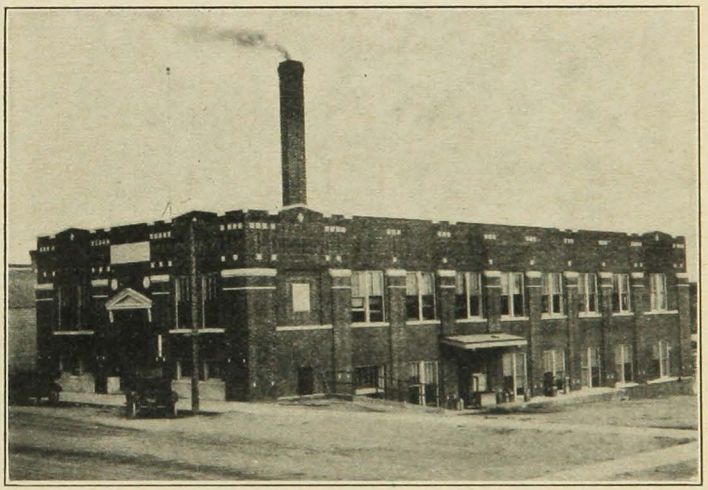
Bulletin 273 November, 1930

UNIVERSITY OF MINNESOTA
AGRICULTURAL EXPERIMENT STATION

FAT LOSSES IN BUTTERMILK

W. B. COMBS AND S. T. COULTER
DIVISION OF DAIRY HUSBANDRY



A MODERN MINNESOTA CREAMERY

UNIVERSITY FARM, ST. PAUL

FAT LOSSES IN BUTTERMILK

W. B. COMBS AND S. T. COULTER

When large quantities of butter are manufactured, the butterfat losses that occur in the buttermilk are an important item. It is estimated that in manufacturing 271,000,000 pounds of creamery-made butter in 1929, there was produced in the state of Minnesota 460,700,000 pounds of buttermilk. The butter manufactured in Minnesota is made largely from sweet cream, therefore the importance of the problem is emphasized, as it is the common impression that the losses from churning sweet cream are materially higher than those in churning sour cream. The amount of fat in buttermilk is given little or no consideration when the product is sold. Buttermilk is strictly a by-product and it is exceedingly important that its fat content be reduced to the very minimum.

The chief objects of this publication are to place before the creamery industry of Minnesota answers to certain questions regarding fat losses in buttermilk. These questions may be set forth as follows:

1. What is the present status of methods of determining the butterfat content of buttermilk?
2. What method of testing buttermilk for butterfat is recommended by the Division of Dairy Husbandry of the University of Minnesota?
3. What are the losses of fat now occurring in buttermilk under Minnesota conditions where a large proportion of sweet cream is churned?
4. How do the fat losses compare in buttermilk churned from sweet and sour cream?
5. Can the fat losses in buttermilk be kept at a low level and at what level might an average creamery expect to keep these losses?
6. Is it practical to separate the butterfat from buttermilk by means of a separator?
7. What conditions influence the fat losses in buttermilk?
8. How may a creamery maintain low fat losses in buttermilk?

PRESENT STATUS OF THE METHODS OF TESTING BUTTERMILK FOR FAT

The problem of analyzing milk and its products is one that has received attention by chemists for more than fifty years. Between the years of 1885 and 1892 considerable progress was made, including the development of the gravimetric method known as the Roese-Gottlieb. By this method the material is weighed on a delicate chemical balance and the fat extracted by means of ether. The Association of Official Agricultural Chemists selected the Roese-Gottlieb method of fat analysis as the official means for determining the fat content of milk and cream.

The time required to complete the fat determination by the Roese-Gottlieb method makes it impractical for commercial plants where large numbers of samples must be tested regularly. The Babcock test for the determination of the fat in milk, introduced in 1890, met the needs of the commercial plant. The accuracy of the Babcock test was measured by comparison with the gravimetric method.

For forty years attempts have been made to apply the principle of the Babcock test to the determination of the percentage of fat in buttermilk. The first problem was that of finding a suitable bottle. After this had been accomplished it was apparently some years before investigators questioned the accuracy of the method when applied to buttermilk. It was learned that tests of buttermilk were lower than those indicated by the use of the Roese-Gottlieb method. Attempts were then made to modify the Babcock method in order to bring about a closer agreement with determinations made by the Roese-Gottlieb method.

Several modifications were proposed, but the most generally accepted were those by Bouska and Farrington, and by Mitchell. The method proposed by Bouska and Farrington consisted of prolonging the first whirling period in the Babcock centrifuge to fifteen minutes at a high speed rather than for five minutes as is commonly used in the operation of the Babcock test. Mitchell suggested the addition of normal butyl alcohol to the acid used in the Babcock test. His plan was adopted by the American Creamery Association and became known as the Normal Butyl Alcohol test, or the American Creamery Association test. The accuracy of these methods was questionable, tho it became evident that determinations made by the Normal Butyl Alcohol check closely with results secured by the Roese-Gottlieb method.

In 1928 a report from the Division of Dairy Husbandry, of the University of Minnesota, corroborated later by Chapman, of Iowa, showed that the Roese-Gottlieb test fails to measure accurately the true butterfat in buttermilk owing to the relatively high phospholipid

chiefly lecithin, content of this product. The phospholipides are present in milk surrounding the butterfat globule. During the churning process these substances are shaken off the fat globule and remain concentrated in the buttermilk. These investigations made clear the cause of the difficulties experienced for many years regarding the variations in the test of buttermilk by the different methods. It also showed conclusively that the Roese-Gottlieb, the official method for many years for the fat determination of milk and cream and which served as the standard by which accuracy of other methods was judged, does not give correct results when applied to buttermilk, because it includes as fat a considerable amount of substance which is not fat.

The Minnesota test[1] for buttermilk was introduced in February, 1930, by the Dairy Husbandry Division, of the University of Minnesota. In this method an alkaline mixture is substituted for the sulphuric acid used when the regular Babcock method is followed. The test gives a measure of the true butterfat present in the sample and does not include the phospholipides that were shown to be present in relatively large quantities in buttermilk. It is true that these materials exist in milk. However, they occur in such small quantities that it is doubtful if they materially affect the test for whole milk. It is possible that their presence may be responsible for some of the discrepancies in testing cream by the Babcock test; however this remains an unsettled question.

THE MINNESOTA METHOD FOR TESTING BUTTERMILK

The Minnesota test[1] for buttermilk is recommended to creameries wishing an accurate means of measuring the actual butterfat content. The Babcock skimmilk bottle is used as well as the Babcock centrifuge. The procedure is briefly as follows:

1. Nine grams of buttermilk is placed in a skimmilk test bottle by means of a calibrated pippette.

2. Ten cc. of the Minnesota Babcock test reagent[1] is added and the contents of the bottle are well mixed.

3. The test bottles are placed in a water bath at 160° to 180° F. for six to seven minutes, and shaken several times during this interval.

4. The bottles are centrifuged for five minutes, using the same speed as when the regular Babcock method is followed (800 revolutions per minute in an 18-inch centrifuge).

5. Warm water is added to bring the contents of the test bottles to the base of the neck and the centrifuge is again operated for two minutes.

[1] Minnesota Technical Bulletin No. 63.

6. Sufficient warm water is added to bring the fat into the graduated neck of the test bottles and the centrifuge is operated for another minute.

7. The test bottles are placed in a water bath at 140° F. for five minutes and the fat reading is multiplied by two because a 9-gram sample of buttermilk is used.

The Minnesota test has been used by several creamery operators who pronounced the results excellent. The test has been in use at the Minnesota State Experimental Creamery since May 1, 1929. It is strongly recommended as a method for measuring the true fat losses in buttermilk.

COMPARISON OF THE MINNESOTA, THE BABCOCK, AND THE NORMAL BUTYL ALCOHOL TESTS

The question arises, how does the Minnesota test compare with the the Babcock and the Normal Butyl Alcohol tests, which are now used in creameries for testing buttermilk? The data assembled in Chart 1 show the relation of these three tests to each other.

