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Creamery Butter

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DAIRY HUSBANDRY DEPARTMENT

CREAMERY BUTTER

1. Factors Affecting Acidity
2. The Acid Test as a Measure of Deterioration
3. Handling Cream to Improve Quality of Butter

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Factors Affecting Acidity of Creamery Butter

—AND—

The Acid Test as a Measure of Deterioration of Butter

BY

C. LARSEN T. H. LUND L. F. MILLER

INTRODUCTION

The results reported in this Bulletin are a continuation of the investigations on the acidity of creamery butter, a preliminary report of which was published as Bulletin No. 116 of this Station under the title, "Acidity of Creamery Butter and Its Relation to Quality." In this latter Bulletin it was shown that no definite relation was found to exist between the score and the acidity of fresh butter, but that experiments then in progress indicated that the acid test was a fair measure of the extent and rapidity of the deterioration of butter held in storage.

Investigations on the acidity of cold storage butter, amount and nature of acids and other decomposition products of butter, and their relation to rancid and ill-flavored butter are now in progress, and results will be reported in future publications.

SOME FACTORS AFFECTING ACIDITY OF BUTTER

Of the numerous factors affecting the keeping quality of butter, five were selected for further detailed study of their relation to the acidity, and were as follows: Amount the butter was washed, pasteurization of cream, amount of salt in butter, acidity of cream, and temperature at which the butter was held.

All of the butter was made in the college creamery from the regular milk and cream supply. In each experiment one lot of cream was divided into two parts, and each part treated as described in connection with that experiment. The butter was packed in ten pound tubs and held in the creamery refrigerator (with the exception of that held in the warm room) for sixteen weeks. A sample was taken from each tub every two weeks and the acidity determined by the ether-alcohol method described in Bulletin No. 116 of this Station. The

acidity of the butter is expressed as the number of cubic centimeters of tenth normal alkali required to neutralize the acid in ten grams of butter.

A complete record of the method of manufacture was kept in each case, and a chemical analysis was also made to determine the composition of the butter.

The results of these various determinations affecting the results are recorded in the following tables, and will be discussed in detail under their separate headings.

EFFECT OF AMOUNT OF WASHING ON ACIDITY OF BUTTER

The chief effect of washing butter is to remove as much buttermilk as possible, and thereby eliminate the protein or curd, and lessen the danger of mottles. The benefits derived from thorough washing on the keeping property of butter have in some instances been questioned. Some years ago, while the whole milk system of operating creameries was prevalent, some investigators and many practical creamery operators advised little or no washing if a highly flavored piece of butter was desired. Such unwashed or little washed butter, made from whole milk cream and properly ripened cream, also kept remarkably well. Butter made in this manner contains some buttermilk, and therefore many lactic acid-producing germs, lactic acid, and milk sugar. These undoubtedly had some favorable effect upon the keeping of the butter, by checking or retarding the growth of the undesirable germs, which decompose the proteid substances and the butterfat. Decomposition products from these latter substances are the principal causes of the rancid and undesirable flavors in aged butter.

The cream used in these experiments was not fresh whole milk cream skimmed and ripened at the college creamery. It represents the average quality of hand separator cream obtained at the college from the regular patrons, most of it being sour when delivered. The two lots of cream in each experiment were treated alike except in amount of washing.

TABLE 1

TABLE SHOWING COMPARISON OF ACIDITY OF LITTLE AND THOROUGHLY WASHED BUTTER

Tub No.	Washing	C. c. n/10 Alkali to Neutralize 10 g. Butter									Remarks
		When Made	2 Weeks	4 Weeks	6 Weeks	8 Weeks	10 Weeks	12 Weeks	14 Weeks	16 Weeks	
18	Little	2.4	2.8	3.4	3.8	4.2	....	....	....	....	Neither rinsed nor washed.
17	Thorough	2.0	2.2	2.6	3.0	3.2	....	....	....	....	Rinsed and washed twice, 12 and 12 revs.
76	Little	3.8	4.4	4.4	4.2	4.6	4.6	4.4	4.6	....	Neither rinsed nor washed.
77	Thorough	3.6	3.6	4.0	3.8	4.4	4.5	4.4	4.6	....	Rinsed and washed three times, 5 and 36 and 9 revs.
78	Little	2.6	3.4	3.8	4.4	4.2	4.4	4.8	5.0	....	Rinsed.
79	Thorough	3.2	3.2	3.4	4.2	3.8	4.2	4.6	4.8	....	Rinsed and washed three times, 5 and 10 and 50 revs.
72	Little	3.6	3.6	4.0	4.2	4.6	4.6	5.0	5.2	5.4	Rinsed with 3 pails water.
73	Thorough	3.2	3.4	3.4	4.0	4.4	4.5	4.8	4.8	5.0	Rinsed as above and washed 10 revs.
74	Little	2.8	3.4	3.8	3.8	4.2	4.8	5.0	4.8	4.8	Neither rinsed nor washed.
75	Thorough	2.2	2.8	3.0	3.4	3.8	4.2	4.2	4.2	4.2	Rinsed and washed 30 revs.
31	Little	3.0	3.8	4.0	5.0	5.2	4.1	5.0	5.1	5.6	Neither rinsed nor washed.
32	Thorough	2.2	3.4	3.5	3.8	3.9	4.4	4.6	4.7	5.0	Rinsed and washed twice, 10 and 10 revs.
33	Little	2.7	3.4	3.9	4.5	5.1	4.4	5.4	5.8	5.9	Rinsed.
34	Thorough	2.1	3.5	3.6	4.0	4.6	4.0	5.2	6.2	6.3	Rinsed and washed twice, 10 and 10 revs.
35	Little	2.3	3.9	4.3	5.4	5.5	6.2	5.6	6.9	7.4	Rinsed and washed once, 10 revs.
36	Thorough	2.0	3.8	4.2	5.4	5.5	5.5	5.6	5.7	5.8	Rinsed and washed twice, 10 and 10 revs.
59	Little	2.0	2.1	2.4	2.3	2.6	2.6	2.8	2.8	2.8	Neither rinsed nor washed.
60	Thorough	2.1	2.0	2.2	2.0	2.3	2.3	2.4	2.4	2.5	Rinsed and washed 10 revs.
61	Little	2.0	2.5	2.7	2.6	2.8	2.7	2.7	2.8	3.0	Neither rinsed nor washed.
62	Thorough	1.9	2.0	2.1	2.2	2.2	2.3	2.4	2.4	2.6	Rinsed and washed 10 revs.; worked 50 revs. in water.
Av'ge	Little washing.....	2.7	3.3	3.7	4.0	4.3	4.3	4.5	4.8	5.0	
Av'ge	Thorough washing.	2.4	3.0	3.2	3.6	3.8	4.0	4.2	4.4	4.5	

In these experiments, the average acidity of the thoroughly washed butter, when made, was .3 c. c. less than the little washed butter. At the end of the sixteen weeks this difference had only increased to .5 c. c. Considering the rather inferior quality of cream from which this butter was made, it is somewhat surprising not to find a greater difference in acidity. This would indicate that there is but little difference in the extent of deterioration of the two kinds of butter under these conditions. However, in all of the experiments there was some difference in favor of the thoroughly washed butter.

These results should not lead one to believe that it is not essential to thoroughly wash butter made from hand separator cream. On the other hand, it is of greatest importance. Thorough washing removes some of the undesirable flavors, lessens the danger of mottles, and produces clear brine in the butter, and therefore better appearing butter.

