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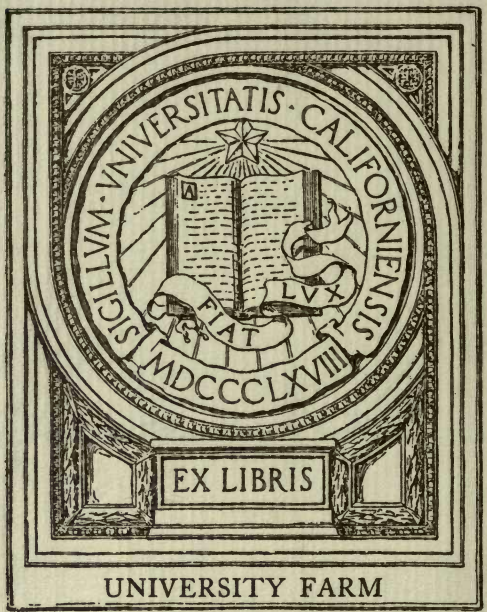
DAIRY LABORATORY GUIDE

G. L. MARTIN



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DAIRY LABORATORY GUIDE

By
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PREFACE

This laboratory guide is designed to give the beginning dairy student a few suggestions in the study of the production and care of milk, and the testing, manufacturing, and marketing of dairy products. It is the outgrowth of a demand from dairymen, creamerymen, and high school, short course, and college students for a guide in the practical application of modern dairy science.

It will be quite necessary to supplement these exercises with text-book references in order that the student may gain a thorough knowledge of the underlying principles of dairying. A grasp of the fundamental principles in each exercise herein followed out systematically and applied in practice is bound to bring results.

The writer is indebted to the Creamery Package Manufacturing Company and the J. G. Cherry Company for a number of the cuts used in this book.

G. L. MARTIN.

North Dakota Agricultural College,
January 1, 1913.

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PART ONE

THE PRODUCTION AND CARE OF DAIRY PRODUCTS

The trend of modern farm management is to put each separate enterprise upon a sound business basis. The dairyman is fortunate in having perfected an accurately detailed system which enables him to detect the smallest leak in the business anywhere from the time the milk leaves the cow until it is sold as a finished product. In order to insure a fair margin of profit, he needs to produce at the lowest cost, increase the output of each cow to the maximum, and utilize all of the by-products to advantage.

The first problem before the student of dairy science is to study the best methods of production and care of milk and cream on the farm. This end of the business is essentially the most difficult to perfect, owing to the widely varying conditions, and needs a close study of the technicalities of dairy science applied in a practical way to actual conditions.

EXERCISE 1

Microscopic Examination of Milk

Object: To examine microscopically milk from different breeds of cows.

Apparatus: Samples of milk, and microscope.

Steps: 1. Place a drop of milk upon a microscope slide and examine.

2. Dilute the sample of milk with an equal quantity of distilled water; then prepare a slide of the same.

3. Make drawings of the field for each sample and note the character of the impurities.

Breed	Jersey	Guernsey	Aryshire	Holstein
Drawing				
Impurities				

Application: 1. In what particular do the samples differ?

2. What part of the milk contains the coloring matter?

3. How do the fat globules compare in size, shape, and number?

4. How does the milk from the different breeds compare as to color?

Student's Notes:

EXERCISE 2

The Physical Differences Between Milk and Its Products

Object: To determine the physical difference microscopically between whole milk, cream, skimmilk, and colostrum, when heated and cooled.

Apparatus: Samples to be examined and microscope.

Steps: 1. Place a drop of each sample upon a slide and examine.

2. Heat the slide gradually and reexamine.
3. Cool the slide gradually and reexamine.
4. Diagram the field in each case and record all findings.

Data:

	Normal	Heated	Cooled
Milk			
Cream			
Skimmilk			
Colostrum			

Application: 1. In what manner do the various samples differ?

2. What is the effect of heat upon the samples?
3. How does cold affect the samples?

Student's Notes:

EXERCISE 3

Effects of Adding Chemicals to Dairy Products

Object: To determine the physical effects of adding chemicals to milk, cream, skimmilk, and pasteurized milk.

Apparatus: Samples to be examined and a microscope.

Steps: 1. Place a drop of milk upon a slide and then add a drop of dilute acid.

2. Place a drop of milk upon a second slide and add a drop of dilute rennet extract.

3. Place a drop of milk upon a third slide and add a drop of ether.

4. Prepare samples of cream, skimmilk, and whey in the same manner.

5. Diagram the field each time before and after applying the chemical agent.

Data:

	Acid	Rennet	Ether
Milk			
Cream			
Skimmilk			
Pasteurized milk			

Application: 1. What particular constituents of milk are affected by the acid? By the rennet? By the ether?

2. In what way is pasteurized milk affected by these agents?

Student's Nctes:

EXERCISE 4

The Purity of Market Milk and Cream

Object: To determine the purity of market milk and cream with reference to the amount of suspended dirt present.

Apparatus: Samples of milk, cream, and skimmilk; sediment tester; and pint jars.

Filter Method

Steps: 1. Secure a pint of unstrained milk from a common milk pail, and filter. Remove the cotton disks and dry on blotting paper or on a warm surface. Examine with a reading glass and record the findings.

2. Secure a sample of milk from a small-top milk pail to test its sanitary efficiency.

3. Test the efficiency of different kinds of strainers by filtering samples of milk after straining through an ordinary wire strainer, a cotton strainer, or a cheesecloth strainer.

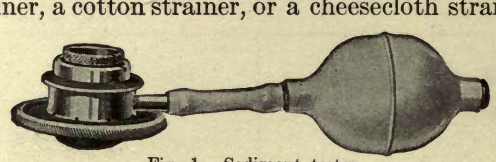


Fig. 1. Sediment tester.

4. Test the efficiency of a hand separator in removing suspended dirt by filtering a pint of milk before separating; then filtering samples of the cream and the skimmilk after separation.

Gravity Method

Steps: 1. After stirring the milk well, take samples and put into covered glass cylinders or bottles and set aside undisturbed for a short time.

2. To examine, raise the cylinder carefully to a position even with the eye; then look for sediment in the bottom.

This method is of little value except in cases of much sediment.

Data:

	Filter	Gravity
Amount		
Character		

Application: 1. What practical application can be made of sediment tests?

2. What percentage of the sediment in milk remains undissolved?

3. What is the influence of sanitary milk pails upon the purity of market milk according to the above tests?

Student's Notes:

EXERCISE 5

The Source of Fermentations in Dairy Products

Object: To note the effects of undesirable fermentations in milk and to determine their source by means of the Wisconsin curd test.

Apparatus: Samples of milk, pint jars with covers, rennet, extract, thermometer, knife, and warming tank.

Steps: 1. Number the jars and sterilize them thoroughly.

2. Fill each jar about half full of the milk and then place them in the water bath.

3. Heat the water until the samples reach a temperature of 100 degrees F.; then add ten drops of rennet to each and mix thoroughly.

4. After the milk has curdled, allow it to stand for a few minutes and settle; then cut into small pieces and drain off the whey.

5. Cover the jars and replace them in the bath for several hours at the regular temperature.

6. Examine the samples for odor, flavor, and appearance of curd at short intervals for several hours; then allow to stand for a few days and reexamine.

7. Care is necessary in every detail of this test to keep the temperature of the samples uniform and to prevent contamination.

Application: 1. How do the samples of milk differ as to appearance of curd?

2. How do the appearance of the curd and the character of its flavor correspond?

3. To what are pin holes due?

4. How may they be distinguished from mechanical holes?

5. What practical application may be made of this test?

Data:

	Time	1	2	3	4	5	6
Appearance of curd	24 hrs.						
	48 hrs.						
Odor	24 hrs.						
	48 hrs.						
Flavor	24 hrs.						
	48 hrs.						

Student's Notes:

EXERCISE 6

Lactic Acid in Dairy Products

Object: To determine the percentage of lactic acid in dairy products according to various methods.

Manns' Test

Apparatus: Samples of whole milk, skimmilk, buttermilk, cream, butter, whey, and starter; Manns' testing outfit.

Preparing the Alkali Solution. The best way to do, where the facilities are not at hand for standardizing, is to secure at the drug store a quantity of standard solution of sodium hydroxide; then dilute it to N/10 as needed. This can be done by putting 100 c. c. of the standard solution into a liter flask and filling to the 1000 c. c. mark with distilled water or with soft water.

Preparing the Indicator. Obtain a small quantity of the compound phenolphthalein at the drug store; then dissolve 1 gram of the dry powder in 30 c. c. of 90% alcohol. It is necessary to use only a few drops at a time.

Steps: 1. Put 50 c. c. of the sample to be tested into the white cup; then add a few drops of the phenolphthalein indicator.

2. Add the N/10 alkali solution from the burette drop by drop until a permanent pink color appears.

3. One c. c. of N/10 alkali solution contains .004 grams of sodium hydroxide, which is sufficient to neutralize .009 grams of pure lactic acid. Read from the burette the number of c. c. of alkali used and substitute in the formula.

Formula:

$$\frac{\text{c.c. alkali used} \times .009}{\text{c. c. of sample}} \times 100 = \text{percentage of acid.}$$

Ferrington Test

Apparatus: Samples to be tested, 100 c. c. graduate, white cup, Ferrington's alkaline tablets, and a 17.5 c. c. pipette.

Preparation of Alkali Solution. Dissolve five of the prepared tablets in 97 c. c. of warm, preferably distilled, water or soft water. Keep in a tightly stoppered bottle when not in use. It is necessary to prepare a fresh solution frequently, as it will lose its strength within a few days.

Steps: 1. With a pipette transfer to a white cup 17.5 c. c. of the sample to be tested; then add the alkali from a graduate or from a burette until a permanent pink color remains.

2. In reading the results, the number of c. c. of the alkaline solution required to bring the permanent pink color indicates the number of hundredths of one per cent of acid present. For instance, if 25 c. c. of alkali are required, it indicates that .25% of acid is present.

Data:

	Manns		Ferrington	
Sample	*C. C. alk.*	*Per cent*	*C. C. alk.*	*Per cent*
Milk				
Skimmilk				
Buttermilk				
Cream				
Butter				
Whey				
Starter				
Cheese				

Application: 1. What is the object in making up the alkali solution from soft water or from distilled water?

2. What causes the pink color to appear?
3. Why should the Ferrington tablets be kept dry?
4. What effect has standing upon the tablet solution?

Student's Notes:

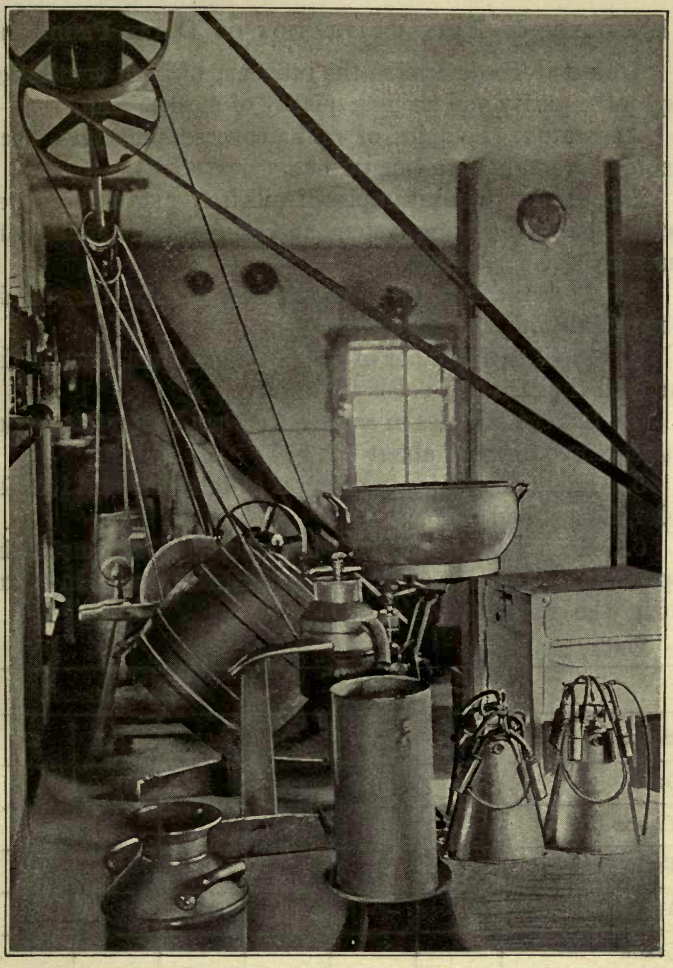


Fig. 2. A farmer's dairy room and equipment, showing an economical use of power.

EXERCISE 7

Influence of Barn Ventilation on Dairy Products

Object: To determine the influence of barn ventilation upon the purity and keeping quality of market milk.

Apparatus: Samples of milk, covered pint jars, thermometer, and acid testing outfit.

Steps: 1. Secure samples of milk from a stable equipped with a good ventilating system, and from another stable with no provision for ventilation.

2. Test the samples in each set for acidity; then strain the milk through sterile cheesecloth.

3. Sterilize a number of glass jars and then transfer the milk to the jars and cover tightly.

4. Set the samples in a place that can be kept at a constant temperature of about 70° F.

5. Examine one jar in each set at intervals and test for odor, flavor, and acidity.

6. Keep one jar in each set unopened and note the appearance of curd. Always use a sterilized pipette in examining the samples.

Data:

	Ventilated			Not ventilated		
Hours	*24*	*48*	*72*	*24*	*48*	*72*
Odor						
Flavor						
Temperature						
Acidity						
Grade						
Market value						

Application: 1. Which sample had the cleanest odor and flavor when set?

2. How did the two sets of samples compare as to rapidity of development of flavor? Of acid? Of odor?

Student's Notes:

EXERCISE 8

Cleanliness and the Keeping Quality of Milk

Object: To determine the effects of cleanliness upon the keeping quality of milk.