For this chart the tests of the buttermilk from 20 churnings were selected at random from among several hundred available. It will be observed that the Minnesota tests fall about half-way between the figures secured by means of the Normal Butyl Alcohol test and the Babcock test. Tho there are minor fluctuations, a sample having

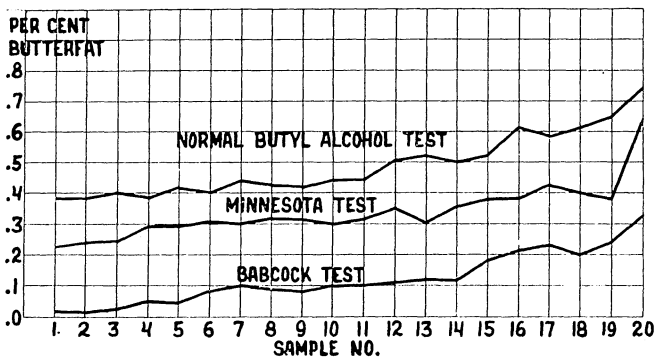


Chart. 1. Relation Between Normal Butyl Alcohol, Minnesota, and Babcock Tests when Applied to the Analysis of Buttermilk for Butterfat

Several hundred samples of buttermilk have been analyzed at the Experimental Creamery for butterfat by the three methods. The twenty samples charted are representative of the results secured.

a high or low test by one method will have a corresponding high or low test by either of the other methods. Whether a sample of buttermilk contains a relatively high or a low fat content will be indicated by any of the three methods if the results secured are compared with other analyses by the same method.

Methods of Determining the Fat Content of Buttermilk Used in Investigational Work

The data following are from investigations conducted in the State Experimental Creamery at Albert Lea, Minnesota, and the laboratories of the Division of Dairy Husbandry, of the University of Minnesota, during the five-year period from 1925 to 1929, inclusive. During this period buttermilk samples were tested for fat by the Babcock, the Normal Butyl Alcohol, the Roese-Gottlieb (Mojonnier), and the Minnesota methods. This five-year period was one of uncertainty regarding the proper method of testing buttermilk. For this reason most of the buttermilk samples were tested by at least two methods and during part of the period all four were employed.

In 1925 the opinion prevailed that the Babcock method did not give accurate results in determining the fat in buttermilk. The accepted standard was the Roese-Gottlieb, which required considerable time and skill. The Normal Butyl Alcohol test was reported to check closely with the Roese-Gottlieb test. Before the work had progressed far into 1926, it was found that certain discrepancies existed between the Roese-Gottlieb test and the Normal Butyl Alcohol test, which raised some doubt as to the value of the latter. During the years 1926 to 1928 it was the opinion of the staff members of the Dairy division that little progress could be made in studying fat losses in buttermilk until a more satisfactory method of testing was available. During this period both the Babcock test and the Normal Butyl Alcohol test were used on each churning at the State Experimental Creamery. Since the introduction of the Minnesota test for buttermilk there exists a clearer conception of the difficulties that existed in connection with the fat analysis of buttermilk and the relation of the various methods heretofore employed to the actual fat contained in buttermilk.

Fat Content of Buttermilk from Minnesota Creameries

The fact that there are so many butter manufacturing units operating separately in the state makes it possible for Minnesota creameries to receive and churn a large proportion of sweet cream into butter. The number of separate units, however, places the responsibility of the churning operation in the hands of a large group of individuals. The questions frequently arise as to what is the fat content of buttermilk resulting from churning cream in Minnesota creameries, and how do the losses compare when churning sweet and sour cream?

To secure information on the above question two surveys were made by the Division of Dairy Husbandry, of the University of Minnesota. The first was made during the fall and winter of 1925 and the winter, spring, and summer of 1926, and the second during the fall and winter of 1929 and the winter, spring, and summer of 1930. A total of 542

samples of buttermilk churned from sweet and sour cream were secured from Minnesota creameries in making the two surveys. In 1925-26, 321 samples of sweet, and 65 samples of sour buttermilk were collected. A total of 139 samples from sweet cream and 17 samples from sour cream were tested in 1929-30. The samples were taken by the staff members of the Dairy Husbandry division, Inspectors of the Dairy and Food Commission, and the fieldmen of the Land O' Lakes Creameries. Butterfat determinations were made by the Roese-Gottlieb (Mojonnier) method on the samples secured during 1925-26. During 1929-30 it was deemed advisable to make fat determinations by the Babcock (official), the Normal Butyl Alcohol, and the Minnesota tests, in addition to determinations made by the Roese-Gottlieb (Mojonnier) method.

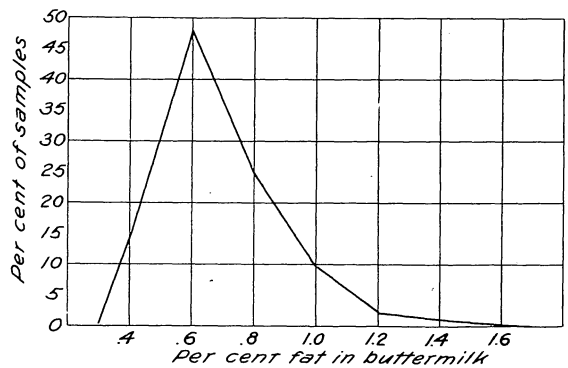


Chart 2. The Distribution of Fat Determinations, 1925-26

A total of 386 samples of buttermilk were gathered from Minnesota creameries in 1925-26. Of these 321 were sweet buttermilk and 65 were sour buttermilk. Butterfat determinations were made by the Roese-Gottlieb (Mojonnier) method. The average fat content of all the samples was 0.68 per cent. The sweet buttermilk and sour buttermilk samples contained an average of 0.64 and 0.79 per cent fat, respectively.

Results of survey made in 1925-26.—The results of the determinations for fat in the buttermilk samples gathered in 1925-26 are grouped in Table 1 and in Chart 2, which shows the distribution of the tests through a range of 0.30 to 1.7 per cent. A study of the results indicated that the average fat content of buttermilk during this period was 0.64 per cent in the case of samples churned from sweet cream, and 0.79 per cent in sour cream samples. The average butterfat content of all samples was 0.68 per cent. The extreme variations of the sweet and sour cream buttermilk samples was 0.3 to 1.7 per cent and 0.4 to 1.4 per cent, respectively. Altho the highest fat test was found among the samples of buttermilk churned from sweet cream, the average determinations indicate that creameries churning sweet cream are churning more efficiently than those churning sour cream.

In testing these samples no attempt was made to estimate the amount of water which found its way into the buttermilk from various sources.

It is quite probable, especially in plants practicing the neutralization of sour cream, that considerable dilution occurs owing to added water that serves as a carrier of the neutralizer. For this reason it seems logical to conclude that much less added water is present in buttermilk churned from sweet cream than in that churned from sour cream. With these facts in mind, the above figures become more significant and should serve as a warning to creameries churning sour cream and experiencing such high fat losses in buttermilk.

Table 1

Fat Determination of Buttermilk from Sweet and Sour Cream

Samples from Minnesota creameries, 1925-26. Determinations by the Roese-Gottlieb (Mojonnier) method

Per cent fat in buttermilk	Sweet cream		Sour cream	
	No. of samples	Per cent of samples	No. of samples	Per cent of samples
0.301 to 0.50	49	15.3	5	7.7
0.501 to 0.70	173	53.9	12	18.5
0.701 to 0.90	63	19.6	33	50.8
0.901 to 1.10	26	8.1	11	17.0
1.101 to 1.30	6	1.9	3	4.5
1.301 to 1.50	3	0.9	1	1.5
1.501 to 1.70	1	0.3	0	0.0
Total	321	100.0	65	100.0
Average per cent fat in buttermilk	0.6403	....	0.7910	....

Results of the survey made in 1929-30.—A total of 156 samples of buttermilk were secured from Minnesota creameries in 1929-30, of which 139 were churned from sweet cream. The results of the fat determinations of 135 of these by the Roese-Gottlieb (Mojonnier) method indicate that the fat content of sweet cream buttermilk had not changed since the survey of 1925-26. The distribution of the determinations for fat by the Roese-Gottlieb (Mojonnier) method on sweet cream buttermilk samples gathered during 1929-30 is shown in Table 2[2] and in Chart 3.

The higher losses occurred during the spring and summer months. Seventy-seven per cent of the samples had a fat content ranging from 0.501 to 0.9 per cent. The average test of 135 samples of sweet cream buttermilk was 0.6562 per cent, as compared with an average of 0.6403 for those in 1925 and 1926.

