be placed in a cool place away from the light. This action is to comply with the New York State law regarding the holding of composite samples.

11.

Ques: What should be the specific gravity of the acid used in the Babcock test?

Ans: The specific gravity of sulphuric acid used in the Babcock test should be between 1.82 and 1.83, preferably 1.825. The proper straw-colored fat column is the best indication of the proper strength of the acid.

12.

Ques: Why must cream be weighed into the Babcock test bottle in place of measured like milk?

Ans: Since cream has a larger percentage of butter fat than milk, it must be weighed into the Babcock test bottle in place of measured, because otherwise it would cling to the inside of the pipette. For this reason, 9 grams—the amount required—would not be delivered. Again, the weight of the cream decreases as the percent of the fat increases. Separated cream contains air bubbles and ripened cream gases of fermentation which also decrease the weight.

13.

Ques: At what speed should the disks of Babcock centrifuges revolve when they have the following diameters:

(a) 10 inches (b) 16 inches (c) 20 inches

Ans: (a) 10 in.—1100 revolutions
(b) 16 " — 850 "
(c) 20 " — 760 "

The complete scale for reference:

10 in.—1100 revolutions
12 " —1000 "
14 " — 925 "
16 " — 850 "
18 " — 800 "
20 " — 760 "
22 " — 725 "
24 " — 700 "

The following pages are to be reserved for the inserting of such additional information on testing that will from time to time be sent to all branches. These additions will be of proper size to be pasted on specified blank page of this book.

BACTERIAL CONTROL

DIRECT MICROSCOPIC OR BREED METHOD

In order to provide a method of analysis that would permit of the rapid bacteriological examination of a number of milk samples without evolving too complicated a procedure, and thus minimizing the cost of analysis per sample, the direct microscopic method was introduced by Dr. Robert S. Breed of the New York State Experiment Station at Geneva.

In commenting on the Breed Method, the last report of the Committee on Standard Methods of Bacteriological Analysis of Milk states:

"For the purpose of rapidly dividing raw milk into a series of grades, in such a way that the results can be obtained in the quickest possible time, the direct microscopic method is extremely useful. The use of the direct microscopic method is particularly valuable at the dairy end of the milk route, where the farmer wishes to know the kind of milk he is producing, or the **purchaser at the shipping station wishes to know the kind of milk he is receiving from the farmer.**"

DETECTION OF HIGH COUNT DAIRIES

The latter consideration is the one that applies to us in our efforts to meet the Department of Health regulations as to bacteria standards. **The maintenance of a satisfactory bacterial count of the mixed raw milk will be dependent largely on our ability to detect and apply corrective efforts on those dairymen who chronically exceed the prescribed bacterial standard. It is this type of dairy, habitually delinquent in methods (usually unclean utensils or indifferent cooling) that supplies sufficient contaminating influence in its milk so that when mixed in the storage vat at the milk station, it raises the entire receipts beyond the prescribed bacterial standards. Accordingly, our mission lies in detecting high count dairies, and here the Breed method is particularly useful.**

The following are given as directions for preparing dried smears by the Breed method for forwarding to laboratory for examination and report of results. It is absolutely essential that these directions be closely followed:

COLLECTION OF SAMPLES

Samples are to be taken once every two weeks on specified day as per schedule, in the sterilized four-dram vials. A can of the night's milk of each patron is to be sampled, the same to be thoroughly stirred with a thoroughly clean regulation can stirrer. The can stirrer is to be immersed first in a can of clean water and then allowed to remain between samplings in another can of boiling water before being used to stir the night's milk of another patron. The sample is to be taken from the stirred can, as the can is being poured into the weigh tank, catching the sample when about half of the milk has been poured from the can. The metal cap should be replaced immediately, and the vial numbered with the dairy number that it represents. The vial should then be placed in a sample tray that has been provided for that purpose, in its proper numerical position in the tray.

SAMPLE TRAY

The sample tray regularly supplied will accommodate 70 vials. The outer case of the sample tray should at all times be liberally supplied with finely crushed ice and water so that practically the entire vial will stand in ice water.

In most instances the smears from the samples can be prepared best in the early afternoon, in which event, precautions should be taken to see that the tray is well provided with ice, the cover placed over same, and the tray put away in a cool place.

Always be sure that the tray is well provided with ice, and that the samples are standing in ice water up to the time of making the smear of each individual sample.

