THE USE OF SALT IN THE PRESERVATION OF HIGH FAT CREAM

By

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Introduction

Deterioration of cream due to microbiological causes is a problem that concerns the whole butter industry, but the problem is more acute in the southern states, which includes Oklahoma. Butter made in Oklahoma generally grades lower on the market than does butter from the northern states because of the deterioration of the cream before it reaches the butter plant.

In general, cream production in Oklahoma is secondary to other enterprises on the farm and facilities for cooling cream, such as mechanical refrigeration, are not generally available. Generally higher temperatures prevail in the southern states than in the northern states and the ground water temperature in Oklahoma ranges from 60° to 70° F. which makes it less useful for cooling cream than is the case in northern states where the temperature of the ground water is considerably lower.

If a method of preservation of cream could be perfected, a higher farm income to cream producers in Oklahoma would be possible from the sale of higher grade cream, and it would lessen the possibility of producing illegal butter according to current regulations of the Federal Food and Drug Administration.

The fact that salt has been found useful in improving the keeping quality of a number of foods, including butter and cheese, suggests the possibility of its use on the preservation of cream on the farm. The fact that salt is dissolved only in the serum of cream suggests that the production and marketing of high fat cream might be practical because the weight of the cream marketed would be reduced, more skim milk would be left on the farm for

animal feeding, and less salt would be required for the preserving of the cream than would be the case with lower fat cream.

High fat salted cream might have another practical use in the continuous butter making process that is now being studied on a commercial basis because one of the first steps involved in this operation is the separation of cream to a high fat content.

REVIEW OF LITERATURE

The preservative effect of salt in butter has been observed for many years. In 1919, Washburn and Dahlberg (22) found that under ordinary conditions the increase in keeping quality of butter due to the antiseptic property of the salt more than offsets the deterioration caused by the salt itself.

Spitzer and Parfitt (16) tabulated salt concentrations and their relationship to the growth of microorganisms in butter. They found that salt inhibited the growth of bacteria since the number of butters showing increases in bacterial growth during storage decreased as the salt concentrations in the brine increased.

Macy (12) observed that there is a marked difference in growth of bacteria in salted and unsalted butter. He found that 70 to 80 percent of the unsalted samples examined increased in count during storage while 60 to 75 percent of the salted samples decreased in count. He also observed that the more highly salted samples showed no greater tendency to decrease in bacterial count than those of lower salt content. This may be explained by the fact that the majority of organisms which are checked by salt are inhibited even by relatively small amounts of it.

Williams (1) of the U. S. Department of Agriculture obtained a patent in 1939 on a process for preserving cream with salt and dedicated it to the free use of the American people. His process involved the addition of 7% salt, which would keep the cream fresh for seven days at room temperature. In his patent he stated that the objectives of his process were to inhibit growth

of bacteria, to inhibit the development of off-flavors, to make possible the storage of sweet cream without refrigeration, and to make savings in transportation costs by the reduction in number of cream collections. This salted cream could be used for the manufacture of sweet cream butter or, if reseparated, it could be used as a substitute for sweet market cream.

Thompson and Macy (21) found that 7.5% to 10% salt added to cream and the cream stored for 10 days at 70° F. or lower was effective in retarding bacterial growth and acid development. Staleness was the only off-flavor found to be produced. In the same experiment control lots, to which no salt had been added, developed several off-flavors and became unlawful cream before the end of the storage period.

Castell and Garrard (3) reported that oxidizing bacteria, believed to be responsible for cheesy and rancid flavors, were almost completely inhibited in cream which contained 7% salt and which was stored for eight days at 60° F. to 77° F. Butter was manufactured from this salted cream after eight days of storage at 60° F. to 77° F. and it was scored superior to butter made from unsalted cream which was stored for eight days at 50° F.

Caulfield, Nelson, and Martin (4) working with 30% cream found that the amount of salt which is necessary to preserve freshness in cream is determined by the time and temperature of storage. They found that the salt must be added to the fresh cream at separation if it is to be effective. If added at the time of separation they found that 10% salt on a serum basis was satisfactory. Also they found that further deterioration of

cream which had been held three days at 70° F. could not be checked by the addition of even 13% salt.

Unpublished data obtained at the Oklahoma Agricultural Experiment Station (13) on the use of salt in preserving cream indicated that a storage or stale flavor developed in cream that had a high salt content. This storage or stale flavor somewhat resembled the flavor commonly referred to as oxidized. Brown and Thurston (2) cite many references in their review of oxidized flavors in milk and milk products and their causes. Leeder and Herreid (11) concluded that ascorbic acid was an important factor in the development of oxidized flavor because the disappearance of the ascorbic acid seemed to be associated with the development of the oxidized flavor. Weinstein, Loewenstein, and Olson (23) proposed a method for adding ascorbic acid to milk to prevent the development of oxidized flavor. This suggests the use of ascorbic acid in preventing storage flavor from developing in salted cream.

Caulfield, Nelson, and Martin (4) found that the Babcock test for fat in salted cream was unsatisfactory because of the foaming action caused by the reaction of H_2SO_4 and NaCl. When the acid was added HCl gas was given off and often the sample foamed out the top of the test bottle. Also a grayish-brown deposit was sometimes formed at the base of the fat column making the readings inaccurate. They proposed a modified method of the Babcock test that requires several intervals of waiting between additions of acid.

Hansen and Snyder (6) found that it is extremely dangerous to test salted cream for fat with the conventional Babcock method

because the sulphuric acid reacts with the salt to produce HCl gas which is an irritant that acts on the upper respiratory tract. They stated that 10 ppm HCl is the maximum concentration allowable for prolonged exposure, 50 ppm is the maximum concentration allowable for one-half to one hour exposure and 1,000 to 2,000 ppm is dangerous for even a short exposure. The amount of HCl gas given off from a single fat test on cream with a salt concentration of 10% is 12.2 ppm in a space of 1,000 cubic feet which is above the maximum allowable for prolonged exposure. Sets of 12 to 24 samples in any of the concentrations tested released HCl gas above the maximum allowable for even short exposure. The slow rate of diffusion causes high concentrations of gas in the immediate vicinity of the operator. They suggested the use of a vent fan in all laboratories when using this test.

A number of modifications of the Babcock test have been recommended for various dairy products, particularly ice cream. Some of these tests are: the Pennsylvania method (20), the Nebraska method (5), the California method (10), the Illinois or Garrett-Overman method (14), the Minnesota method (15), and the glacial acetic-sulphuric acid method (9). No reference could be found of any of these tests having been used on salted cream.

Hillig (7) working with unsalted cream, did considerable work on the progressive decomposition of the cream. He observed the relationship of temperature and length of the storage period upon the rate of deterioration. He found that the butterfat may break down and form water-insoluble fatty acids (hereafter abbreviated as WIA) which in some cases are found in

quantities far in excess of those normally present in sweet cream. The mean molecular weight of the WIA so separated indicates that they consist principally of oleic and palmitic acids produced by the partial biological hydrolysis of milk fat.

Hillig (8) proposed a method of analysis for all the WIA found in butter and cream, including those that occur in the form of a salt. This is a rather long test involving special techniques and apparatus not found in ordinary commercial butter plants.

METHODS

A. Separation of High Fat Cream

Ten gallons of milk were obtained from the milking herd at Oklahoma A & M College or from a local cheese plant for the separation of high fat cream. A small electrically driven separator of approximately 300 pounds per hour capacity was used in this experiment. The milk was forewarmed to 95° F. and poured into the separator supply tank. When the separator reached maximum speed, the milk inflow valve was opened fully. When the milk had been separated the cream was poured back into the tank and reseparated. Approximately two quarts of skim milk were removed from the cream. This skim milk was caught in a separate container and was used to flush the heavy cream from the separator.

B. Calculation of the Amount of Salt to Add

The cream used in this experiment was tested by the Babcock method. The amount of salt to add was calculated by multiplying the weight of the cream by the percent serum to determine the weight of the serum. The weight of the serum was multiplied by the percent salt desired in the serum to get the weight of salt necessary to add to the cream.

C. Determination of Cream Acidity

A nine gram sample of cream was weighed into a white custard cup. An equal amount of hot distilled water was added to the sample and mixed thoroughly by stirring with a glass rod. Three to five drops of 1% phenolphthalien were added, and the sample was titrated to a permanent pink color with N/10 NaOH from a

Kimble automatic acidity tester. The results were expressed as percent lactic acid.

D. Pasteurization and Cooling of Cream Samples

The cream samples, contained in eight ounce glass sample jars, fitted with aluminum screw caps, were pasteurized by immersing the sample jars in a water bath to a depth where the water in the bath was above the level of the cream in the jars. The water bath was equipped with a steam coil, a cold water line, and an overflow pipe. The water was heated by the steam coil until the temperature of the cream in the jars reached 145° F.. Cold water was then added until the water reached a temperature of 145° F.. This temperature was maintained for 30 minutes. The samples were stirred frequently during pasteurization to insure even heating and to prevent oiling off. After 30 minutes at the pasteurization temperature, the cream samples were cooled to 70° - 80° F. by running cold water into the bath. The samples were stirred frequently and were kept in this flowing water about ten minutes. They were then tempered to 50° F. by placing in a cold water bath for about 4 hours.