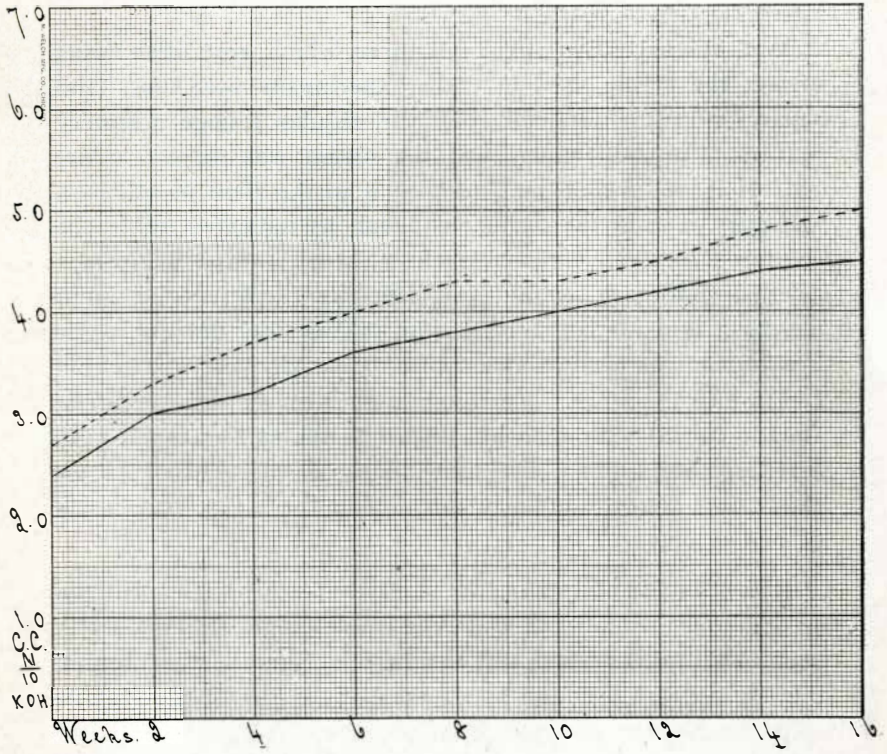

FIGURE I

Comparison of acidity of little washed and thoroughly washed butter, graphically shown. The dotted line represents the little washed butter, and the solid line the thoroughly washed butter.

EFFECT OF PASTEURIZATION OF CREAM ON ACIDITY OF BUTTER

With the exception of the last three, which were fresh sweet cream, the cream used in these experiments was sour hand separator cream obtained from the regular college creamery patrons. In each experiment the cream was mixed. One-half of it was pasteurized, part of it in the Reid pasteurizer, and part of it in the Eclipse coil vat, as indicated under the column Remarks. This latter is a three hundred gallon vat divided into two equal compartments, each compartment having a separate coil for stirring, cooling and heating. The raw cream was put into one compartment, and the pasteurized cream into the other. An equal amount of starter was added to, and mixed with each lot, cooled to the same temperature, and left over night. The two lots were then churned separately, and treated similarly throughout the various processes of manufacture.

It will be noticed from the table that the butter from the pasteurized cream, with the exception of one, contained less acid, when made, than did the butter from the raw cream. This undoubtedly is due to the escape of some of the volatile acids during the pasteurization process. The acid of butter consists of volatile and non-volatile acids, that is, when butter is melted and heated a portion of the acid passes off, while the more fixed acids remain in the butter. It is undoubtedly due to this fact, at least in part, that the butter made from pasteurized cream is not so highly flavored, but has a flatter, though usually cleaner flavor, when freshly made, than has butter made from raw cream.

TABLE II

TABLE SHOWING COMPARISON OF ACIDITY OF RAW AND PASTEURIZED CREAM BUTTER

		C. c. n/10 Alkali to Neutralize 10 g. Butter									
Tub No.	Cream	When Made	2 Weeks	4 Weeks	6 Weeks	8 Weeks	10 Weeks	12 Weeks	14 Weeks	16 Weeks	Remarks
82	Raw	1.8	1.8	2.2	2.6	2.2	2.6	.....	.....	.....	
83	Past.	1.6	1.6	1.8	1.8	1.6	1.8	.....	.....	.....	Pasteurized to 165° F. in Reid pasteurizer.
84	Raw	2.4	2.6	2.8	3.4	3.6	4.8	.....	.....	.....	
85	Past.	2.2	2.2	2.0	1.8	1.6	1.8	.....	.....	.....	Pasteurized to 190° F. in Reid pasteurizer.
86	Raw	2.0	2.2	2.2	2.4	2.6	3.2	.....	.....	.....	
87	Past.	1.8	1.8	1.6	1.6	1.6	1.8	.....	.....	.....	Pasteurized to 185° F. in Reid pasteurizer.
80	Raw	2.2	2.6	2.6	2.8	3.2	3.0	3.2	3.4	.....	
81	Past.	1.8	2.0	2.1	2.2	2.2	2.4	2.2	2.2	.....	Pasteurized to 185° F. in Reid pasteurizer.
19	Raw	2.0	3.0	3.3	3.6	4.6	4.7	4.4	4.8	5.0	
20	Past.	1.7	2.3	2.4	2.5	2.6	2.6	2.0	2.0	1.8	Pasteurized to 160° F. in coil ripening vat.
21	Raw	1.8	2.6	2.8	3.1	3.4	3.4	3.6	3.8	4.1	
22	Past.	1.9	2.0	2.0	2.2	2.4	2.4	2.4	2.5	2.7	Pasteurized to 140° F. in coil ripening vat.
45	Raw	1.7	2.0	2.3	2.4	2.4	2.5	2.4	2.2	2.4	
46	Past.	2.0	2.0	1.9	2.2	2.1	2.2	2.3	2.3	2.5	Pasteurized to 140° F. in coil ripening vat.
63	Raw	1.6	1.7	1.6	1.8	2.4	2.4	2.0	2.0	2.2	
64	Past.	1.5	1.8	1.7	1.8	1.8	1.9	2.1	2.0	2.6	Pasteurized to 140° F. in coil ripening vat.
70	Raw	1.8	2.5	2.6	3.0	3.1	3.2	3.3	3.6	3.8	
71	Past.	1.8	2.5	1.9	2.3	2.2	2.2	2.2	2.4	2.5	Pasteurized to 140° F. in coil ripening vat.
Av'ge	Raw cream	1.9	2.3	2.5	2.8	3.1	3.3	3.2	3.3	3.5	
Av'ge	Past. cream	1.8	2.0	1.9	2.0	2.0	2.1	2.2	2.2	2.4	

The butter made from the pasteurized cream did not increase in acidity as rapidly as did the butter made from raw cream. The average difference when made amounted to only .1 c. c., but after the butter had been kept sixteen weeks, this difference had increased to 1.1 c. c. During the sixteen weeks the acidity of the pasteurized cream butter had only increased .6 c. c., as compared with an increase of 1.6 c. c. in the raw cream butter.

These results, in terms of the acid test, strikingly verify previous experimental evidence of the superior keeping quality of pasteurized butter.

