
The Influence of Various Methods of Neutralizing Cream on the Quality of Fresh and Stored Butter

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THE practice of partially neutralizing with lime and soda neutralizers the acidity of sour cream intended for buttermaking has been a well-recognized commercial procedure for years. Early investigations comparing butter made from sour, partially neutralized cream with butter made from sour, untreated cream have definitely demonstrated the beneficial effects which may be derived from the intelligent application of certain neutralizers. Recently the influence of different types of neutralizers and the methods of applying them have received considerable attention. The results indicate a lack of agreement as to the type of neutralizer and the method of neutralization that should be employed for the most satisfactory results. Most of the butter manufactured in North Dakota creameries is made from sour cream; therefore, further investigational work to determine the influence of various neutralizers and different methods of applying them seems desirable.

The studies herein reported were for the purpose of determining (1) the chemical composition of the neutralizers commonly employed in the neutralization of cream for buttermaking; (2) the relationship between the type of neutralizer used and the quality of the butter from the standpoint of the flavor score; and (3) the effect of the method of neutralization upon the quality of butter.

HISTORICAL

In a study of the neutralization of sour cream for buttermaking, Ramsey (4) mentions the possibility of objectionable, volatile substances being removed from cream during the pasteurization process when bicarbonate of soda is employed as the neutralizing agent. Jackson (3), Davel (1) and Hunziker (2) believe that lime gives the best neutralizing

results. Stiritz and Ruehe (5) reported that no one of the neutralizers tried in their experiments could be said to produce better results than another in fresh butter. Bicarbonate of soda tended to reduce the score of the fresh butter slightly, since a perceptible bicarbonate flavor was present. Walts and Libbert (6) concluded from their examinations that, of the neutralizers studied, all had about the same effect on the flavor score of butter.

Double neutralization involves the reduction of the acidity of cream in two stages, either the same or different neutralizers being employed for each stage. The results of the experiments conducted by Stiritz and Ruehe (5) indicate that double neutralization shows no beneficial effects as compared with neutralizers used singly.

METHODS

Chemical analyses and alkalinity determinations were made on the neutralizers. The alkalinities of hydrated lime, quick lime, calcium and magnesia limes were determined by boiling a one-gram sample with an excess of N/2 hydrochloric acid and back titrating with standardized N/10 sodium hydroxide, using phenolphthalein as the indicator. The alkalinities of the soda neutralizers were determined by double titration, first with phenolphthalein and then with methyl orange.

In most of the trials cream containing more than 0.20 percent acidity, calculated as lactic acid, was reduced to approximately 0.20 percent by the addition of 10 percent aqueous solutions or suspensions of one of the following neutralizers: Hydrated lime ($\text{Ca}(\text{OH})_2$), magnesia lime ($\text{MgO} \cdot \text{Ca}(\text{OH})_2$), bicarbonate of soda (NaHCO_3), soda ash (Na_2CO_3) and sodium sesquicarbonate ($\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3$). Combinations of these were used for the comparisons involving double neutralization. The following method of adding the neutralizing materials was used: The temperature of the cream was raised to approximately 90° F. and the acidity determined. The cream was then divided into separate lots in tinned metal containers and the calculated amount of neutralizing mix was added by means of a small garden sprinkler. The cream was pasteurized at 145° F. for 30 minutes, cooled to 40° F. and held in a refrigerator over night. The churning was done the following morning.

When the cream was neutralized to various acidities with the same neutralizing mix, the acidity in each lot of cream was reduced by adding different amounts of the neutralizer and was then pasteurized by the method already described.

Churnings were made in a combined churn. The butter was washed by revolving it 8 to 10 revolutions in wash water equal to the amount of buttermilk drained from the churn. Salt was added at the rate of two and one-half percent of the calculated amount of butter. The butter was packed in 10-pound tubs lined with butter circles and liners which had been boiled in a saturated brine solution. After being held in a refriger-

ator at 40° F. from two to six days, the butter was shipped to a cold storage plant, where it was scored while fresh by two commercial butter judges. The butter was then placed in cold storage at 0° F. for periods ranging from three to four months.