Apparatus: Samples of milk, covered pint jars, thermometer, acid testing outfit, and sediment tester.

Steps: 1. Secure the following samples of milk: from clean stables, from dirty stables, strained, unstrained, from wagon, and pasteurized milk.

2. Test each sample for acidity and sediment.

3. Sterilize six glass jars and number them from 1 to 6.

4. Pasteurize a sample of milk at 140° F. for 15 minutes. Have cap jars.

5. Fill a jar with each of the samples; then cover tightly and set at 60° F.

6. Examine each jar at intervals of 24 hours and test for acidity, odor, and flavor.

7. Note the length of the time required to curdle and the appearance of curd from each sample.

Data:

Sample	Clean stable	Dirty stable	Strained	Unstrained	Wagon	Pasteurized
Sediment						
Odor						
Flavor						
Acidity						
24 hrs.						
48 hrs.						
72 hrs.						

Application: 1. Which sample showed the greatest amount of acid when set?

2. How did the amount of sediment affect the flavor?

3. How did the pasteurized sample compare in flavor with the rest?

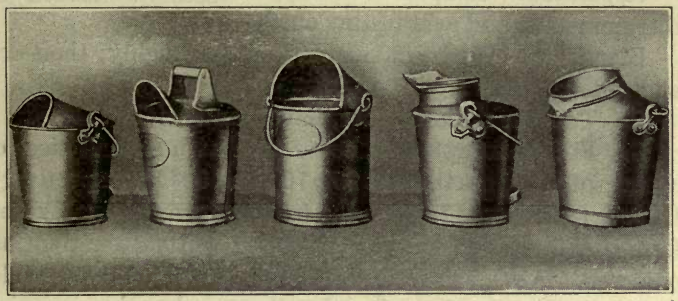


Fig. 3. Covered milk pails.

Student's Notes:

EXERCISE 9

Temperature and the Keeping Quality of Milk

Object: To determine the effect of temperature upon the keeping quality of milk.

Apparatus: Samples of freshly drawn milk, sample jars, thermometers, and acid testing outfit.

Steps: 1. Wash six sample jars thoroughly; then dry and number them from 1 to 6.

2. Test the milk for odor, flavor, and acidity.

3. Fill the sample jars, cover each with a small piece of cheesecloth, and set them at 90°, 70°, and 50° F., respectively. Have arrangements to keep the temperature reasonably uniform. A fireless cooker well insulated will answer the purpose well. Always have as nearly farm conditions as possible.

4. Record the time of setting the samples; then examine them regularly at intervals of 24 hours.

Data:

Temperature	90°			70°			50°		
Hours	*24*	*48*	*72*	*24*	*48*	*72*	*24*	*48*	*72*
Odor									
Flavor									
Acidity									
Grade									
Market value									

Application: 1. At which temperature does the acid develop the most rapidly?

2. What are the effects of temperature on the odor? On the flavor? On the appearance of the curd?

3. Compute the value of returns in one year from 5000 lbs. of 3% milk, containing 405 lbs. of cheese.

4. Figure from findings after 12 hours and use current prices for various grades of Cheddar cheese.

Student's Notes:

EXERCISE 10

Efficiency of Methods of Cooling Milk and Cream

Object: To determine the variation in quality of cream, when cooled and kept at room temperature, when set in water, and when cooled in a refrigerator.

Apparatus: A small quantity of milk and freshly separated cream, acid testing outfit, thermometers, six pint bottles or containers, and a piece of cheesecloth.

Steps: 1. Secure samples of fresh milk and cream, and test them for acidity, odor, and flavor.

2. Number the bottles in sets 1, 2, and 3; then measure out three bottles of milk and three of cream. Cover each with a piece of cheesecloth.

3. Place set No. 1 in the open at the ordinary room temperature. Place set No. 2 in cold running water, if possible. Place set No. 3 in a refrigerator.

4. Examine the samples at frequent intervals, not to exceed twelve hours, and record all data.

Rules for Grading Cream.

First Grade: All sweet cream of clean odor and flavor, with not to exceed .2% of acidity.

Second Grade: All sour cream reasonably clean in odor and flavor, with not to exceed .8% of acidity.

Application: 1. Determine from data whether the butter made from such cream would grade Extra, First, or Second.

2. How much butter can be made in one year from a cow giving 5000 lbs. of 3% milk, allowing 16% O. R.?

3. What will the butter be worth at current quotations for the various grades?

Data:

	Room						Water						Refrigerator					
Samples	Milk			Cream			Milk			Cream			Milk			Cream		
Hours	*24*	*36*	*48*	*24*	*36*	*48*	*24*	*36*	*48*	*24*	*36*	*48*	*24*	*36*	*48*	*24*	*36*	*48*
Odor																		
Flavor																		
Acidity																		
Temp.																		
Grade																		
Market value																		

Student's Notes:

EXERCISE 11

Open and Covered Containers for Dairy Products

Object: To determine the effects upon quality of keeping milk and cream in open and covered containers.

Apparatus: Samples of milk and cream, jars, thermometer, acid tester, and Babcock testing outfit.

Steps: 1. Obtain two pints of milk warm from the cow and two pints of cream immediately after separating.

2. Arrange the bottles in sets of two, with milk in bottles 1 and cream in bottles 2. Leave one set open and cover the second set with tight-fitting covers.

3. Set the samples aside at ordinary room temperature and examine at intervals for odor, flavor, and acidity.

4. Secure two Mason jars or two milk cans with tight-fitting covers. Wash them perfectly clean by ordinary methods and then cover one tightly and leave the other open. Examine them after a few hours and note the odor when removing the cover.

Data:

	Open								Covered							
Samples	Milk				Cream				Milk				Cream			
Hours	*12*	*24*	*36*	*48*	*12*	*24*	*36*	*48*	*12*	*24*	*36*	*48*	*12*	*24*	*36*	*48*
Odor																
Flavor																
Acidity																
Grade																
Market value																

Application: 1. What effect has covering upon the development of odors? Flavors?

2. Which sample developed acid the most rapidly?

3. How would the covering of warm cream influence its market value?

Student's Notes:

EXERCISE 12

Absorbing Capacity of Dairy Products

Object: To determine the capacity of dairy products to absorb odors and flavors from their surroundings.

Apparatus: Several samples each of first-grade milk, cream, and butter.

Steps: 1. Thoroughly clean and sterilize 8 pint jars; then divide these into two sets and number them from 1 to 4.

2. Fill one set of the bottles with milk, and the other set with cream.

3. Secure several pound prints of butter and place them in open containers.

4. Make up four lots containing a sample each of milk, cream, and butter; then number the sets from 1 to 4.

5. Place lot No. 1 in close proximity to corn silage, lot No. 2 in a vegetable cellar, lot No. 3 in a closed icebox containing other foods, and lot No. 4 in close proximity to cooked cabbage, onions, or other vegetables.

6. Examine the samples at intervals and note the changes which take place in the odors and flavors.

Data:

Lot	1			2			3			4		
Samples	*Milk*	*Cr.*	*But.*	*Milk*	*Cr.*	*But.*	*Milk*	*Cr.*	*But.*	*Milk*	*Cr.*	*But.*
Odor												
Flavor												
Grade												
Market value												

Application: 1. Which sample absorbs corn silage flavors most readily?

2. At what time would dairy products be likely to acquire the flavor of silage?

3. How are dairy products influenced by being kept in the cellar? In a closed icebox with other food? In the kitchen?

4. How does the flavor of milk and cream influence its market value?

Student's Notes:

EXERCISE 13

Effects of Impure Water on Dairy Products

Object: To determine the effect of impure water upon the quality of milk, when the water is added or used for washing the utensils.

Apparatus: Samples of fresh milk, four covered jars, incubator, and thermometer.

Steps: 1. Sterilize the glass jars by placing them in a water bath; then gradually raise the water to a boiling temperature.

2. Remove the jars and invert them upon a clean surface to cool.

3. Fill jar No. 1 with milk for a check sample.

4. Add 10 c. c. of impure water to jar No. 2; then fill with milk.

5. Fill jar No. 3 with milk, pasteurized at 145° F. for fifteen minutes.

6. Rinse jar No. 4 with impure water and then fill with milk.

7. Cover all the jars tightly; then set them into an incubator and hold at 70° F.

8. Examine at intervals and record all data.

Application: 1. How do the odors and flavors of the different lots compare?

2. Which samples show the effect of impure water?

3. How can the presence of objectionable odors and flavors be accounted for in the various samples?

Data:

Sample	1			2			3			4		
Hours	*24*	*48*	*72*	*24*	*48*	*72*	*24*	*48*	*72*	*24*	*48*	*72*
Odor												
Flavor												
Acidity												
Grade												
Market value												

Student's Notes:

EXERCISE 14

Determination of Moisture in Dairy Products

Object: To determine the percentage of moisture in dairy products.

Apparatus: Samples to be tested, torsion balance, beaker and flame.

Steps: 1. Transfer a sample of butter to a beaker; then heat gently by setting the beaker into a waterbath until the butter softens to the consistency of cream.

2. Balance the cup on the scales and weigh out 10 grams of the sample.

3. Heat gently over the flame until all of the moisture is removed; then reweigh and record the percentage of moisture.

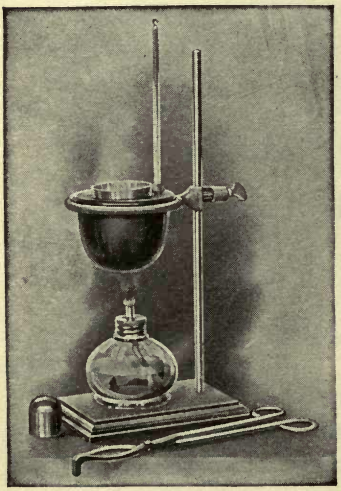


Fig. 4. Ames moisture test.

4. Precaution is necessary not to heat too rapidly nor overheat, as the volatile fats may escape. Stop heating when the casein film of small bubbles over the butter rises well up in the cup and just before the brown color appears in the butter.

5. To avoid overheating, it is well to temper the heat by placing the sample in a steam oven, in a bath, or by placing an asbestos mat between the flame and the container.

Data:

	Butter	Unsalted butter	Margarine	Cheese
1				
2				
3				

Application: 1. What is the legal standard limit of moisture in butter?

2. Of what importance is the presence of moisture in butter?

3. Where does the moisture come from in dairy products?

Student's Notes:

EXERCISE 15

Determination of Salt in Dairy Products

Object: To determine the percentage of salt in dairy products.

Apparatus: Samples to be tested, torsion balance, beaker, flask, burette, and N/10 silver nitrate solution.

Preparation of Silver Nitrate Solution. In case no N/10 normal silver nitrate solution is at hand, obtain from the drug store an ounce of chemically-pure silver nitrate crystals. Weigh out 1.69 of the crystals and dissolve them in 100 c. c. of distilled water or in pure soft water, when it is ready for use. The silver nitrate is readily affected by sunlight; so it is best kept in a glass-stoppered, preferably brown glass, bottle, so it will not lose strength.

Preparing Indicator. The indicator used is potassium chromate. An ounce of chemically-pure chromate obtained from the drug store and dissolved in 100 c. c. of distilled water or pure soft water will make up a sufficient amount to last indefinitely.

Steps: 1. Weigh out 10 grams of butter in a beaker the same as in the moisture determination.

2. Melt the butter and transfer to a 250 c. c. stoppered flask. Rinse the beaker with warm water several times and transfer to the flask.

3. Fill the flask to the 250 c. c. mark with warm water and shake thoroughly until all of the salt is dissolved. Allow the flask to stand quiet for a short time until the butterfat has collected on the surface and then remove it by means of a pipette.

4. Transfer 17.5 c. c. of the solution with a pipette to a white cup; then add a drop of the potassium chromate indicator.

5. Add N/10 silver nitrate solution from a burette drop by drop until a permanent brownish color remains.

6. Read the number of c. c. of the silver nitrate solution used and determine the percentage of salt in the butter. With an N/10 solution, each c. c. is equivalent to one per cent of salt, which gives directly the percentage of salt in the sample.

Data:

	Butter	Margarine	Cheese
1			
2			
3			

Application: 1. What percentage of salt does the average butter market demand?

2. Is all butter salted?

3. In what way is salt beneficial to butter?

4. Why is it necessary to keep the silver nitrate in a brown glass-stoppered bottle?

Student's Notes:

EXERCISE 16

Tests for Renovated Butter and Margarine

Object: To determine the action of genuine butter, renovated butter, and margarine, when heated and cooled.

Apparatus: Samples of genuine butter, renovated butter, margarine; spoon; beaker; and flame.

Steps: 1. *Spoon Test.* Take a piece of each sample about the size of a chestnut and melt it in a spoon over a slow flame. Bring the fat to the boiling point and stir gently with a splinter of wood. The genuine butter will produce much foam and make little noise on boiling. The renovated butter and the margarine produce no foam, and boil with much noise and sputtering.

2. *Waterhouse Test.* Put about 100 c. c. of sweet milk or water in the beaker and then add a piece of the sample and heat until it is melted. Stir with a splinter of wood while heating and then set the beaker into ice cold water to cool. On being stirred, the margarine will collect in a lump, while genuine butter-fat will remain separated into fine granules.

3. Mix together well a small amount each of genuine butter and beef tallow, and examine according to the tests.

4. Mix together well a small amount each of genuine butter and lard and examine according to the tests.

5. Take equal parts of butter, tallow, lard, and cottonseed oil; then mix them together well and examine according to the tests.

Application: 1. What is the current market value of creamery butter? Of beef tallow? Of lard? Of cottonseed oil?

2. If butter containing 82.5% of butter-fat sells for 25c per pound, what should be the market price per pound of

butterine containing 50% of foreign fats worth 15c per pound?

3. If renovated butter is made from butter grading Thirds on the market and selling for 15c per pound, what should the renovated butter sell for per pound?