MAKING OF SMEARS

The remainder of the technique of the Breed method consists of accurately measuring 0.01 c.c. of each sample, transferring this amount of milk by means of a small pipette to a

clean glass slide, distributing the milk evenly over one square centimeter of the slide by means of a stiff needle, and then allowing the smear to dry in a moderately warm, level place. The slides are then ready to be shipped by parcel post to the laboratory, where they are properly treated to remove the fat, after which they are stained and examined under a high power microscope.

GUIDE SLIDES

In order to make the smears conveniently a guide is furnished, containing a number of accurately measured square centimeter areas, this guide slide being placed under the plain slide on which the smears are to be mounted. The plain slides have etched margins to permit lead pencil markings of dairy number which each smear represents.

Smears should be made in numerical order, each sample vial being allowed to remain in its proper place in sample tray of ice water until smear is made.

MEASURING THE MILK FOR SMEAR

The sample vial should be thoroughly shaken and the special 0.01 c.c. pipette inserted below the mark of graduation on same. Ordinarily capillary attraction will draw the milk slightly above the graduation mark. The finger is then placed over the upper end of the pipette as it is withdrawn from the vial. By means of a **clean towel** the milk adhering to the outside and tip of the pipette is then wiped off. If the milk still remains above the graduation mark of the pipette it may be brought down by gently touching the tip of the pipette with the clean towel at the same time slightly releasing the finger over the upper end of the pipette. **The milk must be brought exactly to the graduation mark.**

By gently blowing on the pipette the milk should then be deposited on the plain glass slide over one of the centimeter squares. By means of the needle that is provided, the milk is then smeared out evenly until it entirely covers the one square centimeter space as indicated by the guide slide. (The number of the dairy should then be marked on the etched margin of the slide opposite the smear). When a number has been assigned on the milk register to a dairy that is not delivering milk, a

vacant place should be allowed on the slide, thus alloting twelve dairies as carried on the milk register to each slide. Furthermore, the particular number assigned to a dairyman should not be changed at any time, as the records that will be kept and compared from time to time will be carried on the basis of dairy number only.

RINSING PIPETTE

Before proceeding to the next sample, it is necessary to clean the pipette and this can be accomplished by rinsing it in clean warm water. The needle should also be rinsed in the clean water and wiped dry on the clean towel. After the work on two slides has been completed—that is, 24 smears prepared—the rinsing water should be discarded and a fresh supply used. The procedure as above outlined should be continued, placing twelve smears on each slide and keeping the smears in numerical order, until all the samples have been thus prepared.

DRYING SMEARS

When the twelve smears have been prepared, the slide should be placed **in a moderately warm, level spot so that they will be entirely dry in approximately ten minutes.** This feature is important, inasmuch as there is danger of increase in number of bacteria up to the point when the milk is entirely dry. A convenient method to bring about prompt drying is to lay a board over a radiator and place the slides on this board. If the slides are placed directly upon a hot surface they will crack and peel off. **However, drying must be prompt and should always be accomplished in from ten to fifteen minutes.** While preparing for the next smear, place the pipette in the rinsing water. Before taking pipette sample, blow out the surplus water, then rinse a second time by drawing in a fresh supply of water, again blowing this out. Be sure the pipette is absolutely free from water before placing same in milk vial.

LABORATORY EXAMINATION

The slides containing the dried smears are now ready to be placed in the special mailing box to be sent by parcel post to the laboratory for proper treatment and examination. A small wad

of paper should be placed between the upper edges of the slides and the under side of the box cover, so as to hold the slides securely in place and thus prevent breakage in transit. A report will be sent promptly to the forwarding branch in which the results will be listed under "Report of Results." At the same time another mailing box, containing the proper number of clean slides will be sent to the branch to be used for the next set of smears.

CLEANING AND STERILIZING VIALS

Immediately after the smears are prepared, the milk should be emptied and the vials washed in the following manner: Rinse both caps and vials several times in cold water. Prepare a solution of soap powder in hot water. Thoroughly wash each vial and cap in the soap solution, using a test tube brush. Rinse several times in clean, hot water. Invert the vials, with cap still removed, until thoroughly dry. When dry, screw cap on each, and **sterilize by live steam in box sterilizer for at least thirty minutes.** The day before samples are to be taken, vials should be sterilized a second time, again giving them at least a thirty minute exposure to the live steam. A small wire basket is the most convenient container for sterilizing vials.

