THE EFFICIENCY OF CHURNING

by

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INTRODUCTION

In 1926, Kansas creameries produced 62,966,998 pounds of butter valued at nearly $26,400,000, according to the report of the Secretary of Agriculture (1921-22, 1926-26). There has been an increase of 14,217,834 pounds of butter between the years 1921 and 1926, indicating that cream for buttermaking is an important source of revenue for the producers.

Cream is marketed mainly through the local cream stations and shipped to the centralizer creameries for churning. Most of the cream is produced in small quantities as a side line and arrives at the creamery very sour. To avoid excessive loss of butter fat in churning sour cream it is necessary to reduce this relative high acid content. This is done by adding some weak alkali to the cream before it is pasteurized. This process is called neutralization.

When cream is churned some fat is lost in the buttermilk. This loss, which is excessive at times, may be due to many factors. It has been demonstrated by early investigators that the per cent of fat in the buttermilk is influenced by: The fullness of churn, per cent of fat in the

cream, churning temperature, condition of cream, temperature and period of holding preceding churning, and speed of churn.

Cream is an oil in water type of emulsion, that is, the butter fat globules are dispersed in the serum or hydrated colloid. Likewise, butter is a water in oil type of emulsion. The churning process involves the changing of the cream from the oil in water type of emulsion to the water in oil type as represented by the butter. If this change of emulsion were complete there would be no loss of fat in the buttermilk. The fact that buttermilk contains some fat suggests that a varying amount of the fat in the cream is in such a stable emulsion that it cannot be churned. The fat thus existing in the buttermilk is associated with both the curd and the serum of the buttermilk.

The loss of fat in the buttermilk is one of the important problems of the butter industry. Hunziker (1927) states that the average fat loss in the buttermilk under normal conditions ranges from 0.4 to 0.7 per cent. From the cream for buttermaking produced in Kansas in 1926 there would be approximately 101,000,000 pounds of buttermilk, assuming that the cream averaged 35 per cent fat. If the average loss of fat in the buttermilk was 0.5 per cent there would be a fat loss to the industries in the state of Kansas

in one year of 500,500 pounds of fat, valued at approximately $215,990.

The value of this amount of fat lost in the buttermilk is sufficiently great to warrant more study on this important problem and, if possible, to find some means of reducing it to a minimum.

The purpose of this experiment is to study the losses of fat in buttermilk as influenced by various neutralizers and degrees of neutralization; also to make a study of fat recovery from buttermilk. Since churning efficiency is judged by the loss of fat in buttermilk it was deemed advisable to compare the various methods of determining the fat in buttermilk.

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REVIEW OF LITERATURE

Excess acid in sour cream is reduced by the addition of some weak alkali such as lime, magnesium, sodium carbonate or sodium bicarbonate. The pasteurization of high acid cream without neutralization may cause an abnormal curdling which locks up and carries into the buttermilk fairly large amounts of fat. Therefore, the purpose of neutralizing sour cream is to reduce the acid in the cream to prevent this excessive loss. It is possible to make a uniform quality of butter by controlling the acidity through neutralization and ripening of the cream with good starter. There is danger of impairing the quality of the butter, if care is not taken to neutralize the acid properly. Sometimes a limy flavor results due to excess lime, or a soapy flavor due to the saponification of some of the fat, when sodium compounds are used.

It is not known exactly when or by whom the first neutralizer was used to reduce the acid in cream. Flint (1888) discovered that soda and water in the cream would improve the resulting butter. According to McKay and Larson (1922) one creamery used "Viscogen" as a neutralizer in sour cream at an early date. "As far back as 1901-02, one of the authors conducted extensive experiments in the use of

alkalies of various kinds for reducing the acidity of cream; and so far as he knows he was the first to take up experimental work in reducing the acidity of cream for buttermaking." They further reported that as early as 1905, lime was used by some butter manufacturers and since then the practice has gradually grown. Dean (1913) concludes that concentrated milk of lime is preferable to a large quantity of lime water.

Several chemicals have been used in the cream to reduce the fat losses in the buttermilk; some have proved successful, while others were unsatisfactory. Ruehe and Stirits (1925) decreased the fat losses in buttermilk by adding sodium chloride and hydrochloric acid to the cream before churning. The sodium chloride decreased the fat in the buttermilk 0.227 per cent, the hydrochloric acid decreased it 0.406 per cent, while a combination of the two chemicals decreased it 0.490 per cent. These were the average reductions from all neutralizers used.

Churning efficiency is usually measured by the amount of fat remaining in the buttermilk. Hunziker (1927) finds that the actual amount of fat lost in the buttermilk ranges from 0.3 to 1.5 per cent and may be greater under abnormal conditions. Ruehe and Stirits (1925) report than 0.214 per cent was the average fat content of 57 samples of buttermilk obtained from different creameries in Illinois.

It seems to be an established fact that the higher the acidity of cream at the time of pasteurization the greater the loss of fat in the buttermilk. Sproule and Grimes (1921) found from 50 experiments that cream having 0.35 per cent or less, 0.35 to 0.40 per cent, 0.45 to 0.50 per cent, and over 0.50 per cent acid at the time of heating had, respectively, 0.135, 0.2, 0.355, and 0.522 per cent fat in the buttermilk. Partial neutralization of the acid in the cream made a saving of 0.27 per cent of butter fat in the buttermilk. This was determined from 11 trials in which one part of the cream was neutralized and the other part was not. They had an average loss of 0.45 per cent with the neutralized and 0.72 per cent with the unneutralized cream.

Hunziker (1927) points out that one object of neutralization is to avoid excessive fat loss which results from churning cream that is pasteurized while extremely sour.

Stirits and Rauhe (1925) found that a 5 per cent solution of soda ash or sodium bicarbonate and a 10 per cent solution of lime gave more exhaustive churning than stronger solutions of these neutralizers. They also found that the use of soda ash increased the fat loss in the buttermilk while the sodium bicarbonate and the limes gave a more exhaustive churning. The buttermilk from cream neutralized with the five limes averaged 0.0645 per cent below the

average buttermilk tests for all churnings while that in which sodium bicarbonate was used averaged 0.021 per cent below.

The earliest exact method for determining the per cent of fat in dairy products was the gravimetric method. In 1890, the Babcock test was invented which was a more rapid test for fat determination; however, it gave lower results when compared with the gravimetric method. The gravimetric method, which was improved by Roese and known as the Roese-Gottlieb method, was established as the official test for fat determinations in the United States. Later the Babcock method was accepted as a standard test and was used by practical men because it was a rapid method for testing dairy products. It was used as a reliable test for buttermilk in the commercial plant until a few years ago. Then the American Association method known as the normal butyl alcohol test, which checks very closely with the gravimetric method, was introduced into the practical creamery. Many investigators have proved that the Babcock method gave lower results than the gravimetric method. Sproule and Grimes (1926) tested 12 samples of buttermilk and found that the Babcock test averaged 0.1977 per cent and the gravimetric method averaged 0.4518 per cent, a difference of 0.2541 per cent between the two tests. These tests ranged from 0.122 to 0.33 per cent fat with the Babcock method and from 0.332

to 0.641 per cent with the gravimetric method. Work by Washburn and Dahlberg, and others, (1918) indicates that buttermilk tested by the Babcock method shows only about one-third to one-half as much fat present as is shown by the chemical method. Hunziker (1927) admits that fat losses in the buttermilk are greater than formerly believed. Earlier conceptions of fat losses in the buttermilk were based on tests by the ordinary Babcock method.