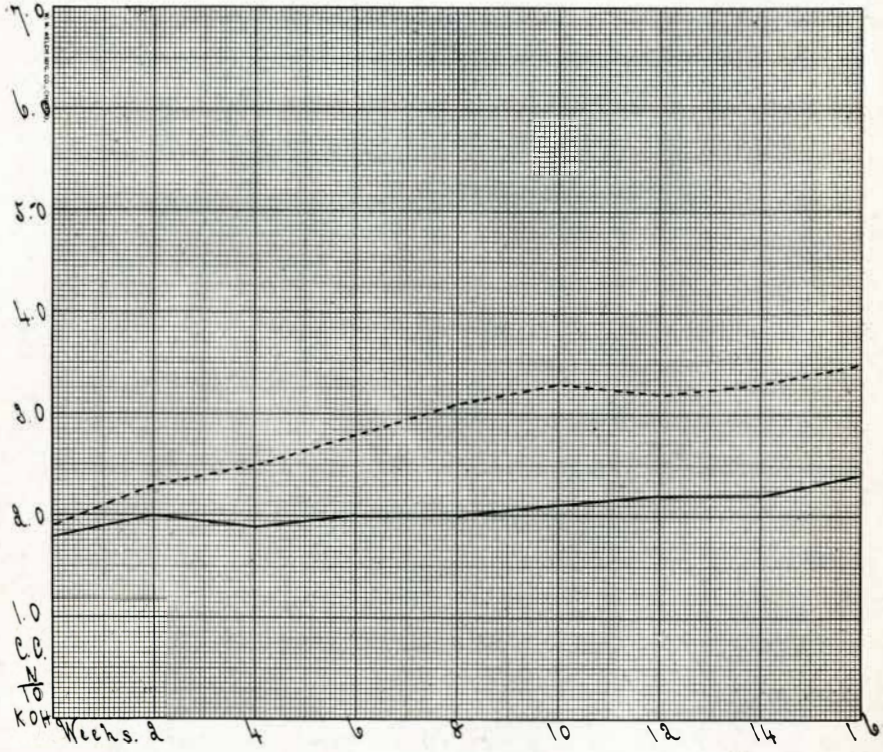

FIGURE II

Comparison of acidity of raw and pasteurized cream butter graphically shown. The dotted line represents the raw cream butter, and the solid line butter from pasteurized cream.

EFFECT OF AMOUNT OF SALT ON ACIDITY OF BUTTER

The two parts into which each lot of cream was divided in this experiment were treated alike throughout the different manufacturing processes with the exception of amount of salt added. The butter from one part of the cream was salted lightly, and that from the other part was heavily salted. The percentage of salt in all of the butters is shown in Table III.

TABLE III

TABLE SHOWING COMPARISON OF ACIDITY OF LOW AND HIGH SALTED BUTTER

Tub. No	Salt	C. c. n/10 Alkali to Neutralize 10 g. Butter									Remarks
		When Made	2 Weeks	4 Weeks	6 Weeks	8 Weeks	10 Weeks	12 Weeks	14 Weeks	16 Weeks	
24	Low	2.0	3.0	3.8	**4.0**	4.4	.....	.....	.....	.....	0.32% salt.
23	High	2.0	2.4	2.8	3.0	3.2	.....	.....	.....	.....	1.94% salt.
26	Low	2.2	2.8	3.8	**4.6**	5.0	.....	.....	.....	.....	0.40% salt.
25	High	2.0	2.2	2.6	2.8	3.0	.....	.....	.....	.....	3.25% salt.
28	Low	2.8	3.2	3.6	**4.0**	4.2	.....	.....	.....	.....	0.23% salt.
27	High	2.2	2.4	2.6	2.8	2.8	.....	.....	.....	.....	2.81% salt.
88	Low	1.8	2.2	2.6	**2.6**	3.4	.....	.....	.....	.....	0.46% salt.
89	High	1.8	2.2	2.4	2.4	3.0	.....	.....	.....	.....	1.05% salt.
90	Low	1.6	1.8	2.2	**2.1**	3.0	.....	.....	.....	.....	0.81% salt.
91	High	1.6	1.8	1.8	**2.0**	2.6	.....	.....	.....	.....	1.76% salt.
92	Low	2.0	2.6	3.0	**3.4**	4.8	.....	.....	.....	.....	0.00% salt.
93	High	1.8	1.8	1.8	1.9	1.8	.....	.....	.....	.....	5.97% salt.
37	Low	2.6	7.0	9.2	12.1	13.2	14.8	19.7	19.7	19.9	0.62% salt.
38	High	2.5	4.6	4.8	5.7	6.2	6.3	6.4	6.9	7.0	2.98% salt.
56	Low	1.8	2.8	2.9	**3.4**	3.4	3.4	3.5	3.6	3.8	1.58% salt.
55	High	1.8	2.6	3.0	3.3	2.9	3.0	3.2	3.5	3.5	2.88% salt.
58	Low	1.9	2.0	2.8	2.8	3.2	3.2	3.2	3.4	3.2	1.05% salt.
57	High	1.8	1.9	2.2	2.3	2.2	2.5	2.4	**2.4**	2.3	5.17% salt.
67	Low	1.9	2.3	2.5	2.5	2.8	3.0	3.0	3.4	3.3	1.06% salt.
66	High	1.9	2.0	2.1	1.8	2.0	1.9	2.0	2.0	2.1	6.12% salt.
69	Low	2.0	2.3	2.5	2.9	2.8	2.8	3.1	3.2	3.8	0.83% salt.
68	High	1.9	2.1	1.9	2.0	2.0	2.2	2.1	2.2	2.5	5.30% salt.
Av'ge	Low salt	2.1	2.9	3.5	**4.0**	**4.6**	5.4	6.5	6.7	6.8	0.39% salt.
Av'ge	High salt	1.9	2.4	**2.5**	2.7	2.9	3.2	3.2	3.4	3.5	3.56% salt.

From this table it will be seen that the amount of salt has considerable effect upon the amount of acid in the butter. This fact is manifest at once after the butter is manufactured. The low salted butter required on an average .2 c. c. more of the tenth normal alkali to neutralize ten grams of butter than did the butter with the higher salt content. This difference is not due to the greater amount of salt neutralizing the acid in the butter. The first effect of adding salt to butter is to eliminate buttermilk. When none or only a small amount of salt is added to the butter, it is reasonable to suppose that a corresponding smaller amount of the sour buttermilk will drain away. Buttermilk contains acid, and when not eliminated, it increases the acid content of butter. The extent to which this increase occurs is shown in the above table. The heavier salted butter is brought into a condition which causes the acid buttermilk to drain away more completely. This undoubtedly accounts for the lower acid content in the fresh highly salted butter.

The effect of salt on the keeping property of butter is also plainly shown in the greater amount of acid developed in the low salted butter. The experiments show that when the butter contained 6% of salt there was very little development of acid during the sixteen weeks, and it is safe to say, therefore, little deterioration of the butter. Unfortunately, butter containing this amount of salt is very gritty and too salty to the average consumer's sense of taste. Butter containing a normal amount of water will not dissolve more than 3% salt. This latter amount has a great preservative effect upon the butter, as is evidenced in above table.

The average increase in the acidity of low salted butter during the sixteen weeks is 4.7 c. c., while the average increase in the acidity of the highly salted butter is only 1.6 c. c., the former being about three times as great as the latter. The longer time the butter is kept the greater is this difference, which fact is shown in the graphic illustration. The

lines diverge quite uniformly from the beginning of the experiment.

The average difference in the acidity of the high and low salted butter when fresh is .2 c. c., and the average difference when six weeks old was 3.3 c. c. These results verify that salt is a preservative of butter.