The same general results were secured in 1929-30 as in 1925-26, with reference to the butterfat content of buttermilk churned from sour cream. The average test of seventeen samples of sour cream

[2] See Appendix Table 1 for distribution table showing results secured when butterfat determinations by the Babcock test, the Normal Butyl Alcohol test, and the Minnesota test were made on the sweet and sour cream buttermilk samples secured during 1929-30.

buttermilk collected in 1929-30 was 0.7379 per cent, compared with an average of 0.7910 per cent for the sixty-five samples collected in 1925 and 1926. The survey of 1929-30 serves, therefore, as a check on the survey conducted in 1925-26. The two surveys yield practically the same results when the fat content of the buttermilk was determined by the Roese-Gottlieb (Mojonnier) test. The average fat determinations of all samples of buttermilk, that churned from both sweet cream and sour cream in 1929-30, was 0.6670 per cent according to the Roese-Gottlieb (Mojonnier) test, 0.6817 per cent according to the Normal Butyl Alcohol test, 0.2006 per cent according to the Babcock test, and 0.5025 per cent according to the Minnesota test.

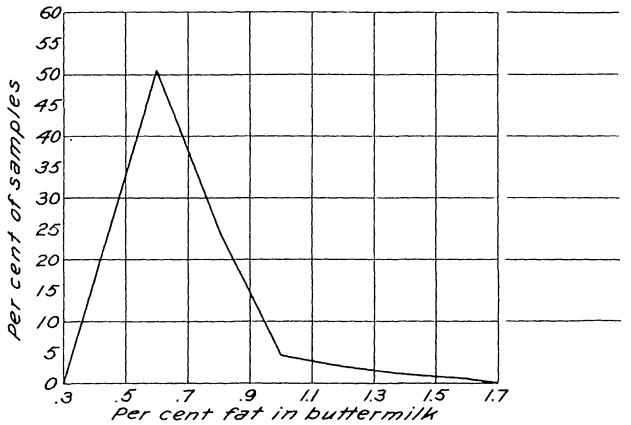


Chart 3. The Distribution of Fat Determinations

A total of 156 samples of buttermilk were secured during 1929-30 from Minnesota creameries. Of these 139 were sweet and 17 were sour buttermilk. Fat determinations were made by the Roese-Gottlieb (Mojonnier) method. (Shown in Chart.) In addition, fat determinations were made by the official Babcock, the Normal Butyl Alcohol, and the Minnesota tests. The average fat content of the samples according to the Roese-Gottlieb (Mojonnier) method was 0.66 per cent. These results indicate no change in the fat losses in buttermilk during 1929-30 as compared with 1925-26. The average fat content of the samples according to other methods of determining the fat were as follows: Babcock 0.20 per cent, Normal Butyl Alcohol 0.68 per cent, and Minnesota 0.50 per cent.

Fat Losses in Buttermilk in the Average Creamery

The data secured in the two surveys, which indicate the fat losses occurring in buttermilk churned in Minnesota creameries, make it possible to set forth certain facts regarding the losses that are occurring in average creameries. Using as a basis for calculation the fat determinations given in Table 1 on the samples secured during 1925-26, the losses of fat which occur in buttermilk in the average creamery may be set forth as follows:

1. From a single churning of 2,400 pounds of 30 per cent cream there will result approximately 1,500 pounds of buttermilk. The aver-

age creamery is losing about 10.2 pounds of fat in the buttermilk of each such churning, according to the average determination made by the Roese-Gottlieb (Mojonnier) method.

2. The average creamery when manufacturing butter from sweet cream is losing slightly less than this amount, or 9.6 pounds of fat, in the buttermilk from each churning.

3. The average creamery manufacturing sour cream into butter is losing about 11.85 pounds of fat in the buttermilk from each churning.

It is a simple matter from the above calculations to estimate roughly the fat loss through buttermilk in a creamery where the losses are near the average of those occurring in the state. For example, if 500 churnings are made in a plant manufacturing butter from sweet cream, and the average fat loss in the buttermilk is 0.64 per cent according to the Roese-Gottlieb (Mojonnier) test, or 9.6 pounds of butterfat are lost from each churning, such a creamery is losing 4,800 pounds of butterfat each year.

Table 2

Fat Determination of Buttermilk from Sweet Cream

Samples from Minnesota creameries, 1929-30. Determinations by the Roese-Gottlieb (Mojonnier) method

Per cent fat in buttermilk	Fall, 1929		Winter, 1929-30		Spring, 1930		Summer, 1930		Total	
	No. of samples	Per cent of samples	No. of samples	Per cent of samples	No. of samples	Per cent of samples	No. of samples	Per cent of samples	No. of samples	Per cent of samples
0.301 to 0.50	8	28	8	22	1	2	4	14	21	15
0.501 to 0.70	18	62	26	70	13	33	12	41	69	51
0.701 to 0.90	3	10	3	8	20	50	9	31	35	26
0.901 to 1.10	0	0	0	0	3	8	4	14	7	5
1.101 to 1.30	0	0	0	0	2	5	0	0	2	2
1.301 to 1.50	0	0	0	0	1	2	0	0	1	1
1.501 to 1.70	0	0	0	0	0	0	0	0	0	0
Total...	29	100	37	100	40	100	29	100	135	100
Av. per cent fat in buttermilk...	0.5619	...	0.5570	...	0.7901	...	0.6922	...	0.6562	

In a creamery manufacturing 500,000 pounds of butter annually, their results approximate 850,000 pounds of buttermilk. Based on the average figures for 1925-26, the loss in such a plant is 5,780 pounds of butterfat. If manufacturing butter from sweet cream with a butterfat loss near the average of 0.64 per cent, such a creamery would lose about 5,440 pounds of butterfat annually. If manufacturing butter from sour cream and using the average determination of 0.79 per cent, as was found for such buttermilk, such a creamery would lose about 6,715 pounds of butterfat annually.

Butterfat Losses in Buttermilk in Minnesota Creameries

In 1925 approximately 260,000,000 pounds of butter were manufactured by the creameries of Minnesota. Assuming the butter to contain 81 per cent of fat, calculating the cream used of an average of 30 per cent butterfat, it is conservatively estimated that 440,000,000 pounds of buttermilk were produced. If, according to the Roese-Gottlieb (Mojonnier) test, the average fat content of buttermilk was 0.68 per cent, there was a loss of 2,992,000 pounds of fat through buttermilk in the state of Minnesota in 1925. Valued at 50 cents per pound, which was near the value of butterfat in 1925, this fat lost would have a value of $1,496,000.

In 1929 more than 271,000,000 pounds of butter were made in the state, which yielded approximately 460,700,000 pounds of buttermilk. According to the survey of 1929-30 the average butterfat content of buttermilk during this period was 0.66 per cent, when the determinations were made by the Roese-Gottlieb (Mojonnier) test. Using the above figures it appears, therefore, that 3,040,000 pounds of fat were lost in buttermilk in 1929.

As previously shown, results in 1925-26 and in 1929-30 were similar when fat losses in the buttermilk produced in Minnesota creameries were determined. The average fat content of buttermilk produced in the creameries included in the 1929-30 survey was 0.50 per cent, according to the Minnesota test. It is logical to conclude, therefore, that the same result might have been secured had the Minnesota test been in use when the survey of 1925-26 was made. Calculating the losses of fat in buttermilk produced in the state on the basis of the Minnesota test, it appears that there was a loss of 2,200,000 pounds in 1925 and 2,300,000 pounds in 1929.

Butterfat Losses at the State Experimental Creamery

The fat losses in buttermilk at the Experimental Creamery in 1925 were apparently near or slightly below the average for the state. One of the chief problems confronting those in charge during the years from 1926 to 1929 was the selection of a practical and accurate method of determining the butterfat content of buttermilk. The Babcock method was employed continuously, however, making it possible to draw certain comparisons. During 1927, 1928, and 1929 the Normal Butyl Alcohol test was used in addition to the Babcock test and beginning in May, 1929, the Minnesota test, also, was employed. Altho three methods for the determination of the fat content of buttermilk have been employed during this period, only those made by the Babcock method are complete. It is deemed advisable, therefore, to present the

results secured by means of the Babcock test in making the comparison of butterfat losses in buttermilk during the four years included in this study.

The average monthly fat test of buttermilk churned from sweet cream at the Experimental Creamery during the years 1926, 1927, 1928, and 1929 are plotted in Charts 4, 5, 6, and 7.