E. Churning Procedure

The tempered cream samples were churned by the following procedure: the cream sample was poured into a malt mixer and whipped at high speed until all the cream was thoroughly whipped, then just enough cold water was added to keep the sample agitating freely. This agitation was continued until butter granules the size of wheat grains were formed. The cup was then removed from the mixer and the buttermilk drained. Iced water was added

to cover the butter granules and the mixture was then agitated for about 30 seconds. The water was drained and the butter sample wrapped in wet parchment and squeezed with the hands to force out the excess water. The sample was then wrapped in dry parchment and stored at 40° F. or lower.

EXPERIMENTAL

A. Separation of High Fat Cream

One might assume that the first step in the marketing of high fat salted cream would be a practical and efficient method of producing high fat cream with the small separators now in use on many farms. With this idea in mind, methods for separation of high fat cream were investigated.

In a few preliminary trials it was found that by adjusting the cream screw the fat content of the cream could be increased considerably but above a certain limit the fat content of the skim milk increased to the extent that this method appeared impractical.

1. The Influence of Successive Separations on the Fat Content of Cream and of Skim Milk.

Another method that involved successive separation of cream was investigated. In this experiment a small electrically driven separator with a capacity of approximately 300 pounds per hour was used. For this study five gallons of whole milk were preheated to 95° F. and then poured into the separator supply tank. When the separator reached maximum speed the milk inflow valve was opened fully. After all the milk had been separated, about one quart of the skim milk was used to flush the separator. Samples were taken for fat tests of both the cream and the skim milk. The cream was then poured back into the supply tank of the separator and reseparated. Approximately one quart of skim was removed from the cream. This skim milk was caught in a container and was used to flush the heavy cream from the separator. The skim milk obtained by the first and second separations were

mixed and samples were taken for fat tests of the mixed skim milk and of the cream.

The cream obtained by the second separation was returned to the separator supply tank and was again reseparated. The small amount of skim that was removed from the cream was used to flush the heavy cream from the separator. This skim was then mixed with the skim milk from the first and second separations. Samples were then taken for fat tests of the cream and of the mixed skim milk. Fat tests were made on the cream and on the skim milk samples by the Babcock method.

The influence of successive separations on the fat content of cream and on the skim milk is shown in table 1.

The average fat tests of the cream and skim milk obtained by the methods of separation used in this study were: single separation, cream 43.6%, skim milk .027%; second separation, cream 61.9%, skim milk .035%; third separation, cream 68.2%, skim milk .10%.

The second separation procedure produced cream with fat tests that averaged 18.3% higher than the cream obtained by single separation. The skim milk test averaged .008% higher after the skim milk of this second separation was mixed with the skim milk obtained from the first separation.

The triple separation procedure produced cream with fat tests that averaged 24.6% higher than the cream obtained by single separation and 6.3% higher than the cream obtained by the second separation. The test on the mixed skim milk, obtained by the first, second, and third separations was .073% higher than the

Table 1

THE INFLUENCE OF SUCCESSIVE SEPARATIONS ON THE FAT CONTENT OF CREAM

Trial Number	First Separation		Second Separation		Third Separation	
	Butterfat Test					
	Cream %	Skim %	Cream %	Skim %	Cream %	Skim %
1	38	.02	60	.03	67	.09
2	38	.02	58	.03	60	.16
3	36	.02	62	.025	74	.08
4	39	.02	62	.025	70	.07
5	38	.02	60	.03	70	.10
6	42	.02	60	.03		
7	43.5	.03	60.5	.05		
8	44	.032	62	.037		
9	44	.025	62.5	.035		
10	43	.035	61.5	.037		
12	50	.037	63	.035		
13	46	.03	64	.032		
14	44	.02	62	.03		
15	44	.05	59	.045		
16	42	.025	61	.035		
17	41	.02	60	.03		
18	56	.05	70	.055		
19	57	.06	67	.08		
AVERAGE	43.6	.027	61.9	.035	68.2	.10

skim milk obtained by the first separation and .065% higher than the mixed skim of the first and second separations.

Trials 12, 18, and 19 show very high fat tests for the skim milk on both the single and double separation. The data also shows high fat tests on the cream from the single separation on these same trials which indicates that as the fat content of cream is increased, by adjusting the cream screw, above a certain limit the separation becomes inefficient because of the increase in amount of fat lost in the skim milk.

According to the data presented, triple separation of cream is not a practical procedure for obtaining high fat cream because of the high fat losses in the skim milk. Also the fat content of the cream obtained by triple separation is not appreciably increased over the fat content of the cream obtained by double separation. The double separation procedure produced high fat cream with only a slight increase in the fat content of the skim milk as compared with the fat content of the skim milk of the first separation. This double separation procedure appears to be the most practical and efficient method studied for the production of high fat cream.

2. The Influence of Reduced Milk Inflow to the Separator upon the Fat Content of Cream and of Skim Milk.

In another series the rate of inflow of milk to the separator was reduced and the effect of this reduction on the fat content of the cream and skim milk obtained was observed.

For this experiment ten gallons of milk were forewarmed to 95° F. and divided into two lots. One lot was separated with the milk inflow valve opened fully. Fat tests were made on the cream

and on the skim milk by the Babcock method. The second lot was separated with the milk inflow valve reduced to one-half. Fat tests were made on the cream and on the skim milk by the Babcock method.

The influence of reduced milk inflow to the separator upon the fat content of the cream and of the skim milk is shown in table 2.

The data indicate that if the milk inflow to the separator is reduced one-half the fat content of the cream is increased. On ten trials, with the inflow valve opened fully, the cream obtained averaged 40.3% fat and the skim contained .022%. The average fat test on ten samples obtained with the milk inflow reduced one-half was 53.2% for cream and .032% for the skim milk. This data shows the fat content of cream increased 12.9% by reducing the milk inflow one-half. The test on the skim milk increased only .01%.

On the basis of the amount of fat lost in the skim milk the reduced inflow method appears efficient for the production of high fat cream, but it is impractical because it requires considerably more time for separation than does the double separation method that is reported in Section 1 of this study.

Table 2

THE INFLUENCE OF REDUCED MILK INFLOW TO THE SEPARATOR UPON THE FAT CONTENT OF THE CREAM AND OF THE SKIM MILK

Trial	Full Inflow		One-Half Inflow	
Number	Butterfat Test			
	Cream %	Skim %	Cream %	Skim %
1	38	.02	45	.025
2	38	.03	46	.025
3	36	.02	59	.03
4	39	.02	59	.025
5	46	.032	56	.035
6	47	.03	58	.07
7	42	.015	62	.03
8	42	.02	57	.03
9	38	.02	45.5	.025
10	37	.02	45	.027
AVERAGE	40.3	.022	53.2	.032

B. Determination of Fat in Salted Cream

Since several investigators have reported that the conventional Babcock method is impractical for use on salted cream because of the inaccuracies that may result from a foaming action caused by the evolution of HCl gas and because of the health hazard involved, an effort was made to find a satisfactory method for the determination of fat in salted cream. Several modifications of the Babcock method have been proposed for use on other dairy products. These tests may be classified as acid or alkaline type tests. In the acid type test the sulphuric acid is diluted with some weak acid or other chemical to weaken the strength of the sulphuric acid. In the alkaline type tests an organic solvent or combination of organic solvents is used in conjunction with alkaline reagents.

In a few preliminary trials in this study some of these modified methods were used. The original Babcock method was found to be unsatisfactory for use on salted cream because of a foaming action which was caused by the reaction of sulphuric acid on the salt contained in the cream. This often caused the sample to boil, thus forcing some of the contents out of the test bottle. The HCl gas given off from the reaction of the sulphuric acid on the salt was irritating to the eyes, nose, and throat and is poisonous if inhaled in sufficient quantity.

A modified Babcock test (4) that involved the addition of the H_2SO_4 in several portions with an interval of waiting between each addition was tried. It was found to be more time consuming than the conventional Babcock test because of the periods of

waiting. This method eliminated inaccuracies due to foaming but did not reduce the amount of HCl gas produced. Also a curd-like deposit was often formed at the base of the fat column, making accurate readings impossible.

The Nebraska method (5), which uses sulphuric acid diluted with ethyl alcohol, was found to be unsatisfactory because of a foaming action caused by the evolution of HCl gas. The glacial acetic-sulphuric acid method (9) was unsatisfactory for this same reason.

The California method (10) was unsatisfactory because when the red reader was added it diffused throughout the fat column. The diffusion added to the volume of the fat column instead of eliminating the meniscus and made accurate reading impossible. This action is probably caused by the solvent properties of ethyl and petroleum ethers which are used as part of the reagents in this test.

Several other tests appeared to give promising results and were selected for further study. These tests were: the old Minnesota, the new Minnesota, the Garrett-Overman, the Pennsylvania, and the Mojonnier. In this study twenty-four tests were made with each of the old Minnesota and the new Minnesota methods. Sixteen tests were made with each of the Garrett-Overman and Pennsylvania methods. Duplicate tests were made on the cream with the Mojonnier method.