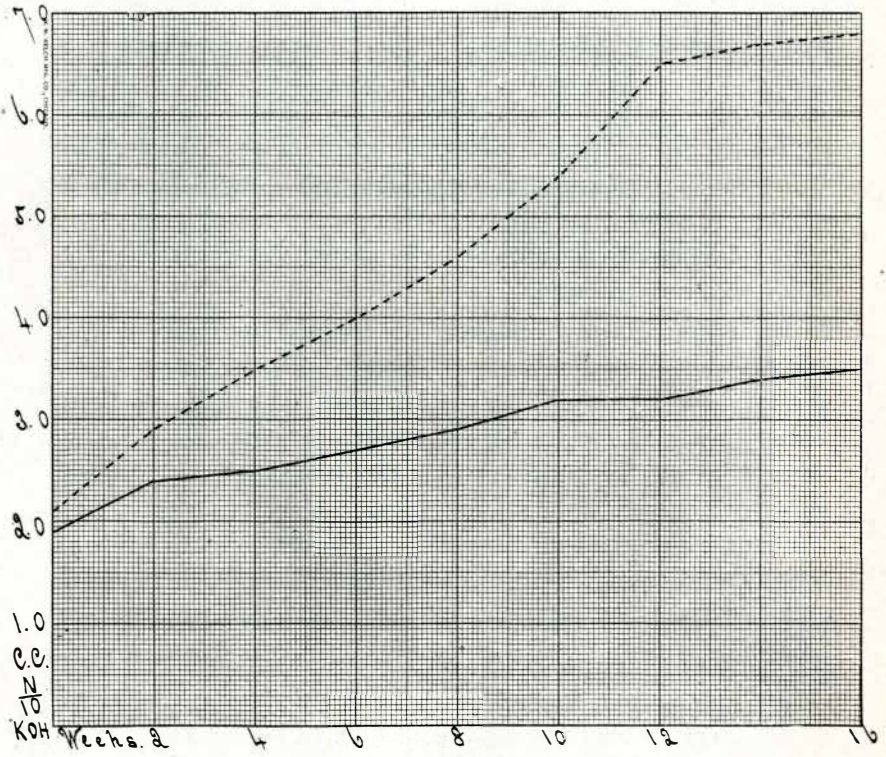

FIGURE III

Comparison of acidity of lightly and heavily salted butter graphically shown. The dotted line represents lightly salted butter, and the solid line the heavily salted butter.

RELATION OF FRESH AND RIPE CREAM TO ACIDITY IN BUTTER

In each of these experiments the cream from the college dairy herd was used. The morning milk was brought to the college creamery as soon as milked, and skimmed at once. The resulting cream was divided into two equal lots. To one lot a good starter equal to 10% of the cream was added. This cream was ripened and cooled in the usual way, and churned at various ages as shown in the table under remarks. The other lot of fresh sweet cream was cooled from one and one-half to five hours, then churned without the addition of any starter, under similar conditions as the other half.

In this connection it should be stated that this cooled fresh sweet cream did not churn as well as did the ripened cream. The butter from it when churned was softer and did not have the bright and clear color as did the butter from the ripened cream. Perhaps the sweet cream had not been cooled a sufficiently long time to permit the fat globules to become thoroughly cooled. The real fresh, sweet condition of the cream caused it to be viscous, due undoubtedly to the unchanged condition of the protein. The acid developed in the cream, at least in part, coagulates the casein, which aids in setting free the fat globules, and thereby facilitates churning.

TABLE IV

TABLE SHOWING COMPARISON OF ACIDITY OF SWEET AND RIPENED CREAM BUTTER

		C. c. n/10 Alkali to Neutralize 10 g. Butter									
Tub. No.	Cream	When Made	2 Weeks	4 Weeks	6 Weeks	8 Weeks	10 Weeks	12 Weeks	14 Weeks	16 Weeks	Remarks
95	Ripened	1.8	2.0	1.8	1.8	2.0	2.4	2.6	.....	.....	Cream 1 day old. Acidity 0.65%.
94	Sweet	1.4	1.8	1.6	1.8	2.0	2.2	2.4	.....	.....	Cream fresh. Acidity 0.15%.
40	Ripened	1.6	2.1	2.4	2.5	2.6	2.8	2.8	2.5	2.5	Cream 1 day old. Acidity 0.63%.
39	Sweet	0.9	1.5	1.9	2.0	2.4	2.8	2.9	3.0	3.6	Cream fresh. Acidity 0.14%.
42	Ripened	1.8	2.5	2.6	2.8	3.0	3.1	2.8	2.8	3.0	Cream 1 day old. Acidity 0.58%.
41	Sweet	1.1	1.5	1.7	2.2	2.4	3.3	3.8	3.9	4.2	Cream fresh. Acidity 0.14%.
44	Ripened	1.6	2.2	2.3	2.4	2.5	2.8	2.6	2.8	3.0	Cream 2 days old. Acidity 0.54%.
43	Sweet	1.1	1.4	1.9	2.0	2.1	2.2	2.3	2.0	2.4	Cream fresh. Acidity 0.14%.
48	Ripened	2.3	2.5	2.6	2.7	2.8	2.8	2.8	3.1	3.9	Cream 3 days old. Acidity 0.66%.
47	Sweet	1.1	1.6	1.8	1.9	2.1	2.1	2.1	2.4	2.4	Cream fresh. Acidity 0.15%.
50	Ripened	2.2	2.4	2.8	2.9	3.0	3.3	3.3	3.2	3.4	Cream 9 days old. Acidity 0.70%.
49	Sweet	1.2	1.5	1.8	2.0	2.5	2.6	2.1	2.5	2.5	Cream fresh. Acidity 0.14%.
52	Ripened	2.8	4.5	4.5	4.9	4.6	5.4	5.4	5.9	5.6	Cream 7 days old. Acidity 0.74%.
51	Sweet	1.1	1.6	2.0	2.0	2.2	2.4	2.7	2.6	2.7	Cream fresh. Acidity 0.13%.
54	Ripened	2.8	4.2	6.4	6.9	**6.8**	7.0	7.8	8.7	9.0	Cream 5 days old. Acidity 0.75%.
53	Sweet	1.3	1.8	1.9	2.0	**2.0**	2.4	2.4	2.8	2.8	Cream fresh. Acidity 0.14%.
Av'ge	Ripened cream ...	2.1	2.8	3.2	3.4	3.4	3.7	3.8	4.1	4.3	Cream 3½ days old. Acidity 0.65%.
Av'ge	Sweet cream	1.1	1.6	1.8	2.0	2.2	2.5	2.6	2.7	2.9	Cream fresh and sweet. Acidity 0.14%.

The fresh butter from the ripened cream required on an average 1 c. c. more alkali to neutralize the acid in the sample than did the butter made from the fresh sweet cream. This verifies what has already been mentioned in connection with the washing experiments, that the sour buttermilk of butter is responsible for the large portion of the acid when the butter is first made.

Contrary to expectations, the fresh sweet cream butter, on an average, did not develop acid and deteriorate more quickly than did the butter made from the ripened cream. The average results show that the butter made from the ripened cream, immediately after churning, contained 1 c. c. more acid than did the butter made from the sweet cream. At the end of the sixteen weeks the ripened cream butter contained 1.4 c. c. more acid than did the sweet cream butter. During the whole sixteen week period the acidity of the butter from the ripened cream increased 2.2 c. c., while the acidity of the butter from the sweet cream increased only 1.8 c. c.