Results of butterfat determinations made in 1926.—The results shown in Chart 4, secured in 1926, represent the first year's work in which the operator gave attention to the daily losses of fat in buttermilk. The average fat content of buttermilk during the year was 0.208 per cent, according to the Babcock test. The losses during the year, however, were very irregular, as will be observed from the results plotted on Chart 4. During the winter months of December, January, and February, the losses were relatively low. It was during the spring, summer, and early fall months that the operator experienced the chief difficulty in maintaining low fat losses. This was particularly noticeable during May, June, and July. During August the operator was able to reduce the losses to a level below that experienced during the winter months. In September and October the losses reached the peak for the year. The results of this year's observations probably represented the losses that frequently occur in the average Minnesota creamery.

Results of butterfat determinations made in 1927.—Chart 5 gives the fat losses during each month of 1927 at the Experimental Creamery. The average for the year was 0.180 per cent according to the Babcock test. It will be observed that the losses in 1927 were somewhat irregular, tho less than in 1926. By referring to Chart 4, which pictures the losses occurring in 1926, it will be observed that in December of that year there was a slight rise in the butterfat losses over those in November. This rise continued through January and February of 1927. It is the belief, however, that this increase was largely due to the fact that the operator was away from the plant a good portion of these two months. The responsibility of operating the churn was given to a helper during this period, with the result that the fat losses in buttermilk increased to an average above 0.30 per cent in February, 1927.

It will be observed from Chart 5 that the losses were greatly reduced during March, April, and May. Beginning in June and continuing through July, August, September, and October high losses prevailed. In spite of the high losses in January and February, owing to the carelesssness of the helper in charge, the average fat loss for 1927 was 0.180 per cent, as compared with 0.208 per cent in 1926. By giving closer attention to the daily losses, the operator found it possible to keep the losses slightly more nearly uniform and on the average at a lower level than in 1926.

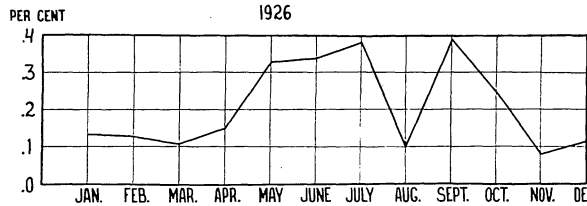


Chart 4. Average Monthly Fat Loss in Buttermilk at the State Experimental Creamery

Fat determinations were made by the Babcock test. The average fat content of buttermilk produced in 1926 was 0.208 per cent. Particular attention is directed to the irregularity of the monthly losses. It is thought that this chart well represents the losses in the average Minnesota creamery.

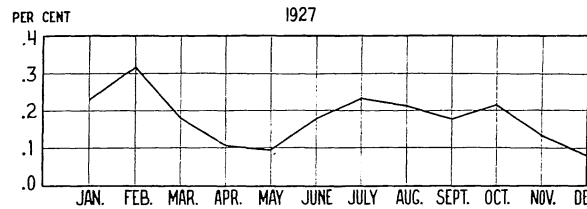


Chart 5. Average Monthly Fat Loss in Buttermilk at the State Experimental Creamery

Fat determinations were made by the Babcock test. The average fat content of buttermilk produced in 1927 was 0.18 per cent as compared with an average loss of 0.208 per cent in 1926. The losses were not so irregular as those occurring in 1926; however, considerable irregularity existed. Particular attention is directed to the high loss occurring in February when the responsibility of operating the churn was given to one of the helpers.

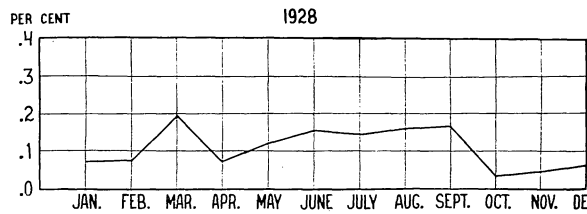


Chart 6. Average Monthly Fat Loss in Buttermilk at the State Experimental Creamery

Fat determinations were made by the Babcock test. The average fat content of the buttermilk produced in 1928 was 0.108 per cent as compared with an average of 0.208 and 0.18 per cent in 1926 and 1927. The average monthly losses were not so irregular as those occurring in 1926 and 1927. Particular attention is directed to the high loss in March, when the operation of the churn was given to one of the helpers.

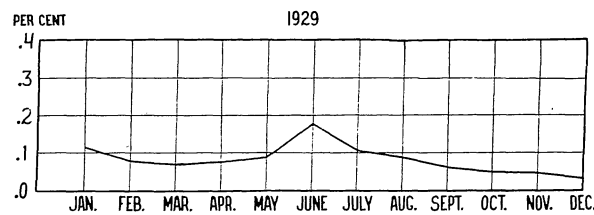


Chart 7. Average Monthly Fat Loss in Buttermilk at the State Experimental Creamery

Fat determinations were made by the Babcock test. The average fat content of buttermilk produced in 1929 was 0.082 per cent as compared with an average loss of 0.208, 0.18, and 0.108 in 1926-27-28. The average monthly losses were kept uniformly low during the year. Every effort was made to hold the losses at a low level in the spring and summer months.

Results of butterfat determinations made in 1928.—Chart 6 pictures the monthly average losses in buttermilk at the Experimental Creamery in 1928. It clearly shows that the losses were reduced to more uniformly low levels. The average percentage of fat in the buttermilk for the entire year was 0.108, as compared with 0.208 and 0.180 for 1926 and 1927. A rise occurred again in March, when it was necessary to place a helper in charge of the churn. Low butterfat losses prevailed during the winter months, however, as in 1926. The higher losses occurred again in May and June, continuing on through July and August. For the third consecutive year a seasonal variation occurred; low losses were experienced in the winter months and higher losses in the spring and summer months and the early fall months. An improvement resulted in 1928, however, as compared with previous years. By closely watching the daily losses more efficient churnings were accomplished.

Results of butterfat determinations made in 1929.—The year 1929 represents a concentrated effort on the part of all employees at the Experimental Creamery to maintain a low butterfat loss for the entire year. Each man employed was made more or less familiar with the project. Each day's test was plotted, and from time to time attention was directed to the current losses as compared with those of other years. Since the losses of previous years were before the workers, they were on guard to improve the record at points where they had been high. The curve shown in Chart 7 pictures the results. The losses were held uniformly low. The average for the entire year was 0.082 per cent as compared with 0.208, 0.18, and 0.108 per cent for 1926, 1927, and 1928. The rise that occurred in previous years, when the operator left the creamery to assist with dairy short courses at University Farm, did not occur in 1929. The seasonal rise in the spring was not avoided in May and June. It will be observed, however, that during this year the operator was able materially to reduce the losses in July and continued to bring about this reduction through the rest of the year. The dry condition of pastures may have assisted in bringing about the results but, at least, the operator took advantage of conditions.

Summary of Fat Determinations of Buttermilk at the Experimental Creamery

A more detailed study of the buttermilk tests made by the Babcock method at the Experimental Creamery during the years 1926 to 1929 is shown in Table 3 and Charts 8, 9, 10, and 11. A total of 1,991 Babcock tests of buttermilk were made during the four years, each representing a churning of sweet cream. The analyses are divided

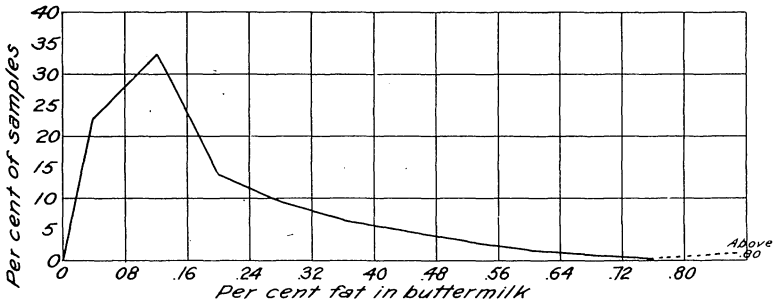


Chart 8. Distribution of Fat Determinations of Buttermilk at the State Experimental Creamery

Fat determinations were made by the Babcock test. The average fat content of buttermilk produced in 1926 was 0.208 per cent. Of the tests made, 22.87 per cent contained 0.08 per cent or less of fat, and 8.29 per cent contained 0.481 per cent or more of fat.