Thurston (1927) in a paper before the National Creamery Buttermakers' Association stated that the Babcock test is more accurate for testing buttermilk than had been formerly believed. He based his statement on the fact that milk contained lecithin, which is a fatty like substance and is dissolved in the reagents used in the chemical analysis and normal butyl alcohol test for fat in buttermilk. In his work he used synthetic milk with and without lecithin present to determine the accuracy of the tests used.

The amount of fat found in the whey and curd portions of buttermilk seems to vary with the neutralizer used and other conditions affecting losses of fat in churning such as temperature, acidity, and time held. Ruehe and Stirits (1925) reported that when sour cream was neutralized with soda ash, approximately three-fourths of the fat was in the whey of the buttermilk; also that buttermilk from unneutralized cream contained three-fourths of the fat in the curd.

The other neutralizers they used varied between these extremes.

Some studies were made by Hunziker (1927) in which he found that buttermilk from cream high in acid at pasteurizing time had a greater portion of the fat in the curd. He also found that such buttermilk contained from 1 to 8 per cent fat.

The neutralization of sour cream not only reduces the loss of fat in the buttermilk but also improves the keeping qualities and flavor of the butter.

Ramsey (1915) claims that the taints and foul odors are taken out by neutralization. Giltner and Brown (1917) conducted an experiment on sour cream in which they neutralized one portion and did not neutralize the other although both were pasteurized. The fresh butter made from neutralized cream scored 90, while that made from unneutralized cream scored 89.

Jackson (1923) concluded from his investigation that butter made from high acid cream pasteurized at a high temperature is prone to have a "coarse, oily like flavor," and that one of the most important objects of neutralization is the improvement of the keeping quality of butter made from properly neutralized pasteurized sour cream.

The losses of fat in buttermilk seem to be sufficiently high in many cases to try to recover some of this fat. As

yet there seems to be no method which will reduce the amount of fat in the buttermilk as low as that in skim milk. Then after the fat is lost in the buttermilk it would be reasonable to presume that it could be separated to regain some of the fat. Combs (1923) reported that a number of trials were made to separate buttermilk to regain the fat lost. From the results it was not practical to separate buttermilk that contained approximately 0.5 per cent fat according to the normal butyl alcohol test. However, if the buttermilk contained 0.6 per cent or more fat when the normal butyl alcohol test was used with a volume of around 25,000 pounds it was advisable to separate the buttermilk. This buttermilk came from sweet cream.

PLAN OF EXPERIMENT

THE EFFECT OF THE DEGREE OF NEUTRALIZATION ON THE EFFICIENCY OF CHURNING

Object of Experiment

The object of this part of the experiment was to determine what effect the degree of neutralisation has on the efficiency of churning. A study was made of the effects of neutralising the cream to 0.25 per cent acidity, 0.15 per

cent acidity, and 0.15 per cent acidity then ripened to 0.3 per cent acidity with starter.

Method of Procedure

Sources of Neutralizers. The neutralizers used in this experiment were: Wyandotte C.A.S, purchased from J. B. Ford Company, Wyandotte, Mich.; Perfection Lime purchased from Great Lakes Industrial Laboratories, Toledo, Ohio; and M. and R. magnesium carbonate purchased from M. and R. Chemical Company, Chicago, Ill.

Preparation of the Cream. A 12-can batch of cream was dumped into a vat, thoroughly agitated, and then divided into three equal parts. The fat and acid determinations were made by the method as outlined by Hunziker in The Butter Industry, second edition, pages 568 and 557, respectively. Each part of the cream was pasteurized at 145 degrees F. for 30 minutes in a 50-gallon Creamery Package coil vat.

Preparation and Addition of Neutralizers to the Cream. Wyandotte C.A.S. and Perfection Lime were made up into 10 per cent solutions. For magnesium carbonate a 3 per cent solution was used as it was found a 10 per cent solution was too thick to go through the holes of a sprinkling can. Each neutralizer was made up with hot water and added with

a sprinkling can on the surface of the cream at 90 to 95 degrees F. while being agitated. The cream to which Perfection Lime had been added was allowed to agitate at this temperature for five minutes before going to the pasteurizing temperature. The cream that contained Wyandotte C.M.S. and magnesium carbonate was heated immediately to pasteurizing temperature after all the neutralizer was added.

Care of the Cream after Pasteurization. The cream after being held for 30 minutes in the vat at pasteurization temperature was cooled by circulating water through the coil to 75 to 80 degrees F. and then cooled with ice and salt brine through the coil to 42 to 45 degrees F. Special care was taken to cool the cream as rapidly as possible. After the cream was cooled it was drawn out of the vat and strained into 10-gallon cans and held in the cooler for two hours at a temperature of 40 degrees F. Each batch of cream was handled so that the holding time was the same through all the trials. It was so arranged that as soon as one batch was pasteurized, cooled, and drawn off, another batch could be put in the same vat. In that way it gave plenty of time to get the butter out of the churn before the next batch was ready. When starter was used the cream was allowed to stand in the cooler over night in order to develop the acidity to about 0.30 per cent. Ten per cent of starter was added to the cream at 70 degrees F. in the vat

while cooling. This was then cooled to holding temperature.

Churning of the Cream. The cream was churned in a Cherry junior single-roll churn. Care was exercised to handle all the trials under the same conditions.

Method of Taking Samples of Buttermilk for Analysis. The buttermilk was strained through a cheesecloth to remove any loose particles of butter fat. This cheesecloth was put in a dipper which contained a strainer in the bottom. A 10-gallon can of buttermilk thus strained was stirred thoroughly and a pint sample secured for analysis.

Testing the Buttermilk. The buttermilk was tested for fat by the Babcock, normal butyl alcohol, and Mojonnier methods. In the Babcock method, the double-necked skim milk bottles were used. A 17.6 c.c. pipette was used for measuring out the samples of buttermilk. Twenty c.c. of acid was used. The acid was added by means of a graduated pipette in 10 c.c. installments, shaking very thoroughly after each addition. The mixture was shaken until a very dark color was produced. The bottles were then put in the tester, with the funnel neck facing the center of the tester, and whirled for 10 minutes. After whirling, water 140 degrees to 150 degrees F. was added to near the top of the neck, then whirled 10 minutes. The bottles were then taken out and held in a water bath at 135 to 140 degrees F. for three minutes, then read with the help of dividers.

For the butyl alcohol method, double-neck bottles as in the Babcock test were used. Two c.c. of normal butyl alcohol was put into each bottle from a 50 c.c. burette. A nine c.c. portion of a well mixed sample of buttermilk was placed in each bottle from a nine c.c. pipette. Seven and one-half to nine c.c. of sulphuric acid (specific gravity 1.82-1.83) was added to each bottle. The contents of the bottle were mixed by a rotary motion. When the color of the mixture had turned to a dark brown, the bottles were centrifuged for six minutes. Water between 140 and 150 degrees F. was then added to the base of the neck of the bottles and they were whirled for two minutes, after which water was added to near the top of the filling tube and they were again whirled for two minutes, then placed in a 135 to 140 degree F. water bath for three minutes and read with the aid of a pair of dividers. The reading which was obtained was multiplied by two as a nine-gram sample of buttermilk was used.