Student's Notes:

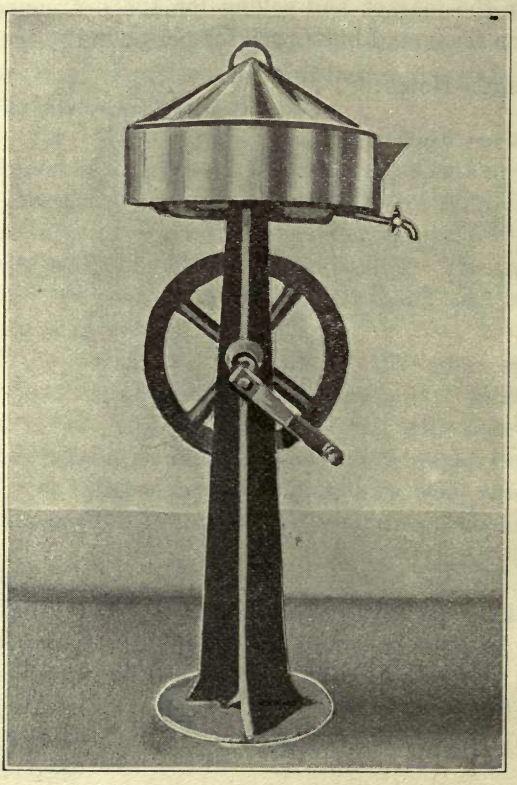


Fig. 5. The original Babcock milk tester. (Wisconsin Circular 32).

PART TWO

THE TESTING OF DAIRY PRODUCTS

The percentage of butter-fat is made the basis for determining the market value of nearly all dairy products, and is calculated by the Babcock test. In connection with the test for butter-fat there are several other tests which are often used to determine the quality and the composition of dairy products. In acquiring a knowledge in the manipulation of these tests the student will need to practice extreme accuracy.

Taking Samples. The butter-fat exists in milk in minute globules which float about in the milk and are brought to the top by the action of gravity. The milk and cream must be mixed thoroughly with a stirring rod or by pouring from one container into another before taking the sample to test. A small sample dipper or sampling tube will serve in taking the sample.

A *composite* sample is one made up from milk delivered at different times or from several cans, and should give an average test for the period or for the total amount of milk. Care is necessary to take a proportionate amount from each can in order to get a representative test of the whole amount.

Preserving Samples. In case the samples cannot be tested immediately, they may be kept from souring by using chemicals. The preservatives in common use are corrosive sublimate and bichromate of potash. These are put up in convenient tablet form of sufficient strength that one or two

will preserve a pint of milk for several weeks. The tablets are *very poisonous*, and so are colored red and yellow respectively, as a safeguard against accidents.

Churned Milk. It often happens that milk will become partially churned in transit, especially if the container is not completely filled, and the butter-fat will gather in lumps. When this occurs it is well to warm the milk to about 100° F., and hold it there until the lumps of fat are melted and then mix thoroughly by pouring before taking the sample to test.

Frozen Milk. The water in the milk or cream freezes first, which forces the solids toward the center of the can. In order to get a representative sample, all frozen portions must be thawed out and then the entire contents of the can must be thoroughly mixed before taking the sample to test.

Sour Milk. The casein in milk coagulates on souring and tends to incorporate the fat globules, which often makes it difficult to secure an accurate sample. In case the sample becomes sour, a small quantity of alkali added to the milk will dissolve the casein sufficiently to enable an accurate sample to be taken. It is well to take a definite quantity of the alkali and in proportion to the size of the milk sample, which will enable a corresponding correction in reading the test.

How to Calibrate Glassware

A great deal of the glassware used for testing has not been carefully standardized before leaving the factory, and so is very unreliable. In order to insure accuracy, it is often necessary for the operator of the Babcock test to calibrate the glassware.

Milk Bottles. 1. *Plunger Method.* This plan requires the use of a metal plunger made in two parts connected with a wire. Each part is of the proper size to displace 1 c. c. of

liquid. In making the test, fill the test bottle to the zero mark with water or a similar liquid; then remove with a strip of blotting paper all drops adhering to the neck within, and insert the plunger. If the bottle is graduated accurately, the liquid will rise from the zero mark to the 5% mark when the first part of the plunger is submerged, and to the 10% mark when the second part of the plunger is submerged. Any test bottle showing a variation of .2 % is not sufficiently accurate to insure a reliable test.

2. *Liquid Method.* A very satisfactory way is to color some water with dark ink; then transfer this to the bottle to be tested and fill to the zero mark. Remove all drops adhering to the neck within and add 1 c. c. of the water from a burette or pipette. If the graduations are accurate, the liquid will then extend to the 5% mark. Add another cubic centimeter of the liquid, which should bring the surface of the liquid to the 10% mark. Any fraction of the scale may be tested by adding .2 c. c. of the liquid, which represents one per cent on the scale.

Cream Bottles. The same methods employed in testing milk bottles may be used in calibrating cream bottles.

Pipettes. The liquid method can be used to advantage in testing the pipette. Close the tip end of the pipette and then add from a burette or from a standardized pipette 17.6 c. c. of the liquid. If the pipette is accurately made, the liquid should reach to the mark on the neck.

How To Clean Glassware

It is well to empty the test bottles into an earthen jar immediately after completing the test and before the butterfat becomes crystallized. The test bottles will need to be shaken while being emptied to loosen the lime sediment clinging to the bottom.

The glassware used in testing readily accumulates a film of butter-fat and has to be kept thoroughly cleaned so as not to interfere with the test. The fat can be removed by washing in a solution of water to which a small amount of washing powder has been added and well dissolved by boiling. A small brush will aid materially in cleaning the glassware, after which it will need to be rinsed in clean water and inverted in a rack to drain and dry.

Fig. 6. An experiment station expert making tests for official dairy records.

EXERCISE 1

Operation of the Babcock Test

Object: To determine the percentage of butter-fat in dairy products by the Babcock method.

Apparatus: Samples to be tested, two milk bottles, 17.6 c. c. pipette, acid measure, beaker, tester, acid, and water.

Steps: 1. Number the test bottles 1 and 2.

2. Mix the samples well by pouring from one beaker to another; then measure into each bottle with the pipette 17.5 c. c. of the milk.

3. Add 17.5 c. c. of sulfuric acid to each bottle and mix well by rotary motion until all of the curd is thoroughly digested.

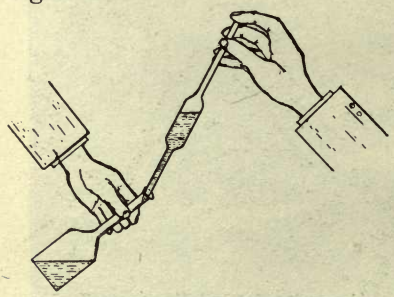


Fig. 7. Proper method of filling the test bottle.

4. Put the bottles into the tester and whirl at full speed for two minutes. It may be necessary to whirl longer.

5. Add hot water to each until the butter-fat rises to the neck of the bottle.

6. Whirl again at full speed for two minutes.

7. Add hot water until the butter-fat rises half way up the neck of the bottle; then whirl one minute and read the test.

8. Always read each test carefully and record all data accurately in the exercises that follow.

Reading the Test. The whole-milk test is read from the extremes of the top meniscus to the bottom of the fat column, as indicated by Nos. 1 and 2, Fig. 8, page 50.

The cream test is read from the bottom of the top meniscus to the bottom of the fat column, as indicated by Nos. 3 and 2, Fig. 8, page 50.

Data:

Sample	Test	B. F.	Value	Error	Value
1					
2					
3					
4					

Application: 1. How much butter-fat will be obtained in one year from a cow giving 5000 pounds of milk testing as above?

2. What will be the cash value of the butter-fat at current prices per pound?

3. What will be the loss due to error in testing?

4. Why pour the sample back and forth before taking the sample to test?

5. What is the correct method of holding the pipette?

6. Why is the Babcock test based upon 18 grams?

7. Why use 17.6 c. c. of milk for the test?

8. Why whirl the tester at high speed?

Student's Notes:

EXERCISE 2

Mixing Milk and Acid for Testing

Object: To determine the effect upon the reading of the test from incomplete mixing of the milk and acid.

Apparatus: Sample of milk, four whole-milk test bottles, and testing outfit.

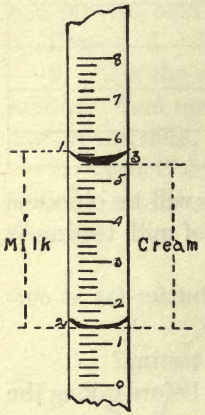


Fig. 8. How the fat column should be read.

Steps: 1. Number the bottles from 1 to 4.

2. Mix the sample well and measure 17.5 c. c. into each bottle.

3. Add a measure of acid to each bottle.

4. Mix numbers 1 and 2 well until all curd is thoroughly digested.

5. Do not mix 3 and 4 quite enough but leave a little white undigested curd on top.

6. Put into tester and proceed with the remainder of the test according to Exercise 1.

Data:

	Thoroughly digested		Not thoroughly digested	
Sample	*1*	*2*	*3*	*4*
Test				
B. F.				
Value				
Error				

Application: 1. What will be the amount of butter-fat in one year from a cow giving 5000 lbs. of milk testing the above percentage?

2. What will be the value of the butter-fat according to your tests at current prices?

3. What will be the loss on error in one year due to methods of mixing?

4. How may one tell when the milk and the acid are completely mixed?

5. Why is there an error when the curd is not thoroughly digested?

6. Why tip and turn the bottle when adding acid?

Student's Notes:

EXERCISE 3

Varying the Amount of Acid in Testing

Object: To determine the effect upon the reading of the test from using varying amounts of acid.

Apparatus: Samples of whole milk, four milk test bottles, small graduate, and testing outfit.

Steps: 1. Arrange the bottles and number them from 1 to 4, respectively.

2. Prepare the samples of whole milk for testing according to the previous exercises.
3. Add 10 c. c. of acid to bottle No. 1.
4. Add 17.5 c. c. of acid to bottle No. 2.
5. Add 25 c. c. of acid to bottle No. 3.
6. Add the regular amount of acid to bottle No. 4.
7. Mix all the tests well; then complete the test as usual.

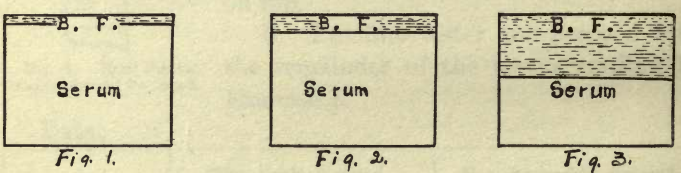


Fig. 9. The relative proportion of butter-fat and serum in dairy products.

These diagrams will serve to show the relative proportion of butter-fat and serum in dairy products. The proportion of serum decreases as the butter-fat increases; therefore less acid is required when testing products rich in butter-fat. Figure No. 1 represents skimmilk, buttermilk, and whey; No. 2, whole milk; and No. 3, average cream.

Data:

	10 c. c.	17.5 c. c.	25 c. c.	Check
Sample	*1*	*2*	*3*	*4*
Test				
B. F.				
Value				
Error				

Application: 1. How much butter-fat would be obtained from 5000 lbs. of milk according to the various tests?

2. What would be the value of the butter-fat at current prices?

3. How much would the error amount to in each case?

4. What is the cause for variation in color of butter-fat?

5. What are the results from using too little acid?

6. What would be the effect of using weak acid?

7. How does the use of too much acid affect the reading of the test?

8. How would the use of too strong acid affect the reading of the test?

Student's Notes:

EXERCISE 4.

Temperature of the Water in Testing

Object: To determine the influence of the temperature of the added water upon the accuracy of the test.

Apparatus: Sample of milk, two whole-milk bottles, thermometer, and testing outfit.

Steps: 1. Prepare four test bottles by numbering; then execute the first four steps in Exercise 1.

2. Add cold water with a temperature of 50° F. to sample No. 1.

3. Add warm water with a temperature of 100° F. to sample No. 2.

4. Add hot water with a temperature of 140° F. to sample No. 3.

5. Add very hot water with a temperature of 180° F. to sample No. 4.

6. Complete the test as usual, noting the influence of the various temperatures of the water upon the appearance of the fat column and on the accuracy of the test.

Data:

	Temp. 50° F.	Temp. 100° F.	Temp. 140° F.	Temp. 180° F.
Sample	*1*	*2*	*3*	*4*
Test				
B. F.				
Value				
Error				

Application: 1. How much butter-fat would you obtain from 5000 lbs. of milk according to your test at the various temperatures?

2. What would be the value of the butter-fat at 2c above current quotations for New York Extras?

3. How much would the error amount to per year from the above tests?

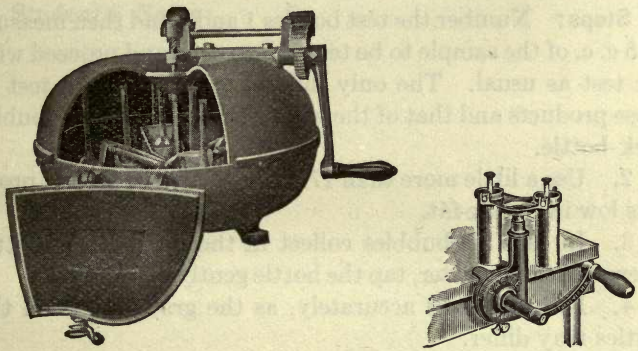


Fig. 10. Hand testers.

4. What temperature of the sample gives the best test?

5. What degree of temperature of water gives the best test?

6. What effect has the cold water upon the accuracy of the reading of the test?

7. In what condition should the butter-fat be when the reading is taken?

8. What would be the results if the milk were cold?

9. How would cold acid affect the test?

10. How would hot acid affect the test?

11. How could you get an accurate test with an open tester if the test room were cold?

12. What is the object of a check test?

EXERCISE 5

Testing Skimmilk, Buttermilk, and Whey

Object: To determine the percentage of butter-fat in skimmilk, buttermilk, and whey by the Babcock method.