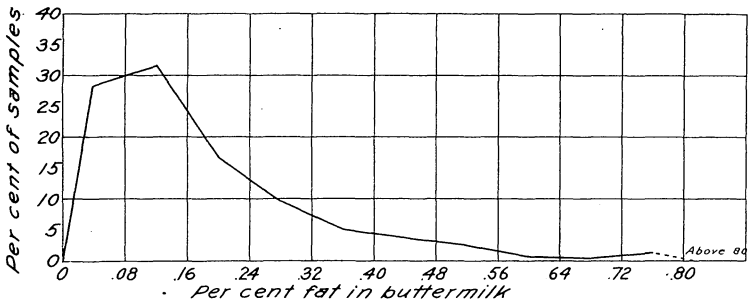


Chart 9. Distribution of Fat Determinations of Buttermilk at the State Experimental Creamery

Fat determinations were made by the Babcock test. The average fat content of buttermilk was 0.18 per cent in 1927. Of the tests made, 28.37 per cent contained 0.08 per cent or less of fat, and 5.04 per cent of the tests contained 0.481 per cent or more of fat.

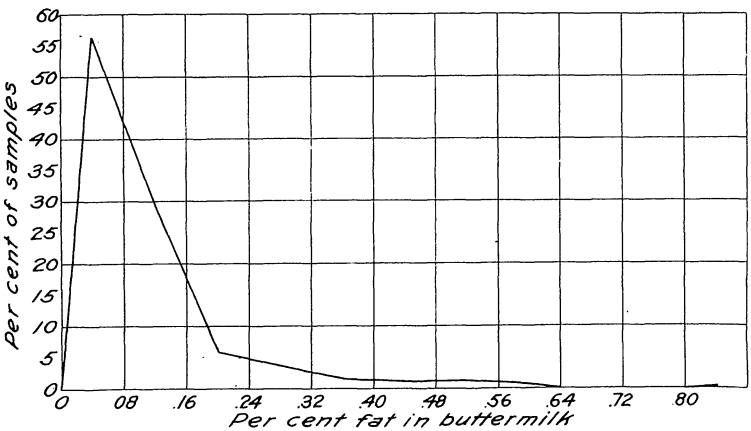


Chart 10. Distribution of Fat Determinations of Buttermilk at the State Experimental Creamery

Fat determinations were made by the Babcock test. The average fat content of buttermilk produced in 1928 was 0.108 per cent. Of the tests made, 56.26 per cent contained 0.08 per cent or less of fat and but 2 per cent contained 0.481 per cent or more of fat.

into groups, those falling between 0.00 to 0.08 per cent constitute the lower group, and those testing 0.481 per cent or higher constitute the high group. A study of these groups of tests is interesting. It will be observed that 22.87 per cent of the buttermilk samples in 1926 tested between 0.00 and 0.08 per cent according to the Babcock test, and 8.29 per cent of the samples tested 0.481 per cent or above. In 1927 there was 28.37 per cent, or a slight increase, in the number of samples falling in the low group, or testing between 0.00 and 0.08 per cent. During this year the number of samples testing 0.481 per cent or above was reduced to 5.04 per cent of all samples tested. In 1928 a decided improvement was brought about, as it will be recalled from previous

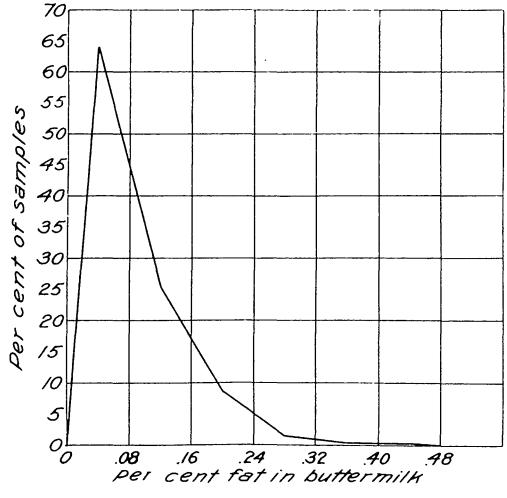


Chart 11. Distribution of Fat Determinations of Buttermilk at the State Experimental Creamery

Fat determinations were made by the Babcock test. The average fat content of buttermilk produced in 1929 was 0.082 per cent. Of the tests made, 63.91 per cent contained 0.08 per cent or less of fat, and none of the samples contained above 0.481 per cent of fat. Attention is directed to the fact that of the tests made in 1926, 22.87 per cent contained 0.08 per cent or less of fat and 8.29 per cent contained 0.481 per cent or more of fat.

statements. This is largely accounted for by the fact that 56 per cent of the samples of buttermilk contained from 0.00 to 0.08 per cent fat and but 2 per cent of the samples contained 0.481 per cent or more. In 1929 the results were even more striking. During this year 64 per cent of the buttermilk samples tested fell within the low group, between 0.00 and 0.08 per cent. It is of further interest to note that in 1929 not a single sample of buttermilk contained 0.481 per cent or more of fat. During the year buttermilk from 579 churnings was tested and but four samples contained more than 0.32 per cent fat; more than 89 per cent of all the samples ranged from 0.00 and 0.16 per cent.

Butterfat determinations were made by the Normal Butyl Alcohol test and the Minnesota test in addition to the Babcock test. The average fat content was 0.55 per cent according to the Normal Butyl Alcohol test in 1925. This was reduced to 0.45 per cent in 1929. The Minnesota test was put into use at the Experimental Creamery on April 1, 1929. The average fat content of buttermilk by this test during 12 months of 1929 and 1930 was 0.28 per cent. These results will be referred to in the material to follow.

Table 3

Fat Determination of Buttermilk by the Babcock Method

Samples represent buttermilk from the Minnesota State Experimental Creamery during a period of four years

Range of analyses	1926		1927		1928		1929	
	No. of tests	Per cent	No. of tests	Per cent	No. of tests	Per cent	No. of tests	Per cent
0.000 to 0.08....	99	22.87	135	28.37	283	56.26	370	63.91
0.081 to 0.16....	148	34.18	151	31.73	147	29.21	147	25.39
0.161 to 0.24....	60	13.86	79	16.59	30	5.96	50	8.63
0.241 to 0.32....	41	9.47	46	9.66	19	3.77	8	1.39
0.321 to 0.40....	28	6.48	24	5.04	8	1.60	2	0.34
0.401 to 0.48....	21	4.85	17	3.57	6	1.20	2	0.34
0.481 and above.	36	8.29	24	5.04	10	2.00	0	0.00
Total samples	433	...	476	...	503	...	579	...
Average fat analysis (per cent)	...	0.208	...	0.180	...	0.108	...	0.082

Note.—Standard deviation of Babcock determinations made during 1926, 1927, 1928, and 1929 were 0.191, 0.16, 0.14, and 0.06, respectively.

See Appendix Table 2 for monthly standard deviations.

Value of Daily Tests of Buttermilk at the State Experimental Creamery

A study of the results of the buttermilk tests at the Experimental Creamery from 1926 to 1929 shows clearly that it is possible to reduce materially the fat losses in buttermilk. By determining the pounds of buttermilk produced each year at the Experimental Creamery and the pounds of butterfat contained in the buttermilk, it is possible to evaluate this work in dollars and cents. The results of these calculations are shown in Table 4. In addition to the value of the fat lost in the buttermilk, the fat lost per each 1,000 pounds of butterfat churned is calculated. It will be observed that the loss of butterfat per 1,000 pounds of fat churned was 4.39 pounds in 1926 as compared with 1.74 pounds in 1929. It is estimated that in 1926 a total of 1,637.9 pounds of fat was lost in the buttermilk at the Experimental Creamery, worth $655.20 at 40 cents per pound. By supervising the handling of the cream more closely in 1929, the fat loss was reduced to 641.4 pounds with a value of $256.40, counting butterfat at the same price per pound. The greater

care in controlling the churning conditions, therefore, increased the income of the creamery $400 for the year.