The Kojonnier method was used as outlined by Kojonnier and Trey (1938, p. 108) in the Technical Control of Dairy Products.

Samples of Butter for Scoring. The butter was packed into Friday boxes from the churn and was allowed to harden in the cooler. When the butter was cut samples were taken from the center of the box. These samples were wrapped

with parchment paper and cartoned. Three one-pound samples were saved out of each trial to be scored at the end of one, two, and three months. The samples that were to be scored at the end of the month were placed in the cooler at a temperature of 35 degrees F. The samples to be scored at the end of the second and third months were placed in the hardening room at a temperature of 0 degrees F.

Manner of Scoring the Butter. The samples from each trial were scored and compared, and then compared with the other trials. In this way a comparative score was secured. The identity of the samples when scored was not known. The butter was scored by Prof. W. H. Martin, of the Department of Dairy Husbandry, and the author.

Discussion of Results

The neutralizers used in this experiment were Wyandotte C.A.S., Perfection Lime, and magnesium carbonate. Wyandotte C.A.S., according to Hunziker (p. 170), is a soda neutralizer composed of 58.3 per cent sodium carbonate and 38.3 per cent sodium bicarbonate. The Perfection Lime (Hunziker, p. 163) is a magnesium hydrated lime composed of

61 per cent calcium hydroxide and 31.5 per cent magnesium oxide. The third type of neutralizer used was magnesium carbonate.

Lime has certain advantages as a neutralizer. Due to its high alkalinity it can be used over a wide range of acidity without danger of the cream foaming; only a relatively small amount is needed for high acid cream. It is a natural constituent of milk and therefore needed in the body and can be bought at a relatively low cost. The chief disadvantage of lime is that it is not readily soluble in water and must be handled carefully to insure a homogeneous mixture. Also if used in excess in the cream it will impart a characteristic limy flavor in the resulting butter. The soda neutralizers are not harmful but have no dietary value. Their chief advantage over the lime neutralizer is that they are readily and completely soluble in water so that a definite strength of the neutralizer can be made up. They also react more quickly than the lime. The soda neutralizers are relatively weak bases and larger quantities must be used to reduce a given amount of acid than in the case of lime. There is a foaming of the cream when soda neutralizers are used; the greater the acidity of the cream, the more the foaming. The magnesium carbonate is more expensive than the other two neutralizers because it cannot be used as found in nature and has to be purified artificially.

It is claimed by the manufacturer that magnesium carbonate will prevent saponification of the fat and a limy or neutralizer flavor in the butter if a larger amount is used.

Each trial in this experiment consisted of three churnings of cream. In the first churning the acidity of the cream was reduced to 0.15 per cent and compared with a second churning consisting of cream neutralized to 0.25 per cent acidity. The cream for churning Number Three was neutralized to 0.15 per cent as in the case of Number One. It was then inoculated after pasteurization with starter and the acidity permitted to develop to about 0.30 per cent before churning. The 0.25 per cent acidity was chosen because it is just below the curdling or scouring point of cream and the minimum amount of neutralizer could be used. The 0.15 per cent was used to see if further reduction of acid would prevent excessive curdling and decrease fat loss. The 0.15 per cent acidity was used in the ripened cream so that the starter would have a greater range in which to develop.

Three trials consisting of nine churnings from cream neutralized with Wyandotte C. .3. were made. The sour cream of the average cream station quality was used. In Table I are recorded the degree of neutralization, the test of the buttermilk by the Babcock, butyl alcohol, and

No former methods and the score of the butter at the end of 30, 60, and 90 days.

Table I.— Effect of the degree of neutralisation on the efficiency of churning and quality of butter when Wyandotte C.[illegible] was used as a neutraliser.

Trials	Degree of neutralization	Per cent of fat in buttermilk: Total	Butyl	Glycerol	Score of butter: 30 days stored at 40° F	60 days stored at 0° F	90 days stored at 0° F	Remarks (a)
1	0.15	0.367	0.660	0.714	87.00	90.00	90.00	Sl. neu., tal.
	0.25	0.360	0.640	0.698	86.00	90.50	90.50	Sl. neu., fl.
	0.15 ripened to 0.30	0.400	0.680	0.777	89.00	91.00	91.00	St. fla.
2	0.15	0.362	0.610	0.701	86.00	90.50	90.00	Sl., neu.
	0.25	0.367	0.690	0.703	89.50	91.00	90.50	Sl. neu., fl.
	0.15 ripened to 0.30	0.390	0.650	0.678	90.00	91.50	91.00	St.
3	0.15	0.[illegible]	0.680	0.651	87.50	91.50	89.00	Neu., old
	0.25	0.345	0.775	0.747	88.00	91.00	89.75	Sl. neu., old
	0.15 ripened to 0.30	0.270	0.[illegible]	0.867	89.50	92.00	[illegible].00	Sl.
Average results:	0.15	0.305	0.650	0.689	87.50	90.66	89.66	
	0.25	0.324	0.702	0.696	88.50	90.85	89.86	
	0.15 ripened to 0.30	0.[illegible]	0.[illegible]	0.[illegible]	89.50	91.50	90.66	

(a) Neu., neutraliser; tal., tallowy; sl., slightly; fl., flat; st. fla., starter flavor.

The Babcock and butyl alcohol methods were run in duplicate and the average of the two tests are found in Table I.

It can be observed from the average tests of the buttermilk that the three methods of neutralization used in Table I resulted in about the same loss of fat. This loss amounted to 0.305, 0.324, and 0.330 per cent fat in the buttermilk from cream neutralized to 0.15 per cent, 0.25 per cent, and ripened cream, respectively, as shown by the Babcock test. On the basis of the butyl alcohol test the buttermilk contained 0.65, 0.702, and 0.623 per cent less butter fat than the buttermilk from cream neutralized to 0.25 per cent. This difference is not to be considered significant, as the Mojonnier method of testing shows that the buttermilk from these three methods each contained in the average 0.68 per cent of fat.

Slight difference in the fat content of the buttermilk in favor of one method of neutralization, as shown by any particular test, may not show a lower loss of fat when another test was used. For example, in trial Number Two the Babcock test indicates that the buttermilk from cream neutralized to 0.15 per cent acidity contained the lowest per cent of butter fat but when compared with the Mojonnier method the ripened cream showed the lowest loss of fat; the former test gave 0.262, 0.267, and 0.320 per cent while the

latter test gave 0.701, 0.703, and 0.678 per cent for the 0.15 per cent acid cream, 0.25 per cent acid cream, and the ripened cream, respectively. Here again it is demonstrated that a slight difference in fat content of the buttermilk may appear to favor a method of neutralization, but may be reversed when the buttermilk is subjected to another test. If either of the methods of testing was taken to judge the efficiency of churning, the difference in the per cent fat from the various degrees of neutralization would be within experimental error. Therefore, one could not recommend that cream should be neutralized to any one of these degrees to obtain less loss of fat in the buttermilk.

