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Influence of Acidity on Flavor and Keeping Quality of Butter

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INFLUENCE OF ACIDITY ON FLAVOR AND KEEPING QUALITY OF BUTTER.

By M. Mortensen.

An increased demand during recent years for sweet cream butter emphasizes the question as to its flavor and keeping qualities as compared with ripened cream butter, and the desirability of manufacturing still more of the sweet cream product.

Merchants who are primarily interested in fancy butter are possibly to some extent responsible for creating this increased demand for sweet cream butter, altho it has been recognized for some years that this product has better keeping qualities than butter churned from sour cream and is therefore better suited for cold storing. Both factors are evidently responsible for the changes brought about in the type of butter manufactured in many plants.

At the same time, however, the general demand thruout the United States does not seem to be entirely in favor of sweet cream butter, and that fact brings about an uncertainty which prompts many buttermakers to write to the dairy section of the experiment station for advice.

To secure information of direct bearing upon the question at issue, the dairy section undertook the experiments reported in this bulletin. In general, it may be said that the results show that commercial judges of butter still grade ripened cream butter above sweet cream butter, when both are fresh, because the former has more of the characteristic butter flavor. Butter made from ripened cream deteriorates more rapidly, and at the end of two months' storage has about the same quality as sweet cream butter. For cold storing sweet cream butter is naturally more desirable.

PREVIOUS EXPERIMENTAL WORK.

As early as 1890 Patrick¹ at the Iowa Agricultural Experiment Station made comparisons between sweet and sour cream buttermaking. These experiments were repeated three years later by Patrick, Leighton and Heileman.² It was found from both series of experiments that sweet-cream butter suffered less deterioration during keeping than did the ripened-cream product and in some measure acquired the flavor characteristic of the latter. Dean³ (1904) reported that he churned sweet cream

¹ G. E. Patrick. Sweet versus Ripened Cream Butter. Ia. Agr. Exp. St. Bul. 18, 1890.

² G. E. Patrick, F. A. Leighton, W. H. Heileman. Sweet versus Ripened Cream Butter. Ia. Agr. Exp. St. Bul. 21, 1893.

³ H. H. Dean. Sweet Cream with Culture versus Ripened Cream. Thirtieth An. Rep. Ontario Agr. College and Exp. Farm, 1904.

to which 27½ percent starter was added and obtained better results than from ripened cream. Dean also reported that he compared butter made from sweet cream with butter made from sweet cream to which 20 to 30 percent starter was added and that the butter made by the latter method was superior in quality to the sweet-cream butter. Rogers and Gray⁴ (1909) reported that in accordance with their experiments butter made from pasteurized cream with starter added retained its fresh flavor better than the ripened-cream butter, but was not quite equal in keeping quality to that made from pasteurized cream alone.

Gray⁵ (1906) found that butter made from cream received at the creamery, sweet and in good condition, kept well while stored at -10° and 10° F; after removal from storage, this butter also gave results wholly satisfactory, while butter made from cream received at the creamery sour, but in fair condition, kept well in storage at -10° and 10° F, but deteriorated rapidly after removal from storage, giving, on the whole, results which were very unsatisfactory. Shutt and Charron⁶ (1907) compared sweet-cream butter and ripened-cream butter and concluded that the keeping qualities of the sweet-cream butter are distinctly superior to those of the ripened-cream butter and that by the sweet-cream process there is no greater loss of butterfat than in the ordinary method with ripened cream.

Rogers, Thompson and Keithley⁷ (1912) found that the scores of various samples of butter stored for 40 days at 0° F, 150 days at 0° F, and 150 days at 20° F, respectively, ranged with two exceptions, above 90 for the butter made from cream with an acidity below 0.3 percent, while those from cream testing higher in acidity were variable and usually below 90, this being especially true of samples stored at 20° F. The deterioration in the pasteurized ripened-cream butter stored at 0° F, was four times as great as that in the pasteurized sweet-cream butter at the same temperature and the difference at the higher temperatures was nearly as great. Even at 20° F the deterioration of the sweet cream was comparatively slight, indicating that this butter would retain its flavor well after removal from storage.

Rogers⁸ (1909) reported that in all cases in which his records were complete it was found that the experimental butters that became fishy were made from high acid cream. Fishy butter

⁴L. A. Rogers and C. E. Gray. The Influence of Acidity of Cream on the Flavor of Butter. U. S. Dept. of Ag. B. A. I. Bul. 114, 1909.