Table 4

Loss of Fat in Buttermilk at the State Experimental Creamery, 1926 to 1929

Year	Total butterfat churned	Total buttermilk	Average fat loss by Babcock test	Total fat loss in buttermilk	Fat loss per 1,000 lb. butterfat churned	Value of total fat loss at 40 cents per pound
	lb.	lb.	%	lb.	lb.	
1926.....	372,740	787,447	0.208	1,637.90	4.395	$655.20
1927.....	362,976	767,502	0.180	1,381.50	3.806	552.80
1928.....	330,577	704,689	0.108	761.00	2.302	304.40
1929.....	369,098	781,278	0.082	641.40	1.738	256.40

Significance of Results Secured at the Experimental Creamery when Applied to Creameries of the State

Attention has been directed to the fact that several methods of determining the fat content of buttermilk have been employed at the Experimental Creamery and in the laboratories of the Dairy Division of the University. The relation of the Babcock, the Normal Butyl Alcohol, and the Minnesota methods have been presented. It is clear, therefore, that when fat losses in buttermilk are reported by one method these will not check with those secured by either of the other methods. Sufficient data are available to make application of the results here reported by three methods.

Calculations based on the Babcock test.—As previously stated, it is believed that the Experimental Creamery well represented the average creamery of Minnesota in 1925. The average loss of 4.39 pounds of fat to the thousand in 1925-26 was probably somewhat less than that occurring in the average creamery of the state. If it is assumed that the same loss occurred per 1,000 pounds of fat churned in Minnesota creameries in 1925, the total loss was approximately 926,640 pounds. From this amount of fat lost in buttermilk in 1925 there might have been made 1,149,035 pounds of butter, assuming an overrun of 24 per cent. During 1929 over 219,789,000 pounds of fat was churned in the state. The survey showed little improvement in 1929-30 compared to 1925-26. It is therefore reasonable to assume that the fat losses in the average creamery of the state in 1929 were about the same as in 1925-26, or 4.395 pounds of butterfat were lost per 1,000 pounds of butterfat churned. Calculating on this basis, the total loss was approximately 964,873 pounds of fat in 1929. In 1929 the losses at the Experimental Creamery were reduced to 1.74 pounds of fat per 1,000 pounds of butterfat churned. Had the creameries of the state reduced their losses to the same extent, the total fat

in the buttermilk would have been 382,432 pounds, a saving of more than 582,000 pounds of fat. From this amount of fat saved, 721,680 pounds of butter might have been made during 1929.

The results at the Experimental Creamery are significant from the standpoint of an individual plant. Table 4 includes the losses per 1,000 pounds of fat churned. From these calculations it is possible to make comparisons of the losses occurring in creameries manufacturing varying amounts of butter. Assuming that the average creamery loses 4.395 pounds of fat per 1,000 pounds of fat churned, the individual creamery manufacturing 100,000 pounds of fat into butter will lose 439.5 pounds; if manufacturing 1,000,000 pounds of fat the loss will equal 4,395 pounds. During 1929 it was possible to reduce the fat loss per 1,000 pounds of fat to 1.738 pounds, at the Experimental Creamery. Such a loss in a plant manufacturing 100,000 pounds of fat into butter would equal 173.8 pounds, and in a plant manufacturing 1,000,000 pounds of fat the loss would equal 1,738 pounds. These facts are set forth as follows:

Losses equal to those at Experimental Creamery		Pounds of butterfat churned yearly and losses in buttermilk				
Year	Losses per 1,000 pounds fat churned	100,000	200,000	300,000	500,000	1,000,000
	lb.	lb.	lb.	lb.	lb.	lb
1925.....	4.395	439.5	879.0	1,318.5	2,197.5	4,395.0
1929.....	1.738	173.8	347.6	521.4	869.0	1,738.0
Difference...	....	255.7	531.4	797.1	1,328.5	2,657 0

These calculations clearly show the value to the individual creamery of using every precaution to keep fat losses in buttermilk at a low level.

Calculations based on the Normal Butyl Alcohol test.—The surveys of 1929-30 indicated that the average fat loss in buttermilk was 0.66 per cent, according to the Roese-Gottlieb (Mojonnier) test. It was shown that in 1929 a total of 460,700,000 pounds of buttermilk was produced in Minnesota creameries, which contained 3,040,000 pounds of fat. During 1929 the average fat loss, according to the Normal Butyl Alcohol test at the Experimental Creamery, was 0.45 per cent. Had the fat loss in the creameries of the state been reduced to this figure there would have been a saving of 967,000 pounds of fat.

Calculations based on the Minnesota test.—The survey of 1929-30 indicated that the average fat content of butter according to the Minnesota test was 0.50 per cent. According to this test 2,303,000 pounds of fat was lost in the 460,700,000 pounds of buttermilk produced during 1929 in Minnesota creameries. This is probably a more accurate estimate than those made when using the average determinations by the Babcock, the Normal Butyl Alcohol, or the Roese-Gottlieb (Mojonnier) methods.

During 12 months of 1929-30 the average fat content of buttermilk produced at the Experimental Creamery was 0.28 per cent according to the Minnesota test. Had the creameries of Minnesota churned as efficiently during 1929, there would have been a loss of 1,290,000 pounds of fat in the buttermilk produced, a saving of 1,013,000 pounds of fat. From this amount of fat might have been made an additional 1,256,000 pounds of butter if an overrun of 24 per cent is assumed.

Separation of Buttermilk

The survey made in 1925 and 1926 showed the fat lossses in the buttermilk of the state to be at least 0.6 per cent as measured by the Roese-Gottlieb (Mojonnier) method. Most of the buttermilk was from sweet cream and this suggested the possibility of using a cream separator to recover a portion of the fat. A search of the literature revealed that this procedure had been tried and the results reported more than forty years ago by Meyers, of the West Virginia Experiment Station. He experimented with the churning of sweet cream to which no culture had been added; this he considered a new method of buttermaking. He immediately noticed that such churnings resulted in an excessive loss of fat in the buttermilk and found that this excessive loss could be reduced by passing the buttermilk through a separator. He later found that by reducing the churning temperature of sweet cream, efficient churning was accomplished and that separation of the buttermilk no longer was advisable.

Work similar to that of Meyers was conducted by members of the Division of Dairy Husbandry. Attempts were made to reduce the fat content of sweet buttermilk by passing it through such machines as hand and power separators, a power whey separator, and a high speed super-centrifuge. Trials were made in the laboratories of the Dairy division and in various creameries in the state, including the Experimental Creamery at Albert Lea. The process is proving a success in one buttermilk drying plant in Minnesota where the buttermilk from 16 to 20 creameries is gathered and passed through a large factory separatory before drying.

The data shown in Table 5 are typical of the results secured in attempts made to reduce the fat content of buttermilk in experimental trials. Here are shown the results of six trials. Trials 1, 2, 3, and 4 represent attempts to separate buttermilk of a fat content ranging from 0.42 to 0.48 per cent according to the Roese-Gottlieb (Mojonnier) test. The buttermilk used was representative of that which would result from churning cream more efficiently than is done in the average Minnesota creamery, according to the survey of 1925 and 1926. In these four trials a total of 5,861 pounds of buttermilk were separated,

with the result that 3.792 pounds of fat were recovered in the cream. These results clearly show the impracticability of the procedure when cream is churned efficiently. Trials 5 and 6 represent buttermilk from churnings that were churned at a relatively high temperature, thus encouraging high fat losses. It will be observed that in these two trials 3,658 pounds of buttermilk were separated and from this 24.52 pounds of fat were recovered in the cream on separation. If creamerymen should find it essential to churn at such temperatures as to bring about high fat losses in the resulting buttermilk, the procedure of separation would well pay.

Table 5

Separation of Butterfat from Sweet Cream Buttermilk

Trial No.	Buttermilk	Fat content of buttermilk by Mojonnier method	Fat recovered in cream separated from buttermilk	Fat content in skimmed buttermilk by Mojonnier method
	lb.	%	lb.	%
1	1,400	0.46	0.665	0.38
2	1,756	0.42	0.937	0.36
3	1,394	0.46	1.23	0.376
4	1,311	0.48	0.96	0.38
5*	1,761	1.28	11.76	0.52
6*	1,897	1.40	12.76	0.43

* A high churning temperature was used to induce an excessive fat loss.

Additional data showing the results of attempts to remove fat from buttermilk by means of centrifugal separators appeared in the *Dairy Record* under the dates of November 24 and December 1, 1926. The results of the work completed clearly indicate that the procedure is not practical unless sweet buttermilk is available in large quantities, 25,000 pounds or more, or in cases where a relatively high per cent of butterfat is present in the buttermilk. When sour cream buttermilk is passed through the separator, the machine soon becomes clogged with coagulated casein, making the process impractical.