It is interesting to note, that in the first three experiments in Table IV, the acidity of the butter, when sixteen weeks old, from the ripened cream not over one day old, is less than that of the sweet cream butter, even though it contained more acid than the sweet cream butter when made; while the butter from the sour cream more than one day old increased in acidity more rapidly than did the sweet cream butter.

These results indicate that butter from fresh and properly ripened cream not over one day old keeps better than does butter made from sweet cream. The butter fat from very fresh cream is apparently in a more stable condition than is the fat in the sour cream over one day old, and not so predisposed to decomposition. It indicates that butterfat, in the form of butter, keeps better than does butterfat in the form of cream, even though it be in properly ripened cream.

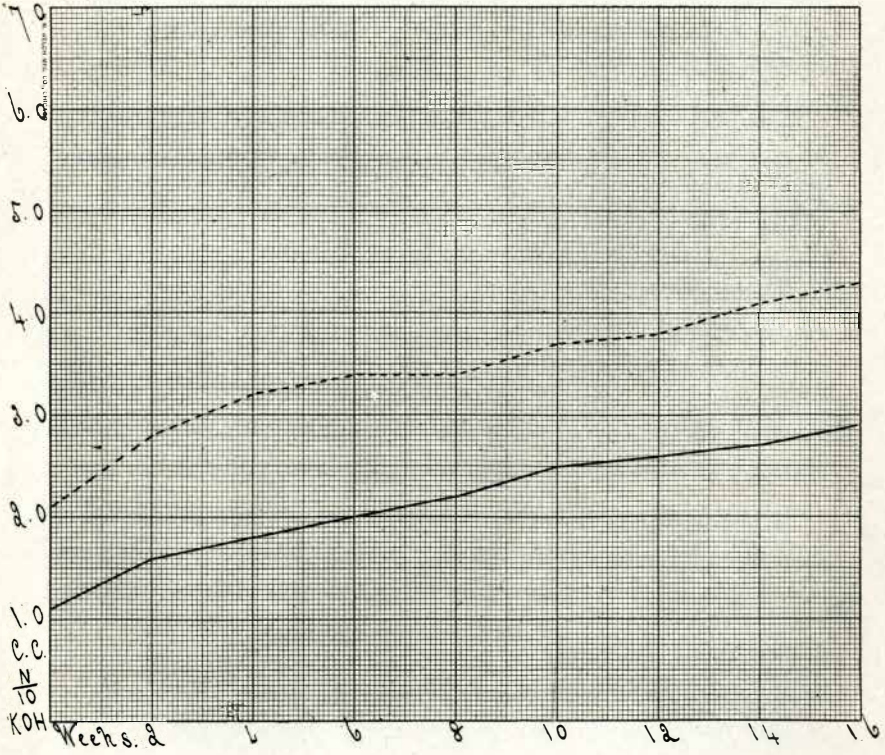

FIGURE IV

Comparison of acidity of sweet and ripened cream butter graphically shown. The dotted line represents butter from ripened cream, and the solid line represents butter from sweet cream.

EFFECT OF TEMPERATURE ON ACIDITY OF BUTTER

The conditions for carrying on this experiment were not very favorable. This experiment station did not have the necessary proper cooling facilities. The small creamery refrigerator was used in which to store the butter at the low temperature. The temperature in this place varied considerably, as it was necessary to open and close the door at intervals. The temperature varied between 50° F. and 60° F., being nearer 60° F. the greater part of the time during the day. The butter exposed to the high temperature was kept in the creamery factory room, where the temperature varied between 70° F. and 80° F., being nearer 80° F. the greater part of the day time. The data from the experiments on the effect of cold storage on the acidity of butter could not be completed in time for this report.

However, the results obtained clearly indicate that the butter exposed to the high temperature developed acid and deteriorated more quickly than that kept in the refrigerator. This verifies that which is well known, that high temperature unfavorably affects the keeping quality of butter.

TABLE V

TABLE SHOWING COMPARISON OF ACIDITY OF BUTTER HELD IN WARM ROOM AND CREAMERY REFRIGERATOR

Tub No.	Storage	C. c. n/10 Alkali to Neutralize 10 g. Butter						
		When Made	2 Weeks	4 Weeks	6 Weeks	8 Weeks	10 Weeks	12 Weeks
12	Warm	2.4	5.8	7.0	7.8	9.0	10.6	9.8
1	Cool	2.4	4.8	6.2	7.0	7.8	8.4	8.0
4	Warm	2.4	4.6	5.8	7.0	7.6	8.0	8.6
3	Cool	2.4	4.0	5.0	5.4	5.8	6.4	6.6
6	Warm	2.4	4.2	4.8	5.6	6.2	.....	7.2
5	Cool	2.4	4.2	4.8	5.2	5.8	.....	6.0
8	Warm	2.8	5.8	7.8	9.6	11.0	12.0	13.8
7	Cool	2.8	5.8	6.8	8.2	9.2	10.6	10.8
10	Warm	2.0	4.8	7.0	8.6	9.4	9.8	.....
9	Cool	2.0	4.0	5.0	5.8	6.6	7.2	.....
12	Warm	2.4	.....	.....	6.8	7.8	8.4	9.6
11	Cool	2.4	.....	.....	4.4	5.2	5.4	6.4
14	Warm	3.0	.....	.....	17.8	21.4	22.2	26.4
13	Cool	3.0	.....	.....	10.0	12.8	13.2	15.6
Av'ge	Warm storage ...	2.5	5.0	6.5	9.0	10.3	11.8	12.6
Av'ge	Cool storage	2.5	4.6	5.6	6.6	7.6	8.5	8.9

The difference in the acidity of the butter kept at different temperatures would have been still more marked if the temperature in the refrigerator could have been kept below 50° F. As it is, the difference is very outstanding.

The butter kept in the cool room gained 6.4 c. c. during the twelve weeks, while the butter kept in the warm room gained 10.0 c. c., a difference of 3.7 c. c.

The two lots of butter in each experiment were made from the same cream and taken out of the same churning. The difference in acidity is therefore caused only by the difference in temperature at which the samples were kept.