⁵C. E. Gray. The Keeping Qualities of Butter made under different Conditions and stored at different Temperatures. U. S. Dept. of Ag. B. A. I. Bul. 84, 1906.

⁶Frank T. Shutt and A. T. Charron. Sweet-Cream Butter. Dept. of Ag. Ottawa, Canada, Bul. 13, 1907.

⁷L. A. Rogers, S. C. Thompson and J. R. Keithley. The Manufacture of Butter for Storage. U. S. Dept. of Ag. B. A. I. Bul. 148, 1912.

⁸L. A. Rogers. Fishy Flavor in Butter. U. S. Dept. of Ag. Cir. 146 1909.

resulted from cream acidified with lactic and acetic acid. However, Rogers admitted that cream of high acidity does not uniformly develop fishiness. In accordance with the experience of Ruehle⁹ (1921) sour cream does not make butter of good keeping quality, fishy flavors being particularly likely to result. He found wild yeasts and the mold, *Öospora lactis*, usually associated together in a number of samples of oily and old-cream flavored butters. Guthrie¹⁰ (1916) concluded from experiments conducted on metallic flavor in dairy products that high acidity of the medium is a necessary condition for development of me-

lot to be divided for three churnings, arrangements were made for carrying on most of this work in cooperative creameries where sweet cream was being received. Much of this work was therefore done at the cooperative creameries at Manly, Algona, Hull, Boyden, and Northwood, Iowa, and credit is due to the buttermakers and creamery managers of these plants for their valuable assistance.

The sweet cream was received and mixed in a large vat, in which it was pasteurized at a temperature of 145° F for 30 minutes. After pasteurization, the cream was divided into two or three lots. One lot was cooled immediately to a temperature of 40° F and left at that temperature for three hours or longer and then churned while sweet. A second lot was likewise cooled to 40° F, but from 10 to 20 percent starter was added after a temperature of 60° F had been reached; at 40° F the cream was held three hours or longer. The third lot was cooled to ripening temperature, ranging from 65° to 70° F. A starter of the same kind as that used for the second lot was then added and the cream allowed to ripen until the desired amount of acidity had been produced, when the cream was cooled to churning temperature and held for not less than three hours before churning. The ripening was often completed in the evening; the cream was then cooled to 40° F and held at that temperature until churned the following morning. All of the lots of cream were churned at such temperatures that it would require from 40 to 60 minutes for churning.

The acidity to which the cream was to be ripened was determined from a number of preliminary experiments. Sweet cream was pasteurized, divided into various lots and ripened to different degrees of acidity. The butter was scored by commercial judges.

The best butter seemed to be obtained when the cream was ripened to a percent acidity determined by multiplying the milk serum of the cream by the factor .0063. As an illustration: Suppose the cream to be ripened contains 30 percent fat. It would then contain 70 percent milk serum. The percent acidity for this cream would be equal to $70 \times .0063 = .44$ percent. If the buttermaker figures the acidity in degrees, he will multiply the percent milk serum by the factor .35, or in the above illustration the cream should be ripened to $70 \times .35$ or 24 degrees of acidity.

As most of the butter was made in outside creameries and as the dairy analyst at the Iowa station had left to enter war service, complete chemical analyses of the butter samples were not made, but the butter was analyzed only for moisture and salt. This was done by ordinary factory methods. An Ames moisture test was employed in making the analysis for moisture. The salt

content was determined by titrating a salt solution, obtained by shaking 10 grams of butter with 250 cc. of water, with a solution of silver nitrate prepared by using 2.906 grams silver nitrate for a liter of solution. The percent salt in butter was determined by the following formula:

$$\frac{\text{Cc. silver nitrate solution required}}{5} = \text{percent salt.}$$

The butter was shipped to Chicago and New York. Two 10-pound tubs were shipped from each churning. They were numbered consecutively and one of a pair was marked "A" and the other "B." The "A" tubs were scored immediately upon arrival on the market. Both tubs were then placed in cold storage, where they were held at a temperature of 0°F. After about two months storage, the "A" tubs were rescored, while the "B" tubs remained in cold storage and were scored after a nine months' period. Credit is due to the judges, M. P. Kieffer of Gude Bros. and Kieffer Co., New York, and the butter experts from the following firms: James Rowland Co., New York, W. N. Mapes Co., New York, and G. W. Bull Co., Chicago.