Apparatus: Samples of each kind of product, two skimmilk test bottles, and testing outfit.

Steps: Number the test bottles 1 and 2 and then measure 17.5 c. c. of the sample to be tested into each and proceed with the test as usual. The only difference in making a test of these products and that of the whole milk is in using a double-neck bottle.

2. Use a little more than 17.5 c. c. of acid in testing products low in butter-fat.

3. In case air bubbles collect in the neck of the bottle when adding the water, tap the bottle gently on the table.

4. Learn to read accurately, as the graduations on the bottles may differ.

Data:

	Skimmilk		Buttermilk		Whey	
Sample	*1*	*2*	*1*	*2*	*1*	*2*
Test						
Butter-fat						
Value						
Loss on error						

Application: 1. How much butter-fat will be lost in 4500 lbs. of skimmilk according to above tests?

2. What will be the cash value of the butter-fat at current prices per lb.?

3. Complete the data for the same amount of buttermilk and of whey.

4. Why does the skimmilk bottle differ from the whole milk bottle?

5. Why should one use a little more than a full measure of acid when testing skimmilk and buttermilk?

Student's Notes:

EXERCISE 6

Testing Cream

Object: To determine the percentage of butter-fat in cream by the Babcock method.

Apparatus: Samples of cream, two cream test bottles, cream test scale, and testing outfit.

Steps: 1. Prepare the bottles by numbering; then balance them on the scales.

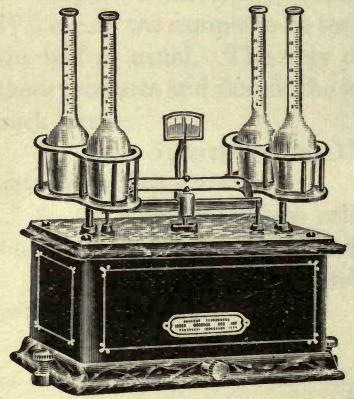


Fig. 11. Cream scales.

2. Mix the cream well by pouring and then transfer 18 gr. of the sample to each bottle by means of the pipette.

3. Add somewhat less than a full measure of acid to each and proceed with the test as usual.

4. Read the test carefully according to rule in the text and record all data.

Data:

Sample	1				2			
Test								
B. F.								
Value								
Loss on error								

Application: 1. Compute the amount of butter-fat in 750 lbs. of cream according to the various tests.

2. What is the value at 2c above current quotations for Extras on New York butter market?
3. Compute the loss in each case due to error in testing.
4. Why use less acid in testing cream than in the case of whole milk or skimmilk?
5. In testing cream what should be the color of the fat column?
6. How does the rule for reading the cream test differ from reading the whole-milk test?
7. What is centrifugal force?
8. What is meant by specific gravity?
9. What is the Sp. Gr. of whole milk? Skimmilk? B. F.?

Student's Notes:

EXERCISE 7

Measuring and Weighing Cream

Object: To determine the effects of measuring and weighing thin and thick cream upon the accuracy of the Babcock test.

Apparatus: Samples of cream, four cream test bottles, cream scale, and testing outfit.

Steps: 1. Number the bottles from 1 to 4.

2. Mix the samples well by pouring them several times.

3. Weigh 18 gr. of thin cream into bottle No. 1 and 18 gr. of thick cream into bottle No. 3.

4. Measure with the pipette 17.5 c. c. of thin cream into bottle No. 2 and 17.5 c. c. of thick cream into bottle No. 4.

5. Proceed with the test as usual for cream; then read and record the tests.

Data:

	Thin		Thick	
Sample	*1*	*2*	*3*	*4*
Test				
B. F.				
Value				
Loss on error				

Application: 1. Compute the value at current prices of the butter-fat lost in one year from a cow producing 750 lbs. of cream.

2. From your results, which is the correct way to transfer the cream to the test bottle? Why?

3. Why is the cream sample weighed instead of measured into the test bottle?

Student's Notes:

EXERCISE 8

Speed of the Babcock Tester

Object: To determine the effect from a variation in speed of the tester upon the percentage reading of butter-fat.

Apparatus: Samples of milk, skimmilk, and cream; three bottles for each sample to be tested; and testing outfit.

Steps: 1. Number each set of bottles 1, 2, and 3; then prepare the samples by pouring.

2. Measure 17.5 c. c. of milk into each of the three whole-milk bottles and 17.5 c. c. of skimmilk into each of the skimmilk bottles. Then weigh 18 gr. of cream into each of the cream bottles.

3. Complete the test as usual but run the sets at the different speeds indicated below.

4. The testers are not all geared alike; so be sure to use the same tester throughout the exercise; otherwise the final results will be of no comparative value

Data:

Speed	Half			Full			High		
Sample	*Milk*	*S. M.*	*Cream*	*Milk*	*S.M.*	*Cream*	*Milk*	*S.M.*	*Cream*
Test									
B. F.									
Value									
Loss on error									

Application: 1 Determine the number of turns of the handle per minute for each speed. Likewise compute the revolutions of the tester.

2. Determine the correct amount of butter-fat from a cow producing 5000 lbs. of milk in one year according to the above test.

3. Determine from your tests the amount of butter-fat in 4250 lbs. of skimmilk and 750 lbs. cream. Compute the value of butter-fat at current prices.

4. How does low speed of tester affect the test?

5. How can one tell when the proper speed of the tester is reached?

Student's Notes:

EXERCISE 9

Temperature in Reading the Tests

Object: To determine the influence of varying temperatures upon the accuracy of the test in reading the fat column of milk and cream.

Apparatus: Samples of milk and cream, two whole-milk bottles, two cream bottles, thermometer, and testing outfit.

Steps: 1. Prepare the samples and complete the tests as usual.

2. Read immediately after stopping the tester and record the temperature by inserting a thermometer into the neck of one of the cream bottles until the mercury bulb is immersed in the butter-fat. Allow it to remain in place throughout the exercise and use this reading for all of the other bottles.

3. Reread the tests at intervals of three and five minutes when left standing.

4. Set the test bottles into a waterbath at 120°F. for two minutes; then reread and record all data.

5. Set the test bottles into a waterbath at 70°F. for two minutes; reread.

Data:

	Milk		Variation	Cream		Variation	Temp.
Samples	*1*	*2*		*1*	*2*		
Read immediately							
Read after 2 min.							
Read after 5 min.							
Read at 120°F.							
Read at 70°F.							

Application: 1. Is there any difference in the appearance of the fat column after standing; if so, what is the cause?

2. How are the readings affected by standing?

3. What temperature of the butter-fat column gives the correct reading of the test? Why?

4. How may the test bottles be kept warm when whirling in a hand tester?

5. How may the test bottles be kept warm when reading in cold surroundings?

Student's Notes:

EXERCISE 10

Testing Cheese

Object: To determine the butter-fat content of cheese by the Babcock method.

Apparatus: Samples of Cheddar, Cream, Club, and Swiss cheese; four 50% cream test bottles; and testing outfit.

Steps: 1. Prepare the samples of cheese by pulverizing very fine with a knife.

2. Balance the bottles on the scales; then weigh into each 4½ grams of the prepared sample.

3. Add gradually to each bottle about 10 c. c. of hot water and shake in the meantime until all of the curd is thoroughly dissolved. To hasten disintegration, add a few c. c. of sulfuric acid.

4. After the curd is thoroughly disintegrated, add about 10 c. c. of acid to each sample to digest the curd; then complete the test as with cream.

Rule 1. In order to obtain the correct percentage of butter-fat, increase the reading by whatever factor the sample is of 18 grams.

Rule 2. Multiply the reading by 18 and divide by the number of grams in the sample tested.

Data:

Sample	Cheddar	Cream	Club	Swiss
Test reading				
Corrected test				

Application: 1. Why is it necessary to pulverize the cheese well when preparing the sample?

2. Why is it well to disintegrate the curd with hot water before adding the acid?

3. Why use less than 18 grams of the sample in testing cheese?

4. How much butter-fat does the full cream cheese contain? Half cream?

5. How does Cheddar cheese compare with cream cheese in fat content? What is a filled cheese?

6. How does Club cheese compare with full cream cheese in fat content?

Student's Notes:

EXERCISE 11

Determining the Butter-fat in Butter

Object: To determine the percentage of butter-fat in butter according to the Babcock method.

Apparatus: Samples of butter, two butter test bottles or two cream bottles.

Steps: 1. Balance the bottles on the scales the same as in testing cream.

2. Place several ounces of butter in a beaker and soften to the consistency of cream by heating in a waterbath.

3. Mix the sample thoroughly and transfer 9 grams to a butter test bottle by means of a pipette.

4. Heat the sample gently until it runs into the test bottle, and wash down all of the fat adhering to the sides of the bottle by using 9 grams of hot water.

5. Next add from 5 to 8 c. c. of sulfuric acid and complete the test as with cream.

6. In case butter test bottles are not at hand, the test may be made by using cream bottles. Weigh out 4½ grams of the butter sample into the cream bottle; then add the same amount of hot water and shake well. Add about 5 c. c. of sulfuric acid and complete the test as with cream.

7. To correct the readings of the test, use the same rule as in testing cheese.

8. Care will be necessary not to burn the butter-fat by an excessive amount of acid.

Data:

Sample	1	3	3	4
Test reading				
Corrected test				

Application: 1. What is the standard percentage of butter-fat in butter?

2. What is whey butter?

3. What is the object of melting the butter and thoroughly mixing before taking the sample?

4. In what other way may the butter-fat content of butter be determined?

5. Of what value is such a test to the buttermaker?

Student's Notes:

EXERCISE 12

Testing Condensed Milk

Object: To determine the percentage of butter-fat in condensed milk, containing no added sugar.

Apparatus: Sample of unsweetened condensed milk, four milk bottles, 50 c. c. graduate, and testing outfit.

Weight Method

Steps: 1. Number bottles 1 to 4.

2. Balance bottles 1 and 2 on the cream scales; then weigh into each 9 grams of the sample.

3. Add 9 grams of water to each bottle and dissolve the sample as much as possible before adding the acid.

Add about 10 c. c. of acid to the sample; then complete the test as usual and record the reading.

Volume Method

Steps: 1. Measure into the graduate 20 c. c. of the sample; then add to this the same amount of water. Shake well until the milk and water are thoroughly mixed.

2. Measure 17.5 c. c. of the mixture into bottles No. 3 and 4; then complete the test as described under the previous method.

3. Record and correct all data according to the previous rule.

Data:

	Weight method		Volume method	
Sample	*1*	*2*	*3*	*4*
Test reading				
Corrected test				

Application: 1. What is the object of adding water to the condensed milk?

2. Why is it necessary to dissolve thoroughly the condensed milk before taking the sample?

3. Why is it necessary to double the reading on completing the test?

4. How much is the volume of the milk reduced by the process of condensing?

5. What is evaporated milk and cream?

6. Why cannot sweetened condensed milk be tested by this process?

Student's Notes:

EXERCISE 13

The Specific Gravity of Milk

Object: To determine the specific gravity of milk by means of the Quevenne lactometer.

Apparatus: Samples to be tested, eight-inch cylinder, thermometer, Quevenne lactometer, and Babcock testing outfit.

Steps: 1. Test the sample for butter-fat; then fill the cylinder nearly full of the sample to be tested.

2. Take the temperature of the sample, and record.

3. Float the lactometer in the sample and observe the exact point on the scale where it cuts the surface of the liquid, and record the reading. Care is necessary in putting the lactometer into the milk not to let it drop to the bottom of the cylinder, as it is very easily broken.

4. The scale of the Quevenne lactometer is divided into 25 equal parts, ranging from 15 to 40. Each division is called a degree, and is divided into fifths. If the instrument floats at 18, for example, it indicates a liquid whose specific gravity is 1.018.

5. Corrections for temperature: The lactometer is standardized at 60° F.; so corrections need to be made in reading if the temperature of the sample varies from 60° F. For each degree above 60° add one-tenth to the lactometer reading; for each degree below 60° subtract one-tenth from the lactometer reading. It is a good plan to bring the temperature of the sample within the extremes of 50° and 70°F., as the rules are only approximately correct.

6. Calculate the solids not fat (S. N. F.) and total solids (T. S.) by the following formulas. The total solids include the solids not fat plus the B. F.

$$\text{S. N. F.} = \tfrac{1}{4}L + .2f$$
$$\text{T. S.} = \tfrac{1}{4}L + 1.2f$$

in which L is the lac. reading at 60° F., and f the percentage of fat in the sample.

7. Calculate the percentage of adulteration.

Formula:

$$100 - \frac{\text{S.N.F.} \times 100}{9} = \text{percentage of adulteration.}$$

Data:

Sample	Temp.	Lac.	Correct	Per cent B. F.	S. N. F.	T. S.	Per cent adult.
1							
2							
3							
4							

Application: 1. What is the Sp. Gr. of normal cow's milk? Why is it necessary to make a correction in the lactometer reading when the temperature varies? What is the effect of heating upon the Sp. Gr. of the sample? Of cooling?

2. What are the solids not fat in milk? Total solids?

3. What is the legal standard for each in the United States?

4. A sample of 4% milk at 60° F. shows a lactometer reading of 31. What is the percentage of S. N. F. in the sample? Calculate the percentage of adulteration.

5. Find the S. N. F. in a sample of 3.5% milk at 28° F., when the lactometer is 34.

6. If milk has a Sp. Gr. of 1.032 at 60° F., what will be the Sp. Gr. at 70° F.? At 50° F.?

Student's Notes:

PART THREE

THE MANUFACTURING OF DAIRY PRODUCTS

Hand Separators

The hand separator is a machine of unusually high speed. As a rule few operators are familiar with high-speed machinery, and many times a separator is permanently injured before the operator learns how to make it do efficient work. The fact that the separator is a high-speed machine makes it all the more necessary that the operator realize that a slight variation in the speed, a small change in the cream screw, or a few degrees difference in the temperature of the milk will result in a considerable error in efficiency unless exceeding care is practiced.