Conditions Influencing the Loss of Butterfat in Buttermilk

The extent of the fat losses in buttermilk is known to be dependent upon several factors including (1) temperature of churning; (2) temperature and time of holding cream previous to churning; (3) nature of agitation; (4) the fullness of the churn; (5) composition of the butterfat; (6) condition of the cream, sweet or sour; (7) the percentage of fat in the cream; (8) the size of butterfat globules; and (9) the viscosity of the cream. Some of these (numbers 5, 7, 8, and 9) are beyond the control of the operator altho they may affect the fat percentage of the buttermilk. Of these, 5 and 8 vary with the season of

the year and are factors partly responsible for the variations in fat losses from winter to summer conditions. However, the factors that are under the control of the operator—including the temperature of churning, the time and temperature of holding cream previous to churning, and the fullness of the churn—are very important factors and must receive careful attention if excessive losses are to be eliminated.

Temperature and Time of Holding Cream Previous to Churning

With the exception of the temperature at which cream is churned, no other factor is so closely related to the fat losses in buttermilk as the temperature and time of holding cream previous to churning. Frequently cream received in the forenoon is churned in the afternoon of the same day. This may be done because of limited vat capacity for holding cream in the plant, or the cream received on one day must be churned in order to make room for that expected the following day. Sometimes the operator follows the practice of churning cream on the day it is received in order to make the most efficient use of the labor or to permit more time the day following for other work needed to be done in the plant. However, in many creameries cream is pasteurized and cooled to the churning temperature and held at this point until the day following, when it is churned. These practices are mentioned because of their influence on the time of holding cream at a given temperature.

A churning made at the Experimental Creamery will serve as an example to demonstrate the importance of the factors of time and temperature of holding the cream. At the time this churning was made the regular procedure was to churn at 53° F. after holding the cream at or near 50° F. over night. As a result of holding a churning but 80 minutes at 53° F. previous to churning, a loss of 4.3 per cent of butterfat occurred in the buttermilk. Such a figure represents a loss of 64.5 pounds of butterfat on a single churning of 2,400 pounds of 30 per cent cream, from which approximately 1,500 pounds of buttermilk would result. It is hardly conceivable that any creamery would tolerate such a loss for any length of time. However, some creameries in Minnesota are churning cream immediately after cooling to about 40° F. The fat content of the buttermilk in such cases is unquestionably high.

A series of experiments conducted in the laboratories of the Dairy division serves to illustrate the importance of holding cream at the churning temperature or below. Cream was standardized to 30 per cent fat, pasteurized at 145° F. for forty minutes, cooled to 32°+ F., and either churned immediately after raising the temperature of the cream to 48° F. or held for two to four hours previous to churning.

By referring to Table 6 it will be observed that a decidedly higher loss occurred when the cream was churned immediately after pasteurization and cooling as compared to holding cream two hours at 32°+ F. previous to churning. Altho it is doubtful if such a procedure is practical, holding cream at 36° F. for longer periods has proved very effective in maintaining low fat losses in buttermilk during the spring and early summer months at the Experimental Creamery.

Table 6

Influence of the Time of Holding Cream Previous to Churning on the Butterfat Losses in Buttermilk

Cooled to 32°+ F., churned immediately at 48° F.		Cooled to 32°+ F., held 2 to 4 hours, churned at 48° F.	
Churning No.	Fat test of buttermilk (Babcock)	Churning No.	Fat test of buttermilk (Babcock)
	%		%
11	0.43	3	0.06
12	0.22	6	0.05
14	0.36	7	0.05
17	0.95	9	0.045
20	0.60	10	0.05
23	0.80	13	0.075
26	1.50	16	0.084
		18	0.07

It is not an uncommon practice to hold cream overnight at or near the churning temperature. This is the practice most frequently followed at the Experimental Creamery. Several churnings were made, however, when cream was held for shorter periods. A comparison of the fat losses occurring in churnings held less than two hours, for two hours, and overnight, is assembled in Table 7. In assembling the data shown in the table, churnings were selected of nearly the same size, churned during various seasons, and held and churned at temperatures ranging between 47° and 50° F.

The results show a decidedly lower fat content in the buttermilk resulting from cream held overnight. The largest loss of fat occurred when the cream was held less than two hours preceding the churning.

Table 7

Influence of Holding Cream at the Churning Temperature or Lower on Fat Losses in Buttermilk

Time held before churning	No. of churnings	Churning temperature	Time required to churn	Fat loss in buttermilk by Babcock test
hr.		°F.	min.	%
Under 2	41	48.4	52.2	0.154
2	10	48.4	57.2	0.138
Overnight	65	49 0	66.7	0.084

The results verify the practice of the creameryman who has found it advisable to hold cream overnight previous to churning. It has been observed at the Experiment Creamery, however, that little is gained by holding sweet cream overnight at or near the churning temperature during the winter months. Low fat losses are quite easily maintained during these months by holding sweet cream at least two hours at such a temperature as will result in 40 to 50 minutes being required to bring butter in a churn with a normal load.

One theory as to why cream must be held for a period is based on the difference which exists in the specific heat of butterfat and milk serum.

Temperature of Churning

As indicated, the time and temperature at which cream is held previous to churning are factors so closely related that their effects can not be separated. In a like manner, the temperature at which cream is churned is an important factor influencing the losses in buttermilk which is also closely linked with the time and temperature of holding previous to churning. Generally speaking, the higher the churning temperature the greater the fat losses in buttermilk. This is quite easily demonstrated. A loss of 1.28 and 1.40 per cent of fat in buttermilk occurred in churnings 5 and 6, as shown in Table 5. These losses were the result of raising the churning temperature from 2° to 4° F. above that in regular use.

The relation of churning temperature to the time of holding, and temperature of cream previous to churning, is borne out by the fact that a lower churning temperature is required to maintain low fat losses when short holding periods are used. In a like manner, a relatively higher churning temperature may be used following a long period of holding at a relatively low temperature. The importance of these factors can not be overestimated to the creamery operator who strives to keep losses in buttermilk at the minimum.

Overloading the Churn

It is frequently stated that high losses occur in buttermilk when the churn is overloaded. The loss that occurs is probably overestimated. The frequency with which the churn is overloaded in creamery practice is far too great. Tho an increase in the fat loss in the buttermilk may occur, the chief objection to the practice of overloading is the time required to churn under such conditions. Table 8 shows the results of a few trials made at the Experimental Creamery. A comparison was made of the time required to churn and the fat losses in the buttermilk when a churn carried a normal load of cream and when

it was greatly overloaded. It will be observed that altho higher fat losses occurred when the churn was overloaded, the striking effect was the difference in time required. This increased time required is of greater significance to the creamery than the slightly increased loss of fat.

Season of the Year

By referring to Charts 4, 5, 6, and 7 it will be observed that in May and June and in July relatively higher fat losses occurred in the buttermilk churned at the Experimental Creamery. These seasonal variations prevail regardless of the treatment given the cream. They are chiefly due to the changes in the composition of butterfat, which are known to occur in the spring of the year. Soft fats prevail during these months because the cow has access to green grass, resulting in an increase in the olein content of butterfat. A lower churning tem-

Table 8

Influence of Overloading the Churn on the Fat Losses in Buttermilk

Churning	Date churned	Cream in churn	Temperature churned	Time required to churn	Fat loss in buttermilk according to analysis by the Babcock test
		lb.	°F.	min.	%
Overloaded	4/ 6/28	2,800	52	270	0.23
Normal load	4/10/28	2,340	51	50	0.02
Overloaded	4/12/28	2,816	53	360	0.11
Normal load	4/12/28	2,310	53	52	0.06
Overloaded	3/20/28	3,000	53	540	0.08
Normal load	3/17/28	2,350	48	65	0.08

perature at this season is essential to the manufacture of butter with a firm waxy body and to hold the fat losses in the buttermilk to the minimum. Some increase in the fat loss occurs, however, regardless of the precautions taken in the handling of cream. If the operator fails to realize the need of putting in practice every known method of holding losses to the minimum, they will rise to points which should not be tolerated.

The operator should be constantly on the alert in the spring and early summer to notice changing conditions and to make the necessary adjustments. As has been observed, it has not been possible to avoid a seasonal rise in the fat content of the buttermilk at the Experimental Creamery during May and June. The losses at this season of the year may be reduced materially, however, by lowering the churning temperature to such a point as to require 60 to 70 minutes to complete the process. Little advantage appears to be gained in churning longer than 60 to 70 minutes. This is shown in Table 9.