There was, however, a decided difference in score of the butter from the various churnings. In comparing the score of the butter it must be remembered that the butter scored at the end of 30 days was stored in a cooler at 40° F. and the butter scored at the end of 60 and 90 days was stored in a cooler at 0° F. At the end of 30 days it will be noticed that the butter from cream neutralized to 0.15 per cent acidity scored on the average 87.5 points while the butter from the same cream ripened to about 0.30 per cent acidity scored 89.5 points. The score of the butter made from the cream neutralized to 0.25 per cent acidity averaged 88.5 points which is one point higher than that from the cream neutralized to 0.15 per cent acidity. The

fresh butter was examined from the churn and no noticeable difference was found in the three churnings from each trial. In all the trials the first scoring shows that the butter from the cream neutralized to 0.15 per cent acidity scored consistently two points lower than that of the same cream ripened to 0.30 per cent acidity; also the butter from the cream neutralized to 0.25 per cent acidity scored one point less than the ripened cream butter. In the same butter stored at 0 degrees F. for 60 days there was less difference between the score of the butter from cream neutralized to 0.15 per cent than the ripened cream butter. The 0.15 per cent cream butter averaged 90.05 points and the ripened cream 91.5 points. This may be accounted for by the fact that the butter was held at a low temperature which checked the growth of both the desirable flavor organisms and the undesirable bacteria. Nevertheless, the same relative scores hold true in that the average score of the butter from 0.15 per cent acid cream scored the lowest; that of the 0.25 per cent cream, next; and the ripened cream, the highest. The butter from the same cream stored for 90 days at 0 degrees F. shows some deterioration, on the average being 0.99, 0.99, and 0.84 points lower for butter from 0.15 per cent acidity cream, 0.25 acidity, and the ripened cream, respectively.

The chief difference between the butter from cream

neutralised to 0.15 per cent acidity and that from cream neutralised to 0.25 per cent acidity was the degree of neutraliser taste in the butter. The butter from the ripened cream had in most cases a decided starter flavor and the objectional neutraliser flavor was not noticeable. From the standpoint of the quality of butter as indicated by the above results, it would be advisable to ripen the cream with a good starter so that the desirable bacteria would develop and keep in check the undesirable ones, and also to overcome the neutraliser taste in the butter.

It was noticed that this neutralizer caused the cream to foam in the vat.

A second series of churnings was made following the same procedure as in the first except Perfection Lime was used as a neutralizer. Table II shows the degree of neutralization, the Babcock, butyl alcohol, and Mojonnier tests for fat in the buttermilk, and the score of the butter at the end of 30, 60, and 90 days.

Table II.-- Effect of the degree of neutralization on the efficiency of churning and the quality of butter when Perfection Lime was used as a neutralizer.

Trials	Degree of neutralization	Per cent of fat in buttermilk: Babcock	Per cent of fat in buttermilk: Butyl alcohol	Per cent of fat in buttermilk: Mojonnier	Score of butter: End of 30 days stored at 40° F	Score of butter: End of 60 days stored at 0° F	Score of butter: End of 90 days stored at 0° F	Remarks
	0.15	0.290	0.525	0.604	[illegible]	[illegible]	[illegible]	Slightly neutralizer
	0.25	0.447	0.690	0.765	89.00	88.50	88.50	Slightly rancid
1	0.15 ripened to 0.25	[illegible]	[illegible]	0.737	[illegible]	[illegible]	[illegible]	[illegible]
	0.15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	0.25	0.250	0.630	0.651	89.50	89.50	89.50	Flat, clean
2	0.15 ripened to 0.25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	0.15	0.[illegible]	0.[illegible]	0.555	[illegible]	89.00	[illegible]	Neutralizer
	0.25	0.232	0.565	0.570	89.00	89.50	89.50	Slightly neutralizer
3	0.15 ripened to 0.25	0.218	0.[illegible]	[illegible]	[illegible]	[illegible]	90.00	Starter
	0.15	0.[illegible]	0.[illegible]	0.[illegible]	[illegible]	[illegible]	88.66	
Average results	0.25	0.310	0.628	0.656	89.16	89.20	89.20	
	0.15 ripened to 0.25	0.[illegible]	0.[illegible]	0.[illegible]	[illegible]	[illegible]	[illegible]	

Trial One in Table II indicates that the buttermilk from cream neutralized to 0.15 per cent acidity gave a decidedly lower loss of fat than the other two churnings. When analyzing the churn records it was found that in the case of this particular churning, churned for one hour and 50 minutes; whereas, the cream neutralized to 0.25 per cent acidity and the ripened cream churned in 40 and 50 minutes respectively. Trial Two shows that all tests gave the lowest loss of fat in the ripened cream buttermilk. The Babcock, butyl alcohol, and Mojonnier methods gave 0.070, 0.110, and 0.063 per cent less fat, respectively, in the ripened cream buttermilk than in that from the cream neutralized to 0.15 per cent acidity. In Trial Three the Babcock test gave 0.070 per cent lower fat in the ripened cream; and the Mojonnier method, 0.003 per cent higher than in that from 0.15 per cent acid cream. From the average results it is found that the lowest loss of fat in the buttermilk was from 0.15 per cent acid cream but this is probably due to the first churning in Trial One which was explained above. When one analyzes Trials Two and Three they show by all tests that the ripened cream buttermilk contained the lowest amount of fat and that from the 0.15 per cent acid cream the highest. The Babcock, butyl alcohol and Mojonnier tests show the average test in the former to be 0.065, 0.043, and 0.030 per cent, respectively, lower

than in the latter. Analyzing the average results of ripened cream buttermilk and that of the 0.25 per cent acid cream it is found that the Babcock test gave 0.005 per cent higher in the former while the butyl alcohol and Mojonnier methods gave 0.011 and 0.20 per cent lower in the former than the latter. Results indicate that the degree of neutralization with Perfection Lime does not make any appreciable difference in the efficiency of churning as shown by the tests used.

The difference in the score of the butter in the various churnings was not so marked when Perfection Lime was used as it was in the case of Wyandotte C.A.S. The butter from cream neutralized to 0.15 per cent acidity scored at the end of 30 days, on an average, 89 points as compared to 89.5 from ripened cream and 89.6 from the 0.25 per cent acid cream. Although these differences are small, they show that the butter from ripened cream was one-half point higher than that from 0.15 per cent acid cream. In going over the churn reports it was noted that the starter used in the first trial was not so high-quality as was used in the later trials and this accounts for the lower score of the ripened cream butter in the first trial. The butter from the ripened cream scored one-half and one and one-half points higher than the butter from 0.15 per cent acid cream in Trials Two and Three, respectively, and one-half point

lower in Trial One. The latter score is probably due to the starter used. The butter stored at 0 degrees F. and scored at the end of 60 and 90 days has practically the same score. The butter from 0.15 per cent acidity cream averaged 0.17 of a point lower at 90 days than it did at the end of 60 days, and the other butter scored the same in all cases. The ripened cream butter averaged 0.83 and 1 point higher than that from cream neutralized to 0.15 per cent acidity at the end of 60 and 90 days, respectively. The butter from 0.25 per cent acid cream scored 0.16 of a point lower than the ripened cream at the end of 60 and 90 days. The quality of the butter, when using Perfection lime as a neutralizer, was practically the same at the end of 90 days as it was at the end of 60 days. This shows that at the low storage temperature there was practically no increase in the undesirable bacteria.

A third series of churnings was made following the same procedure as in the first series except magnesium carbonate was used as a neutralizer. Table III records the degree of neutralization; the Babcock, butyl alcohol, and Mojonnier tests for the butter fat in the buttermilk; and the score of the butter at the end of 30 and 60 days.