In tabulating the results, the churnings resulting from the same original lot of cream are numbered alike with prefix "a" for sweet-cream butter, "b" for sweet-cream and starter butter, and "c" to designate that the cream was ripened.

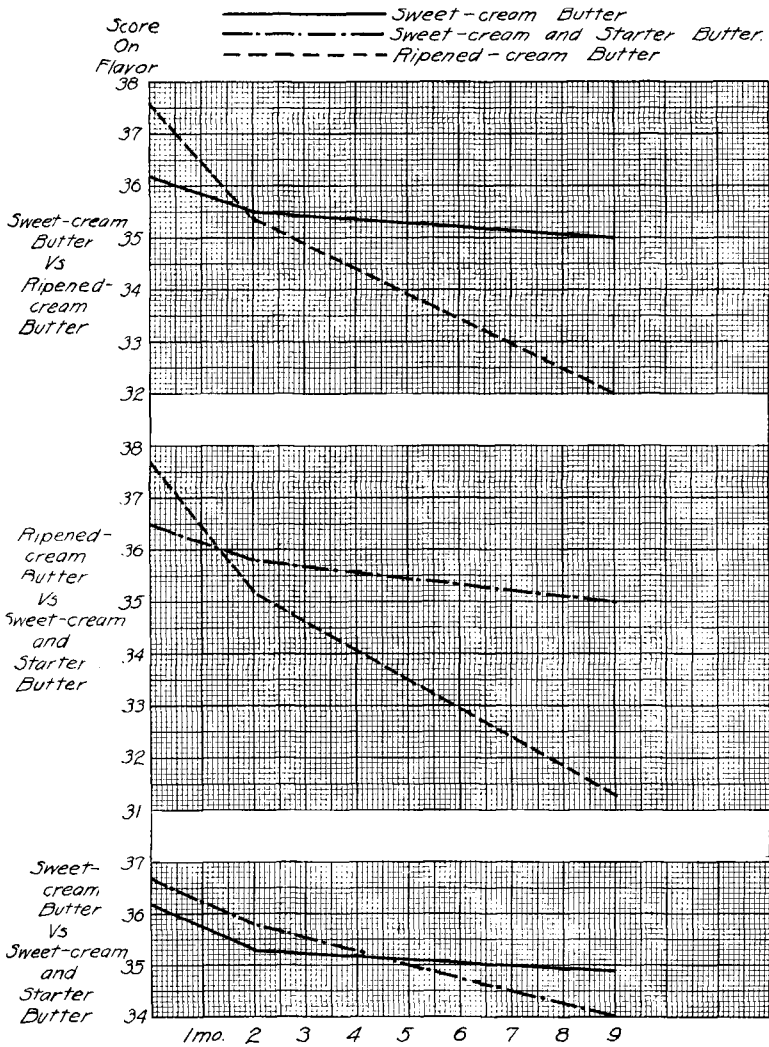
RESULTS.

SWEET-CREAM BUTTER VS. RIPENED-CREAM BUTTER.

Comparing results obtained between churning sweet and ripened cream, the ripened cream obtained the highest scores in 31 experiments out of 40 when scored immediately after it had reached the market in Chicago and New York; in 4 experiments the sweet-cream butter scored highest, while in 5 experiments the scores were the same. The average score for the ripened-cream butter was 37.6 on flavor as against a score of 36.2 on flavor for the sweet-cream butter.

After two months' holding in cold storage, the ripened-cream butter obtained the highest score in 19 out of 42 experiments, the sweet-cream butter ranked highest in 17 experiments, while for 6 experiments the score was the same for both. The average score on flavor was 35.4 for the ripened-cream butter as against a score of 35.5 for the sweet-cream butter.

After nine months' holding in cold storage, the sweet-cream butter obtained the highest scores in 15 of 26 experiments, the ripened-cream butter scored highest in 7, while the scores were the same in 4 experiments. The average score on flavor was 35. for the sweet-cream butter as against a score of 32. for the ripened-cream butter.



Graph showing comparison of flavor and keeping quality of sweet-cream butter.

RIPENED-CREAM BUTTER VS. BUTTER MADE FROM UNRIPENED SWEET CREAM AND STARTER.

Comparing results obtained from butter made from ripened cream and from sweet cream to which merely a starter was added and the cream churned without ripening, the ripened-cream butter obtained the highest scores in 23 of 32 experiments

when scored immediately after the butter had reached the market; the sweet-cream and starter butter scored highest in 6, while the scores were the same in 3 experiments. The average score on flavor for the ripened-cream butter was 37.7 as against 36.5 for the sweet-cream and starter butter.