The titratable acidity was determined in duplicate by titrating 20-gram portions of cream with N/10 sodium hydroxide.

RESULTS

Table 1 gives the composition and neutralizing strength of the neutralizers used in the trials.

For the sake of convenience, in the following discussion each butter will be specified by a symbol indicative of the neutralizer employed: Bicarbonate of soda (B.S.); hydrated lime (H.L.); soda ash (S.A.); sodium sesquicarbonate (S.S.C.); hydrated calcium and magnesium (H.C.M.).

The flavor score based upon 45 points as the perfect score was employed in all trials. Six trials, involving a total of 33 comparisons of various neutralizers, were made and the results are tabulated in table 2.

COMPARISONS OF BICARBONATE OF SODA (B.S.) WITH HYDRATED LIME (H.L.)

The data show that B.S. and H.L. produced slight but significant differences in the quality and keeping quality of the butter. Fresh B.S. butter appeared to be slightly superior to fresh H.L. butter since it ranked high in four comparisons, while in no comparison did the H.L. butter rank high. The average score of fresh B.S. butter was 0.50 points higher than that of the H.L. butter, but at the end of three months the difference in favor of B.S. butter was reduced to 0.07 points. Each type of butter exhibited a noticeable increase in score during the first month of storage, after which there was a gradual decrease. At the end of the three months the average score of the B.S. butter was 0.37 points lower than that of fresh B.S. butter, whereas the score of H.L. butter was 0.06 higher than that of the same butter when fresh.

COMPARISONS OF SODA ASH (S.A.) WITH HYDRATED CALCIUM AND MAGNESIUM (H.C.M.)

It is evident that there was no significant difference in the quality and keeping quality of the butters made with H.C.M. and S.A. When fresh, the S.A. butter scored high in one comparison, the H.C.M. butter in two, while the scores were the same in two. After one month the S.A. butter scored high in one comparison, the H.C.M. butter in three, while in one the scores were the same. After three months the S.A. butter ranked high in one comparison, the H.C.M. in two, and the scores were the same in two.

COMPARISONS OF HYDRATED LIME (H.L.) WITH SODIUM SESQUICARBONATE (S.S.C.)

The results indicate no apparent difference in the quality and keeping quality of the butter made with H.L. and S.S.C. neutralizers. The average

TABLE 1. *Composition and neutralizing strength of various neutralizers*

Cream neutralizer classification	Name of neutralizer	Pounds dry neutralizer required to neutralize one pound of lactic acid	CO ₂ %	Fe %	SiO ₂ %	SO ₃ %
I. Hydrates and carbonates of calcium	1. Ash Grove	0.552	9.35	0.52	0.36	T+ ¹
	2. Peerless	0.540	12.46	0.155	0.72	T+
II. Hydrates and carbonates of magnesium	1. K. and M. Technical	0.309	4.58	T	1.58	T
III. Oxides, hydrates and carbonates of calcium and magnesium	1. Kelley Island	0.454	13.70	0.129	0.28	T+
	2. K. and M.	0.660	36.22	T	0.47	T+
	3. Neutralac	0.447	6.47	0.11	0.35	T+
	4. Perfection	0.445	10.54	0.078	0.20	T+
IV. Oxides and hydrates of calcium and magnesium	1. Allwood	0.325	T+	0.418	0.35	T
V. Sodium bicarbonate	1. Bicarbonate of soda (U.S.P.)	1.110	51.42	none	0.02	T
VI. Sodium carbonate	1. Soda Ash (C.P.)	0.824
VII. Sodium sesquicarbonate	1. National Neutralizer	0.894	40.33	none	0.08	T
	2. Neutralene	0.920	40.82	none	0.04	T
	3. Wyandotte C.A.S.	0.956	39.98	none	0.06	T
	4. J. I. Holcomb Neutralizer	1.016

¹ T+ indicates slightly more than a trace; T indicates trace.