Table III.-- Effect of the degree of neutralization on the efficiency of churning and the quality of butter when magnesium carbonate was used as a neutraliser.

Trials	Setting	Per cent of fat in buttermilk: Babcock	Per cent of fat in buttermilk: Alkali	Score of butter: End of 30 days stored at 40° F.	Score of butter: End of 60 days stored at 0° F.	Remarks
1	0.15	0.430	0.945	1.016	88.00	88.75	Old, neutraliser
	0.25	0.402	0.840	0.882	89.00	89.00	Slightly neutraliser
	0.15 ripened to 0.30	0.277	0.838	1.0[illegible]	[illegible]0.00	[illegible]87.50	Starter
2	0.15	0.520	0.900	0.968	88.00	88.00	Flat, old
	0.25	0.545	0.930	0.931	89.00	88.50	Flat, old
	0.15 ripened to 0.30	0.287	0.715	0.761	89.75	89.00	Good starter
Average results	0.15	0.500	0.928	0.992	88.50	88.38	
	0.25	0.474	0.885	0.891	89.00	88.75	
	0.15 ripened to 0.30	0.472	0.840	0.861	89.87	90.25	

It will be noticed from Table III that all the tests in this series averaged higher than the preceding series. This may be due to the fact that the cream used in this experiment averaged 0.65 per cent acid which is 0.10 to 0.15 per cent higher than the bulk of the preceding cream used. The cream was in a curdy condition when received due to the fact that it contained a high acid content. In Trial One the ripened cream buttermilk had 0.007, 0.020, and 0.006 per cent higher fat according to the Babcock, butyl alcohol, and Mojonnier methods, respectively, than the buttermilk from 0.15 per cent acid cream; in Trial Two the buttermilk from the ripened cream had 0.153, 0.135, and 0.267 per cent, respectively, lower fat. In averaging the tests from the two trials made, it was found that all the tests gave the lowest amount of fat in the ripened cream buttermilk and the highest in the buttermilk from the cream neutralised to 0.15 per cent acidity.

It was found with this neutraliser that the buttermilk was difficult to strain through a cheesecloth because of a thick, pasty substance which clogged the holes of the cloth. The buttermilk was more difficult to strain when the cream was neutralised to the lower degree. Also the cream foamed very much when this neutraliser was used.

Table III shows that the average score of the butter from ripened cream was higher than the butter from 0.15 per

cent acid cream when stored at 40 degrees F. for one month. The score of the ripened cream butter was 89.75 while that of the same cream neutralized to 0.15 per cent acidity was 88.5 and 89 for the butter from 0.25 per cent cream. The average score of the butter at the end of 60 days was 88.35, 88.75, and 89.25 from 0.15 per cent acidity, 0.25 per cent acidity, and ripened cream, respectively. In all trails the ripened cream butter scored the highest and that from the cream neutralized to 0.15 per cent acidity scored the lowest. Table IV gives the average results of the various neutralizers used on the fat lost in the buttermilk. The average of all the neutralizers is shown in the first part of the table and the average of the individual neutralizers given in the last part of the table.

Table IV.-- The relation of the various neutralizers to the loss of fat in the buttermilk.

Number of churnings	Neutralizer	Degree of neutralization	Acidity of cream at start	Acidity of cream at start	Test of the buttermilk: Babcock	Test of the buttermilk: Normal butyl alcohol	Test of the buttermilk: Mojonnier	Test of the buttermilk above or below the average for all churnings: Babcock	Test of the buttermilk above or below the average for all churnings: Normal butyl alcohol	Test of the buttermilk above or below the average for all churnings: Mojonnier
			Per cent	Per cent						
24	Average of all combined	0.15 to 0.25 ripened to 0.30	0.525	0.260	0.369	0.738	0.744	.000	.000	.000
9	Wyandotte C.A.S.	0.15 to 0.25 ripened to 0.30	0.490	0.260	0.324	0.702	0.696	-.045	-.036	-.050
9	Perfection Lime	0.15 to 0.25 ripened to 0.30	0.473	0.260	0.310	0.626	0.655	-.059	-.110	-.089
6	Magnesium carbonate	0.15 to 0.25 ripened to 0.30	0.650	0.245	0.474	0.865	0.891	+.105	+.147	+.147
			0.645	0.310	0.472	0.840	0.861	+.009	+.147	+.136

The cream used for these trials was of fairly good quality. The acidity varied from 0.32 to 0.66 per cent and the butter fat from 29 to 40 per cent.

Table IV shows that when the average tests of all the neutralisers were summarized, the butyl alcohol and Mojonnier tests gave 0.024 and 0.033 per cent lower fat, respectively, in the ripened cream buttermilk than in that from cream neutralised to 0.15 per cent acidity, while the Babcock method gave 0.006 per cent higher in former buttermilk. The differences between each individual test are small and would come within the error of testing. Table IV indicates that Perfection Lime gave the lowest loss of fat in the buttermilk while magnesium carbonate gave the highest loss in the buttermilk. For example, the buttermilk from cream neutralised with Perfection Lime as shown by the Mojonnier method contains 0.154, 0.089, and 0.091 per cent less fat from 0.15 per cent, 0.25 per cent, and ripened cream, respectively, than the average test of the buttermilk from all neutralisers; the buttermilk from cream neutralised with magnesium carbonate shows 0.288, 0.147, and 0.136 per cent more fat, respectively, than the average fat test of all neutralisers. It must be remembered that the latter cream contained a higher original acid and some of this greater loss may be due to this original high acid.

There is a tendency to be a higher loss of fat in the buttermilk neutralized to a lower degree without ripening the cream. The Mojonnier shows for the average of all neutralizers, 0.764, 0.744, and 0.726 per cent for the 0.15 per cent, 0.25 per cent, and ripened cream. This difference is very small and varies with each trial and in most cases was within experimental error. The results from Table IV would indicate the losses of fat in the different degrees of neutralization from the various neutralizers used were not enough to say that there was a more exhaustive churning of the cream neutralized to any of the degrees used.

A trial was made in which all the neutralizers were used in the same cream and neutralized to the same degree of acidity. The cream was mixed thoroughly in a vat, then divided into three equal parts. Parts one, two, and three of the cream were neutralized with Wyandotte C.[illegible].S., Perfection Lime, and magnesium carbonate, respectively, to 0.25 per cent acidity under the effects of the degree of neutralization. Table V gives the results.

Table V.-- The loss of fat from various neutralisers in the same cream.

Neutraliser	Babcock	Normal butyl alcohol	Mojonnier
Wyandotte C.A.S....	0.210	0.660	0.661
Perfection Lime....	0.165	0.435	0.532
Magnesium carbonate	0.290	0.640	0.681

It will be noted from Table V that the Perfection Lime showed the lowest loss of fat in the buttermilk by all the testing methods and magnesium carbonate the highest loss of fat. This is only one trial, although it bears out the trials that were made on the different degrees of neutralization, in that Perfection Lime showed the least loss and the magnesium carbonate the highest loss of fat in the buttermilk.