REPORT ON RESULTS

In the report sent from the Laboratory, the designations "A," "B" or "C" will be given opposite each of the dairies from whose milk smears were prepared. Specific counts are only given for those dairies that fall in the "B" and "C" classes. The three designations will represent as follows:

A.—Dairies whose count does not exceed 100,000 per c.c. by the Breed method. Such milk will be considered entirely satisfactory from a bacteriological standpoint.

B.—Dairies whose count falls between 100,000 and 500,000 per c.c. Such milk is considered only fair from a bacterial standpoint.

C.—Dairies whose count is in excess of 500,000 per c.c. Such milk is considered unsatisfactory in itself and also a source of danger in the contaminating influence it exerts on the "A" and "B" dairies when mixed with them in the raw milk storage tank.

The report will also contain a summary in which the number of "A," "B" and "C" dairies will be totaled, and the percentage of each among the whole number of dairies delivering at the plant will be computed. From these percentages a "bacterial score" will be given, 100 being a perfect score, and in which event it would be necessary to have all the dairies delivering to a plant in the "A" group.

A sample of such summary is here given:

	Number of Dairies	Percent of Dairies	Bacterial Score
A	45	85	
B	3	6	88
C	5	9	

The bacterial score is merely a convenient way of reducing the results into one concrete figure, thereby permitting comparison of the results of one set of smears with those obtained at an earlier date. It also permits the comparison of the milk supply of one locality with that of another locality. The bacterial score is obtained in the following manner:

By allowing 1 point for each percent of "A" dairies.
" " 0.5 " " " " " "B" "
" " 0 " " " " " "C" "

It should be borne in mind that the above system of dividing the milk into "A," "B" and "C" groups by means of the Breed method and reducing the results thus obtained to a bacterial score, has no official recognition, and that it is merely a system devised to meet the desire of our Company to maintain at all times a satisfactory bacterial content of their product. **The designations "A," "B" and "C" are not intended to place these dairies in any particular grade of market milk, but are merely assigned to them as an indication of whether or not they are producing milk that is entirely satisfactory from a bacterial standpoint.**

CORRECTIVE WORK

When a report similar to that above described is received, it is expected that a personal visit will be made to each dairy listed under the "C" designation, the object being to determine

the cause of the high bacterial count. Here a knowledge of the factors that bring about a low bacterial count milk will be of value to the inspector. A survey of the dairy premises and a heart-to-heart talk with the dairyman will usually bring out the evidence that one of the fundamental requirements for a low bacterial count milk is being violated.

ESSENTIALS FOR PRODUCING CLEAN MILK WITH A LOW BACTERIA COUNT

MILKING.—Clean cows; clean, dry hands; narrow top pail; clean strainer.

COOLING.—Plenty of ice or cold water below 50 degrees F.; clean milk house.

STERILIZING.—Rinse pails and strainers with clean, cold water immediately after milking; wash with brush and Alkali Powder; rinse with clean water; sterilize with boiling water.

These are the features in particular that should be "talked up" to the "C" dairymen, for it is usually irregularities in some of these that result in high bacterial counts. Consequently, the "follow up" work on the "C" dairies is largely one of education, every opportunity should be taken to impress on the dairymen's minds the importance of the fundamentals of low bacterial count milk, especially in regard to clean utensils and proper cooling.

The "B" dairies should also be visited as outlined above, inasmuch as there is some irregularity in each, which may, if further neglected, result in their dropping to "C."

As in the past, every effort should be made to encourage the dairymen to properly equip their dairies to meet these fundamental requirements and the milk house with its cooling vat and space to store dairy utensils is an absolute necessity. This holds true for every other feature of equipment and practice in methods that our Company has for years advocated, inasmuch as the average dairyman's ability to produce clean milk—that is, milk of low bacteria count—is largely dependent on the conditions under which he performs his daily work.

In summarizing, it may be said that the object of the above method of bacteria control is:

1st. To determine by the most convenient method known, the approximate bacterial count of the milk of each of our patrons.

2d. To divide the results into suitable groups and to supply this information to our representatives as a guide to them in applying corrective work.

3d. To impress upon the dairymen the fundamental requirements of low bacterial count milk.