The calculated Babcock fat test was determined by testing a known amount of unsalted cream by the Babcock method. Salt was then added at the rate of 10% of the weight of the serum and the sample stirred to obtain uniform distribution of the salt. The weight of the salt was added to the weight of the cream and the

total weight was divided into the weight of the fat and the result was multiplied by 100 to give the calculated Babcock test. This method of calculation can best be expressed by the following formula:

$$\frac{\text{Weight of fat in cream}}{\text{Weight of cream + weight of salt}} \times 100 = \text{Calculated Babcock test.}$$

The Babcock test on the unsalted cream in this particular lot averaged 45.8% and the calculated Babcock test of this cream after salting was 43.5%. The duplicates of the Mojonnier test on the salted cream averaged 43.15% which was 0.35% less than the calculated Babcock test.

The fat tests obtained by the old Minnesota, the new Minnesota, the Garrett-Overman, and the Pennsylvania methods on a lot of salted cream in comparison with the fat tests obtained by the calculated Babcock and Mojonnier method are shown in table 3.

The data indicates that the fat tests obtained by the old (or Petrohl) Minnesota method (15) on the same lot of salted cream ranges from 45% to 46.5% and were consistently higher than either the calculated Babcock test or the Mojonnier test. The tests varied from 1.5% to 3.0% higher than the calculated Babcock test and averaged 2.38% higher. They varied from 1.85% to 3.35% higher than the Mojonnier test and averaged 2.73% higher. There was no boiling action and the fat columns were clear, uniform, distinct, and easy to read. However the test is of little value because it gives inaccurate readings.

The results in table 3 indicate that the new Minnesota method* (15) on the same lot of salted cream gave tests that ranged from 43% to 44% and varied only slightly from either the calculated

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* See Appendix

Table 3

FAT PERCENTAGES OBTAINED BY VARIOUS METHODS ON THE SAME LOT OF SALTED CREAM COMPARED WITH THE CALCULATED BABCOCK AND THE MOJONNIER TESTS

	Old Minnesota			New Minnesota			Garrett-Overman			Pennsylvania		
		Variation from			Variation from			Variation from			Variation from	
Trial	Fat %	Calculated Babcock (43.5)	Mojonnier (43.15)	Fat %	Calculated Babcock (43.5)	Mojonnier (43.15)	Fat %	Calculated Babcock (43.5)	Mojonnier (43.15)	Fat %	Calculated Babcock (43.5)	Mojonnier (43.15)
1	45.5	2.0	2.35	43.5	0	0.35	46.0	2.5	2.85	45.0	1.5	1.85
2	46.0	2.5	2.85	43.5	0	0.35	46	2.5	2.85	44.7	1.2	1.55
3	45.0	1.5	1.85	43.5	0	0.35	46.0	2.5	2.85	44.5	1.0	1.35
4	45.5	2.0	2.35	43.5	0	0.35	45.5	2.0	2.35	45.0	1.5	1.85
5	45.75	2.25	2.60	43.5	0	0.35	45.75	2.25	2.10	44.5	1.0	1.35
6	46.0	2.5	2.85	44.0	0.5	0.85	46.0	2.5	2.85	44.5	1.0	1.35
7	46.0	2.5	2.85	43.5	0	0.35	46.5	3.0	3.35	44.5	1.0	1.35
8	45.75	2.25	2.60	43.5	0	0.35	47.0	3.5	3.85	44.7	1.2	1.55
9	45.75	2.25	2.60	43.25	-0.25	0.10	46.0	2.5	2.85	44.2	0.7	1.05
10	45.0	1.5	1.85	43.5	0	0.35	46.0	2.5	2.85	45.0	1.5	1.85
11	46.0	2.5	2.85	43.0	-0.5	-0.15	46.0	2.5	2.85	45.0	1.5	1.85
12	45.5	2.0	2.35	43.5	0	0.35	46.5	3.0	3.35	44.5	1.0	1.35
13	46.0	2.5	2.85	43.0	-0.5	-0.15	45.75	2.25	2.60	44.5	1.0	1.35
14	46.5	3.0	3.35	43.0	-0.5	-0.15	46.5	3.0	3.35	44.7	1.2	1.55
15	46.5	3.0	3.35	43.0	-0.5	-0.15	46.5	3.0	3.35	44.5	1.0	1.35
16	45.5	2.0	2.35	43.5	0	0.35	46.0	2.5	2.85	45.0	1.5	1.85
17	46.0	2.5	2.85	43.0	-0.5	-0.15						
18	46.0	2.5	2.85	43.0	-0.5	-0.15						
19	46.0	2.5	2.85	43.0	-0.5	-0.15						
20	46.0	2.5	2.85	43.0	-0.5	-0.15						
21	46.5	3.0	3.35	43.0	-0.5	-0.15						
22	46.5	3.0	3.35	43.0	-0.5	-0.15						
23	46.0	2.5	2.85	43.5	0	0.35						
24	46.0	2.5	2.85	43.0	-0.5	-0.15						
Avg.	45.88	2.38	3.73	43.8	-0.21	0.13	46.12	2.62	2.97	44.62	1.17	1.52

Babcock test or the Mojonnier test. The tests varied from 0.5% less to 0.5% higher than the calculated Babcock test and averaged 0.21% less. They varied from 0.15% less to 0.85% higher than the Mojonnier test and averaged 0.35% higher. Of the 24 samples tested by this method 11 samples gave the same test as that of the calculated Babcock test. There was no boiling and the fat columns were clear, uniform, distinct, and easy to read. The new Minnesota appears to be distinctly superior to the old Minnesota because there was less variation from the calculated Babcock test and the Mojonnier test. Further examination will show that this, the new Minnesota method, appeared to be the best of the four methods shown in this table.

The results in table 3 indicate that the tests obtained by the Illinois or Garrett-Overman method (14) gave tests that ranged from 45.75% to 47% which were higher than either the calculated Babcock test or the Mojonnier test. The tests varied from 2.25% higher to 3.5% higher than the calculated Babcock test and averaged 2.62% higher. They varied from 2.60% higher to 3.85% higher than the Mojonnier test and averaged 2.97% higher. There was no boiling and the fat columns were fairly clear and uniform, but there was a slight cloudiness at the base of the fat column which made reading difficult. This method was unsatisfactory because the results obtained were much higher than either the calculated Babcock test or the Mojonnier method.

The tests obtained by the Pennsylvania method (20), as shown in table 3, ranged from 44.2% to 45% and were consistently higher than either the calculated Babcock test or the Mojonnier test.

The tests varied from 0.7% to 1.5% higher than the calculated fat content and averaged 1.17% higher. They varied from 1.05% higher to 1.8% higher than the Mojonnier test and averaged 1.52% higher. The fat columns were cloudy and difficult to read. There was no boiling when the diluted sulphuric acid was added, and apparently no HCl gas was given off. This method was unsatisfactory because the results were higher than the calculated Babcock test or the Mojonnier test. More time is required for this test than is required for either of the Minnesota methods.

Of the four methods used in this experiment, the results of which are expressed in table 3, the new Minnesota method was found to be the most satisfactory test for fat in salted cream. There was no boiling reaction and no harmful gas was given off. Also the Minnesota reagent, unlike sulphuric acid, is not harmful to the skin or clothes. The fat columns were uniform, clear, distinct, and easy to read and the results obtained by this method varied the least from the calculated Babcock test and the Mojonnier method.

C. Effect of Added Salt on the Deterioration of High Fat Cream

Since several investigators have reported that salt can be used for improving the keeping quality of cream and because the continuous butter making processes now being studied on a commercial basis will probably create a market for high fat cream, it may be practical to produce, on the farms, high fat cream preserved with salt. Since this particular problem has not been studied, an experiment to determine the effect of salt on the deterioration of high fat cream was undertaken.

In this study five trials were made. In three of the trials cheese milk was used as a source for high fat cream and in the other two trials milk from the milking herd of Oklahoma A & M College was used. For each trial the high fat cream was obtained by double separation of twenty gallons of milk. The cream was divided into seven lots weighing 675 g. each. One lot served as a control and no salt was added. Salt was added to the other lots to give concentrations in the serum of 4%, 6%, 8%, 10%, 12%, and 14%. The samples were stirred frequently for a period of about thirty minutes to insure uniform distribution of the salt. Three 200 g. samples of cream from each lot were weighed into eight ounce glass sample jars fitted with aluminum screw caps and six samples of nine grams each were weighed into test tubes. The test tubes were plugged with cotton. All the samples were then stored at room temperature (about 80° F.).

One nine gram sample was removed each day except Sunday and the acidity determined by pouring the cream into a white custard cup, rinsing the test tube with about 9 ml. of hot distilled

water from a wash bottle and titrating the cream plus the rinsings with N/10 NaOH, using three drops of 1% phenolphthlaien as the indicator.

After three, five, and seven days storage at 80° F. one sample of each of the seven lots, containing the various concentrations of salt, was pasteurized, cooled, and churned.

The salt content in most of this cream was so high that it was impossible to detect accurately the deterioration that might have occurred. Accordingly it was necessary to churn the cream and score the butter. Nearly all the salt was removed in the buttermilk and wash water, therefore the butter obtained was low in salt content.

Several samples of the butter made from the salted cream were tested for salt content and it was found that these samples of butter generally contained 0.6% to 0.8% salt and no sample tested contained as much as 1% salt. It should be noted that no additional salt was added to the butter after churning.