RECOVERY OF BUTTER FAT FROM BUTTERMILK

The churning of the cream causes the larger fat globules to coalesce leaving the smaller ones in the buttermilk. Some of the fat which is locked in the curd also goes into the buttermilk. Thus, there is fat in the but-

termilk which is locked in the curd and some free fat associated with the whey portion. If a large enough quantity of the fat were in the whey it could be taken out by centrifugal force as there is no curd to clog up the separator bowl. The fat locked up in the curd is hard to recover unless it is dissolved, thus freeing the fat. By dissolving the fat in some reagent it could then be recovered from the solvent by evaporation. The latter method might be very expensive because of the cost of reagents and the time spent to recover the fat. The butter fat, being prone to absorb the odor of the reagents, would render the fat practically unsalable. The recovery of fat by centrifugal force seems to be the most logical method but one difficulty that must be overcome is that of getting the buttermilk in condition for separation.

Object of the Experiment

The object of this part of the experiment was to study the possibility of recovering some fat from the buttermilk.

Method of Procedure

Preparation of the Buttermilk. Buttermilk from the churnings in Part One was used for separation. After the buttermilk was strained through a cheesecloth to remove the

loose particles of fat, it was heated to 90 degrees F. and the acid content determined.

Neutralizing the Buttermilk. The buttermilk from sour cream was neutralized with Wyandotte C.C.S. The amount of neutralizer added was enough to reduce the acid to the neutral point but it was found that this amount only reduced the titratable acid a little lower than one-half. It was necessary to add more neutralizer to reach the desired acidity. The acidity ranged from 0.09 to 0.15 per cent acidity before separation. The sweet cream buttermilk was separated without neutralization.

Separation of the Buttermilk. The buttermilk was heated after neutralization to temperatures ranging from 90 to 120 degrees F. and then separated with a cream separator.

Testing the Skimmed Buttermilk and Cream. The skimmed buttermilk was tested by the normal butyl alcohol test and the cream was tested by the Babcock method.

Separation of the Whey and Curd Portions of the Buttermilk from Sour Cream. The buttermilk was allowed to stand in 10-gallon cream cans until the curd settled to the bottom, making it possible to siphon off the whey portion. The whey portion was separated at 95 degrees F. without any treatment. After they whey was siphoned off the curd, water was added to the curd and thoroughly mixed. This was let stand and the water siphoned off. This was repeated three

times. The purpose of washing the curd was to remove most of the whey and remove any water soluble salts from the curd. Enough water was then added to the curd to make it the consistency of milk. The mixture was neutralised at 90 degrees F. with Wyandotte C.A.3. The acidity of the mixture ranged from 0.05 to 0.15 per cent before separation. The digested curd was then heated to 110 to 130 degrees F. and separated.

Discussion of Results

Table No. VI shows the acidity of the buttermilk before and after neutralization, the fat content of the buttermilk before and after separating, the test of the cream obtained, condition of separator bowl, and the temperature at which the buttermilk was separated.

Table VI.-- Separation of buttermilk from sour cream.

Number of trials	Pounds separated	Acidity before neutralization	Acidity after neutralization	Test of original buttermilk: Butyl alcohol	Test of original buttermilk: Butyl alcohol	Test of cream	Test of skimmed buttermilk	Condition of separator bowl	Temperature of buttermilk at separation
2	72	0.30	0.19	0.270	0.600	2.7	0.17	Clogged	110° F.
2	78	0.42	0.15	0.285	0.630	6.1	0.22	Clogged	120° F.
1	72	0.36	0.09	0.345	0.775	3.1	0.41	Clogged	130° F.
1	73	0.29	0.05	0.315	0.675	4.4	0.20	Clogged	140° F.

It will be noted from Table VI that in every case the separator clogged with curd, thus throwing the buttermilk out through the cream spout. There seems to be no relation between the original amount of acid and the final acidity of the buttermilk and the per cent of fat in the cream. The low tests of the cream as shown in Table VI is due to the clogging of discs with curd throwing some of the buttermilk out through the cream spout. The cream obtained from this neutralized buttermilk had a characteristic neutralizer taste. The lower the degree of neutralization of the buttermilk, the stronger the neutralizer taste of the cream. From the above trials the temperature at time of separation and the amount of original acid in the buttermilk from sour cream had the same effect on the clogging of the bowl of the separator.

After finding difficulty in separating the neutralized buttermilk, it was thought advisable to try to separate the curd after the whey portion of the buttermilk was drawn off. The curd was washed with three waters, neutralized, heated, and then separated. In some cases it was necessary to add water to the curd to make it about the consistency of milk. Table VII gives the results of eight trials run.

Table VII.— Relation of the butter fat in the buttermilk to the per cent of cream from the digested curd after the whey was removed.

Final acidity	Temperature separated	Original test - Babcock	Original test - Butyl alcohol	Test of cream	Test of skim	Pounds of curd	Condition of separator bowl
0.12	90°	0.300	0.640	2.5	0.250	47	Partly clogged
0.10	120°	0.370	0.660	5.7	0.170	52	Partly clogged
0.15	90°	0.400	0.620	4.4	0.200	47	Nearly clogged
0.10	120°	0.300	0.680	3.0	0.175	62	Nearly clogged
0.14	120°	0.270	0.690	1.5	0.210	80	Clogged
0.15	110°	0.245	0.565	5.6	0.170	54	Partly clogged
0.15	120°	0.315	0.675	2.2	0.160	65	Clogged
0.10	110°	0.250	0.630	7.4	0.170	45	Partly clogged

Even though temperatures ranging from 90 to 120 degrees F. and final acidity of the curd from 0.10 to 0.15 per cent were used the curd continued to clog the separator bowl. Although the amount of fat in the samples of buttermilk varied there seems to be no direct relation between the amount of fat and the per cent of fat in the cream. It will be noted from Table VII that one sample of buttermilk testing 0.27 per cent by the Babcock test and 0.69 per cent by

the butyl alcohol method gave, when separated, cream testing 1.5 per cent, while in another sample testing 0.25 per cent by the Babcock test and 0.63 per cent by the butyl alcohol method gave, when separated, cream testing 7.4 per cent. The results from this experiment indicate that it would not be possible to separate a large volume of sour cream buttermilk without having the separator bowl clog up with curd. It would no doubt be possible to separate the buttermilk without having the difficulty of the bowl of the separator clogging with curd if all the curd of the buttermilk could be digested. The results from reducing the original acidity to 0.03 to 0.05 per cent in the curd are found in Table VIII.

The curd and whey from three churnings were separated. The whey yielded no fat when separated. The results from the curd portion are recorded in Table VIII.

Table VIII.— The results of the curd separation of sour cream buttermilk.

Original acidity	Final acidity	Pounds of curd	Tempera-ture	Condition of separator bowl	Test of cream	Test of skim
					Per cent	
0.50	0.05	32	180°	Clogged	----	----
0.50	0.05	37	180°	------	31	0.32
0.66	0.04	29	180°	------	10	0.56
0.66	0.03	22	180°	------	13	0.30
0.71	0.04	23	180°	Clogged	----	----
0.71	0.04	17	180°	Clogged	----	----

In these trials between 70 and 80 pounds of buttermilk were used and treated the same as in Table VII. The separator bowl in the three trials that show that cream was produced, was almost full of curd. This would indicate that only a small amount more of the neutralized curd would have gone through the separator bowl before it would have clogged. The results from Table VIII indicate that neutralized buttermilk can be separated in small quantities by the method used in this experiment.

Table IX.-- Average fat content in the whey and curd from sour cream in buttermilk.