4th. To detect these dairymen who are habitually delivering milk of high bacterial count. These men make it possible for the supply as a whole from any one plant to be shut out by the Department of Health from the market for which it is intended.

STANDARD BREED METHOD TECHNIQUE

The material in preceding pages is drawn up in the form of complete directions for the preparation of Breed smears, where such smears are prepared by local factory representatives. The directions are intended to be minute in each detail of the work, so as to lead to standard and uniform practice in this work. When smears are so prepared, the examination and microscopic work is carried on by a central laboratory, where the prepared smears are shipped by parcel post.

For the trained man who may go into the field equipped with microscope and other necessary apparatus and solutions, the following procedure is given:

"The practice of counting the bacteria in milk by means of the microscope has been, in the last few years, coming somewhat rapidly into use, and offers several advantages:

1st. It is extremely rapid, making reports possible within a very few hours.

2d. It is simple and requires little apparatus.

3d. It gives a means whereby the actual number of bacteria can be determined, and it also gives some idea as to the kinds of bacteria present.

On the other hand, it requires considerable experience to obtain reliable results, and because it does not distinguish the living from the dead, it is not applicable at the present time to the study of pasteurized milk. Its manifest advantages for some purposes makes it certain, however, that its use will extend, and for this reason it is included in these Standard Methods.

Various methods of the microscopic study of milk have been described, but that which may be called the direct microscopic examination of milk is the simplest and most reliable, and is recognized in this report as Standard. It is as follows:

Samples. Milk samples collected as above described may be preserved by icing and handled as in the case of the plate method. All samples on which cream has risen to the surface must be vigorously shaken before preparations are made from them.

Apparatus. In addition to a microscope and ordinary microscopic slides, stain, etc., the only special apparatus required is a pipette which measures 1/100 c.c. The most convenient form of pipette is the straight capillary pipette, calibrated to deliver 1/100

c.c., the graduation mark being 1½ to 2½ inches from tip. Such pipettes are now for sale by manufacturers, and can be easily obtained. Only a single pipette is needed in making a series of tests, provided this is kept clean while in use. In this kind of work, cleanliness rather than sterilization is required. Clean towels may be used for wiping the exterior of these pipettes, while their bores may be kept clean by rinsing them in clean water between each sample. The small amount of water left in the tube may be rinsed out into the milk sample under examination. This method of procedure, while adding a small number of bacteria to each sample, introduces only a theoretical error, tests showing that such bacteria cannot subsequently be detected, and make no difference in the final result.

Preparation of Smears. One one-hundredth c.c. of milk or cream is deposited upon a clean glass slide by means of the pipette above described. By the use of a clean, stiff needle, this drop of milk is spread over an area of one square centimeter. This may be most conveniently done by placing the slide upon any glass or paper ruled into areas one centimeter square. These marks showing through the glass serve as guides. After uniform spreading, the preparation is dried in a warm place upon a level surface. In order to prevent noticeable growth, this drying must be accomplished within five to ten minutes but excessive heat must be avoided or the dry films may crack and peel from the slides in later handling.

After drying, the slides are to be dipped in xylol (gasolene may be used) for one minute, then drained and the slides dried. They are then immersed in 90% grain alcohol (or denatured, or wood alcohol) for about 15 seconds, and then transferred to a fresh aqueous solution of methylene blue. Old or unfiltered stains are to be avoided, as they may contain troublesome precipitates. The slides remain in this solution from 10 to 15 seconds, and then should be transferred immediately to a jar containing clean water to remove the excess stain. When this procedure is followed carefully, subsequent decolorization with alcohol is unnecessary. When properly stained, the general background of the film should be of a light blue tint.

The slides should be allowed to air dry by standing them in a vertical position. When dry, they are ready for examination.

STANDARDIZATION OF THE MICROSCOPE

The microscope to be used must be adjusted in such a way that each field of the microscope covers a certain known fraction of the

total square centimeter's area. This procedure is simple, with the proper materials at hand. The microscope should have a 1.9 mm. ($\frac{1}{12}$ inch) oil immersion objective, and an ocular giving approximately the field desired, and should preferably be fitted with a mechanical stage. To standardize the microscope, place upon the stage a stage micrometer, and by the selection of oculars or adjusting the draw tube, or both, bring the diameter of the whole microscopic field to .202 mm. When so adjusted, the microscopic field will cover almost exactly 1/300,000 of a cubic centimeter of the milk (actually 1/302,840). This means that if the bacteria in one field only are counted, the number should be multiplied by 300,000 to give the total number in a cubic centimeter.