After two months' holding in cold storage, the ripened-cream butter obtained the highest scores in 10 of 35 experiments; the sweet-cream and starter butter ranked highest in 20, while the scores were the same in 5 experiments. The average score on flavor for the ripened-cream butter was 35.2 as against 35.8 for the sweet-cream and starter butter.

After nine months' holding in cold storage, the ripened-cream butter obtained the highest scores in 6 of 23 experiments, the sweet-cream and starter butter ranked highest in 16, while the scores were the same in one experiment. The average score on flavor for the ripened-cream butter was 31.3 as against 35. for the butter made from the sweet cream and starter.

SWEET-CREAM BUTTER VS. BUTTER MADE FROM UNRIPENED-SWEET CREAM AND STARTER.

Comparing results from butter made from sweet cream and from sweet cream to which a starter was added before churning, the sweet cream obtained the highest score in 8 of 32 experiments immediately after the butter reached the market, the sweet-cream and starter butter scored highest in 16 experiments, while the scores were the same in 8 experiments. The average score for the sweet-cream butter was 36.2 and for the sweet-cream and starter butter, 36.7.

After two months' holding in cold storage, the sweet-cream butter obtained the highest scores on flavor in 10 of 35 experiments, while the butter made from sweet-cream and starter obtained the highest scores in 20 and the scores were the same for both in 5 experiments. The average score on flavor for the sweet-cream butter was 35.3 as against an average score of 35.8 for the butter made from sweet cream and starter.

After nine months' holding in cold storage, the sweet-cream butter obtained the highest scores on flavor in 11 of 22 experiments, while the butter made from sweet cream and starter scored highest in 8, and the scores were the same for 3 experiments. The average score on flavor was 34.9 for the sweet-cream butter as against 34. for the butter made from sweet cream and starter.

The results obtained from the above experiments are summarized in table I.

LOSS OF BUTTERFAT IN BUTTERMILK.

The buttermilk from each churning was tested for butterfat by the Babcock method. About 20. cc. commercial sulphuric acid were used for 17.5 cc. buttermilk, the speed of the centri-

TABLE I.—SUMMARY OF RESULTS.

Nature of experiments	Number of experiments	Age of butter when scored	Average score on flavor		
			Ripened-cream butter	Sweet-cream butter	Sweet-cream and starter butter
Sweet-cream butter	40	Fresh	37.6	36.2	
vs.	42	2 mo.	35.4	35.5	
Ripened-cream butter	26	9 mo.	32.1	35.0	
Ripened-cream butter	32	Fresh	37.7		36.5
vs.	35	2 mo.	35.2		35.8
Sweet-cream and starter butter	23	9 mo.	31.3		35.0
Sweet-cream butter	32	Fresh		36.2	36.7
vs.	35	2 mo.		35.3	35.8
Sweet-cream and starter butter	22	9 mo.		34.9	34.0

fuge was increased about 50 percent over normal and a temperature of about 200°F was maintained during the operation.

The average tests of buttermilk from all experiments were as follows: Buttermilk from ripened cream contained .25 of 1 percent fat, from sweet cream .30 of 1 percent, while the buttermilk from sweet cream plus starter contained .22 of 1 percent butterfat.

DISCUSSION OF RESULTS.

It would appear from the above experiments that the demand, as determined by the scores given by commercial judges, is still for butter made from ripened cream, as it possesses the most of the characteristic butter flavor. Butter made from ripened cream deteriorates, however, faster than either butter made from sweet cream or from sweet cream and starter, but in the above experiments where low ripening was employed, the ripened butter at the end of a two months' cold storage period was about of the same quality as the sweet-cream butter and the sweet cream and starter butter. This is of importance inasmuch as the butter ordinarily is consumed in considerably less time than two months after reaching the market. If butter is produced for cold storing, then the sweet-cream butter would naturally be most desirable.

Unless a creamery has a special demand for sweet-cream butter, it would seem to be most advantageous to produce butter from cream ripened to a low degree of acidity.

TABLE II. EXPERIMENTS IN DETAIL--(Continued).