TABLE 2. *Influence of different types of neutralizers on the flavor score of butter*

No. of com- pari- sons	Neutral- izer used	Average acidity of the cream			Average scores on butter			Ave. change in butter scores		Relative placings of butter					
		Raw	Past.	churn- ing	Fresh	One mo.	Three mos.	One mo.	Three mos.	Fresh		One mo.		Three mos.	
										high	same	high	same	high	same
8	B. S. ¹	0.54	0.25	0.21	34.56	34.88	34.19	+0.32	-0.37	4	4	3	4	4	1
	H. L. ¹		0.22	0.20	34.06	34.63	34.12	+0.57	+0.06	0	4	1	4	3	1
5	S. A. ¹	0.50	0.21	0.21	34.80	33.10	34.40	-1.70	-0.40	1	2	1	1	1	2
	H. C. M. ¹		0.20	0.20	35.00	33.90	34.60	-1.10	-0.40	2	2	3	1	2	2
4	H. L. ¹	0.62	0.18	0.18	33.63	33.50	33.38	-0.13	-0.25	1	1	3	0	3	0
	S. S. C. ¹		0.23	0.21	33.75	33.25	33.25	-0.50	-0.50	2	1	1	0	1	0
6	S. A. ¹	0.49	0.19	0.19	fresh	two mos.	four mos.	two mos.	four mos.	fresh		two mos.		four mos.	
	H. L. ¹		0.20	0.20	34.58	33.33	34.25	-1.25	-0.33	high	same	high	same	high	same
4	S. A. ¹	0.67	0.21	0.19	34.42	34.17	33.67	-0.25	-0.75	2	3	3	1	3	1
	B. S. ¹		0.23	0.20	34.25	33.00	32.63	+0.12	-0.25	1	3	2	1	2	1
6	H. L. ¹	0.63	0.23	0.21	32.88	33.00	32.63	+0.12	-0.25	1	0	1	0	1	0
	H. C. M. ¹		0.19	0.17	33.25	33.38	33.28	+0.13	+0.13	3	0	3	0	3	0
6	H. L. ¹	0.63	0.23	0.21	33.63	33.50	33.38	-0.13	-0.25	4	0	3	1	3	1
	H. C. M. ¹		0.19	0.17	33.75	33.25	33.25	-0.50	-0.50	2	0	2	1	2	1

¹ See "Results" for explanation of abbreviations.

flavor scores of the H.L. butter when fresh and after two and four months were 33.63, 33.50 and 33.38, respectively, compared with 33.75, 33.25 and 33.25 for the S.S.C. butter. The slight differences in the scores were too small to be of significance. The decrease in the scores during storage was about the same for the two types of butter.

COMPARISONS OF SODA ASH (S.A.) WITH HYDRATED LIME (H.L.)

The data show that there was no significant difference in the quality and keeping quality of the two types of butter. The fresh S.A. butter and H.L. butter were fairly evenly divided as to the number of times each scored high in both the fresh and the stored products. The average flavor scores of the S.A. butter when fresh and after two and four months were 34.58, 33.33 and 34.25, respectively, compared with the average scores of 34.42, 34.17 and 33.67 for the H.L. butter. The large average decrease of 0.75 points in the H.L. butter after four months was attributed to a four point decrease in one comparison. With the exception of this comparison, the rate of decrease in score was practically the same for both types of butter.

COMPARISONS OF SODA ASH (S.A.) WITH BICARBONATE OF SODA (B.S.)

Although there were only four trials using S.A. and B.S. neutralizers, the data show relatively high scores for the B.S. butter since it ranked first in three of the four comparisons on both fresh and stored samples. A relatively large decrease in score during storage was shown by the S.A. butter, whereas the score of the B.S. butter increased during storage.

