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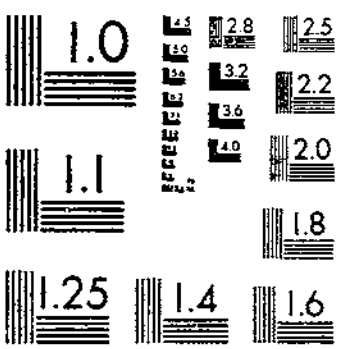
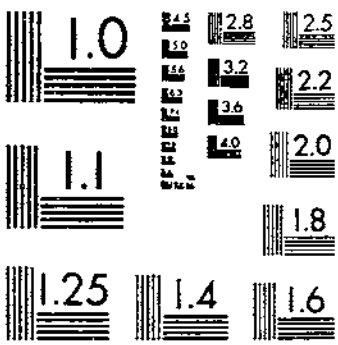


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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KEEPING QUALITY OF BUTTER MADE FROM CREAM OF VARIOUS ACIDITIES

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INTRODUCTION

The custom of permitting cream to sour before churning developed centuries ago, partly as a matter of necessity. The cream was separated by gravity, the accumulation of a sufficient volume of cream to make a churning required some time, and difficulty was experienced in keeping the cream cold during warm weather.

Some of the early butter makers, however, perhaps learned from experience that sour cream churned more quickly than sweet cream and produced a little more butter from an equal volume of cream. These results would indicate that the souring of cream was desirable. The flavor and aroma developed by the souring of the cream were present in the butter and came to be considered characteristics of butter.

When the factory system of butter making was introduced, the souring or ripening of cream previous to churning was a custom so well established that the creamery butter maker adopted it as a matter of course. Even after the cream separator came into general use and sweet milk was delivered to the creamery this custom was not changed. Indeed the ripening of the cream was such an important step in butter making that the use of a starter, consisting of a culture of lactic-acid-producing bacteria, became a general practice in order that the development of a desirable acid flavor might be assured.

The undesirable flavors obtained when the cream became too sour, however, were noted many years ago. Henry Ward Beecher (*1*)[1] in 1859, severely criticised the quality of butter found on the mar-

[1] Italic number in parentheses refers to literature cited, p. 7.

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ket and recommended that the cream be churned while still sweet. The same idea is presented in the following statement in the second annual report of the New York State dairy commissioner (*2, p. 309*) for 1886:

> The best flavored butter is made from "sweet cream," although cream is often allowed to become slightly sour before churning. If the acid fermentation is allowed to go too far it will deleteriously affect the butter.

In 1889 the West Virginia Experiment Station (*6*) reported that the college creamery had established a good demand for sweet-cream butter. In 1890 and 1892 the Iowa Experiment Station (*7, 8*) reported that sweet-cream butter kept better than sour-cream butter. In both instances the sweet-cream butter was made from raw cream.

In 1902 Leclair (*4*) of the St. Hyacinthe Dairy School, Quebec, Can., recommended pasteurizing sweet cream, cooling it, holding it for three hours, adding 30 per cent lactic culture, and then churning it at once. After adopting this practicing he obtained fine-quality butter that was very uniform from day to day. He did not, however, report its keeping quality in storage.

A study, begun in 1905 by the United States Department of Agriculture (*3, 9, 10, 11*), of the influence of acidity of cream on the keeping quality of butter established the fact that butter made from unripened, pasteurized sweet cream maintained its fine quality to a high degree during at least eight months' storage at 0° F.[2] Mortensen (*5*), in 1922, concluded from his work that ripened-cream butter received a higher commercial score when fresh but that sweet-cream butter kept better in storage.

As a result of the work already accomplished, creamery operators have adopted the practice of churning cream at lower acidities than was their custom in the past. The degree of acidity at different creameries, however, still varies materially.

EXPERIMENTAL

LABORATORY BUTTER

Four series of churnings were made for the purpose of obtaining data on the maximum acidity that cream may contain without hastening deterioration of the butter. In these series the cream ranged in acidity from 0.11 to 0.45 per cent, calculated as lactic acid. The keeping quality of the butter [3] obtained is reported.