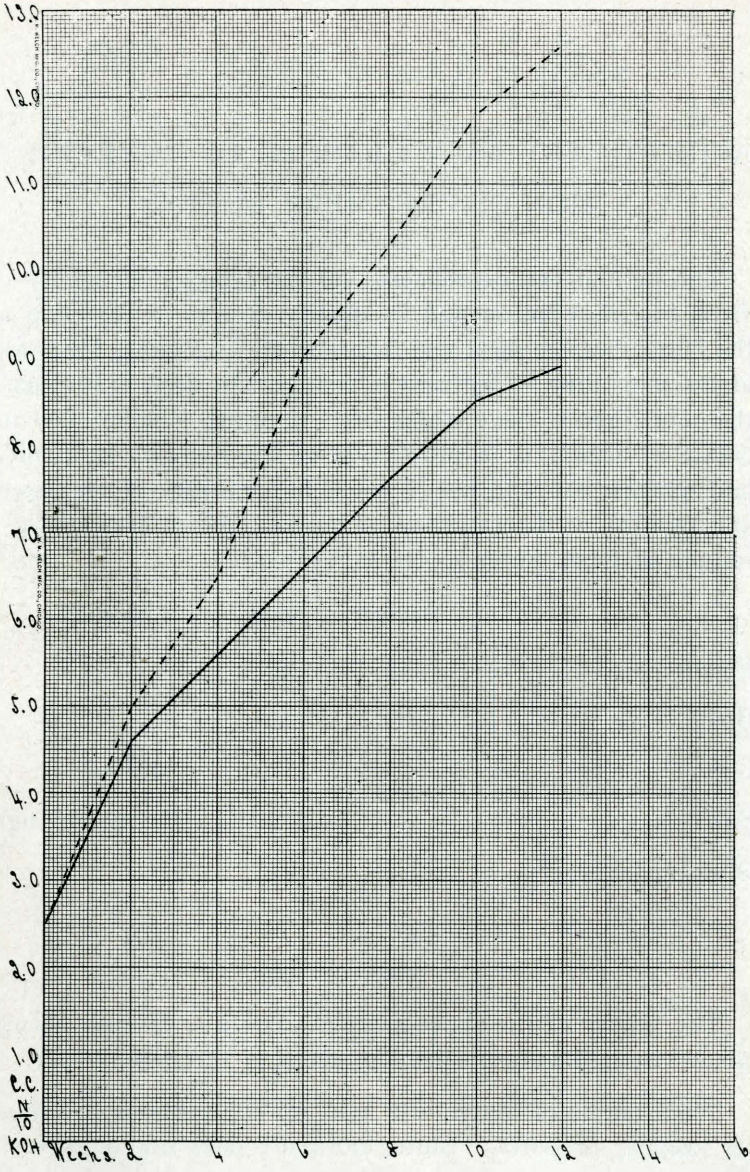

FIGURE V

Comparison of acidity of butter held in warm room and creamery refrigerator graphically shown. The dotted line represents the butter held at high temperature, and the solid line the butter held in creamery refrigerator.

ACIDITY TEST AS A MEASURE OF DETERIORATION OF CREAMERY BUTTER

Throughout the experiments on the relation of acidity of fresh creamery butter and its quality, it was noticed that as the butter became aged and deteriorated in quality, there was at the same time an increase in acidity. In these experiments the investigators have endeavored to study whether this increase in acidity is in proportion to the decrease in quality, and whether the acid test is not a fair measure of the extent and rapidity of deterioration of butter. As an illustration, a sample of fresh butter scores as follows:

	Perfect	Score	Remarks
Flavor	45	40	
Body	25	25	
Color	15	14	Mottled
Salt	10	9	Gritty and high
Style	5	5	
	100	93	

The acidity of the above sample was 1.2 c. c. tenth normal alkali required to neutralize ten grams of the above butter.

This sample of butter was held for the purpose of testing its keeping property. Butter normally does not improve in quality as it ages. The faults of the color and salt in the above sample of fresh butter could not possibly be measured by the acid test. A certain number of points have already been deducted on account of these defects. On keeping, these

faults are not intensified. If any change occurs it will be for the better, because a small additional part of the salt may go into solution. The mottled condition normally is not intensified either, especially if the butter before being judged has been kept long enough for the mottles to form, which at the most requires only a few days. The shade of color may change a trifle with age, but not to an injurious extent. If the butter is kept a very long time the body or texture may become a little weak, but normally this defect does not become sufficiently apparent until the butter is so poor in quality that it is not fit for the market and for consumption. The flavor of the above sample of fresh butter lacks five points of being perfect. As this butter becomes older, the desirable butter flavor disappears. In a short time the less agreeable flavors are substituted, and these undesirable flavors become more and more marked at the expense of the former characteristic delicious, clean butter flavor, due chiefly to decomposition products.

Then, in testing butter for extent and rapidity of deterioration, the flavor stands out as the one predominating quality to be closely observed. Since the developed "off" flavors are due principally to decomposition products, which are acid in character, or accompany the development of acid; and since all of the characteristics of butter except flavor do not materially change, it is reasonable to suppose that the acid test is a fair measure of deterioration of butter.

The important and most difficult point to determine in this connection is the acid factor corresponding to one point deterioration as scored by the butter judge. With a view of establishing such a factor and making further study of relation of acidity to keeping property of butter, the follwing experiemnts were carried out:

TABLE VI

TABLE SHOWING COMPARISON OF ACIDITY AND SCORE OF BUTTER

Tub No.	When Made		4 Weeks		8 Weeks		12 Weeks		16 Weeks	
	Acidity	Score	Acidity	Score	Acidity	Score	Acidity	Score	Acidity	Score
72	3.6	92	4.0	88	4.6	84	.....	.....	.....	.....
73	3.2	92	3.4	89	4.4	86	.....	.....	.....	.....
84	2.4	94	2.8	90	3.6	85	.....	.....	.....	.....
85	2.2	92	2.2	91	1.6	90	.....	.....	.....	.....
86	2.0	93	2.2	90	2.6	88	.....	.....	.....	.....
87	1.8	92	1.6	92	1.6	92	.....	.....	.....	.....
80	2.2	93	2.6	90	3.2	88	.....	.....	.....	.....
81	1.8	93	2.1	91	2.2	90	.....	.....	.....	.....
76	3.8	94	4.4	84	4.6	82	4.4	84	.....	.....
77	3.6	94	4.0	86	4.4	83	4.4	85	.....	.....
78	2.6	94	3.8	89	4.2	84	4.8	82	.....	.....
79	3.2	94	3.4	90	3.8	85	4.6	86	.....	.....
74	2.8	93	3.8	85	4.2	85	5.0	84	.....	.....
75	2.2	93	3.0	91	3.8	86	4.2	85	.....	.....
31	3.0	90	4.0	86	5.2	85	5.0	82	5.6	84
32	2.2	90	3.5	89	3.9	88	4.6	84	5.0	86
33	2.7	93	3.9	87	5.1	84	5.4	80	5.9	86
34	2.1	93	3.6	91	4.6	88	5.2	82	6.3	84
35	2.3	92	4.3	88	5.5	82	5.6	80	7.4	82
36	2.0	92	4.2	89	5.5	84	4.6	83	5.8	82
59	2.0	92	2.4	89	2.6	88	2.8	84	2.8	76
60	2.1	92	2.2	90	2.3	89	2.4	87	2.5	80
61	2.0	91	2.7	90	2.8	86	2.7	82	3.0	84
62	1.9	91	2.1	91	2.0	87	2.4	84	2.6	85
19	2.0	91	3.3	90	4.6	89	4.4	88	5.0	82
20	1.7	92	2.4	91	2.6	89	2.0	88	1.8	84
21	1.8	88	2.8	87	3.4	80	3.6	80	4.1	75
22	1.9	91	2.0	90	2.4	88	2.4	82	2.7	80
45	1.7	88	2.3	88	2.4	85	2.4	80	2.4	80
46	2.0	90	1.9	90	2.1	86	2.3	78	2.5	80
63	1.6	91	1.6	89	2.4	83	2.0	75	2.2	78
64	1.5	93	1.7	91	1.8	85	2.1	78	2.6	82
70	1.8	89	2.6	87	3.1	84	3.3	80	3.8	76
71	1.8	91	1.9	89	2.2	86	2.2	82	2.5	80
38	2.5	92	4.8	91	6.2	88	6.4	85	7.0	83
55	1.8	93	3.0	89	2.9	87	3.2	84	3.5	84
56	1.8	93	2.9	88	3.4	88	3.5	86	3.8	78
57	1.8	92	2.2	88	2.2	86	2.4	80	2.3	78
58	1.9	92	2.8	88	3.2	85	3.2	83	3.2	75
66	1.9	93	2.1	89	2.0	80	2.0	78	2.1	78
67	1.9	93	2.5	90	2.8	82	3.0	80	3.3	76
68	1.9	90	1.9	89	2.0	86	2.1	82	2.5	80
69	2.0	90	2.5	88	2.8	84	3.1	78	3.8	80
40	1.6	95	2.4	91	2.6	90	2.8	91	2.5	86
42	1.8	95	2.6	92	3.0	91	2.8	89	3.0	82
44	1.6	95	2.3	92	2.5	91	2.6	88	3.0	82
48	2.3	94	2.6	88	2.8	90	2.8	84	3.9	78
50	2.2	92	2.8	91	3.0	90	3.3	88	3.4	80
52	2.8	88	4.5	88	4.6	86	5.4	84	5.6	78
54	2.8	88	6.4	89	6.8	89	7.8	84	9.0	76
Av'ge	2.20	91.96	2.94	89.18	3.37	86.34	3.62	83.07	3.84	80.56