Table 9

Relation of Time Required to Churn to the Fat Losses in Buttermilk

Time required to churn	Churnings made in May, 1929		Churnings made in June, 1929	
	No. of churnings	Average butter-fat content by Babcock test	No. of churnings	Average butter-fat content by Babcock test
min.		%		%
30 to 50	11	0.12	9	0.20
50 to 60	13	0.08	17	0.18
60 to 70	13	0.06	9	0.17
70 to 80	5	0.09	7	0.15
80 and above	2	0.09	2	0.19

How a Creamery May Keep Fat Losses in Buttermilk at a Low Level

It has been clearly demonstrated from the results secured at the Experimental Creamery that it is possible for a creamery operator to maintain uniformly low fat losses during the entire year. During 1926 the average fat content of buttermilk at the State Creamery was 0.20 per cent according to the Babcock test. By giving the matter of fat losses closer attention, these were reduced to an average of 0.08 for the year 1929.

The following recommendations are made to creameries churning sweet cream, in order to keep fat losses in buttermilk at a uniformly low level:

1. Churn cream during the winter months at such a temperature as to require 40 to 50 minutes to complete the churning.

2. Churn cream during the spring and summer months at such a temperature as to require 60 to 70 minutes for churning. It has been found desirable to cool the cream to near 36° F., hold at this temperature, if possible, overnight. The churning temperature is adjusted according to the time it is possible to hold cream at the low temperature. If possible, no churning is held for less than four hours during this season.

3. Never overload the churn. A load of 2,500 pounds of 30 per cent cream is considered sufficient in churns rated at a capacity of 1,000 pounds of butter.

4. Small churnings, of 1,000 to 1,800 pounds of cream, should be churned at a lower temperature than is used on normal loads at the same season.

5. The best results follow the plan of cooling cream to a temperature of 5° to 8° F. below churning temperature and holding overnight. Cream to be churned on the day received should be cooled 10° to 12° F. lower than the churning temperature, held at least two hours, and churned 4° to 6° F. colder than cream held overnight.

6. Make butterfat analyses of the buttermilk from each churning. All employes of the plant should be frequently reminded of the need of keeping fat losses in buttermilk low, and be required to co-operate in keeping accurate records.

7. Keep records of butterfat losses of previous years charted and before the churn operator that he may foresee the approximate time in the spring of the year when excessive losses may occur. As this period nears, the cream should be cooled to a lower temperature previous to churning and likewise churned at a lower temperature.

SUMMARY

The present status of the various methods of determining the percentage of fat in buttermilk is discussed. Attention is directed to the fact that results secured by determinations made by the Babcock method are too low; those made by the Roese-Gottlieb (Mojonnier) and the Normal Butyl Alcohol test are too high. The modified Babcock method introduced by the Minnesota Experiment Station (February, 1930)[3] and termed in this publication the "Minnesota Test," gives a true measure of the butterfat content of buttermilk. It is strongly recommended to creamery operators desiring an accurate determination of the fat content of buttermilk. Data are presented that show the Minnesota test to yield results about midway between those secured by means of the Babcock and Normal Butyl Alcohol tests when applied to buttermilk.

A total of 386 samples of buttermilk gathered from Minnesota creameries during 1925-26 contained an average of 0.68 per cent of fat according to the Roese-Gottlieb (Mojonnier) test. A total of 321 samples of sweet cream buttermilk had an average fat content of 0.64 per cent. The average fat content of 65 samples of sour cream buttermilk was 0.79 per cent.

During 1929-30 the average fat content of 156 samples of buttermilk gathered from Minnesota creameries was 0.67 per cent, according to determinations made by the Roese-Gottlieb (Mojonnier) test. According to the Babcock, the Normal Butyl Alcohol, and the Minnesota tests, the average fat content of these samples was 0.20, 0.68, and 0.50 per cent, respectively.

It is concluded that the true average fat content of buttermilk produced in Minnesota creameries is approximately 0.50 per cent. Annual fat loss in buttermilk produced in Minnesota creameries is calculated to be 2,300,000 pounds.

The losses occurring in buttermilk in 1925 at the State Experimental Creamery are considered typical of those occurring in Minnesota cream-

[3] Minnesota Technical Bulletin No. 63.

eries. In 1925 the losses at this plant were 4.39 pounds per 1,000 pounds of fat churned when the Babcock method was employed to determine the fat percentage in buttermilk. In 1929 the loss at the Experimental Creamery was reduced to 1.74 pounds per 1,000 pounds of fat churned. Charts are presented which clearly picture the results of a concentrated effort to keep fat losses at a uniformly low level.

It is shown from the average monthly fat determinations through a five-year period at the Experimental Creamery that the fat losses in buttermilk can be kept uniformly low. It is further shown, however, that the conditions that exist during the spring and early summer months are responsible for a marked rise in the fat content of buttermilk. The creamery operator is warned to make daily tests of buttermilk that he may be prepared to use every known means of keeping fat losses as low as possible during these months.

The average fat content of buttermilk at the Experimental Creamery was 0.28 per cent during 1929, according to the Minnesota test as compared with an average test of 0.50 per cent in Minnesota creameries. It is calculated that Minnesota creameries might have manufactured an additional 1,256,000 pounds of butter during 1929 had the fat losses been reduced in all plants to equal those experienced at the Experimental Creamery.

Data are presented that show it impractical to remove the fat contained in buttermilk by centrifugal separation. It is stated that creameries producing 25,000 pounds or more of buttermilk daily might find the procedure profitable. Little recovery of fat is experienced unless sweet buttermilk of a relatively high fat content is available. The coagulated casein of sour buttermilk so clogs the separator bowl as to make the procedure impractical.

The principal conditions influencing the fat losses in buttermilk are shown to be the temperature of churning, the time and temperature of holding cream previous to churning, and seasonal conditions.

Lower fat losses were experienced at the Experimental Creamery when cream was held overnight at the churning temperature previous to churning than when held for two hours or less. By holding the cream for two to four hours at 32°+ F. previous to churning, decidedly lower losses were secured than when the cream was churned immediately after cooling.

Data are presented which show that overloading the churn results in a slight increase in the fat content of buttermilk. It is shown, however, that the more serious result of this practice is the increased time required to complete the churning process.

Recommendations are made to creamerymen desiring to keep fat losses in buttermilk uniformly low.

APPENDIX

Table 1

Distribution of Fat Determinations of Buttermilk by the Normal Butyl Alcohol, Babcock, and Minnesota Tests

Samples secured from Minnesota creameries during 1929-30. A total of 156 samples were collected. Of these 139 were samples resulting from churning sweet cream and 17 represented buttermilk resulting from churning sour cream.

Fat	Fat determination by Babcock test		Fat determination by Minnesota test		Fat determination by Normal Butyl Alcohol test	
%	no.	%	no.	%	no.	%
0.0 to 0.16	78	50	0	0	0	0
0.161 to 0.32	57	37	27	17	0	0
0.321 to 0.48	15	10	61	39	18	12
0.481 to 0.64	4	2	35	23	62	40
0.641 to 0.80	0	0	21	13	37	24
0.801 to 0.96	0	0	5	3	23	15
0.961 to 1.12	1	1	3	2	9	6
1.121 to 1.28	0	0	4	3	4	2
Above 1.28	0	0	0	0	2	1
Total	155	100	156	100	155	100
Average test	0.2006		0.5025		0.6817	
Average test 17 sour cream samples	0.2171		0.5668		0.7403	
Average test sweet cream samples	0.1985		0.4946		0.6745	

Table 2

Monthly Standard Deviation of Babcock Analysis Made at the State Experimental Creamery During 1926, 1927, 1928, and 1929

Month	1926	1027	1928	1929
January	0.0700	0.2062	0.0283	0.0583
February	0.0447	0.1780	0.0245	0.0346
March	0.0600	0.2309	0.1572	0.0400
April	0.1493	0.2685	0.0447	0.1436
May	0.2807	0.1221	0.1095	0.0510
June	0.1356	0.0812	0.1752	0.0728
July	0.1778	0.1005	0.1044	0.0574
August	.....	0.0775	0.1039	0.0400
September	.....	0.1020	0.1658	0.0224
October	0.1606	0.0700	0.0100	0.0173
November	0.0721	0.0775	0.0300	0.0658
December	0.1281	0.0387	0.0265	0.0141
For the year	0.1905	0.1658	0.1412	0.0615