Trial No.	Whey			Curd			Original buttermilk		
	Babcock	Butyl alcohol	McJonnier	Babcock	Butyl alcohol	McJonnier	Babcock	Butyl alcohol	McJonnier
One	0.070	0.430	0.438	0.675	1.085	1.115	0.4800	0.725	0.737
Two	0.070	0.390	0.383	0.460	0.770	0.799	0.2900	0.525	0.604
Three	0.066	0.410	0.456	0.670	1.015	1.070	0.4675	0.690	0.763
Average	0.067	0.407	0.426	0.602	0.967	0.994	----	----	----

There were six trials run on the above averages -- two trials from each of three churnings. The cream was sour and neutralized with Perfection Lime. In the trials designated as Number One in Table IX the cream was neutralized to 0.15 per cent and ripened to 0.27 per cent acidity with starter. In Number Two, the cream was neutralized 0.15 per cent acidity and in Number Three, the cream was neutralized to 0.24 per cent acidity.

The buttermilk from these churnings was allowed to stand until the curd had settled to the bottom and the whey was siphoned off, thoroughly mixed, and tested. The curd was stirred thoroughly and tested.

Table IX shows that the curd portion of the buttermilk contained 0.535, 0.550, and 0.568 per cent more fat according to the Babcock, normal butyl alcohol, and Mojonnier methods, respectively, than they contained in the whey.

The Babcock test of the whey used in this experiment showed that it contained, on an average, 0.06 per cent fat which is about the average per cent of fat in skim milk, while the Mojonnier showed that the same whey contained 0.426, a difference of 0.359 per cent fat. From the results of the separation of the whey portion of the buttermilk it was found that no fat was secured and no difficulty was encountered in separation.

If there were 0.426 per cent true butter fat contained

in this whey it would be reasonable to assume that some cream would have been recovered. It is possible that the Mojonnier and the butyl alcohol methods do not give the correct per cent of butter fat in buttermilk because the reagents used in these tests dissolve some of the fatty-like substances which are not true butter fat.

Three lots of sweet cream were mixed thoroughly in a vat. One-half of each lot was pasteurized at 145 degrees F. for 30 minutes, cooled to holding temperature, and held over night in the cooler at 40 degrees F. It was then churned. The other half of each lot was allowed to sour. It was neutralized to 0.25 per cent acidity and then handled the same as the sweet cream. The buttermilk from sweet cream was heated to about 100 degrees F. and separated. The sour cream buttermilk was neutralized to 0.15 at 90 degrees F., then heated to about 100 degrees F., and separated. The average results from this experiment will be found in Table X.

Table X.— Separation of buttermilk from sweet and sour cream of the same lot.

Kind of buttermilk	Pounds separated	Test of skimmed buttermilk			Cream Test	Original test of buttermilk			Condition of separator bowl
		Babcock	Butyl alcohol	Mojonnier		Babcock	Butyl alcohol	Mojonnier	
Sweet	80	0.240	0.400	0.476	19.6	0.215	0.305	0.630	----
Sour (one lot)	65	0.415	0.655	0.674	13.0	0.500	0.705	0.725	----
Sour (other two lots)	75	----	----	----	No cream	0.417	0.662	0.662	Clogged

The acidity on the one lot that did not clog the separator bowl was 0.25 per cent before and 0.09 per cent after neutralization. The bowl, when taken apart, showed that it would have taken only a small amount more of buttermilk to clog it. The two lots of buttermilk that clogged the bowl had an original acidity of 0.26 and 0.29 per cent and final acidity of 0.09 and 0.11 per cent. From the above results it will be noted that the buttermilk from the sweet cream separated without any difficulty while the same cream after it had soured then neutralized clogged the separator bowl.

COMPARISON OF THE BABCOCK, NORMAL BUTYL ALCOHOL, AND MOJONNIER METHODS FOR FAT DETERMINATION IN BUTTERMILK

Fifty-three samples of buttermilk were gathered from three creameries in Kansas. The samples were tested in duplicate by the Babcock, normal butyl alcohol, and Mojonnier methods. The original tests will be found in the appendix. Table XI shows average results from each creamery and the average results from all three creameries.

Table XI.— Average results of fat in buttermilk in three creameries in Kansas.

Creamery	Babcock	Normal butyl alcohol	Mojonnier	Above and below the average for three plants: Babcock	Normal butyl alcohol	Mojonnier
The three creameries	0.346	0.[illegible]	0.656	.000	.000	.000
No. One	0.327	0.[illegible]	0.651	.019	.000	.004
No. Two	0.396	0.[illegible]	0.717	.068	.052	.062
No. Three	0.336	0.[illegible]	0.662	.008	.048	.055

There were 39 buttermilk samples tested for creamery Number One, and 12 samples each for creamery Numbers Two and Three. These samples were gathered from September to December, 1927. The acid content of the cream ranged from 0.32 to 0.72 acidity. The milk of the cream averaged from 0.63 to 0.72 per cent acid. The cream from creamery Number One averaged 0.618 per cent acidity; creamery Number Two averaged 0.55 per cent acidity; and creamery Number Three averaged 0.534 per cent acidity. There were different neutralizers used to neutralize the cream in each plant so the correlation between the loss of fat and acidity could

not be determined.

It will be noted from Table XI that the normal butyl alcohol and Mojonnier methods gave one-third to one-half higher results than the Babcock method. This is in accordance with results from other investigators.

From unpublished work at this station an experiment was conducted in which a qualitative test for phosphorus was made on fat secured from buttermilk by the Babcock and gravimetric methods. The fat from the buttermilk by the Babcock method showed no trace of phosphorus, while fat obtained from buttermilk by the gravimetric method contained a considerable amount of phosphorus. This is in agreement with unpublished work done at the Minnesota station in that the Babcock method shows fat and not lecithin while the gravimetric method shows that both are present. It would be reasonable to believe then that the difference between the Babcock and gravimetric methods is due to the reagents of the latter test dissolving the phospholipids of the buttermilk. This being the case the loss of fat in the buttermilk is not so great as was formerly believed. The loss of fat in buttermilk according to the Babcock method would be only one-third to one-half as much as it is assumed to be according to the butyl alcohol method of testing. If the above were true the time and labor involved in the separation of sour cream buttermilk might not pay for the fat recovered

especially if the cream contained the neutraliser flavor as it did in this experiment.

SUMMARY

Thirty-six churnings of cream were made in this experiment.

In this investigation three neutralizers, Wyandotte C.A.S., Perfection Lime, and magnesium carbonate were studied. From the average results of all churnings, Perfection Lime gave the lowest loss of fat in the buttermilk while the magnesium carbonate gave the highest. The Perfection Lime averaged 0.633 per cent; the Wyandotte C.A.S. averaged 0.685; and the magnesium carbonate, 0.914 per cent fat in the buttermilk. The greater fat loss from the cream neutralized with magnesium carbonate may be accounted for due to the higher acid content of the original cream, although the results from these neutralizers used in the same cream showed that Perfection Lime gave 0.532 per cent fat and the magnesium carbonate 0.681 per cent fat in the buttermilk according to the Mojonnier test.

Three degrees of neutralization were used; the cream was neutralized to 0.15 per cent acidity, 0.25 per cent acidity, and 0.15 per cent acidity and ripened to about 0.30 per cent acidity. The degree of neutralization from the

results obtained indicate that there is approximately the same exhaustiveness of churning.