The cream was usually standardized to 30 per cent butterfat, but when this was not done the acidity of the serum was calculated to that basis. For standardizing the acidity to the desired points a lactic culture in skim milk was used for acidities up to 0.25 per cent and in some cases up to 0.31 per cent. To obtain higher acidities the cream was ripened, a lactic culture being used for a starter. The cream was pasteurized in shotgun cans or in a steam jacketed vat, run over a cooler, held overnight, and churned the next day in a small combined churn and worker, 8 to 10 pounds of butter being made in each churning. The butter in all churnings was washed, salted, and worked in the same manner; and all conditions were controlled as

[2] Because of this work the U. S. Navy in 1909 adopted the practice of purchasing each year a quantity of sweet-cream butter to be placed in cold storage and used throughout the ensuing year. This practice is still continued.

[3] The word "butter" in this bulletin refers only to salted butter.

closely as possible. The composition of most of the butter came within the following range: Butterfat, 80.8 to 83 per cent; moisture, 14 to 15.8 per cent; salt, 1.8 to 2.8 per cent; curd and ash, 0.7 to 1 per cent. The butter was solidly packed into 2-pound paraffined fibre containers.

Samples of each churning were stored in two refrigerators, one of which was maintained most of the time at a temperature of approximately 0° F. though the range was from −5° to 20°. The latter temperature, however, occurred only a few times and for short periods except at the time that series 4 was in storage, when a temperature of 20° was reached daily for two weeks. The temperature of the other refrigerator ranged from 30° to 50°. This refrigerator was used for various purposes, and the door was frequently opened during the day.

The butter was scored by competent butter graders, one from the Bureau of Agricultural Economics[4] and two from the Bureau of Dairy Industry. None of the men knew the identity of the samples being scored.

SERIES 1

Ten lots of sweet cream were each divided into five parts, one of which was used sweet, the acidity of the cream averaging 0.15 per cent; and the others were standardized to 0.22, 0.25, 0.28, and 0.31 per cent acid respectively. The cream was pasteurized after the acidity had been standardized. The organisms and flavor of the lactic culture, therefore, were largely destroyed. The butter was made during the winter when the cows were on dry feed. Table 1 shows the average scores of butter when fresh and after different periods of storage.

TABLE 1.—*Average scores of butter when fresh and after different periods of storage*

[Ten churnings at each acidity]

Cream acidity when churned	Fresh	After 4 months at 30° to 50° F.		After 8 months at 0° F.		After 8 months at 0° F. and 2 months at 30° to 50°		After 12 months at 0° F.	
	Score	Score	Decrease	Score	Decrease	Score	Decrease	Score	Decrease
Per cent	*Points*	*Points*	*Points*	*Points*	*Points*	*Points*	*Points*	*Points*	*Points*
0.15	90.49	89.78	0.71	90.13	0.36	89.20	1.29	89.32	1.17
.22	90.67	89.70	.97	90.21	.46	89.35	1.32	89.17	1.50
.25	90.57	89.62	.95	90.22	.35	89.10	1.47	89.29	1.28
.28	90.46	89.47	.99	90.12	.34	88.15	2.31	88.71	1.75
.31	90.32	89.19	1.13	90.10	.22	87.90	2.42	88.51	1.81

When stored for eight months at 0° F. all of this butter kept equally well and deteriorated very little. After the longer storage periods butter in the 0.28 and 0.31 per cent acid groups had deteriorated more than that in the lower acidity groups. After four months' storage at 30° to 50° butter in the 0.31 per cent acid group had lost 0.42 point in score more than that in the 0.15 per cent acid group.

[4] The authors wish to express their appreciation of the work of C. E. Eckles, Bureau of Agricultural Economics, U. S. Department of Agriculture, in scoring the many samples of butter used in this investigation.

SERIES 2

In series 2 the procedure was similar to that of series 1, except that the acidity was standardized after pasteurization. The organisms and flavor of the lactic culture, therefore, remained. This butter was also made during the winter. Seven churnings of each acidity were used in this series. The scores are shown in Table 2.