COMPARISONS OF HYDRATED LIME (H.L.) WITH HYDRATED CALCIUM AND MAGNESIUM (H.C.M.)

The data presented show no significant difference in the quality and keeping quality of the two types of butter. Although the fresh H.L. butter scored high in four trials compared with two for the H.C.M. butter, the samples were fairly evenly divided as to the number of times each ranked high or low in the stored products. There was a slight difference of 0.12 points in the average score in favor of the fresh H.C.M. butter; but after two and four months there was a difference of 0.25 and 0.13 points, respectively, in favor of the H.L. butter. These differences were not enough to be of any significance.

SINGLE VERSUS DOUBLE NEUTRALIZATION

Table 3 presents the results obtained on the 10 comparisons made to determine the difference in the quality and keeping quality of butter made from sour cream neutralized by single and double methods. When the double method was employed, the acidity of the sour cream was reduced to approximately 0.40 percent with hydrated lime; then the final acidity was reached with a different type of soda neutralizer. The cream was pasteurized at 145° F. for 30 minutes.

TABLE 3. The influence of different neutralizers on the flavor of butter
Single vs. double neutralization

Lot No.	Kind of neutralizer used	Percent acidity			Butter scores			Changes in the score from the fresh butter	
		Raw cream	Pasteurized cream	Cream at churning	Fresh	Two months	Four months	Two months	Four months
5	Hydrated lime (H.L.)	0.80	0.16	0.16	36.0	34.0	33.0	-2.00	-3.00
	Hydrated lime (H.L.) to 0.40		0.27	0.27	35.5	35.0	34.0	-0.50	-1.50
	Bicarbonate of soda (B.S.) to 0.27								
13	Hydrated lime (H.L.)	0.43	0.25	0.25	34.5	32.0	32.0	-2.50	-2.50
	Hydrated lime (H.L.) to 0.30		0.23	0.23	35.0	34.0	34.0	-1.00	-1.00
	Sodium sesquicarbonate (S.S.C.) to 0.19								
18	Hydrated lime (H.L.)	0.63	0.21	0.21	34.0	33.0	33.0	-1.00	-1.00
	Hydrated lime (H.L.) to 0.40		0.21	0.21	35.0	34.0	33.0	-1.00	-2.00
	Bicarbonate of soda (B.S.) to 0.21								
20	Hydrated lime (H.L.)	0.64	0.21	0.18	33.0	33.5	33.0	+0.50	0.00
	Hydrated lime (H.L.) to 0.40		0.13	0.14	34.0	33.5	33.5	-0.50	-0.50
	Bicarbonate of soda (B.S.) to 0.13								
21	Hydrated lime (H.L.)	0.66	0.25	0.23	34.0	34.5	34.5	+0.50	+0.50
	Hydrated lime (H.L.) to 0.40		0.26	0.25	33.0	33.0	33.0	0.00	0.00
	Sodium sesquicarbonate (S.S.C.) to 0.25								
22	Hydrated lime (H.L.)	0.76	0.24	0.25	33.0	32.0	32.0	-1.00	-1.00
	Hydrated lime (H.L.) to 0.40		0.21	0.21	33.0	32.0	32.0	-1.00	-1.00
	Soda ash (S.A.) to 0.21								
18	Bicarbonate of soda (B.S.)	0.63	0.23	0.23	33.5	33.5	34.0	0.00	+0.50
	Hydrated lime (H.L.) to 0.40		0.21	0.21	33.5	34.0	33.0	+0.50	-0.50
	Bicarbonate of soda (B.S.) to 0.21								
20	Bicarbonate of soda (B.S.)	0.64	0.22	0.19	33.0	33.0	33.0	0.00	0.00
	Hydrated lime (H.L.) to 0.40		0.13	0.14	34.0	33.5	33.5	-0.50	-0.50
	Bicarbonate of soda to 0.14								
21	Sodium sesquicarbonate (S.S.C.)	0.66	0.23	0.23	34.0	34.0	34.0	0.00	0.00
	Hydrated lime (H.L.) to 0.40		0.26	0.25	33.0	33.0	33.0	0.00	0.00
	Sodium sesquicarbonate (S.S.C.) to 0.25								
22	Soda ash (S.A.)	0.76	0.16	0.16	32.0	32.0	31.0	0.00	-1.00
	Hydrated lime (H.L.) to 0.40		0.21	0.21	33.0	32.0	32.0	-1.00	-1.00
	Soda ash (S.A.) to 0.21								
Average scores:		S. butter			33.70	33.15	32.95		
		D. butter			33.90	33.40	33.10		
Differences in the average scores					0.20	0.25	0.15		