Date	No. of churning	Percent acidity in cream		Percent starter added	Composition of butter		Scoring on flavor of butter											
		when received	when churn'd		Moisture	Salt	Sweet cream			Starter added			Ripened cream					
							1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd			
Aug...	25 b	.25	.30	10	13.6	2.63					37	38						
Aug...	25 c	.25	.49	5	15.9	1.51										38	39	28
Aug...	26 a	.27	.22	0	14.6	2.23	36½	36	33									
Aug...	26 b	.27	.38	20	15.2	3.16				37½	38							
Aug...	26 c	.27	.50	2½	15.1	2.84									37	37½	27	
Aug...	27 a	.22	.18	0	15.1	2.41	37	35										
Aug...	27 b	.22	.35	20	14.9	2.71				37	36							
Aug...	27 c	.22	.43	2½	14.6	2.69									38½	35		
Aug...	28 a	.20	.18	0	14.8	1.91	37	36										
Aug...	28 b	.20	.38	20	15.0	2.80				38	36							
Aug...	28 c	.20	.47	2½	15.7	2.52									37½	29		
Aug...	29 a	.21	.18	0	14.4	2.62	37½	36										
Aug...	29 b	.21	.35	20	14.4	2.63				37½	35							
Aug...	29 c	.21	.47	2½	15.7	2.57									37	29		
Aug...	30 a	.25	.20	0	14.7	1.85	36	37	33½									
Aug...	30 b	.25	.47	20	14.6	2.88				38	36½	31						
Aug...	30 c	.25	.53	2½	15.2	2.40									38½	36	26	
Aug...	31 a	.27	.20	0	14.5	2.51	36½	36	33									
Aug...	31 b	.27	.34	20	14.8	2.52				38	38	32						
Aug...	31 c	.27	.45	2½	16.0	2.29									39	37	24	
Aug...	32 a	.21	.21	0	15.4	2.08	36½	36	34½									
Aug...	32 b	.21	.33	17.4	15.2	2.71				36	37	32						
Aug...	32 c	.21	.46	2½	15.1	2.53									35½	34	25	
Aug...	33 a	.21	.20	0	14.6	2.32	37	35										
Aug...	33 b	.21	.35	20	14.6	2.35				37½	35							
Aug...	33 c	.21	.46	2½	15.5	2.05												
Aug...	34 a	.21	.21	0	14.4	2.20	37	35							39	33		
Aug...	34 b	.21	.34	20	15.8	2.67												
Aug...	34 c	.21	.46	2½	14.5	1.90				37	33							
Aug...	35 a	.17	.21	0	16.0	1.53									39	30		
Aug...	35 b	.17	.26	20	14.6	2.33	37½	35										
Aug...	35 c	.17	.45	2½	15.3	2.03				37	35							
Aug...	36 a	.20	.20	0	14.3	2.62	37	37	34½						38	32		
Aug...	36 b	.20	.31	15	14.5	2.31												
Aug...	36 c	.20	.46	2½	15.5	2.11				38½	38	34						
Aug...	37 a	.18	.19	0	14.7	2.32	37	39	32½									
Aug...	37 b	.18	.31	20	14.1	2.49				37½	37	32						
Aug...	37 c	.18	.38	2½	14.4	2.31									40	37	26	
Sept...	38 a	.20	.18	0	14.8	1.05	37½	37	34									
Sept...	38 b	.20	.28	20	14.2	2.62				38½	38	32						
Sept...	38 c	.20	.41	2½	15.8	2.58									39	34	25	
Sept...	39 a	.26	.25	0	15.0	2.16	37½	34	36									
Sept...	39 b	.26	.35	20	14.8	2.67				37	32	36						
Sept...	39 c	.26	.45	2½	14.8	2.50									38	31	32	
Sept...	40 a	.24	.23	0	14.3	1.74	37½	34										
Sept...	40 b	.24	.29	8½	14.9	2.51				37	32	36						
Sept...	40 c	.24	.48	2½	14.8	2.34									38	32	33	
Sept...	41 a	.16	.12	0	14.5	2.20	35	36½	34½									
Sept...	41 b	.16	.20	10	14.1	1.82				35	37	35						
Sept...	41 c	.16	.49	4	13.9	1.36									36	36	29	
Sept...	42 a	.23	.17	0	15.3	1.96	35	36½	33½									
Sept...	42 b	.23	.31	20	14.4	1.80				37½	37½	34½						
Sept...	42 c	.23	.48	2½	15.9	2.03									39	36	26	
Sept...	43 a	.20	.20	0	14.0	2.11	36	36½	33									
Sept...	43 b	.20	.31	20	14.4	2.12				37	37	33						
Sept...	43 c	.20	.45	2½	15.9	2.37									39	37	25	