Setting. It is very necessary in setting the machine to have it placed upon a solid foundation of cement or heavy timbers, so that it will sit level and run free from any vibration. To level the machine, place a spirit level upon the bowl casing and then tighten the lag screws until the machine is level.

Lubricating. A failure to lubricate a high-speed machine may result in cutting out the bearings in a very short time. At the present time many machines are made with an oil bath within the frame, which eliminates the necessity of oiling each bearing separately. It is usually necessary even with this device to lubricate the bowl spindle separately, as that is the part most likely to be injured.

Cleaning. In using the hand separator, perfect cleanliness is absolutely essential at all times. A dirty machine will

contaminate the cream and materially lower the grade. The separator bowl needs to be very carefully taken apart and the contrivances within handled in such a manner that they will not become bent, injured, nor misplaced. All parts of the machine coming in contact with the milk need to be cleaned each time after using. Care is necessary to first dip the parts into warm water and clean with a brush, after which hot water or live steam will serve to sterilize them. After washing, it is well to place the parts in warm surroundings to drain and dry to prevent rusting.

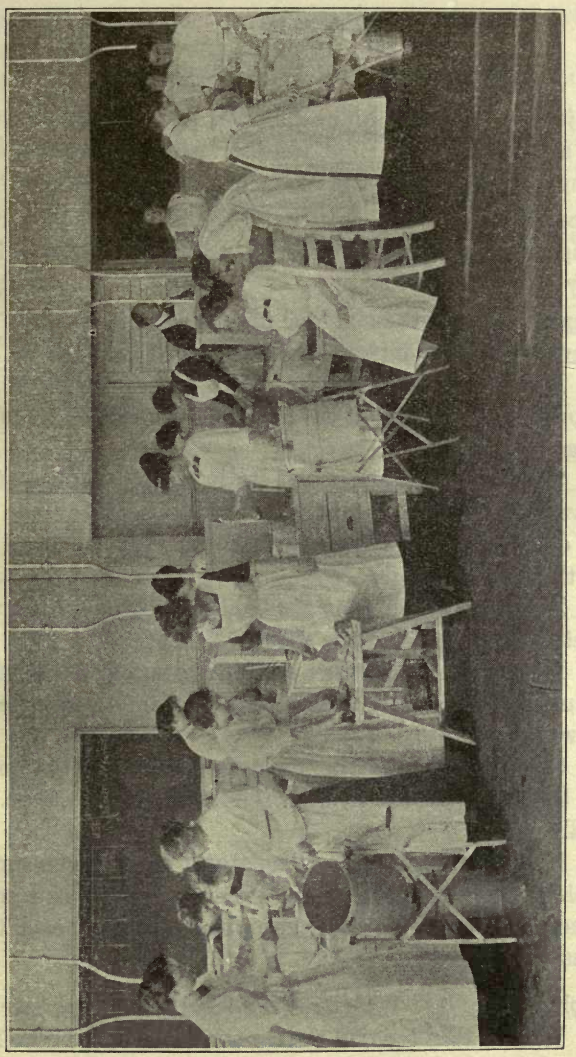


Fig. 12. A girls' class in buttermaking.

EXERCISE 1

Examination of Hand Separators

Object: To set a hand separator, knock down movable parts, analyze and become familiar with the variation in mechanism, and reassemble ready for use.

Apparatus: A number of hand separators, tools accompanying the same, level, lag screws, and copy of Dairy Laboratory Guide.

Steps: 1. Set the machine upon a solid foundation and then level the bowl frame and bolt down with lag screws.

2. Remove parts of the separator sufficiently to enable a thorough examination of the gearing; then locate all of the bearings and oil cups.

3. Take the bowl apart and study the mechanism of the contrivances within. Locate the intake and trace the course of the cream and the skimmilk through the bowl and locate the exits for each.

4. Trace the power from the handle to the bowl and note the method of increasing the speed.

5. Determine the number of revolutions of the bowl for each turn of the handle; then determine the normal speed of the bowl per minute.

6. Observe carefully the manner of adjusting the height of the bowl and adjust it with reference to the cream and skimmilk pans.

7. In all of the subsequent separator exercises be sure to clean thoroughly all parts of the machine coming in contact with the milk; then wipe the frame with a dry cloth each time after using.

Application: 1. Why does the bowl need to be level?

2. What is the object of the contrivances in the bowl?

3. How does the bowl need to be adjusted with reference to the cream and skimmilk pans? Why?

4. How does the size of the cream and the skimmilk exit compare in size? In position? Why?

5. In what way would rusting affect the separator bowl? How can one prevent rusting of the bowl and the parts?

6. What is the rubber ring for in the bowl? What precaution is necessary in washing and drying the rubber ring?

Data:

Separator	Kind of bowl bearings	No. oil bearings	Contrivances in bowl	Speed of handle	Speed of bowl

Student's Notes:

EXERCISE 2

Flushing the Separator

Object: To determine the loss of butter-fat from not flushing the separator bowl after skimming.

Apparatus: Separator, milk, scales, containers, sample bottles, thermometer, and testing outfit.

Steps: 1. Assemble the separator ready for use. Temper the milk to 85° F. and weigh out two lots of a definite amount each. Retain a sample of whole milk to test.

2. Separate lot No. 1; then flush the machine with one quart of warm water or skimmilk. Determine the weight of the cream and the skimmilk separately; retain samples to test.

3. Drain the separator bowl and separate lot No. 2 without flushing. Determine the weight of the cream and the skimmilk; retain samples and determine the percentage of butter-fat.

4. In all subsequent hand separator exercises retain all skimmilk testing over .02% and reseparate to avoid unnecessary waste of butter-fat.

5. After making the butter-fat tests, record all of the data; then check your results and account for all of the butter-fat in the original amount of milk.

Application: 1. Compute the amount of butter-fat from a cow giving annually 4000 lbs. of milk testing 4.2%, with a loss in the skimmilk as with the flushed bowl. What would be the value of the butter-fat at 2c above the current price paid for New York Extras?

2. What will the loss in the skimmilk amount to in a year from a herd of five cows averaging 4500 lbs. of milk each?

3. Is it advisable to flush the separator after using? If so, flush the bowl whenever skimming.

Data:

	Flushed			Not flushed		
	Wt.	*Test*	*B. F.*	*Wt.*	*Test*	*B. F.*
Milk						
Cream						
Skimmilk						
Loss						
Value						

Student's Notes:

EXERCISE 3

Washing the Separator

Object: To determine the effect upon the efficiency of the hand separator from not washing the bowl each time after using.

Apparatus: Separator, milk, containers, scale, sample bottles, thermometer, and testing outfit.

Steps: 1. Assemble the separator ready for use, temper the milk to 85° F., and weigh out two lots of a definite amount each. It is a good plan to try this exercise with several different separators, as the comparative results will be of much more value.

2. Separate lot No. 1 in a machine which has been left over night unwashed. Determine the weight of the cream and of the skimmilk and retain samples of each to test.

3. Wash the separator parts thoroughly; then reassemble and skim lot No. 2. Determine the weight of the cream and of the skimmilk and retain samples of each to test.

4. Test all of the samples, make the computations, and record the data.

Data:

	Unwashed			Washed		
	Wt.	*Test*	*B. F.*	*Wt.*	*Test*	*B. F.*
Milk						
Cream						
Skimmilk						
Loss						
Value						

Application: 1. Compute the loss of butter-fat in the skimmilk for one year from a cow giving 5000 lbs. of 3.5% milk, using the above tests for cream and skimmilk.

2. How much will the loss amount to in a year at current prices for butter-fat in case the separator were washed but once a day.?

3. What is the proper way to care for the separator parts after washing?

Student's Notes:

EXERCISE 4

Temperature of the Milk for Separation

Object: To determine the effects of variation in skimming temperature upon the efficiency of the hand separator.

Apparatus: Separator, milk, containers, sample bottles, scale, thermometer, and testing outfit.

Steps: 1. Assemble the separator, temper the milk to 85° F., and weigh out three lots of a definite amount each.

2. Temper lot No. 1 to 70° F., lot No. 2 to 85° F., and lot No. 3 to 100° F.

3. Separate each lot at the proper speed; then determine the weight of the cream and the skimmilk and retain samples of each to test.

4. Test the samples, make all computations, and record the data.

Data:

	Temp. 70°F.			Temp. 85°F.			Temp. 100°F.		
	Wt.	*Test*	*B.F.*	*Wt.*	*Test*	*B.F.*	*Wt.*	*Test*	*B.F.*
Milk									
Cream									
Skimmilk									
Loss									
Value									

Application: 1. What effect has the skimming temperature upon the percentage of butter-fat in the cream?

2. How does the temperature affect the loss of butter-fat in the skimmilk?

3. Compute the loss of butter-fat in one year from a cow giving 4000 lbs. of 4% milk, at current prices for butter-fat.

4. How does the separation of cold milk affect the machine mechanically? Why?

Student's Notes:

EXERCISE 5

Speed of the Separator

Object: To determine the effects of variation in speed upon the efficiency of the hand separator.

Apparatus: Separator, milk, containers, sample bottles, scale, thermometer, and testing outfit.

Steps: 1. Assemble the separator, temper the milk to 85° F., and weigh out three lots of a definite amount each.

2. Separate lot No. 1 at proper speed, which is usually indicated on the handle of the machine. Determine the weight of the cream and of the skimmilk and retain samples of each to test.

3. Separate lot No. 2 at five revolutions of the handle below proper speed. Determine the weight of the cream and of the skimmilk and retain samples to test.

4. Separate lot No. 3 at five revolutions of the handle above proper speed. Determine the weight of the cream and of the skimmilk and retain samples to test.

5. In case the speed of the machine is not indicated on the handle, refer to the book of instructions usually accompanying the machines. Exceeding care is necessary to avoid accidents.

Data:

	Low speed			Proper speed			High speed		
	Wt.	*Test*	*B. F.*	*Wt.*	*Test*	*B. F.*	*Wt.*	*Test*	*B. F.*
Milk									
Cream									
Skimmilk									
Loss									
Value									

Application: 1. How did the variation in speed influence the test of the cream? The skimmilk?

2. How high a speed is necessary to give efficient skimming?

3. How may one determine when the proper speed is reached?

Student's Notes:

EXERCISE 6

Changing the Cream Screw on the Separator

Object: To determine the effect of adjusting the screw upon the variation in percentage of butter-fat in the cream and in the skimmilk.

Apparatus: Separator, milk, containers, scale, sample bottles, thermometer, and testing outfit.

Steps: 1. Assemble the separator, temper the milk to 85° F., and weigh out three lots of a definite amount each.

2. Separate lot No. 1 with the screw in a normal position; then determine the weight of the cream and the skimmilk and retain samples to test.

3. Adjust the screw slightly so as to increase the percentage of butter-fat in the cream 5% above normal. Separate lot No. 2, determine the weight of the cream and the skimmilk, and retain samples to test.

4. Adjust the screw so as to decrease the percentage of butter-fat in the cream 5% below normal. Separate lot No. 3, determine the weight of the cream and the skimmilk, and retain samples to test.

5. In this exercise care will be necessary to note whether the adjustment is done by means of a cream screw or a skimmilk screw. The amount of adjustment will be determined by the position and character of the screw.

Application: 1. Compute the amount and the value at current prices of the butter-fat lost in one year in 10,000 lbs. of skimmilk when the percentage of loss is normal.

2. How do the screws in different makes of separators compare as to the amount of adjustment required to obtain the same results?

3. In skimming, what percentage of cream does the separator in hand do the most efficient work?

Data:

	Normal			Increased 5%			Decreased 5%		
	Wt.	*Test*	*B.F.*	*Wt.*	*Test*	*B.F.*	*Wt.*	*Test*	*B.F.*
Milk									
Cream									
Skimmilk									
Loss									
Value									

Student's Notes:

EXERCISE 7

Comparison of Various Methods of Creaming

Object: To determine the amount of butter-fat lost in skimmilk by various methods of creaming.

Apparatus: Separator, shotgun cans, shallow pans, milk scales, thermometer, and testing outfit.

Steps: 1. Temper a quantity of milk to 85°F. and weigh out three lots of definite amounts.

2. Skim lot No. 1 with a hand separator; then determine the weight of the cream and of the skimmilk and retain samples to test.

3. Put lot No. 2 into shotgun cans and set into cold water several hours before creaming. Remove the cream as well as possible by means of a perforated skimmer; then determine the weight of the cream and of the skimmilk and retain samples to test.

4. Put lot No. 3 into shallow pans and set aside to cool for several hours before creaming. Remove the cream with a perforated skimmer; then determine the weight of the cream and the skimmilk and retain samples to test.

5. Have all of the conditions for the various methods as nearly as possible like those found in practice on dairy farms.

Application: 1. Compute the loss of butter-fat in the skimmilk from the different methods of creaming from a herd of five cows for ten months, each cow averaging 500 lbs. of 4% milk per month.

2. What are the advantages of the deep-setting system over the centrifugal? The disadvantages?

3. What is the difference between the two gravity systems? Why?

4. Which system is the most practical for the modern dairyman? Why?

Data:

	Separator			Deep setting			Shallow pan		
	Wt.	*Test*	*B. F.*	*Wt.*	*Test*	*B. F.*	*Wt.*	*Test*	*B. F.*
Milk									
Cream									
Skimmilk									
Loss									
Value									

Student's Notes:

BUTTER MAKING

The beginner, when starting a new line of work, often loses much valuable time because of vague notions as to the plan of procedure. The first thing is to have a clear understanding of the object of the exercise; then proceed systematically.

Ripening. The cream for churning needs to be ripened until a definite percentage of lactic acid is developed. This is best done by placing the cream in a can or a small vat where it can be held at a constant temperature.