The influence of various concentrations of salt on the development of acidity and the deterioration of flavor in high fat, raw cream held at room temperature (about 80° F.) for three, five, and seven days is shown in table 4.

1. Rate and Extent of Acidity Development

The data show that the salt has a very pronounced effect on the development of acidity and of flavor defects in high fat cream. After seven days storage the average acidity increase in the five trials was approximately 0.35% over the initial acidity. In the first three trials, in which cheese milk was used as

TABLE 4

THE INFLUENCE OF VARIOUS CONCENTRATIONS OF SALT ON THE DEVELOPMENT OF ACIDITY AND THE DETERIORATION OF FLAVOR IN HIGH FAT CREAM HELD AT ROOM TEMPERATURE (80° F.)

TRIAL I

(Cream from Cheese Milk. Test 62%; Acidity .07%; Score on Butter from Fresh Cream 37.5)

Percent NaCl	1 Day Acidity	2 Day Acidity	3 Day Acidity	3 Day Butter Flavor Score	3 Day Butter Flavor Criticism	4 Day Acidity	5 Day Acidity	5 Day Butter Flavor Score	5 Day Butter Flavor Criticism	6 Day Acidity	7 Day Acidity	7 Day Butter Flavor Score	7 Day Butter Flavor Criticism
0	.315	.350	.435	35	Malty Stale	.420	.430	35	Coarse Malty Stale	—	.450	34	Cheesy Old Cream
4	.135	.265	.270	36	Coarse Sl. Oily	.300	.320	36.5	Coarse	—	.315	35.5	High Acid
6	.120	.170	.205	37.5	Coarse Sl.Stale	.240	.240	37	Coarse	—	.245	36-	Stale Cream
8	.100	.110	.100	37.5	Sl. Coarse	.110	.160	37	Sl. Coarse	—	.160	36.5	Coarse
10	.080	.105	.100	37	Sl. Coarse	.105	.105	37	Sl. Coarse	—	.105	37	Sl. Coarse
12	.100	.100	.100	37	Sl. Storage	.100	.100	37-	Coarse	—	.105	36-	Sl. Oiliness
14	.070	.095	.080	37	Sl. Storage	.085	.085	36	Oily	—	.090	36.5	Coarse

TRIAL II

(Cream from Cheese Milk. Test 59%; Acidity .08; Score on Butter from Fresh Cream 37.5)

Percent NaCl	1 Day Acidity	2 Day Acidity	3 Day Acidity	3 Day Butter Flavor Score	3 Day Butter Flavor Criticism	4 Day Acidity	5 Day Acidity	5 Day Butter Flavor Score	5 Day Butter Flavor Criticism	6 Day Acidity	7 Day Acidity	7 Day Butter Flavor Score	7 Day Butter Flavor Criticism
0	.360	.415	.425	36	Sl.Stale Cream Coarse	—	.415	35	Stale Cream Sl. Malty	.420	.445	33-	Cheesy
4	.205	.290	.345	36.5	Acid Coarse	—	.370	36	Coarse Acid	.375	.420	35-	Coarse Acid
6	.110	.190	.260	37	Sl. Coarse	—	.270	36	Coarse Acid	.270	.295	36	Coarse Acid
8	.095	.105	.110	37.5	No Criticism	—	.150	36.5	Sl. Coarse	.145	.210	36-	Coarse Acid
10	.105	.090	.100	38	No Criticism	—	.110	37.5	No Deterioration	.115	.140	37	Sl. Storage
12	.085	.100	.105	37.5	No Criticism	—	.105	37⁄	Sl. Storage	.115	.130	37	Sl. Storage
14	.085	.100	.100	37⁄	Sl. Storage	—	.100	37	Sl. Storage	.090	.100	37	Sl. Coarse Sl. Storage

TRIAL III

(Cream from Cheese Milk. Test 61%; Acidity .085; Score on Butter from Fresh Cream 37⁄)

Percent NaCl	1 Day Acidity	2 Day Acidity	3 Day Acidity	3 Day Butter Flavor Score	3 Day Butter Flavor Criticism	4 Day Acidity	5 Day Acidity	5 Day Butter Flavor Score	5 Day Butter Flavor Criticism	6 Day Acidity	7 Day Acidity	7 Day Butter Flavor Score	7 Day Butter Flavor Criticism
0	.345	.345	.415	36-	Coarse Acid	.420	—	36-	Coarse Acid	.700	.760	34	Old Cream Malty
4	.200	.290	.320	36.5	Sl. Stale	.330	—	35.5	Stale Cream	.345	.375	35	Coarse Acid
6	.130	.180	.200	36⁄	Sl. Coarse Acid	.240	—	36	Coarse Acid	.255	.265	36	Stale Cream
10	.110	.120	.110	37⁄	No Criticism	.120	—	37⁄	Sl. Storage	.130	.165	37	Sl. Storage
12	.110	.120	.110	37⁄	No Criticism	.120	—	37	Sl. Coarse	.125	.130	37	Sl. Coarse
14	.110	.120	.110	37⁄	No Criticism	.120	—	37-	Sl. Storage	.125	.125	36.5	Storage

TRIAL IV

(Cream from Grade A Milk: Test 65%; Acidity .07%; Score on Butter from Fresh Cream 38)

Percent NaCl	1 Day Acidity	2 Day Acidity	3 Day Acidity	3 Day Butter Flavor Score	3 Day Butter Flavor Criticism	4 Day Acidity	5 Day Acidity	5 Day Butter Flavor Score	5 Day Butter Flavor Criticism	6 Day Acidity	7 Day Acidity	7 Day Butter Flavor Score	7 Day Butter Flavor Criticism
0	.125	.175	—	37	Sl. Acid	.280	.360	34-	Stale Cream	.250	.305	32	Stale Cheesy
4	.085	.125	—	37	Sl. Coarse	.215	.285	36	Sl. Malty	.245	.250	34	Stale Malty
6	.080	.115	—	37.5	Sl. Coarse	.135	.140	37	Sl. Old Cream	.160	.155	37	Acidy
8	.070	.115	—	38	Sl. Flat	.125	.128	38-	Sl. Flat	.130	.135	37.5	Coarse
10	.090	.105	—	38	No Criticism	.105	.105	38	Sl. Flat	.120	.120	38	No Criticism
12	.085	.085	—	38	No Criticism	.095	.100	38-	Sl. Coarse	.105	.095	37.5	Sl. Storage
14	.090	.100	—	38	Sl. Coarse	.100	.095	37.5	Sl. Coarse	.085	.105	37	Sl. Storage

TRIAL V

(Cream from Grade A Milk. Test 58%; Acidity .08%; Score on Butter from Fresh Cream 38)

Percent NaCl	1 Day Acidity	2 Day Acidity	3 Day Acidity	3 Day Butter Flavor Score	3 Day Butter Flavor Criticism	4 Day Acidity	5 Day Acidity	5 Day Butter Flavor Score	5 Day Butter Flavor Criticism	6 Day Acidity	7 Day Acidity	7 Day Butter Flavor Score	7 Day Butter Flavor Criticism
0	.200	.305	.330	35	Stale Cream	.315	—	33	Stale & Cheesy	.345	.295	32	Rancid Cheesy
4	.120	.220	.275	36.5	Sl. Coarse	.280	—	35	Old Cream	.295	.270	35	Old Cream
6	.115	.120	.125	37.5	Sl. Coarse	.150	—	37	Sl. Stale	.175	.140	37	Old Cream
8	.105	.120	.130	37.5	Sl. Coarse	.145	—	37.5	Sl. Storage	.175	.135	37	Sl. Coarse
10	.115	.125	.115	38	No Criticism	.125	—	38-	Sl. Storage	.140	.110	38	No Criticism
12	.100	.125	.115	38	No Criticism	.115	—	37	Sl. Oiliness	.145	.090	37.5	Sl. Stale
14	.105	.130	.110	37.5	Coarse	.110	—	37.5	Coarse	.110	.090	37.5	Coarse Storage

a source for high fat cream, the acidity developed very rapidly in the unsalted samples. In trial three a very rapid increase was noted towards the end of the seven day storage period. In trials four and five, in which grade A milk was used as a source of high fat cream, the acidity of the unsalted samples did not increase as rapidly as did the acidity of the samples obtained from cheese milk.

The data shows that the cream with enough salt added to contain 4% in the serum had slower and less extensive acid development than the unsalted cream. However there was considerable acid production, indicating considerable bacterial activity in the cream.

When 6% salt was added, acid development was less than that reported for the samples containing 4% salt.

In the sample that had 8% salt added there was relatively little acid produced, but apparently some bacterial growth occurred.

With the addition of 10%, 12%, and 14% salt the production of acidity was inhibited almost completely. The acid content after seven days storage was only slightly above that of the original cream.

In all five trials the acidity development was slower and less extensive in the cream obtained from grade A milk than it was in the cream obtained from cheese milk.

Since the acidity in all five trials was not determined uniformly, in that one day was omitted from each trial, no average daily acidity could be calculated for all samples. The data on

acid development for the seven day samples is complete for all five trials at all salt concentrations for the seven day storage period. These averages are presented in Chart 1 which graphically illustrates very clearly that as the concentration of the salt in the serum of the cream was increased, the amount of acid produced during holding for seven days at room temperature (about 80° F.) was decreased.