In this connection some difficulties have been encountered. First, it has been necessary to compare the acid test, which is

definite and exact, with the score placed upon it by a judge, and which at its best is elastic. To make the judging as exact as possible, the butter was scored by one person, and according to one standard, as nearly as one standard can be carried by a butter scorer.

Secondly, it is difficult to place a proper and uniform rating on old butter. Aged butter, and butter of low quality assume different intensities of off flavors which make it difficult for a judge to place the proper rating upon the butter.

Thirdly, a few samples actually decreased in acidity while kept, and the quality as measured by the judge also decreased. This behavior was an exception. Of the one hundred and twenty-five samples of butter scored and tested for acid during these investigations, only three reacted in this manner. One sample contained an excess of salt (6%), and the other two were made from pasteurized cream. Butter undergoing normal fermentation steadily increases in the acid content with age, when kept at a temperature above 50° F., and undoubtedly at considerable lower temperature than this. The few samples which decreased in acidity with decrease in quality must have been butter undergoing abnormal fermentations, or no fermentation at all.

During the first four weeks, the butter decreased on an average of 2.78 points in the score, and the acidity increased .74 c. c., which would equal .26 c. c. increase in acidity for one point decrease in score.

During the second period of four weeks the average decrease in the score was 2.84 points, and the increase in the acidity was .43 c. c., being .15 c. c. acidity increase for each point decrease in the score.

In the third four weeks period the butter decreased in quality on an average 3.27 points, and the acidity increased .25 c. c., which equals .08 c. c. acidity increase for each score decrease in quality.

During the fourth four weeks period the average decrease in score was 2.51 points, and the increase in acidity during the

same time was .22 c. c., being .09 c. c. of increase in acidity for each point of decrease in quality.

During the whole sixteen weeks period the butter was kept there was an average decrease in quality of the butter of 11.4 points, and an average increase in acidity of 1.64 c. c. This equals .144 c. c. increase in acidity to one point decrease in the score.

From the above detailed discussion it will be noticed that the butter decreased in score quite uniformly during each four weeks period, while the acidity varied somewhat. During the first four weeks period the average acid factor (.15 c. c.) for each point decrease in score is a trifle too low. This same condition was evidenced in a number of short period tests, the data from which are not included in the above table. It will also be noticed that this average factor is the same as that obtained in the second four weeks period of the test, while the factors obtained during the third and fourth four weeks period are considerably below the average.

While in some instances the acid test may not exactly measure the deterioration of the butter as it appeals to the senses of a judge, it does show that decomposition changes are taking place, and this latter is undesirable. Further than this, the acid test gives practically the same results in the hands of different men, while if the butter is scored according to the senses, there likely will be as many different scores as there are judges; even the same judge will place a diffreent score on the same butter when successively judged.

Considering the inaccuracy of the scoring, and the certainty of the acid test, the latter is the most satisfactory in measuring the keeping property of butter, and it is reasonably accurate to allow one point decrease in score for each .15 c. c. of increase in acidity by the ether-alcohol method. If under certain conditions there should be a change in any of the other characteristics of butter, proper explanation can be made of same in the form of remarks.

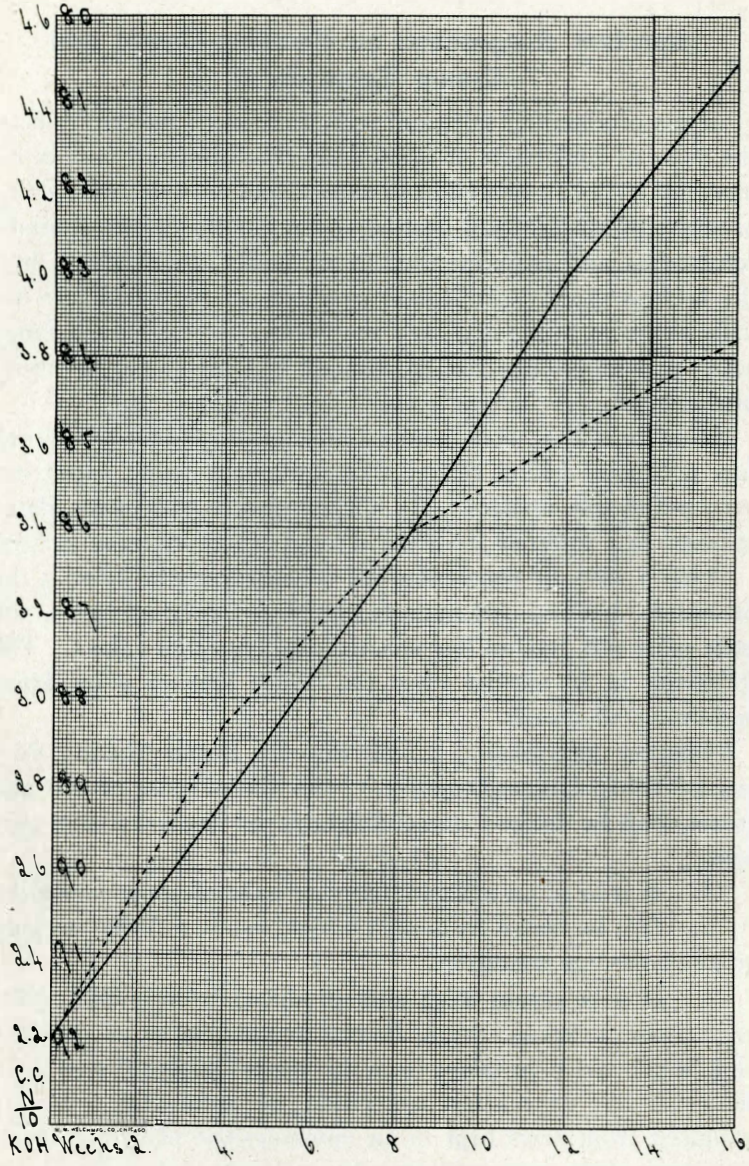

FIGURE VI

Comparison of acidity and score of butter graphically shown. The dotted line shows the acidity, and the solid line the score of the butter.

Important Suggestions on Handling Cream and Cream Separators

In the production, sale, and manufacture of dairy products, the mass of consumers of these daily necessities are vitally interested. They have a right to expect, and even demand, dairy products produced from healthy cows, handled under sanitary conditions, and manufactured from fresh raw material into the highest quality of finished products. The consumers are daily demonstrating that they are willing to pay even a fancy price, providing they can be assured that the quality is absolutely right.