The best temperature for ripening cream is about 70°F. At this temperature the lactic acid bacteria multiply rapidly and will require only a few hours to sour the cream so it is ready to churn. It is well to stir the cream frequently during ripening, in order that the acid may develop evenly and the cream be free from lumps when put into the churn.

Preparing the Churn. It is well to prepare the churn by scalding with hot water or steam to fill up the openings in the wood, destroy germs, and prevent the lodging of the buttermilk. After scalding, cool the churn with cold water before adding the cream.

Lock the churn so it will not revolve; otherwise accidents may occur and the cream be lost.

Filling the Churn. Weigh out a definite quantity of cream as directed in the exercises; then determine the percentage of butter-fat and the amount of acidity.

Temper the cream to the proper degree and transfer to the churn. Care is necessary to strain the cream into the churn, in order to eliminate lumps or foreign matter that may be in the cream.

Add sufficient coloring to bring the butter to "June color." The amount will depend upon the season of the year. In

case one neglects to add coloring to the cream, it may be put in at the time of working by mixing it well with the salt.

Agitating. To get the maximum concussion during the agitation, fill the churn not more than half full of cream; otherwise difficulties may arise.

It is well to remove the air from the churn occasionally during the first few minutes of churning.

When to Stop Churning. It is well to continue churning until the butter-fat granules are about the size of barley kernels. This condition will allow a more thorough removal of the buttermilk with the wash water. Overchurning gathers the butter into larger lumps, incorporates much buttermilk, prevents thorough washing, and injures the texture of the butter.

A few common rules in use are: 1. Stop churning when the butter granules are the size of barley kernels.

2. Stop churning when the butter floats half way out of the buttermilk.

3. Stop churning when the glass in the churn cover clears and show bubbles of froth.

Washing the Butter. The wash water will need to be tempered according to the directions in the subsequent exercises. Add an amount of wash water equal to that of the buttermilk; then turn the churn a few revolutions and drain the butter. In case the wash water is very milky, wash the butter a second time It is important to have clean water, free from odors or foreign particles.

Salting and Working. The butter worker is prepared in the same manner as the churn, after which the butter is removed from the churn to the worker and spread out evenly.

The markets call for about 2½% of salt, which will require the addition of about one ounce of salt per pound of butter-fat in the cream. The salt will need to be sprinkled evenly over

the butter and then worked in thoroughly. To prevent overworking, it may be well to let the butter stand for a few minutes in order to let the salt dissolve, and then rework.

It is extremely easy to overwork the butter, especially small quantities, and the student will do well to take much precaution at this point. Overworking destroys the grain and makes the butter gummy, smeary, or salvy in texture.

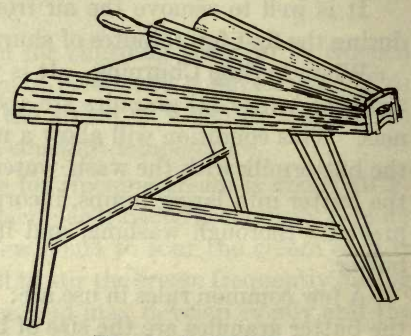


Fig. 13. A butter-worker.

Packing. The best way to pack butter is in thoroughly sterilized stone jars or in pound prints. Butter packs the best when taken directly from the worker, but the prints can be made cleaner cut and more attractive by allowing the fresh butter to sit in a cool place for a few hours.

The Overrun. Overrun means merely that one pound of butter-fat, when made into butter, will produce more than a pound of butter, just the same as a pound of flour, when mixed with water, milk, yeast, and salt, will make more than a pound of bread—or will over-run.

During the process of churning, the butter-fat is brought together by agitation; then the butter-fat is washed to remove as much of the remaining milk as possible and then salted and worked.

Average butter is composed of the following substances:

Butter-fat	82.5 per cent
Water	14.0 per cent
Casein (curd)	1.0 per cent
Mineral matter (salt, etc.)	2.5 per cent
Total	100.0 per cent

Not all butter analyzes the same. The proportions of the several constituents vary, depending upon the condition of the fat, the efficiency of the apparatus used, and the skill of the maker. The water, of course, varies the most. Water in butter, however, must not exceed 16%.

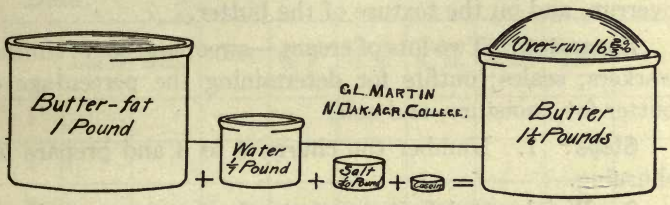


Fig. 14. A graphic explanation of overrun.

A hundred pounds of 30% cream contains 30 lbs. of butter-fat. In churning not all the fat can be recovered, but the loss with proper methods and appliances is very small. One should make from the 30 lbs. of fat about 36 lbs. of butter of the composition as given. To calculate the percentage of overrun, subtract the weight of butter-fat from the weight of the butter and then divide the difference by the weight of butter-fat and multiply by 100.

Formula:

$$\frac{\text{Wt. of butter—wt. of B.F.}}{\text{weight of B.F.}} \times 100 = \text{percentage of O. R.}$$

EXERCISE 8

Influence of Acidity on the Churnability of Cream

Object: To determine the influence of the acidity of the cream upon the loss of butter-fat in the buttermilk, on the overrun, and on the texture of the butter.

Apparatus: Two lots of cream,—sweet and sour; churns; workers; scales; outfits for determining the percentage of butter-fat, moisture, and salt.

Steps: 1. Number the churns 1 to 3 and prepare for churning.

2. Weigh out definite amounts of sweet cream and sour cream, after which weigh out a like quantity of sweet and sour cream in equal parts. Retain samples of each lot to test for acid and butter-fat.

3. Temper each lot of cream to 54°F.; then put the sweet cream into churn No. 1, the properly ripened cream into churn No. 2, and the mixed cream into churn No. 3.

4. Agitate the cream until the butter comes; then record the length of time required to churn, after which remove the buttermilk and retain samples to test.

5. Temper the wash water to 56° F.; then wash, salt, work, weigh, and pack each lot in the same way.

6. Record the time required to churn, make all of the tests for butter-fat, moisture, and salt; then figure the overrun for each lot.

7. Score the butter from each lot of cream after several days and note the flavor and texture of each.

Application: 1. How does the degree of acidity affect the time of churning?

2. In which lot was the greatest loss of butter-fat in the buttermilk? Why?

3. How did the mixing of sweet and sour cream affect the loss of butter-fat in the buttermilk? Why?

4. What is the proper degree of acidity for exhaustive churning?

Data:

Lot	Per ct. acidity	Amt. cream	Test	Amt. B. F.	Per ct. O. R.	Loss B. M.	Per ct. moist.	Per ct. salt	Time
1									
2									
3									

Student's Notes:

EXERCISE 9

Effects of Temperature in Churning

Object: To determine the effects of variation in temperature of cream on the time to churn, the loss of butter-fat in the buttermilk, the moisture content of the butter, the percentage of overrun, and on the quality of the butter.

Apparatus: Sample of cream, churn, worker, testing outfits, thermometer, and scales.

Steps: 1. Test the cream for butter-fat and acid; then divide it into three lots.

2. Temper the cream for lot No. 1 to 48° F., and churn it. Remove the buttermilk; then temper the wash water to 56°, and wash, salt, weigh, and pack the butter according to the preceding directions. Retain a sample of the buttermilk to test.

3. Temper the cream for lot No. 2 to 54° F., and churn it. Remove the buttermilk; then temper the wash water to 56° and complete the work as in step No. 2.

4. Temper the cream for lot No. 3 to 60° F., and churn it. Remove the buttermilk; then temper the wash water to 56° and complete the work as in step No. 2.

5. Record the length of the time to churn the butter, test each sample of buttermilk, make all computations, and record the data.

Data:

Lot	Per ct. acid	Amt. cream	Test	Amt. B. F.	Per ct. O. R.	Loss B. M.	Per ct. moist.	Per ct. salt	Time
1									
2									
3									

Application: 1. How does the temperature of the cream affect the time of churning? The loss of butter-fat in the buttermilk?

2. How did the various lots of butter compare as to the texture of the butter? Why?

3. What influence does the churning temperature have on the percentage of moisture in the butter? On the salt? On the overrun? Why?

4. Did each lot of butter require the same amount of working?

Student's Notes:

EXERCISE 10

Variations in Temperature of Wash Water on Butter

Object: To determine the effects of the variation in temperature of the wash water on the moisture, the salt content, and the texture of the butter.

Apparatus: A quantity of cream, churns, workers, testing outfits, thermometer, and scales.

Steps: 1. Ripen a quantity of cream to the proper degree for churning and divide it into three lots equal in amount.

2. Churn each lot of cream the same; remove the buttermilk and retain samples to test.

3. Temper the wash water to 48° F., and wash lot No. 1.

4. Temper another lot of wash water to 56° F., and wash lot No. 2.

5. Temper another lot of wash water to 60° F. and wash lot No. 3.

6. Remove the butter to the workers; then salt, work, weigh, and pack each lot alike.

7. Compute the overrun; then determine the percentage of moisture, the percentage of salt, and the texture of each lot of butter.

Data:

Lot	Per ct. acid	Amt. cream	Test	Amt. B. F.	Amt. butter	Per ct. O. R.	Loss B. M.	Per ct. moist.	Per ct. salt
1									
2									
3									

Application: 1. How did the various temperatures of the wash water affect the overrun? The moisture content? The salt content? Why?

2. Under what conditions would it be well to wash butter at 48°F.? At 56°F.? At 60°F.?

3. How was the texture of the butter affected by the extreme temperatures?

Student's Notes:

EXERCISE 11

The Distribution of Salt in Butter

Object: To determine the effects of uneven distribution of salt upon the color, grade, and the keeping quality of butter.

Apparatus: Cream, and churning outfit.

Steps: 1. Ripen a quantity of cream to the proper degree of acidity, weigh out a definite amount, and temper it to 54°F.

2. Complete the churning as usual; then divide the butter into two lots.

3. Remove lot No. 1 to the worker; then apply the salt and work it in evenly.

4. Remove lot No. 2 to the worker; then sprinkle the salt unevenly and do not work it in thoroughly.

5. Test each lot of butter for moisture and salt; then store it. Examine the butter at intervals to note the score.

Data:

Lot	1			2		
Hours	*24*	*48*	*72*	*24*	*48*	*72*
Flavor						
Texture						
Color						
Per cent salt						
Per cent moisture						
Grade						
Market value						

Application: 1. How does the uneven distribution of salt affect the color of the butter? The grade? The market value?

2. Compute the returns in one year at current prices for butter from a herd of ten cows averaging 150 pounds of butter-fat each, grading the butter according to the findings in this experiment.

Fig. 15. A butter mold.

Student's Notes:

EXERCISE 12

The Effect of Overworking Butter

Object: To determine the effects upon the texture, moisture content, and the salt content of butter by overworking.

Apparatus: Cream, and churning outfit.

Steps: 1. Ripen a quantity of cream to the proper degree of acidity, weigh out a definite amount, and temper to 54° F.

2. Complete the churning as usual; then divide the butter into two lots.

3. Remove lot No. 1 to the worker, salt evenly and then work the butter just enough.

4. Remove lot No. 2 to the worker, salt evenly; then overwork the butter.

5. Test each lot of butter for moisture and salt; then store and examine it at subsequent intervals to note the score.

Data:

Lot	1			2		
Hours	*24*	*48*	*72*	*24*	*48*	*72*
Flavor						
Texture						
Color						
Per cent salt						
Per cent moisture						
Grade						
Market value						

Application: 1. What effect has working upon the distribution of salt?

2. What causes mottles in butter?

3. How does overworking affect the grain or texture of butter?

4. How may one know when butter is overworked?

5. Compute the returns in one year from a cow producing 150 pounds of butter-fat, at current prices for butter graded according to the findings in this experiment.

Student's Notes:

EXERCISE 13

Influence of the Grade of Cream on the Quality of Butter

Object: To determine the influence of different grades of cream on the grade, the market value, and the keeping quality of butter.

Apparatus: Two lots of cream, grading first and second; and a churning outfit.

Steps: 1. Secure for lot No. 1 a small amount of first-grade cream, which is reasonably sweet and of clean flavor, with acidity not over .2%. Temper this to 54°F. and complete the churning as usual.

2. Secure for lot No. 2 a small amount of second-grade cream, which is reasonably free from objectionable odors and flavors, with acidity over .2%. Temper this to 54°F., complete the churning, wash, salt, work, and store the same as lot No. 1.

3. Examine the butter at intervals and determine the grade and keeping quality of the butter.

Data:

Lot	1			2		
Hours	*24*	*48*	*72*	*24*	*48*	*72*
Flavor						
Texture						
Color						
Per cent salt						
Per cent moisture						
Grade						
Market value						

Application: 1. What is the immediate difference in the butter from each lot of cream?

2. How long would hand-separator cream keep before it would grade second in winter? In the summer?

3. What inducement do many creameries give to insure frequent delivery of cream? Why?

4. Compute the value of 1000 pounds of butter on the Chicago market made from each grade of cream.

5. How much would a farmer gain in one year from a herd of five cows, averaging 150 pounds of butter-fat each, if all of the cream graded first and the creamery paid 2c per pound premium on the butter-fat?

6. How can a creamery afford to pay a premium on first-grade cream?

Student's Notes:

PART FOUR

THE MARKETING OF DAIRY PRODUCTS

The marketing of the finished product and the profitable utilization of the by-products is one of the important branches of any industry. In the past, the dairy instruction, for the most part, has been applied to the production, care, and manufacture of a variety of products, with very little attention given to the marketing end of the business.

There are a great many marketable forms of dairy products and each one is sold on a different basis. This condition requires a knowledge of how to standardize, classify, and grade; how to judge, compare values, and market the products; and how to compute the returns.