2. Rate and Extent of Flavor Deterioration

The data in Table 4 indicate that salt added to cream had a definite inhibitory effect on the development of flavor defects during storage at 80° F. for seven days. The scores on the butter made from the fresh unsalted cream in each trial ranged from 37 to 38 and averaged 37.6.

The unsalted samples of cream held at room temperature deteriorated very rapidly. After only three days storage the cream would require neutralization before churning. The samples held five and seven days developed highly undesirable off-flavors. The principal off-flavors noted were cheesy, malty, old cream, and coarse.

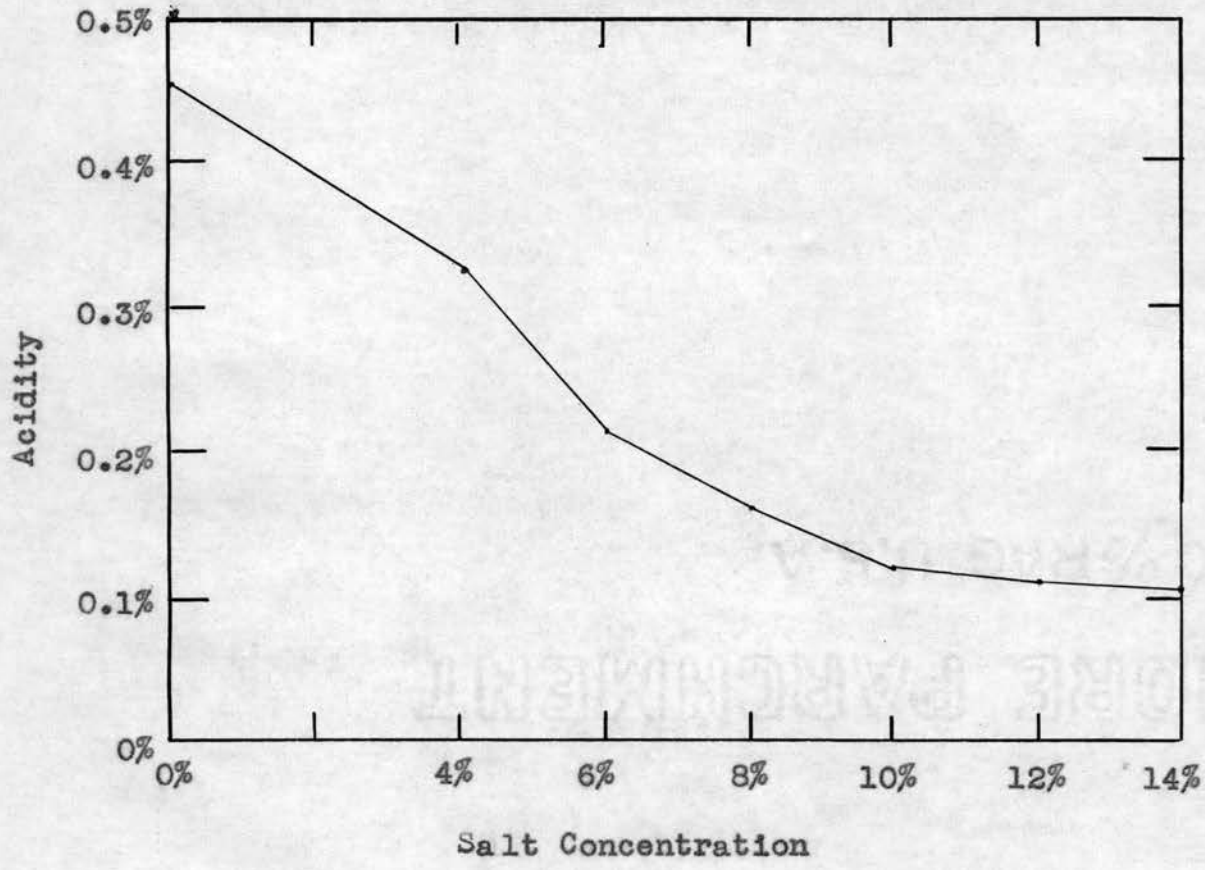
The development of off-flavors was inhibited to some degree in the cream with 4% or 6% salt concentrations in the serum. The criticisms most apparent were coarse acid, slight malty, and slight old cream.

The addition of 8% salt resulted in considerable inhibitory effect on the deterioration of flavor. Criticisms most apparent were slight stale, slight coarse, and slight flat, none of which is considered to be a serious defect.

Chart 1

The Influence of the Concentration of Added Salt on the Development of Acidity During Seven Days Storage at Room Temperature (80° F.)

(Average of Five Trials)



The addition of 10%, 12%, and 14% salt apparently completely stopped bacterial deterioration of flavor. The samples made from cream with 10% salt were often scored without flavor criticisms. The criticisms otherwise noted were slight stale and slight coarse. A stale or storage flavor was predominant in the samples made from cream with 12% and 14% added salt, but it was thought that this flavor was the result of chemical rather than bacterial action.

A summary of the scores of the butter churned from the salted and unsalted cream after three, five, and seven days storage at 80° F. is presented in table 5.

The data indicate that after storage for three days there was rapid deterioration in the unsalted cream and some deterioration occurred in the cream with 4% salt. Slight deterioration occurred in the cream with 6% salt in the serum. There was very little deterioration in cream with 8% or more salt. The scores on the unsalted cream ranged from 35 to 37 and averaged 35.8; on the cream with 4% salt, from 36 to 37 and averaged 36.5; on the cream with 6% salt, from 36 to 37.5 and averaged 37.1; and on the cream with 8% or more salt, from 37 to 38 and averaged 37.5.

The scores on the butter churned after five days storage show that the deterioration continued at a rapid rate in the unsalted cream and to slightly a slower rate in the cream with 4% and 6% salt. Some deterioration in cream with 8% salt added was evident after five days storage, while there was apparently no microbiological deterioration in the cream with 10% or more salt. The scores on the unsalted cream ranged from 33 to 36 and

Table 5

THE INFLUENCE OF SALT ON THE DETERIORATION OF FLAVOR IN BUTTER CHURNED FROM SALTED CREAM HELD AT ROOM TEMPERATURE (ABOUT 80° F.)
(Average Score on Fresh Unsalted Samples 37.6)

Flavor Scores of Butter from Cream Held for Three Days

Trial	Salt Concentrations						
Number	0	4	6	8	10	12	14
1	35	36	37.5	37.5	37	37	37-
2	36	36.5	37	37.5	38	37.5	37/
3	36	36.5	36/	37-	37/	37	37/
4	37	37	37.5	38	38	38	38-
5	35	36.5	37.5	37.5	38/	38	37.5
Average	35.8	36.5	37.1	37.5	37.6	37.5	37.3

Flavor Scores of Butter from Cream Held for Five Days

Trial	Salt Concentrations						
Number	0	4	6	8	10	12	14
1	35	36.5	37	37	37	37-	36
2	35	36	36	36.5	37/	37/	37
3	36-	35.5	36	36	37/	37	37-
4	34-	36	37	38-	38	38-	37.5
5	33	35	37	37.5	38-	37	37.5
Average	34.6	35.8	36.6	37	37.4	37.2	37

Flavor Scores of Butter from Cream Held for Seven Days

Trial	Salt Concentrations						
Number	0	4	6	8	10	12	14
1	34	35.5	36-	36.5	37	36-	36.5
2	33	35-	36	36/	37	37	37
3	34	37	36	34	37	37/	36.5
4	32	34	37	37.5	38	37.5	37
5	35	35.5	37/	37	38	38-	37.5
Average	33.6	35.4	36.4	36.2	37.4	37.1	36.9

averaged 34.6; on the cream with 4% salt, from 35 to 36.5 and averaged 35.8; on the cream with 6% salt, from 36 to 37 and averaged 36.6; on the cream with 8% salt, from 36 to 38 and averaged 37; and on the cream with 10% or more salt, from 36 to 38 and averaged 37.2.

After seven days storage the data indicate that there was considerable deterioration in the unsalted cream and in the cream with 4%, 6%, and 8% salt, but as the salt content increased the rate and extent of flavor deterioration decreased until a level of 10% salt in the serum was reached. The deterioration of the cream with 10%, 12%, and 14% salt was very slow and only to a slight degree. The scores on the unsalted cream ranged from 32 to 35 and averaged 33.6; on the cream with 4% salt, from 34 to 37 and averaged 35.4; on the cream with 6% salt, from 36 to 37 and averaged 36.4; on the cream with 8% salt, from 34 to 37.5 and averaged 36.2; and on the cream with 10% or more salt, from 36.5 to 38 and averaged 37.1.