TABLE 2.—*Average scores of butter when fresh and after different periods of storage*

[Seven churnings at each acidity]

Cream acidity when churned	Fresh	After 4 months at 30° to 50° F.		After 8 months at 0° F.		After 12 months at 0° F.		After 12 months at 0° F. and 3 weeks at 30° to 50°	
	Score	Score	Decrease	Score	Decrease	Score	Decrease	Score	Decrease
Per cent	*Points*	*Points*	*Points*	*Points*	*Points*	*Points*	*Points*	*Points*	*Points*
0.15	91.10	89.21	1.89	90.55	0.55	89.67	1.43	89.50	1.60
.22	91.02	88.93	2.09	90.58	.44	89.58	1.44	88.92	2.10
.25	91.29	88.86	2.43	90.69	.60	89.83	1.46	89.08	2.21
.28	91.38	88.89	2.49	90.65	.73	89.25	2.13	88.67	2.71
.31	91.14	88.71	2.43	90.38	.76	88.58	2.56	87.92	3.22

When stored for 8 months at 0° F. all the butter had good keeping quality. After 12 months at 0° butter in the 0.28 and 0.31 per cent acid groups had deteriorated more than that in the lower acid groups; and after an additional 3 weeks at 30° to 50° there was a progressive increase in deterioration from 1.60 points for the 0.15 per cent acid group to 3.22 points for the 0.31 per cent acid group. After 4 months at 30° to 50° butter in the 0.25, 0.28, and 0.31 per cent acid groups had lost about one-half point in score more than that in the 0.15 per cent acid group.

SERIES 3

In series 3 a comparison was made of the quality of butter while fresh and after different periods of storage when cream was treated in different ways but churned at the same acidity. These churnings were made during the summer when cows were on pasture.

Nine lots of sweet cream were each divided into four parts, each part receiving a different treatment as follows: (1) Cream pasteurized sweet, then culture added just before churning to increase the acidity to 0.25 per cent; (2) culture added to cream to increase the acidity to 0.25 per cent, then pasteurized; (3) raw cream ripened with a culture to 0.35 per cent acidity, then neutralized with lime to 0.25 per cent and pasteurized; (4) raw cream ripened with a culture to 0.45 per cent acidity, then neutralized with lime to 0.25 per cent and pasteurized. The scores of this butter are shown in Table 3.

TABLE 3.—*Scores of butter when fresh and after storage for four months at 30° to 50° F. and eight months at 0°*

[Nine churnings of each method]

Cream No.	Fresh	After 4 months at 30° to 50° F.	After 8 months at 0° F.	Cream No.	Fresh	After 4 months at 30° to 50° F.	After 8 months at 0° F.
1	92.56	88.70	90.85	3	91.88	88.66	90.96
2	92.17	88.90	90.82	4	91.83	88.95	91.02

The scores of the fresh butter varied materially on account of the different methods of treating the cream. No. 1 had a good culture aroma and flavor; Nos. 3 and 4 had a slightly coarse flavor. After storage at 30° to 50° F. for four months all butter was of about the same quality. This was also the case after eight months at 0°. Developing acid in cream Nos. 3 and 4 with a lactic culture and reducing it with an alkali injured the flavor of the fresh butter slightly but did not lower its keeping quality. The acidity of the cream when churned rather than the acidity previous to treatment is the factor affecting keeping quality of butter.

SERIES 4

In this series seven churnings of cream were pasteurized sweet, then cooled, and each churning divided into four parts. One was held overnight and churned, the average acidity being 0.14 per cent. To the others about 10 per cent lactic culture was added, and each was held overnight at such a temperature as to develop nearly 0.25, 0.31, and 0.35 per cent acid, respectively. When the acidity the next morning was less than the desired amount, it was increased to that point by the addition of culture. Scores for butter containing the desired amount of acidity are given in Table 4. In some cases the desired acidity was exceeded. The scores for the butter made from such cream are given in Table 5. The butter in this series was stored only at 0° to 20° F. For a period of two weeks during the sixth month the temperature of the room was as high as 20° a part of each day. Both Tables 4 and 5 show that deterioration increased as acidity of the cream increased.

TABLE 4.—*Scores of butter when fresh and after storage for 8 and 11 months at 0° to 20° F.*

[Seven churnings at each acidity.]

Acidity of cream	Fresh	After storage at 0° to 20° F. for—			
		Eight months		Eleven months	
		Score	Decrease	Score	Decrease
Per cent	*Points*	*Points*	*Points*	*Points*	*Points*
0.14	92.27	90.30	1.97	90.28	1.99
.25	92.71	90.10	2.61	89.83	2.88
.31	92.69	89.87	2.82	89.50	3.19
.35	92.58	89.57	3.01	88.87	3.71

TABLE 5.—*Scores of butter when fresh and after storage for eight months at 0° to 20° F.*

[Six churnings at each acidity.]