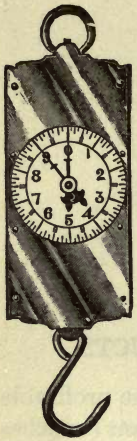


Fig. 16. A milk scales used in keeping milk records.

EXERCISE 1

Variation of Butter-fat in Market Milk

Object: To determine the value of market milk containing varying percentages of butter-fat.

Apparatus: Samples of milk, scales, and testing outfit.

Steps: 1. Determine the percentage of butter-fat in the milk from different patrons.

2. Determine the average weight of a quart of milk by weighing several samples on the scales.

3. Determine the number of quarts in a hundred pounds of milk testing as above, and the market value when retailed at local prices.

Data:

Patron	Amount of milk	Per cent test	Number of quarts	Selling price	Total returns
1					
2					
3					
4					

Application: 1. What will be the cash value of the milk from a cow giving 5000 pounds of 4% milk in one year when retailed at local prices?

2. What is the weight of a quart of milk testing 4%? A gallon?

3. How does the percentage of butter-fat influence the weight? The price?

Student's Notes:

EXERCISE 2

Variation of Butter-fat in Market Cream

Object: To determine the market value of milk when sold as cream containing different percentages of butter-fat.

Apparatus: Samples of milk and cream, scales, and testing outfit.

Steps: 1. Secure samples of cream from the separator and determine the percentage of butter-fat.

2. Determine the average weight of cream containing varying percentages of butter-fat by weighing a number of samples on the scales.

3. Determine the market value of a hundred pounds of milk sold at local prices for sweet cream testing as the above. Record data below.

4. Determine the value of the skimmilk, estimated at ½c per pound.

To determine the amount of cream.. Rule: Multiply the amount of milk by the test and divide the product by the percentage of butter-fat in the cream.

To obtain the amount of skimmilk. Rule: Subtract the amount of cream from the amount of milk, assuming no loss of butter-fat in the skimmilk.

Data:

Patron	Amt. of cream	Per cent test	No. quarts	Selling price	Value of cream	Value skimmilk	Total returns
1							
2							
3							
4							

Application: 1. If the product of a cow giving 5000 pounds of 4% milk in one year is sold as 20% cream at local prices, what will be the total returns, estimating the skimmilk at ½c per pound?

2. How would a variation in the test of the cream influence the selling price?

Student's Notes:

EXERCISE 3

Marketing Butter and By-products

Object: To determine the market value of milk when sold as butter and by-products.

Apparatus: Samples of milk, and testing outfit.

Steps: 1. Determine the percentage of butter-fat in milk from different patrons.

2. Determine the amount of 20% cream and the skimmilk from 100 pounds of milk according to the tests.

3. Determine the amount of butter from each patron, allowing 20% overrun.

4. Find the total value of the butter and the skimmilk at local prices for butter, estimating the value of the skimmilk at 50c per hundredweight.

Data:

Patron	Amount cream	Per ct. test	Pounds butter	Selling price	Value butter	Value skimmilk	Total returns
1							
2							
3							
4							

Application: 1. If the product of a cow giving 5000 pounds of 4% milk be sold as butter at local prices, what will be the cash returns, estimating the skimmilk and the buttermilk at 50c per hundredweight?

2. How much will the skimmilk be worth per hundred when fed to calves? To swine? To poultry?

Student's Notes:

EXERCISE 4

The Marketing of Ice Cream

Object: To determine the value of milk containing varying percentages of butter-fat when marketed as ice cream and skimmilk.

Apparatus: Samples of milk, scales, and testing outfit.

Steps: 1. Determine the percentage of butter-fat in the milk from the different patrons.

2. Determine the number of quarts of 25% cream from 100 pounds of milk from each patron.

3. Determine the number of quarts of ice cream that can be made from the cream of each patron, allowing a 30% overrun.

4. Find the total market value of the ice cream at local prices and the skimmilk at ½c per pound.

Data:

Patron	Amount cream	Test	Quarts ice cr.	Selling price	Value ice cr.	Value skimmilk	Total returns
1							
2							
3							
4							

Application: 1. If the product of a cow giving 5000 pounds of 4% milk in one year be marketed as ice cream, what will be the total cash returns at local prices, estimating the skimmilk at 50c per hundred?

2. Which form of marketing the products of the herd will bring the dairyman the largest total cash returns?

3. In case the by-products, skimmilk, and buttermilk were fed to poultry, which method would bring the largest total returns?

Student's Notes:

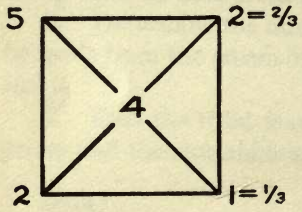
EXERCISE 5

The Standardizing of Dairy Products

Object: To standardize market milk or cream with varying percentages of butter-fat to a product of a definite standard.

Apparatus: A quantity of milk, cream, and skimmilk, two shotgun cans, milk scales, and testing outfit.

Steps: 1. Determine the percentage of butter-fat in the products to be standardized.



The accompanying diagram devised by Pearson will assist in determining the quantity of each product necessary to make up a definite amount of the standard product.

In using the diagram, place the percentage of test of the milk, cream, or skimmilk, to be standardized at the left-hand corners, and the test of the desired product in the center of the square. The difference between the test of the desired product in the center and those to be standardized at the left-hand corners is placed at the right-hand corners. These figures represent the proportions of the products to use in standardizing.

2. Standardize two lots of milk containing different percentages of butter-fat to a product of a definite standard.

Data:

Lot	Test	Standard test	Proportions	Amounts
1				
2				

3. Standardize milk or cream to a product of a definite standard by using cream.

Data:

Lot	Test	Standard test	Proportions	Amounts
1				
2				

4. Standardize milk or cream to a product of a definite standard by using skimmilk.

Data:

Lot	Test	Standard test	Proportions	Amounts
1				
2				

Application: 1. Of what advantage to the milkman is standardization?

2. Why is it necessary to standardize milk and cream?

3. How much 2.5% and 6% milk will it require to standardize 210 pounds of milk to 4%? Prove the accuracy of the computation.

4. Standardize 334 pounds of 6.4% milk from 3.5% milk and 20% cream.

5. How much skimmilk testing .02% will be required to standardize 150 lbs. of 4% milk from milk testing 7.2%?

6. How much gravity cream testing 15% will be required to standardize 250 pounds of 25% cream from cream testing 40%?

7. What will be the increased net returns at 6c per quart, from a cow giving 5000 lbs. of 6% milk in one year, when standardized to 4% by using skimmilk worth 50c per hundred?

Student's Notes:

EXERCISE 6

The Determination of Creamery Dividends

Object: To determine the dividends on a butter-fat basis of patrons selling cream to a co-operative creamery for a given period.

Apparatus: Samples of cream, and testing outfit.

Steps: 1. Determine the percentage of butter-fat in the cream of four patrons.

2. To determine the amount of butter-fat delivered by each patron, multiply the amount of cream delivered by the test.

3. To determine the amount of butter manufactured, allow 20% overrun, with no loss of butter-fat in the buttermilk.

4. To determine the value per pound of butter-fat, divide the total receipts from butter sales at local prices by the total pounds of butter-fat delivered for the period.

5. To determine the dividends due each patron, multiply the pounds of butter-fat each delivered for the period by the net price per pound of butter-fat. Assume the operating expenses of the creamery to be $125 for the period.

Data:

Patron	Amt. cream delivered	Test	Pounds B. F.	Net price butter-fat	Dividend due
1					
2					
3					
4					

Application: 1. What will be the dividends due each patron for a given period when No. 1 delivers 1200 pounds of first-grade cream, No. 2 delivers 3000 pounds, No. 3 delivers 2500 pounds, and No. 4 delivers 1800 pounds, testing according to the above samples? Assume $125 for running expenses and ½c per pound of butter-fat for a sinking fund.

2. What will be the net dividend for each patron where second-grade cream is delivered and the butter from it sells for 4c per pound below market quotations for Extras?

3. What is a sinking fund? How is the net price per pound of butter-fat determined for the period?

4. What conditions make it possible for the price per pound of butter-fat to be more than the selling price for butter?

Student's Notes:

APPENDIX

THE SCORING OF BUTTER

The different butter markets require some standard of perfection whereby certain qualities in the butter can be measured and compared. This has led to the adoption of a system of scoring based upon flavor, texture, color, salt, and package, with relative values attached to each point.

The score card is used by the judge as a yardstick and as a record in case a number of samples are judged at a time.

BUTTER SCORE CARD

	Scale	Score	Remarks
Flavor	45		
Texture	25		
Color	15		
Salt	10		
Package	5		
Total	100		

The butter judge uses a trier to remove a plug of butter from the package to be scored. The sample is then held close to the nose immediately after being withdrawn in order to detect the aroma, which is a very volatile odor. The

aroma of good butter is extremely delicate and passes away soon after the sample is removed from the package.

DESCRIPTIVE TERMS

Flavor. The flavor is the most important quality in butter, and is determined by the sense of smell and taste. The aroma is detected by the sense of smell and the flavor by the sense of taste. The judge combines these two and notes the defects in order to form a judgment on flavor.

Perfect flavor in the highest grade of butter made from the very best cream is described as being clean, sweet, and nutty. It should have a pleasant, delicate aroma, characteristic of clean, well-ripened cream.

Stable flavor is characteristic of cow stables, and is commonly caused by admixture of dirt or by milking, straining, or keeping the milk too long in a dirty stable.

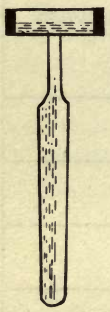


Fig. 17. Butter trier.

Unclean flavor results from dirty pails, strainers, and other utensils, or from careless methods of handling the milk.

Rancid flavor is caused by overripened cream or when milk, cream, or butter is kept too long, especially when kept in the sunshine.

Curdy flavor is often due to adding overripened starters to the cream, or to incomplete removal of the buttermilk when washing the butter.

Weedy flavor is due to the cows eating weeds in the pasture. It may come from feeding the cows onions, cabbage, or turnips, or it may come from exposing the milk and the cream in surroundings where decayed vegetable odors are present.

Oily flavor may result from churning the cream, washing or working the butter at too high a temperature. It may

result from using too much or too old butter coloring. The cause is sometimes attributed to certain kinds of bacteria.

Cowy flavor suggests animal odors, and may appear in the spring when the cows are first turned to pasture. It may appear in milk from a cow that is sick or in a feverish condition.

Texture. Texture refers to the grain and to the body of the butter. It is determined by the appearance and feeling of the sample on the trier. The globules of fat cohere to one another rather loosely and irregularly during the churning. They retain this same position in the body of the finished product, unless the cream is churned too warm or the butter is washed and worked improperly.

Perfect texture allows the butter granules to retain their individuality, and when broken apart the fractured ends will appear like broken steel. It also allows the back of the trier to be free from a greasy appearance when withdrawn from the sample. A good body will show firmness under the thumb when examined at ordinary temperatures.

Salvy texture is due to washing or working the butter at too high temperatures or to overworking. These destroy the grain, which makes the butter appear sticky or greasy and pull apart like gum.

Tallowy texture results from the presence of much hard fats in the butter-fat, due to the cow's being too long in lactation or to chilling the butter in extremely cold wash water.

Poor grain refers to a lack of proper mechanical methods in making the butter.

Weak body refers to butter which is soft and salvy in texture and in which the moisture is high or not thoroughly incorporated. It may be the result of the feed the animal receives, as green grass, or from too high temperatures.

Color. The natural color of butter varies from a light

straw to a deep yellow, depending upon the breed of the cow, the feed she receives, and the season of the year. The average market demands a light straw color similar to that produced by June pasturage. A uniform color is demanded, which makes it necessary to use artificial coloring in varying amounts.

Perfect color is a lively straw yellow, uniform and solid throughout.

Mottles are uneven colors of light and dark spots, waves, or streaks. The high colors are caused by the attraction of moisture from the undissolved salt. The light portions may result from the action of the salt upon the buttermilk remaining in the butter.

White Specks are due either to particles of casein resulting from overripe cream or overripe starter, or to dried particles of cream caused from lack of stirring during ripening.

Salt. The quantity of salt usually varies from none at all to an ounce per pound of butter-fat. The important thing is to have the salt uniformally distributed throughout the butter and thoroughly dissolved.

Flat is the term used to describe the lack of salt.

Gritty refers to undissolved salt, and is a most objectionable defect.

Package. This refers to the appearance of the butter on the market. The trade desires the butter to be put into a tub, jar, or print which is clean, neat, and attractive.

Classification of Butter

It is customary in local markets to classify butter under the general heads of Creamery, Dairy, and Process butter; however, the large mercantile exchanges include a more detailed system.

The Chicago Market.

The Chicago Butter and Egg Board classifies the butter handled on their markets as Creamery, Dairy, Ladle, Renovated, Packing Stock, and Grease Butter.

Creamery Butter. Butter offered under this classification shall have been made in a creamery from cream obtained by the separator system, or gathered cream.

Dairy Butter. Butter offered under this classification shall be such as is made, salted and packed by the dairyman, and offered in its original package.

Ladle Butter. Butter offered under this classification shall have been collected in rolls, lumps, or in whole packages, and reworked by the dealer or shipper.

Renovated Butter. Butter offered under this classification shall be made by taking butter and melting the same, and rechurning with fresh milk, cream, or skimmilk, or other equivalent process.

Grease Butter. Shall consist of all grades of butter below Fourths, free from adulteration.

GRADES.

Extras shall consist of the highest grade of butter, produced during the season when made, scoring 93 points or higher.

Flavor. Must be quick, fine, fresh and clean if of fresh make, and good, sweet and clean if held.

Body. Must be firm and solid, with a perfect grain or texture, free from salviness.

Color. Must be uniform, neither too light nor too high.

Salt. Well dissolved, thoroughly worked in, not too high nor too light salted.

Package. Good and sound as required in classification.