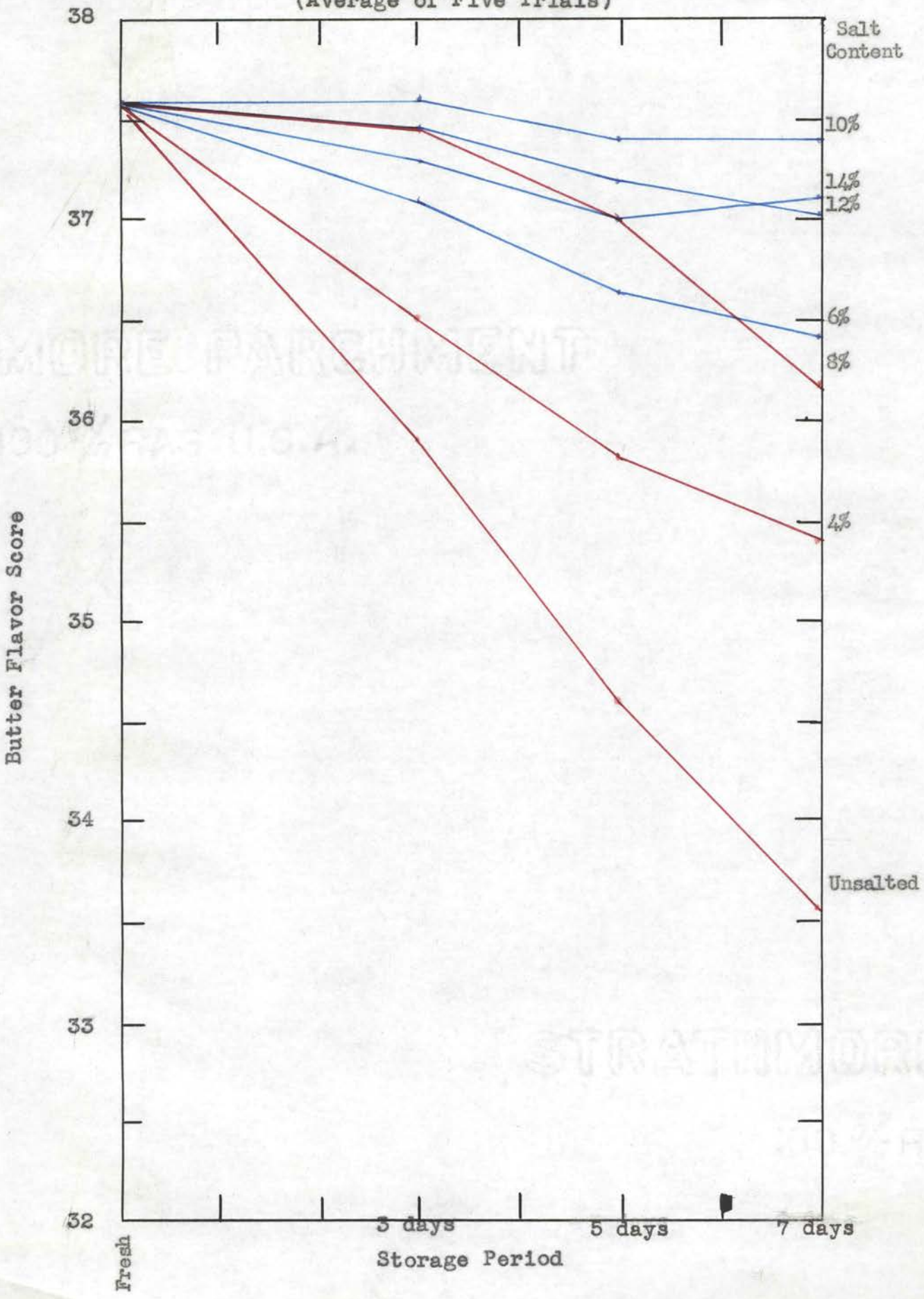
These data show that in each storage period the cream with 10% salt added to the serum averaged higher in flavor score than the cream samples of any other concentration of added salt studied in this experiment. From the data on acid development in the cream it appeared that with 10% or more salt added there was no bacterial growth. The lower scores on the butter churned from the 12% and 14% salted cream samples was presumably due to chemical rather than bacteriological action. The character of the stale or storage flavor evident in these samples also suggested chemical deterioration.

Chart 2 graphically illustrates the influence of salt on the deterioration of flavor in unsalted and salted cream after three, five, and seven days storage at room temperature (about 80° F.). The Chart is based on the average flavor scores of butter of the five trials shown in Table 5.

From this chart it is apparent that added salt has much influence in preventing deterioration of the flavor of cream. According to the data in the chart it is clearly evident that as the salt concentration in the serum of the cream increased, up to 10%, the rate and extent of deterioration decreased. In the cream samples with more than 10% salt in the serum there apparently was some chemical deterioration.

Chart 2

Influence of Salt on the Deterioration of Flavor in Butter Churned from Salted Cream That Was Stored at Room Temperature (80° F.)
(Average of Five Trials)



D. The Effect of Added Ascorbic Acid on the Flavor of Salted Cream

A storage or stale flavor that resembled somewhat the well known oxidized flavor was observed in some of the samples of salted cream that had been held at room temperature (80° F.) for seven days. Oxidized flavor has been associated with the disappearance of ascorbic acid in milk. Weinstein and others (23) found that the addition of ascorbic acid to pasteurized market milk would prevent the development of oxidized flavors. These findings suggested that ascorbic acid might be used to prevent the development of stale or storage flavors in cream.

In order to determine the influence of added ascorbic acid on the flavor of salted cream, various amounts of ascorbic acid were added to cream samples that contained various concentrations of salt. The flavor of the butter made from the cream after holding for seven days at room temperature (80° F.) was observed.

1. Addition of Levels of Ascorbic Acid Ranging from 50 mg. per liter to 200 mg. per liter

For this study ten gallons of cheese milk were obtained from a local cheese plant and high fat cream was obtained by double separation. The cream was divided into three lots of 850 g. each. Salt was then added to give the following concentrations in the serum: 10%, 12%, and 14%. The samples were stirred frequently for approximately 30 minutes to insure uniform distribution of the salt, then from each lot four 200 g. samples were weighed into eight ounce glass sample jars fitted with aluminum screw caps. Ascorbic acid from a stock solution was added and mixed well with three of the samples in each lot in concentrations of

50 mg., 100 mg., and 200 mg. per liter. One sample in each lot served as the control and did not have ascorbic acid added.

The stock solution of ascorbic acid that was used was prepared by dissolving 2 g. of pure crystalline ascorbic acid in glass-distilled water in a 100 ml. volumetric flask. The volume was made to 100 ml. with additional glass-distilled water. Each ml. of this stock solution contained 20 mg. of ascorbic acid, thus for addition to 200 g. cream samples 0.5 ml. was added to obtain 200 mg./L. concentrations.

The samples were stored at room temperature (about 80° F.) for seven days. They were then pasteurized, cooled, tempered, churned, and then examined organoleptically for flavor defects.

The effect of added ascorbic acid upon the development of off-flavors in salted cream stored at room temperature (about 80° F.) for five and for seven days is shown in Table 6.

All of the samples kept very well and the flavor score on all samples were about 37 or 38, and there were no pronounced differences in flavor between the samples with and without ascorbic acid added. A stale flavor was present to a slight degree in all samples that did not show any other outstanding defects. Not enough difference in flavor was noted to assign numerical scores to the butter samples, therefore an attempt was made to rank the butter in the order of their preference with first choice being number one, second choice number two, etc.

The data indicate that ascorbic acid, in the levels used in this experiment, showed only a slight effect in preventing the development of stale or storage flavor in salted cream that had

Table 6

THE EFFECT OF ADDED ASCORBIC ACID ON THE DEVELOPMENT OF STALE FLAVOR IN SALTED CREAM STORED AT ROOM TEMPERATURE (80° F.) FOR SEVEN DAYS

Trial I

Sample No.	Percent Salt	mg./liter Ascorbic Acid	Butter Flavor Criticism	Flavor Rating
1A	10	0	Slight Stale	4
1B	10	50	Slight Stale	3
1C	10	100	Slight Stale	1
1D	10	200	Slight Stale	2
2A	12	0	Slight Stale	4
2B	12	50	Slight Stale	1
2C	12	100	Slight Stale	3
2D	12	200	Slight Stale	2
3A	14	0	Fresher than others	3
3B	14	50	Slight Tallowy	4
3C	14	100	Slight Stale	2
3D	14	200	Slight Stale	1

Trial II

Sample No.	Percent Salt	mg./liter Ascorbic Acid	Butter Flavor Criticism	Flavor Rating
1A	10	0	Slight Rancid	4
1B	10	50	Slight Stale	3
1B	10	100	Slight Stale	1
1D	10	200	Slight Stale	2
2A	12	0	Slight Stale	3
2B	12	50	Moldy Sl. Rancid	4
2C	12	100	Slight Stale	1
2D	12	200	Slight Stale	2
3A	14	0	Slight Stale	4
3B	14	50	Slight Stale	3
3C	14	100	Slight Stale	1
3D	14	200	Slight Stale	2

been held seven days at room temperature (about 80° F.).

It is significant to note that samples with no ascorbic acid added ranked fourth four times and third two times while samples with 100 and 200 mg./L. of ascorbic acid were scored first or second in each lot. But the variation in flavor of all samples was very slight. If the flavor ratings of the butter for each of the four concentrations of ascorbic acid used in the cream were added together, regardless of the amount of salt added to the cream, the following totals are obtained: 0 mg./L. 22, 50 mg./L. 18, 100 mg./L. 9, and 200 mg.L. 11. This indicates that ascorbic acid might have a slight influence in minimizing the development of a stale or storage flavor in salted cream.