For convenience, the butter made with a single method of neutralization will be designated as S. butter and that made with the double method as D. butter.

The fresh S. butter scored high in three comparisons, the D. butter in five, while in two comparisons the scores were the same. When the S. butter scored high, the maximum difference in the score of the two samples in a comparison was 1.0, the minimum difference was 0.5 and the average difference was 0.83. When the fresh D. butter ranked high, the maximum, minimum and average differences in the scores of the two lots in a comparison were 1.0, 0.5 and 0.9, respectively. After two months the S. butter scored high in three comparisons, the D. butter in four, and in two the scores were the same. When the stored S. butter ranked high, the maximum difference in the scores of the two samples was 1.5, the minimum 0.5 and the average 1.0. When the D. butter was high, the maximum, minimum and average differences in the scores in a comparison were 2.0, 0.5 and 1.0, respectively. After four months the S. butter scored high in three comparisons, the D. butter in five, while in two the scores were the same. When the S. butter ranked high, the maximum difference in the score of the two samples was 1.5, the minimum 1.0 and the average 1.2. When the D. butter was high, the maximum, minimum and average differences in the scores of the two samples were 2.0, 0.5 and 1.0, respectively.

The fresh S. butter had an average score of 33.70 compared with 33.90 for the fresh D. butter, or a difference of 0.20 points favoring the D. butter. After two months the average score of the S. butter was 33.15 as against 33.40 for the D. butter, or a difference of 0.25 points in favor of the D. butter. After four months the S. butter scored 32.95 compared with 33.10 for the D. butter, or a difference of 0.15 points in favor of the D. butter.

DISCUSSION

The types of neutralizers included in these studies would not be expected to produce large differences in the quality and keeping quality of the butter made from sour cream, because of their comparatively mild action on the cream. The high rate of solubility of the milder soda compounds, together with rapid chemical action, offsets largely the comparatively slow chemical changes produced by the more concentrated but less soluble calcium and magnesium neutralizers. The technique employed in the application of the neutralizers is undoubtedly of much more importance than the type of neutralizer used insofar as the quality of the resulting butter is concerned.

Considerable foaming was observed when bicarbonate of soda was employed, especially when the cream was relatively high in acid. Foaming of the cream may be a factor of some importance from the standpoint of pasteurization efficiency.

The data indicate that the scores of the butter commonly increased

during the first month of storage. This may be attributed to the disappearance, during the storage, of heated or neutralizer flavors.

CONCLUSIONS

1. Butter made from cream neutralized with bicarbonate of soda was commonly of better flavor when fresh than butter made from cream neutralized with hydrated lime or soda ash; after a three month storage period the scores were about the same.

2. The flavor scores of butter made from cream neutralized with bicarbonate of soda showed a comparatively rapid decrease during storage.

3. Only slight differences were found in the flavor scores of fresh and stored butter made from cream neutralized with soda ash, hydrated lime, sodium sesquicarbonate and hydrated calcium and magnesium.

4. Whether single or double neutralization was employed, the flavor and keeping qualities of the butter were not significantly affected.

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