Extra Firsts shall be a grade just below Extras, scoring 90 points or higher, lacking somewhat in quick flavor, which, however, must be good, sweet, clean and fresh, if of fresh make, and sweet and clean if held. All other requirements being the same as in Extras.

Firsts shall be a grade just below Extra Firsts, scoring 87 points or higher, lacking in flavor, which, however, must be good, sweet and clean. All other requirements the same as in Extra Firsts.

Package. Good and uniform.

Seconds shall consist of a grade just below Firsts, scoring 80 points or higher.

Flavor. Must be fairly good and sweet.

Body. Must be sound and smooth boring.

Color. Fairly good, although it may be somewhat irregular.

Salt. May be irregular, high or light salted.

Package. Same as required in Firsts.

Thirds shall consist of butter below Seconds, scoring 75 points or higher.

Flavor. Reasonably good, may show strong tops and side.

Body. Not smooth boring.

Color. Mixed or streaked.

Salt. Irregular.

Package. Miscellaneous.

Fourths shall be a grade below Thirds and may consist of promiscuous lots, may be off-flavored and strong tops and sides.

Body. Not required to draw a full trier.

Color. May be irregular.

Package. Any kind of package mentioned at time of sale.

Packing Stock shall consist of three grades, viz., Extras, Number One and Number Two.

Extras in Packing Stock shall be original butter without additional moisture or salt, sweet and sound, packed in new barrels having wooden heads in both ends, or in new tubs, both to be parchment paper lined, barrels and tubs to be packed full.

Number One Packing Stock shall be original butter without additional moisture or salt, sweet and sound. May be packed in different kinds of barrels, tierces, pails, tubs or good clean boxes, may be without paper lining, may be packed in two-headed or cloth-covered barrels.

Number Two Packing Stock shall be grade or quality above Grease Butter and packed in any or all kinds of packages.

PACKAGES TO BE USED.

Creamery. Tubs, hardwood, about 60 lbs. (for Extras shall be standard white ash 60-lb. tubs).

Dairy. Tubs of varying size.

Ladles. Tubs of varying size.

Renovated. Tubs of varying size.

Roll. Any style or size of package.

Grease. Any style or size of package.

The New York Market.

The New York Mercantile Exchange classifies the butter handled on their markets as Creamery, Process, Factory, Packing Stock, and Grease Butter.

Creamery Butter offered under this classification shall have been made in a creamery from cream separated at the creamery or gathered from the farmers.

Dairy Butter includes all butter made on the farm, and salted, packed, and sold in the original packages by the dairyman.

Process Butter offered under this classification shall be such as is made by melting butter, clarifying the fat therefrom and rechurning the same with fresh milk, cream, or skimmilk, or other similar process.

Factory Butter offered under this classification shall be such as is collected in rolls, lumps, or in whole packages and reworked by the dealer or the shipper.

Packing Stock. Butter offered under this classification shall be original farm-made butter in rolls, lumps, or otherwise, without additional moisture or salt.

Grease Butter shall comprise all classes of butter grading below Thirds, or of packing stock grading below No. 3, as hereinafter specified, free from adulteration.

Grades of Butter

The grading of butter on the market is determined largely by the score. The standard official rules adopted by the New York Mercantile Exchange stipulate that Creamery, Process, and Factory butters shall be graded as Extras, Firsts, Seconds, and Thirds; and Packing Stock shall be graded as No. 1, No. 2, and No. 3. The grades must conform to the following requirements:

1. Extras shall comprise the highest grade of butter obtainable in the season when offered, under the various classifications. Ninety per cent shall conform to the following standard; the balance shall grade below Firsts.

Flavor. In Class A, fresh butter, current make, must be fine, sweet, fresh and clean. Class B must be reasonably fine, sweet, fresh, and clean.

If held, in Class A, flavor must be fine, sweet, and clean. In Class B, must be reasonably fine, sweet, and clean.

Texture must be firm and uniform.

Color. A light straw shade, even and uniform.

Salt. Medium salted.

Package. Sound, good, uniform, and clean.

Score. In Class A, 93 points or higher. In Class B, 91 points or higher.

2. **Firsts** shall be a grade just below Extras, and must be good butter for the season when offered, under the various classifications. Ninety per cent shall conform to the following standard; the balance shall not grade below Seconds.

Flavor. Must be good, sweet, clean and fresh, if of current make, in Class A; and be good, sweet, reasonably clean and fresh, if of current make, in Class B.

If held, must be good, sweet and clean in Class A; and good, sweet and reasonably clean in Class B.

Texture. Must be firm and fairly uniform.

Color. Reasonably uniform, neither very high nor very low.

Salt. May be reasonably high, light, or medium.

Package. Sound, good, uniform, and clean.

Score. In Class A, 88 to 92 points. In Class B, 86 to 90 points.

3. **Seconds** shall be a grade just below Firsts.

Flavor. Must be reasonably good.

Texture. If Creamery, must be solid boring. If Factory or Process, must be 90 per cent solid boring.

Color. Fairly uniform, but may be mottled.

Salt. May be high, medium, or light.

Package. Good and uniform.

Score. In Class A, 83 to 87 points. In Class B, 81 to 85 points.

4. Thirds shall be a grade just below Seconds, and may consist of promiscuous lots.

Flavor. May be off-flavored and strong on tops and sides.

Texture. Not required to draw a full trier.

Color. May be irregular or mottled.

Salt. High, light, or irregular.

Package. Any kind of package mentioned at time of sale.

Score. In Class A, 77 to 82 points. In Class B, 75 to 80 points.

No. 1 Packing Stock shall be sweet and sound, packed in large, new or good second-hand barrels, having a wooden head in each end, or in new tubs, either to be parchment paper lined. Barrels and tubs to be packed full.

No. 2 Packing Stock shall be reasonably sweet and sound, and may be packed in promiscuous or different kinds of barrels, tubs or tierces, without being parchment paper lined, and may be packed in either two-headed or cloth-covered barrels.

No. 3 Packing Stock shall be a grade below No. 2, and may be off-flavored, or strong; may be packed in any kind or kinds of packages.

Mould. There shall be no grade for butter that shows mould.

STANDARDS FOR MILK AND MILK PRODUCTS

The Association of State and National Food and Dairy Departments adopted the following standards for milk and milk products in 1908.

MILK

1. **Milk** is the fresh, clean, lacteal secretion obtained by the complete milking of one or more healthy cows, properly fed and kept, excluding that obtained within fifteen days before and ten days after calving, and contains not less than eight and one-half (8.5) per cent of solids not fat, and not less than three and one-quarter (3.25) per cent of milk fat.

2. **Blended milk** is milk modified in its composition so as to have a definite and stated percentage of one or more of its constituents.

3. **Skimmilk** is milk from which a part or all of the cream has been removed, and contains not less than nine and one-quarter (9.25) per cent of milk solids.

4. **Pasteurized milk** is milk that has been heated below boiling, yet sufficiently to kill most of the active organisms present, and immediately cooled to 50° F., or lower.

5. **Sterilized milk** is milk that has been heated to the temperature of boiling water, or higher, for a length of time sufficient to kill all organisms present.

6. **Condensed milk, evaporated milk** is milk from which a considerable portion of water has been evaporated, and contains not less than twenty-eight (28) per cent of milk solids, of which not less than twenty-seven and sixty-six hundredths (27.66) per cent is milk fat.

7. **Sweetened condensed milk** is milk from which a considerable portion of water has been evaporated and to which sugar (sucrose) has been added, and contains not less than

twenty-eight (28) per cent of milk solids, of which not less than twenty-seven and sixty-six hundredths (27.66) per cent is milk fat.

8. **Condensed skimmilk** is skimmilk from which a considerable portion of water has been evaporated.

9. **Buttermilk** is the product that remains when butter is removed from milk or cream in the process of churning.

10. **Goat's milk, ewe's milk, etc.,** are the fresh, clean, lacteal secretions, free from colostrum, obtained by the complete milking of healthy animals other than cows, properly fed and kept, and conform in name to the species of animals from which they are obtained.

Cream

1. **Cream** is that portion of milk, rich in milk fat, which rises to the surface of milk on standing, or is separated from it by centrifugal force, is fresh and clean, and contains not less than eighteen (18) per cent of milk fat.

2. **Evaporated cream, clotted cream** is cream from which a considerable portion of water has been evaporated.

Milk Fat or Butter-fat

1. **Milk-fat, butter-fat** is the fat of milk, and has a Reichert-Meissl number not less than twenty-four (24) and a specific gravity not less than $0.905\text{-}\frac{40°}{40°}$.

Butter

1. **Butter** is the clean, non-rancid product made by gathering in any manner the fat of fresh or ripened milk or cream into a mass, which also contains a small portion of the other milk constituents, with or without salt, and contains not less than eighty-two and five-tenths (82.5) per cent of milk fat. By acts of Congress approved August 2, 1886, and May 9, 1902, butter may also contain added coloring matter.

2. Renovated butter, process butter is the product made by melting butter and reworking, without the addition or use of chemicals or any substances except milk, cream, or salt, and contains not more than sixteen (16) per cent of water and at least eighty-two and five-tenths (82.5) per cent of milk fat.

Cheese

1. Cheese is the sound, solid, and ripened product made from milk or cream by coagulating the casein thereof with rennet or lactic acid with or without the addition of ripening ferments and seasoning, and contains, in the water-free substance, not less than fifty (50) per cent of milk fat. By act of Congress, approved June 6, 1896, cheese may also contain added coloring matter.

2. Skimmilk cheese is the sound, solid, and ripened product made from skimmilk by coagulating the casein thereof with rennet or lactic acid with or without the addition of ripening ferments and seasoning.

3. Goat's milk cheese, ewe's milk cheese, etc., are the sound, ripened products made from the milks of the animals specified, by coagulating the casein thereof with rennet or lactic acid with or without the addition of ripening ferments and seasoning.

Ice Creams

1. Ice cream is a frozen product made from cream and sugar with or without a natural flavoring, and contains not less than fourteen (14) per cent of milk fat.

2. Fruit ice cream is a frozen product made from cream, sugar, and sound, clean, mature fruits, and contains not less than twelve (12) per cent of milk fat.

3. Nut ice cream is a frozen product made from cream, sugar, and sound, non-rancid nuts, and contains not less than twelve (12) per cent of milk fat.

MISCELLANEOUS MILK PRODUCTS

1. **Whey** is the product remaining after the removal of fat and casein from milk in the process of cheese making.

2. **Kumiss** is the product made by the alcoholic fermentation of mare's or cow's milk.

COMPOSITION OF DAIRY PRODUCTS AND BY-PRODUCTS

The following are a number of average compositions for dairy products and by-products according to some of the leading authorities:

Normal milk		Richmond.
Water	87.10	per cent.
Fat	3.90	" "
Proteid	3.50	" "
Milk sugar	4.75	" "
Ash	.75	" "
Total	100.00	
Butter		Richmond.
Water	13.0	per cent.
Fat	83.5	" "
Proteid	1.0	" "
Milk sugar	0.0	" "
Ash, (salt, etc.)	2.5	" "
Total	100.0	
Skimmilk		Fleischmann.
Water	90.30	per cent.
Fat	.25	" "
Proteid	4.00	" "
Milk sugar	4.70	" "
Ash	.75	" "
Total	100.00	
Buttermilk		Fleischmann.
Water	91.24	per cent.
Fat	.56	" "
Proteid	3.50	" "
Milk sugar	4.00	" "
Ash	.70	" "
Total	100.00	

Whey		Fleischmann.
Water	93.31	per cent.
Fat	.10	" "
Proteid	.27	" "
Sugar	5.85	" "
Ash	.47	" "
Total	100.00	
Sweetened condensed milk		Fleischmann.
Water	25.68	per cent.
Fat	10.99	" "
Proteid	12.33	" "
Sugar	48.66	" "
Ash	2.34	" "
Total	100.00	
Unsweetened condensed milk		Fleischmann.
Water	48.59	per cent.
Fat	15.67	" "
Proteid	17.81	" "
Sugar	15.40	" "
Ash	2.53	" "
Total	100.00	

CHEESE

Cream		König.
Water	36.33	per cent.
Fat	40.71	" "
Proteid	18.84	" "
Sugar	1.02	" "
Ash	3.10	" "
Total	100.00	
Full Cream		König.
Water	38.00	per cent.
Fat	30.25	" "
Proteid	25.35	" "
Sugar	1.43	" "
Ash	4.97	" "
Total	100.00	
Skimmilk		König
Water	46.00	per cent.
Fat	11.65	" "
Proteid	34.06	" "
Sugar	3.42	" "
Ash	4.87	" "
Total	100.00	

Cheddar cheese (green)		Van Slyke.
Water	36.80	per cent.
Fat	33.75	" "
Proteid	23.75	" "
Sugar	0.00	" "
Ash	5.70	" "
Total	100.00	
Swiss		Fleischmann.
Water	36.1	per cent.
Fat	29.5	" "
Proteid	28.0	" "
Sugar	3.3	" "
Ash	3.1	" "
Total	100.00	
Limburger		Fleischmann.
Water	35.7	per cent.
Fat	34.2	" "
Proteid	24.2	" "
Sugar	3.0	" "
Ash	2.9	" "
Total	100.00	

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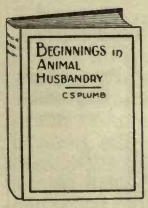

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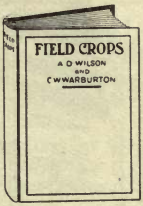

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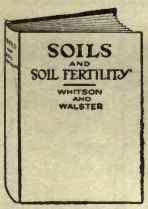

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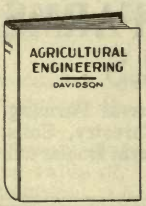

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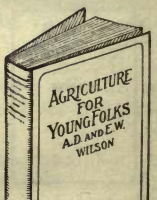

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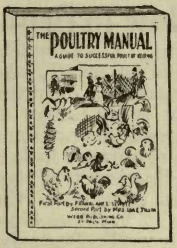

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