2. Addition of Levels of Ascorbic Acid From 200 mg. per Liter to 800 mg. per Liter.

Since the results shown in section one, in which the ascorbic acid levels added to salted cream ranged from 50 mg./L. to 200 mg./L. were only slightly significant, it was thought that perhaps higher concentrations of ascorbic acid might prove more effective for preventing the development of stale or storage flavor.

Accordingly, a second series of samples of salted cream were used with higher levels of ascorbic added. In this second series the cream samples were separated and handled as in series one, except that the salt concentrations were 10% and 14% and the levels of ascorbic acid added were 200 mg., 400 mg., 600 mg., and 800 mg. per liter.

Ten 150 g. samples of each salt concentration were prepared, the indicated levels of ascorbic acid added and the samples

stored at about 80° F. Samples were pasteurized and churned after holding five days and after holding seven days.

The influence of relatively high levels of ascorbic acid in salted cream on the flavors of butter churned from the cream held at room temperature (80° F.) for five and seven days is shown in Table 7.

No significant results are evident in samples that were churned after five days storage because of a strong medicinal flavor that was probably due to a high chlorine content of the water used to wash the butter samples. The strong medicinal flavor, that resembled iodoform, tended to mask any other flavor that might have been present.

After seven days, the sample with 10% salt and no ascorbic acid added had a very slight cooked flavor such as that observed in pasteurized cream. The sample with 10% salt and 200 mg./L. of added ascorbic acid had a more definite cooked flavor. Samples with 10% salt and 500 to 800 mg./L. of added ascorbic acid had a distinct cooked flavor that would have masked any other flavor which might have been present in the sample.

The sample with 14% salt and no ascorbic acid added developed a strong storage or stale flavor. The sample with 14% salt and 200 mg./L. of added ascorbic acid developed a slight staleness and a slight cooked flavor was noted. Samples with 14% salt and 400 to 800 mg./L. of added ascorbic acid all developed cooked flavors of varying intensity and the sample with 600 mg./L. was noted for lacking freshness along with the cooked flavor.

Table 7

THE EFFECT OF HIGH LEVELS OF ADDED ASCORBIC ACID ON THE DEVELOPMENT OF STALE FLAVOR IN SALTED CREAM STORED AT ROOM TEMPERATURE (80° F.) FOR FIVE AND SEVEN DAYS

Sample No.	Days Held	Salt %	Ascorbic Acid mg./L.	Butter Flavor Criticism
15A	5	10	0	Medicinal
15B	5	10	200	Medicinal
15C	5	10	400	Medicinal
15D	5	10	600	Medicinal
15E	5	10	800	Medicinal
25A	5	14	0	Medicinal
25B	5	14	200	Medicinal
25C	5	14	400	Medicinal
25D	5	14	600	Medicinal
25E	5	14	800	Medicinal
17A	7	10	0	Very Slight Cooked
17B	7	10	200	Slight Cooked
17C	7	10	400	Distinct Cooked
17D	7	10	600	Distinct Cooked
17E	7	10	800	Distinct Cooked
27A	7	14	0	Strong Stale
27B	7	14	200	Sl. Stale Sl. Cooked
27C	7	14	400	Distinct Cooked
27D	7	14	600	Cooked Lacks Freshness
27E	7	14	800	Cooked

The data in Table 7 indicate that if relatively high levels of ascorbic acid are added to salted cream a distinct cooked flavor will be produced upon pasteurization. This cooked flavor was not due to over-heating because the temperature was closely regulated during the pasteurization process.

The addition of extremely high levels of ascorbic acid apparently had no great influence on the development of storage or stale flavor in butter made from salted cream that had been held for five days and for seven days before churning. However the medicinal flavor in the five day samples and the cooked flavor in the seven day samples was strong enough to mask any other flavor that might have been present.

E. The Effect of Added Salt and of Storage Temperature on the Development of Water-Insoluble Fatty Acids in Cream

Recently the Federal Food and Drug Administration announced that a new criterion, the water-insoluble fatty acid content (hereafter abbreviated as WIA), would be used in addition to the methods already in use for determining the quality of cream and butter that is shipped inter-state. While no standards have been published for the maximum limit of WIA content for legal butter, it is currently generally accepted to be 400 mg. per 100 g. fat.

The successful use of added salt in checking the deterioration of cream, as reported in section C of this work, suggested the possibility of the use of salt for inhibiting the development of WIA in cream. Accordingly samples of salted and of unsalted cream were held for various periods at different constant temperatures and the WIA contents determined.

For this study thirty gallons of milk were obtained from a commercial creamery and separated. The cream was divided into lots and salt was added to one lot to give a concentration of 10% in the serum. Each of these lots was divided into sixteen samples of 250 g. each, which were weighed into one pint fruit jars with screw tops.

Four samples each of the salted and unsalted cream were incubated at the following temperatures: 40°, 60°, 80°, and 100° F. An additional sample was immediately pasteurized, churned, and the butter stored at 0° to -10° F. to serve as a control.

At the end of one, three, five, and seven days of incubation, at the four temperatures given above, one sample of each of the

salted and of the unsalted cream was removed and the acidity titrated. The samples were then pasteurized (without Neutralization), churned and the butter samples stored at 0° to -10° F.

WIA determinations were made on the samples of butter according to the method given by Hillig (7).

The effect of added salt on the development of WIA in cream stored at 40° to 100° F. for periods ranging from one to seven days is shown in Table 8 and graphically illustrated in Chart 3.

1. Unsalted Cream

a. Cream Held at 40° F.

The WIA content of unsalted cream held at 40° F. increased rather slowly and at the end of five days was 212 mg. which is well below the 400 mg. level. However after seven days the cream contained 565 mg. of WIA which is above the 400 mg. level.

b. Cream Held at 60° F.

The WIA content of unsalted cream held at 60° F. apparently increased slower and less extensively than cream held at 40° F.. However after seven days the WIA content had increased to 528 mg. which is above the 400 mg. level. This slower rate may have been due to more acid development in the samples held at 60° F. than at 40° F..

c. Cream Held at 80° F.

The WIA content of unsalted cream held at 80° F. increased much more rapidly and extensively than it did in the cream held at 40° or at 60° F.. After three days it was 230 mg. but after five days it was 468 mg. which is just