(*From "Standard Methods A. P. H. A.*")

SIMPLIFIED METHOD OF OBTAINING APPROXIMATE BACTERIA COUNT BY MEANS OF BREED METHOD

Examine fifteen fields on each smear.

Count the number of groups or clumps, as well as individual isolated bacteria that are present.

Record this number on examination sheet.

Designate the final result with the following, indicating as A, B and C:

0 to 5 clumps inclusive in 15 fields—A (100,000 per c.c. or less)

6 to 25 " " " " " —B (100,000 to 500,000 per c.c.)

Over 25 " " " " " —C (over 500,000 per c.c.)

When bacteria are so numerous that accurate count cannot be made, show the result as "TNC" (too numerous to count).

When all the examinations are made, and above grades have been given, group results in the form of a summary, as follows:

Count the total number of A, B and C dairies.

Compute the percentage of A, B and C.

Allow 1 point for each percent of A dairies.

" ½ " " " " B "

" 0 " " " " C "

The sum of these points gives a bacterial score.

Report results of 5 or less clumps in 15 field simply as "A."

In those cases where the number of clumps are more than 5 in 15 fields, the actual count per c.c. in each case may be obtained by multiplying the number of clumps in 15 fields by 20,000. For example:

If 21 clumps are found in 15 fields, the bacteria per c.c. would be (21x20,000) 420,000 per c.c.

(Note: The examination of 15 fields is sufficient for routine work, where a classification is merely desired.)

A description of the technique and comments on the Breed method and its application by Joseph Race in a recent work (1918) follow:

"In some of the comparative experimental work reported by Conn, a series of bacterial counts was made by Breed, and this was supplemented in a further series by the inclusion of Brew, a co-worker with Breed. These experimenters made microscopical counts on the samples plated by other observers, and Conn considered that when the groups of organisms only were counted, the count agreed somewhat closely with the plate count. The details of Breed's process are as follows: 0.01 c.cm. of milk, from a well-shaken sample, is measured out by means of an accurately calibrated special pipette and deposited on a glass slide on which an area of 1 square centimeter has been previously marked out. The drop is evenly smeared over this area with a stiff needle and gently dried at about 50 degrees C. The slide is then placed in a Coplin staining jar containing xylol or gasolene to remove the fat, and, after drying, fixed in alcohol (70 to 95%). Immediately afterwards the smear is stained with 1 per cent aqueous methylene blue and finally decolorized to a light blue in 95% alcohol. The microscopical examination is made with a $\frac{1}{12}$ inch oil immersion objective. In order to find the factor for converting the number of organisms per field into organisms per cubic centimeter the diameter of the field is determined with a stage micrometer. The factor is then calculated from the formula:

$$\frac{x}{\pi R^2} \times 100 = y,$$

where y is the factor sought, x, the area of the smear in square millimeters and R the radius of the field.

In practice it is convenient to pull out the draw tube until the area of the fields is of such a value as will give a value to y having as many ciphers as possible. The following are the most satisfactory:

When R = 0.080 m.m., $y = 500{,}000$
When R = 0.089 m.m., $y = 400{,}000$
When R = 0.101 m.m., $y = 300{,}000$

When the desired result is obtained, the position of the draw tube is noted and always set at this point in future examinations. In order to get results comparable with the plate method, only the groups or clumps, together with isolated bacilli are counted; individual cocci, diplococcus or streptococcus chains, and rod forms where the plane of division shows clearly, are counted as individuals. The number of fields to be examined must be determined by the frequency of the organisms. It is obvious that with a factor of 300,000 to 500,000, this method is of the greatest advantage when the count averages one clump or more per field; with high-grade milks under 10,000 bacteria per c.c., the number of fields to be examined would be so large, if reasonable precision is to be obtained, as to consume as much time as the plate count method. Dead bacteria are counted with the living, so that this process is not applicable to pasteurized products; it would, however, be of advantage in determining the quality before pasteurization. A collateral advantage of this method is that in addition to the quantitative estimation of the bacteria, a cell count can be made at the same time and information obtained regarding the bacteria flora.

The following pages are reserved for additional information that will be sent out on bacterial control.