The butter from the different degrees of neutralization, as indicated by the results, show that the ripened cream butter scored the highest and that from the 0.15 per cent acid cream, the lowest. The ripened cream produced 90.13-score butter while that from 0.15 per cent cream scored 89.27.

The efficiency of churning was judged by the Babcock, butyl alcohol, and Mojonnier tests for the fat in the buttermilk. The Babcock test showed that the loss of fat in the buttermilk was from one-third to one-half as great as that indicated by the butyl alcohol and Mojonnier methods. The butyl alcohol test checked reasonably close to the Mojonnier.

Attempts were made to separate the sour cream buttermilk to recover some of the fat lost. Separation was made with neutralized buttermilk. The original acidity of the buttermilk was reduced with Wyandotte C.[illegible].S. from 0.10 to 0.15 per cent. Difficulty was encountered by having the curd clog the separator bowl and only a small quantity of buttermilk would go through before this took place. After encountering this difficulty the buttermilk was divided into the whey and curd portions. The whey separated without difficulty but no fat was received. The curd was neutralized to a lower de-

gree of acidity than the buttermilk but there was still the clogging of the bowl.

There was no difficulty encountered in the separation of sweet cream buttermilk which was taken from the churn and separated without treating.

The curd portion of the sour cream buttermilk contained twice as much fat as the whey portion according to the butyl alcohol and Mojonnier methods while the Babcock test showed that the curd contained nine times more fat than the whey portion. This greater difference as shown by the Babcock test was probably due to the fact that the whey portion contained little true butter fat and about 0.35 per cent phospholipids which were included in the fat of the chemical method.

The loss of fat from 53 samples of buttermilk in three Kansas creameries showed a fat loss of 0.340, 0.388, and 0.655 per cent by the Babcock, butyl alcohol, and Mojonnier tests, respectively.

CONCLUSIONS

1. The method of neutralizing cream and the subsequent handling which it receives are more important factors in controlling fat losses than the kind of neutralizer used. All of the neutralizers tried in this experiment were of

about equal value, with the exception of magnesium carbonate which gave greater fat losses.

2. From the standpoint of efficiency of churning one degree of neutralization cannot be considered to give more exhaustive churning than the other.

3. When neutralizing to 0.15 per cent acidity a good starter aided in overcoming the objectional neutralizer taste in the butter. The butter produced in all the degrees of neutralization was practically the same except the flavor. The objectional neutralizer flavor varied directly with the degree of neutralization in the unripened cream butter.

4. The separation of sour cream buttermilk would not be advisable unless large enough quantities were available; then the time and cost of putting it into proper condition for separators might not justify it, especially if the cream contains the neutralizer flavor. The recovery of fat from sweet cream buttermilk is possible and would be practicable if there were large enough volume and it contains sufficient amount of fat.

5. From the results obtained in this experiment there is a need of further work to be done on the testing of buttermilk in order to perfect a test that will give the true butter fat content.

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APPENDIX

Date 1927	Babcock 1	Babcock 2	Butyl alcohol 1	Butyl alcohol 2	Mojonnier 1	Mojonnier 2	Remarks
Creamery Number One							
Sept.	0.20	0.23	0.60	0.59	0.572	0.600	Babcock curd on bottom
Sept. 29	0.30	0.31	0.52	0.50	0.545	0.546	
Sept. 30	0.35	0.30	0.72	0.72	0.734	0.735	
Oct. 1	0.23	0.24	0.54	0.52	0.599	0.596	Babcock curd on bottom of test
Oct. 4	0.27	0.26	0.64	0.65	0.630	0.639	
Oct. 5	0.36	0.37	0.50	0.48	0.578	0.575	
Oct. 7	0.34	0.33	0.50	0.50	0.564	0.560	
Oct. 8	0.35	0.35	0.54	0.53	0.557	0.563	
Oct. 11	0.43	0.46	0.73	0.74	0.750	0.752	
Oct. 13	0.44	0.45	0.66	0.66	0.626	0.629	
Oct. 15	0.45	0.46	0.68	0.68	0.638	0.634	
Oct. 18	0.41	0.41	0.66	0.64	0.671	0.668	
Oct. 20	0.37	0.38	0.58	0.59	0.619	0.612	
Oct. 22	0.36	0.38	0.58	0.58	0.570	0.579	
Oct. 25	0.36	0.37	0.56	0.57	0.635	0.634	
Oct. 27	0.39	0.40	0.72	0.74	0.773	0.770	
Nov. 1	0.34	0.32	0.58	0.58	0.612	0.613	
Nov. 3	0.23	0.23	0.66	0.66	0.686	0.679	Babcock curd on bottom of test
Nov. 5	0.34	0.34	0.64	0.64	0.697	0.694	
Nov. 8	0.26	0.28	0.62	0.63	0.667	0.662	
Nov. 10	0.28	0.31	0.67	0.67	0.689	0.684	
Nov. 12	0.29	0.28	0.64	0.64	0.699	0.690	
Nov. 15	0.27	0.29	0.62	0.62	0.653	0.660	
Nov. 17	0.37	0.34	0.69	0.70	0.753	0.745	
Nov. 26	0.24	0.24	0.58	0.58	0.592	0.589	
Nov. 28	0.37	0.37	0.76	0.75	0.761	0.766	
Nov. 29	0.24	0.23	0.56	0.58	0.642	0.651	
Nov. 30	0.24	0.26	0.69	0.69	0.694	0.692	
Dec. 12	0.36	0.35	0.78	0.79	0.791	0.793	

Creamery Number Two

Sept. 26	0.38	0.38	0.62	0.64	0.677	0.677	
Oct. 3	0.28	0.29	0.58	0.60	0.698	0.695	
Oct. 10	0.39	0.41	0.62	0.64	0.651	0.659	
Oct. 18	0.38	0.41	0.64	0.64	0.659	0.661	
Oct. 24	0.44	0.44	0.66	0.68	0.656	0.662	
Oct. 31	0.46	0.48	0.88	0.88	0.916	0.916	
Nov. 7	0.44	0.45	0.70	0.72	0.784	0.776	Babcock slightly curdy
Nov. 14	0.45	0.42	0.78	0.80	0.868	0.860	
Nov. 21	0.39	0.38	0.58	0.58	0.600	0.612	
Nov. 28	0.37	0.34	0.54	0.54	0.549	0.553	
Dec. 6	0.36	0.39	0.62	0.64	0.658	0.661	
Dec. 12	0.41	0.41	0.88	0.88	0.889	0.895	

Creamery Number Three

Oct. 17	0.36	0.36	0.54	0.55	0.549	0.552	
Oct. 19	0.40	0.38	0.54	0.54	0.534	0.541	
Oct. 22	0.42	0.41	0.60	0.60	0.561	0.568	
Oct. 24	0.36	0.37	0.59	0.58	0.545	0.545	
	0.34	0.32	0.63	0.62	0.704	0.705	
	0.33	0.32	0.63	0.62	0.702	0.703	
Nov. 1	0.42	0.40	0.69	0.69	0.763	0.753	
	0.36	0.35	0.69	0.69	0.722	0.719	
Nov. 7	0.34	0.34	0.68	0.68	0.716	0.713	
	0.36	0.37	0.70	0.69	0.749	0.738	
	0.40	0.38	0.66	0.66	0.691	0.684	