Some of those who handle dairy products, especially the raw products, do not realize that milk, cream and butter are very perishable articles. As a consequence the whole dairy industry has suffered from the wrong-doings of these parties.

With a view of protecting the consumers, and helping the producers, buyers, and manufacturers of dairy products, the state of South Dakota has enacted adequate dairy laws. The following is an extract from the South Dakota dairy laws, pertaining to cream:

"Chapter 296, Section 5. (Cream for Butter Making Purposes—When Unmerchantable.) For the purpose of this act, cream shall be deemed unmerchantable for buttermaking purposes:

"1. If it be in an unclean, filthy or unwholesome condition.

"2. If it be cream from milk which was in a filthy, unclean or unwholesome condition.

"3. If it be cream from milk produced from animals having disease, sickness, ulcers, abscess or running sores, or from milk which has been taken from the animal within fifteen days before or five days after parturition; or from milk which is produced from cows kept in an unwholesome place, or which have been fed undesirable foods in a state of putrefaction or rottenness or of an unhealthful nature.

"4. If at any time it be contained in a filthy, unclean, unsanitary or unwashed vessel, can, pail or other container.

"5. If it be cream from milk which at any time has been

contained in a filthy, unclean, unsanitary or unwashed vessel, can, pail or other container.

"6. If it be cream which has been skimmed by a filthy, unclean, unsanitary or unwashed separator.

"7. If it contain less than 20 per cent butterfat.

"8. If it has an acidity exceeding 35 degrees, Mann's test.

"9. If it is above 70 degrees Fahrenheit in temperature.

"10. If it contains any artificial preservatives."

With the close observance and strict enforcement of the above law section, plus the moral law and good will of the dairy and creamery men, great improvements should be accomplished.

The following suggstions should be carefully considered:

HEALTHY AND CLEAN MILK

1. Only milk from healthy cows should be used. Milk from an inflamed udder or teat should be discarded. Do not use the milk until four days after freshening.

2. The barn in which the cows are kept should be clean, free from bad odors, and well ventilated. Feeding hay to cows should not be permitted just previous to milking, as it will cause much dust in the air. This dust contains multitudes of germs, which in turn contaminate the milk and the utensils. Neither should sweeping the floor or cleaning the stable be permitted just before milking, as this causes dust and bad odors to saturate the air. Milk and cream quickly absorb these undesirable taints. Open the barn doors during the day while the cows are out, so as to air out the barn well.

3. Wipe off the cows' udders and flanks with a damp cloth just before milking. This removes loose particles and dust which otherwise would fall into the pail. Dirt of all kinds always contains germs. It is the germs which cause milk, cream and dairy products to sour and deteriorate. Therefore, to keep germs out of milk and cream as much as possible, see that no dirt or dust enters the milk or utensils.

4. The milk should be strained at once after milking while still warm. If allowed to cool, the separator is likely to clog, and too much fat is lost in the skim milk, and the cold skim

milk when fed to the calves is likely to cause scours and indigestion. During the cold weather pour a little hot water into the separator just before separation. This warms the separator parts, thereby preventing clogging, and obtaining close skimming at once.

5. Strain the milk through a wire gauze strainer before separation. If flies bother, tie a piece of cheescloth over the top of the separator supply can.

6. All the utensils must be kept clean, dry and sweet. The cream can, milk pails and separator should be cleaned at once after usage to prevent decomposition of the milk parts. If allowed to stand without being cleaned, they soon become saturated with foul odors and undesirable germs. Wash them in warm water containing some washing powder or salsoda. Use a brush for cleaning rather than a cloth. Then rinse in scalding hot water and put them away to drain and dry outside on a slath bench, mouth down. The heat imparted to the tin will soon dry them. The fresh air will circulate through them and the bright sun will destroy the germs.

When tin utensils are treated in this way they do not rust. Rusty cream cans must never be used.

The parts of a cream separator must also be cleaned in the above manner, after each separation, and put in the sun to dry during the day. Assemble the parts just before separation. A dirty cream separator is one of the worst sources of spoiled cream. All the milk and cream passing through it are contaminated. By caring for the separator in this manner, the parts do not rust, the bowl is kept balanced better, more thorough skimming is obtained and the life of the separator is prolonged.

7. The separator should stand level on a solid foundation, in a clean, fresh, well lighted and well ventilated room.

SKIM RICH CREAM

8. Skim as rich cream as is consistent with its handling properties during the different seasons of the year, between 30 and 35 per cent fat during the cold weather, and between 35 and 40 per cent during the summer. Rich cream leaves

more skim milk to be fed on the farm, and less bulk to handle and transport. It keeps better than does thin cream, and the creamery men can make a better quality of butter from it.

The separator can be made to skim thicker cream by turning the cream screw towards the center of the bowl, by increasing the speed, and by lessening the inflow of milk to the bowl. The reverse will cause thinner cream. The per cent fat will vary some from day to day, due to the variation in one or more of these factors.

COOLING CREAM VERY ESSENTIAL

9. Cool the cream at once after separation. This can be done by placing the cream can in a tank of fresh, cold water. A good plan is to have the water used for the stock run through this milk cooler before it reaches the general stock water tank. This method cools the cream during all seasons, and in addition it prevents freezing during the winter. Do not put the can cover on tightly. A loose cover allows the animal odor to pass off, and at the same time prevents the dust from getting into the cream.

10. Never allow freshly skimmed warm cream to be mixed with the previously skimmed cold cream until the former has been well cooled. The warm cream causes the germs to develop, and these sour and spoil the cream.

OLD CREAM IS BAD

11. Deliver the sweet cream as often as possible, at least three times a week in the summer, and twice per week during the winter.

12. Wrap a heavy blanket around the can to keep the cream from freezing on the road to the creamery or cream station. During the summer and warm weather soak this blanket in cold water to keep the cream cold.

TO CREAM BUYERS

13. Creameries and cream stations must be kept in a clean, sanitary condition. Fresh cream and dairy products are human foods. The utensils, as well as room in which the cream is handled and kept, must therefore be sanitary and free from any foreign and obnoxious odors or taints.

14. The cream buyer should sample and test the cream in accordance with rules governing the operation of the Babcock test for butterfat. There is but one correct test. No cream buyer can lawfully over-read or under-read the Babcock test. To do either is manipulating the test, and is a gross violation of the state law, and further is a violation of business principles.

GENERAL

If the above simple points are observed, an improved quality of cream and butter will be obtained. A higher price will be secured from the consumers of the finished products, and therefore a higher price paid to the cream producers.

To obtain improved quality of products in the dairy industry, the producers of the raw material and manufacturers of the finished products must co-operate to a greater extent than perhaps is necessary in any other phase of agriculture. If the cream producers fail to do their part, the manufacturers fail. No one can manufacture good butter from old stale cream. If a good quality of fresh cream is produced, the dairy farmers have a right to expect and even demand the highest possible market price. By producing fresher and better cream, the quality of butter can be improved so that it will sell on the large butter markets in competition with butter from other states at a higher price, and the demand for it will be increased. By paying closer attention to quality, the profits from the dairy industry in the state of South Dakota can be increased by several hundred thousand dollars, and at the same time add to its favorable reputation.

The dairy farmers are at the foundation. They can do more for the improvement of the raw dairy products than any others, but to get maximum improvements, concerted co-operation between the producers and manufacturers is necessary.

Sanitary surroundings at places where cream is produced and handled, keeping the milk and cream cold, and getting the cream to the factory while it is fresh, are three essentials to keep in mind to improve present quality of finished dairy products.