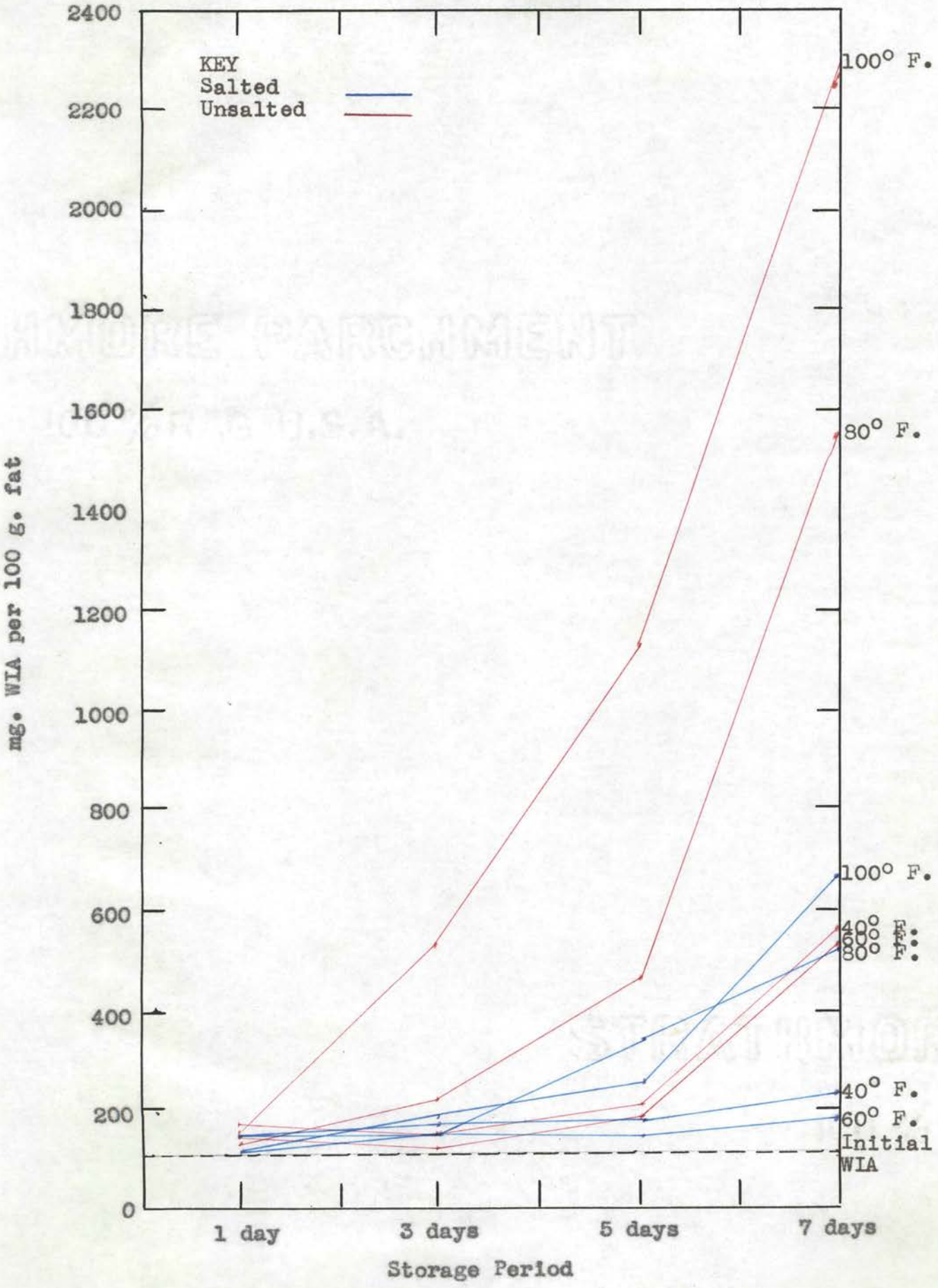
Table 8

EFFECT OF ADDED SALT AND OF STORAGE TEMPERATURE ON THE DEVELOPMENT OF WATER-INSOLUBLE FATTY ACIDS IN CREAM

Days Held	Percent Salt	Holding Temperatures											
		40° F.			60° F.			80° F.			100° F.		
		Flavor Criticism	Cream Acidity	mg. WIA per 100 grams fat	Flavor Criticism	Cream Acidity	mg. WIA per 100 grams fat	Flavor Criticism	Cream Acidity	mg. WIA per 100 grams fat	Flavor Criticism	Cream Acidity	mg. WIA per 100 grams fat
1	0	No Criticism	0.29	172	Clean Sour	0.45	141	Clean Sour	0.56	134	Clean Sour	0.50	151
3	0	Slight Sour	0.36	148	Clean Sour	0.50	125	Clean Sour	0.56	230	Sour Sl. Yeasty	0.50	546
5	0	Sl. Rancid Clean Sour	0.41	212	Sour	0.54	18	Rancid High Acid	0.50	468	High Acid Sl. Fruity	0.54	1061
7	0	Sour Sl. Rancid	0.42	565	Sour Sl. Cheesy	0.57	528	Cheesy&Rancid High Acid	0.68	1539	Fruity and Cheesy	0.60	2230
1	10	No Criticism	0.10	146	No Criticism	0.13	121	No Criticism	0.13	144	No Criticism	0.13	124
3	10	No Criticism	0.12	167	No Criticism	0.13	153	No Criticism	0.15	152	No Criticism	0.16	172
5	10	No Criticism	0.12	180	No Criticism	0.13	135	No Criticism	0.16	342	Sl. Musty	0.21	255
7	10	No Criticism	0.12	224	No Criticism	0.13	173	Sl. Rancid Sl. Cheesy	0.25	520	Cheesy Sl. Musty	0.26	667

Chart 3

Effect of Added Salt and of Storage Temperature on the Development of Water-Insoluble Fatty Acids in Cream



above the 400 mg. level and after seven days storage it had increased to 1539 mg. which is almost four times the 400 mg. level.

d. Cream Held at 100° F.

The WIA content of unsalted cream held at 100° F. increased very rapidly and extensively. There was little increase in WIA content after holding for one day at 100° F., but by the third day it had increased to 546 mg. which exceeded the 400 mg. level. After 5 days storage the cream had developed 1061 mg. WIA and after seven days 2230 mg. which exceeded the 400 mg. level four and one-half times.

The data on unsalted cream samples held at various temperatures indicate that the development of WIA is slow at 40° to 60° F. and did not exceed the 400 mg. level until after holding for seven days. At 80° and 100° F. the WIA developed rapidly and extensively and exceeded the 400 mg. level after holding five days at 80° F. and after only three days at 100° F.

These data indicate that unsalted cream cannot be held longer than five days at 40° and 60° F., three days at 80° F., and only one day at 100° F. before churning if the WIA content of the butter is to be below the 400 mg. level.

2. Salted Cream

a. Cream Held at 40° F.

The WIA content of salted cream held at 40° F. increased very slowly and to such an extent that after seven days it was only 224 mg. which was well below the 400 mg. level.

b. Cream held at 60° F.

The WIA content of salted cream held at 60° F. apparently increased slower and less extensively than cream held at 40° F. After seven days storage the WIA content was only 173 mg. which is well below the 400 mg. level.

c. Cream Held at 80° F.

The WIA content of salted cream held at 80° F. increased rather slowly at first, however after holding seven days it was 520 which is above the 400 mg. level.

d. Cream Held at 100° F.

The WIA content of salted cream held at 100° F. increased slowly at first, but after holding seven days it was 667 mg. which is above the 400 mg. level.

The data on salted cream samples held at various temperatures indicate that the development of WIA is much slower and less extensive than that in unsalted cream, and not until after seven days holding at 80° and 100° F. did it exceed the 400 mg. level.

The data indicates that salted cream may be held at 40° and 60° F. for seven days and for five days at 80° and 100° F. without developing WIA above the 400 mg. level.

DISCUSSION

A study was made on methods of obtaining high fat cream which included: adjustment of the cream screw, multiple separation, and reduced inflow of milk to the separator. On the basis of rapidity of separation, practicability, and fat losses, the results indicate that reseparation was the best method studied in this experiment. At present there is an upper limit, on some separators, to which the fat content of cream can be regulated for efficient separation. If farm separators could be constructed to efficiently produce high fat cream in one operation, the separation of high fat cream would be greatly simplified.

According to the data there was very little variation in the fat tests obtained by the new Minnesota modification of the Babcock test* and those obtained by the Mojonnier or the calculated Babcock methods on salted cream. No HCl gas was given off and the fat columns were uniform, clear, distinct, and easy to read. The reagent for this new Minnesota method, unlike sulphuric acid, does not especially attack the skin or clothing, does not corrode the plumbing if poured down the drain, and the test bottles are cleaned by a single rinsing with hot water since the reagent acts as a cleaning solution.

A concentration of 10% or more salt (NaCl) in the serum of cream apparently completely inhibits bacterial deterioration. However a stale or storage flavor was predominant in the samples made from cream with 12% and 14% added salt, but it was thought

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* See Appendix

that this flavor was the result of chemical rather than bacterial action.

Several changes in the marketing process for cream will be necessary if salted cream is to be used on a commercial basis. Since the salt contained in the cream would probably attack the metal can, thereby shortening the life of the can and also possibly imparting an off-flavor to the cream, some other type container, such as the single service ice cream container, might be satisfactory. With a container of the single service type the cream producer could select the size container to best suit his needs. The reduced volume of high fat cream would eliminate the need of a bulky can for many small cream producers and there would be no can washing problem because the single service container could be emptied, steamed, and discarded.

The data indicate that if relatively high levels of ascorbic acid are added to salted cream a distinct cooked flavor will be produced upon pasteurization. This cooked flavor was not due to over-heating because the temperature was closely regulated during the pasteurization process and all samples in each series were pasteurized, side by side, in the same water bath at the same time. Ascorbic acid is a reducing compound, therefore addition of relatively high levels of ascorbic acid forms a reducing system in cream and apparently the heat labile sulphides formed in the cream at pasteurization temperatures are not oxidized as in ordinary cream and therefore accumulate in concentrations that produce the cooked flavor.

The data on salted cream samples held at various temperatures indicate that the development of WIA is much slower and less exten-

sive than that in unsalted cream. Salted cream may be held at 40° and 60° F. for seven days and for five days at 80° and 100° F. without developing WIA above the 400 mg. level which is currently being generally accepted as the maximum limit for legal cream and butter, although there has been no official publication of a legal limit.

The data indicate that unsalted cream could not be held longer than five days at 40° and 60° F., three days at 80° F., and only one day at 100° F. before churning if the WIA content of the butter is to be below the 400 mg. level.

Much cream produced in Oklahoma during the summer months is held at temperatures of 80° to 100° F. and from the data it is apparent that this cream will exceed the 400 mg. level in less than three days unless salt is added or some other method of preservation is used.

The development of WIA is apparently due to a breakdown of the fat because it occurs in cream that apparently has no bacterial deterioration. This suggests that the stale flavor produced in cream with no apparent bacterial action may also be due to a breakdown in the fat.

CONCLUSIONS

1. High fat cream may be obtained by reseparation of the cream with the separators now in use on many farms with little loss in efficiency and with little additional time than that required for single separation.

2. The new Minnesota modification of the Babcock test* is satisfactory for testing salted cream for fat.

3. A concentration of 10% salt (NaCl) in the serum of high fat cream apparently completely inhibits bacterial deterioration in the cream stored at about 80° F. for seven days.

4. The additions of various levels of ascorbic acid to cream apparently has little effect on preventing the development of stale flavor in salted cream.

5. The development of water-insoluble fatty acids in cream with 10% salt in the serum is slower and much less extensive than in unsalted cream from the same lot.

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* See Appendix

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APPENDIX

The new Minnesota method is a modification of the Babcock test. The secret formula for the reagent used in this test was developed at the University of Minnesota and is licensed to and solely distributed by the Kimble Glass Company of Philadelphia, Pennsylvania.

Typist: Betty Sexton