Acidity of cream		Fresh	After eight months at 0° to 20° F.	Decrease
Range	Average			
Per cent	*Per cent*	*Points*	*Points*	*Points*
0.15	0.150	92.40	90.09	2.31
0.27 to .29	.280	92.78	89.68	3.10
.34 to .39	.365	92.55	88.95	3.60
.40 to .45	.425	93.28	88.63	4.65

COMMERCIAL CHURNINGS

To compare the results of experiments with butter made in the laboratory with that made commercially, a compilation was made of the scores on storage butter[5] judged in the contest held by the National Creamery Buttermakers' Association in 1925 and 1926. The entries were divided into six groups according to the acidity of the cream when churned. In order to make as fair a comparison as possible, no entries were used that reported the acidity of cream when received as being higher than 0.2 per cent, and only those entries were used that gave all the data needed. This butter was held in a commercial warehouse at about 0° F. The storage period for the 1926 butter was about five months and for the 1925 butter somewhat less.

Table 6 shows the scores of the butter when fresh and after storage. When fresh, the butter that scored lowest was that made from the cream of lowest acidity to which no culture had been added.

TABLE 6.—*Average scores of butter in the National Creamery Buttermakers' Association cold-storage butter contest, 1925 and 1926*

[292 entries.]

Acidity of cream when churned	Samples	Average acidity when—		Average score of butter			Samples not decreasing in score during storage		Samples scoring 94 or higher after storage	
		Received	Churned	Fresh	After storage	Decrease				
Per cent	*Number*	*Per cent*	*Per cent*	*Points*	*Points*	*Points*	*Number*	*Per cent*	*Number*	*Per cent*
0.20 or less [1]	60	0.169	0.172	92.83	92.60	0.23	24	40.6	3	5.0
.20 or less [2]	74	.153	.186	93.28	92.77	.51	20	27.0	7	9.5
.21 to 0.25	77	.187	.231	93.16	92.52	.64	22	28.6	6	7.7
.26 to .30	52	.165	.287	93.43	92.59	.84	10	19.2	4	7.7
.31 to .35	17	.182	.331	93.11	92.08	1.03	3	17.6	0	0.0
.36 to .45	12	.164	.401	93.21	91.45	1.76	2	16.6	0	0.0

[1] No culture. [2] Culture used.

After storage, the average scores of the butter in the cream-acidity groups up to 0.3 per cent were very close. The average score for the 0.31 to 0.35 per cent acid group was approximately one-half point lower than the scores for the groups of less than 0.31 per cent acid, and the average score for the 0.36 to 0.45 per cent acid group was about 1 point lower. Table 6 shows that the greater the acidity of the cream the greater the deterioration in the butter. The percentage of samples that scored as high after storage as when fresh, or higher, ranged from 40 for the lowest acidity group to 16.6 for the highest acidity group. None of the butter in the groups of more than 0.3 per cent acid scored as high as 94 points after storage.

SUMMARY AND CONCLUSIONS

Butter made from cream with acidities of 0.15 to 0.31 per cent kept well in storage at 0° F. for 8 months. After 12 months at 0° butter from cream with 0.15 to 0.25 per cent acid had deteriorated less than that in the 0.28 and 0.31 per cent acid groups.

When the butter was held at 30° to 50° F. for four months the deterioration was greater in the butter made from cream of greater

[5] Data obtained through courtesy of the secretary of the association.

acidity than in that made from the less acid cream. Butter in the 0.31 per cent acid group lost about one-half point in score more than that in the 0.15 per cent acid group.

When butter, made from cream with acidities of 0.14 to 0.45 per cent, was stored at 0° to 20° F. for 8 and 11 months the deterioration was greater in the butter made from cream of greater acidity than in that made from the less acid cream.

When commercial butter, made from cream with acidities up to 0.45 per cent, was held at 0° F. for about 5 months the deterioration was greater in the butter made from cream of greater acidity than in that made from less acid cream. After storage, however, the butter in all acidity groups up to 0.3 per cent scored about the same; and the average score for the 0.31 to 0.35 per cent acid group was approximately one-half point lower and for the 0.36 to 0.45 per cent acid group about 1 point lower than the scores for the groups of less than 0.31 per cent acid.

Butter made from cream with an acidity as high as 0.31 per cent may be expected to keep well for as long as 8 months when stored at a temperature of 0° F. or lower. There appears to be no advantage, however, in making butter for storage from cream with an acidity as high as 0.31 per cent.

Ripening cream with a lactic culture even to low acidities improves the score of the butter when fresh, but the improvement is usually lost during storage.

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