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ACIDITY OF CREAMERY BUTTER AND ITS RELATION TO QUALITY

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Acidity of Creamery Butter and its Relation to Quality

BY

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

INTRODUCTION

The first intention in beginning these investigations on acidity of butter was to trace the relationship between the quality or score, and the acidity of the butter. If there should be a uniform relation between the two, then it would be possible, at least in part, to use an acid test in judging or scoring butter. The senses of taste, smell and sight have not always given satisfaction. A person's judgment is elastic, and all judges do not have the same standard, while an acid test is definite.

If any uniform relation existed, a certain percentage of the points in the score card might be based on the acid test.

During the last two years at different seasons, butter from different creameries has been sent to this experiment station, at which place it has been scored or judged by well known butter experts, as shown in the following tables, and at the same time tested for acid. Butter from different states was judged and tested for acid in the Chicago market. In addition, many lots of butter have been manufactured, judged, and tested at the experiment station. These tests and scores have been carefully studied, the results compared, and conclusions are herein reported.

The investigation accomplished so far in this connection has suggested a large additional and apparently fruitful field for further investigation: such as the source of acidity in

butter, factors affecting the different percentages of acid in fresh and aged butter, nature of these acids, and what relation they bear to rancid and ill-flavored butter, and old and fresh raw material. These and allied investigations are now in progress, and results will be reported in future publications.

ACID TEST FOR BUTTER

Butter at ordinary temperature is a solid. Before the acid content of it can be determined, the butter must be brought into solution, or at least into a fluid or liquid condition, at so low a temperature that none or very small amounts of the volatile acids escape.

Butter is so rich in fat that a certain amount of dilution is necessary to obtain a definite end point in the titration process.

Several methods of testing butter for acid were experimented with. The test first tried consisted of weighing 10 g. of butter into a beaker, then adding 50 c. c. of warm water at a definite temperature. This latter melted the butter. It was then mixed by shaking, a few drops of phenolphtalein indicator were added, and finally the whole was titrated with tenth-normal alkali. For comparison, water at different temperatures was used. The results of using water at different temperatures as compared with the ether and alcohol method are given in the following table.

The fresh butter is not over one week old, while the old butter ranges in age between two weeks and four months. All the butter was kept in the creamery refrigerator, the temperature of which was between 40° F. and 50° F.

Each of the results shown in the following tables represent the average of three determinations.

TABLE I

TABLE SHOWING COMPARISONS OF ACID TESTS FOR BUTTER, IN WHICH ETHER AND ALCOHOL, AND WATER AT DIFFERENT TEMPERATURES WERE USED

Sample	Butter Dissolved in Ether and Alcohol—C. c. n/10 alkali to neutralize 10 g. of butter	Butter Melted in 50 c. c. of Distilled Water C. c. n/10 alkali required to neutralize 10 g. of butter				
		At 110°F	At 120°F	At 140°F	At 160°F	At 180°F
Fresh butter	4.28	3.00	2.88	2.85	2.73	2.65
Fresh butter	3.50	.....	2.43	2.38	2.45	2.35
Fresh butter	2.25	.....	1.83	1.70	1.48	1.43
Old butter	8.53	6.60	6.68	6.73	4.80	3.70
Old butter	17.05	11.45	11.00	11.25	10.00	9.20
Old butter	17.75	14.15	13.75	13.30	12.10	10.85
Old butter	11.50	.....	8.30	7.75	7.58	7.30
Average	9.26	.....	6.69	6.66	5.87	5.36

At 110° F. the end point of the titration process is determined with difficulty. For that reason, the test at 110° F. was discontinued, and appears blank in some of the experiments reported in the above table.

The above results show that the use of hot water in connection with the acid test is not satisfactory. The low results obtained by the use of water are undoubtedly due to the escape of some of the volatile acids, especially at the higher temperature, and perhaps to the incomplete removal of the acids from the fat. When water is used, the fat is simply melted and not dissolved. The fat rises to the top, and it is somewhat difficult to get the fat to mix with the water to the extent of removing all the acids from the fat.

Different proportions of butter, ether, and alcohol were used. Five grams of butter were dissolved in 20 c. c. of ether and then mixed with 10 c. c. of denatured alcohol. Ten c. c. of ether and 5 c. c. of alcohol and the same amount of butter (5 g.) were also used. Either of these proportions gave good results, except the butter sample, which was considered too small and consequently increased to 10 g.

Gasoline and benzine were experimented with, but did not give as good satisfaction as ether. The two former did not mix so well with the butter constituents as did the latter.

SAMPLING BUTTER IN TUBS

The following table shows results obtained by testing the top, middle and bottom part of the butter in each tub. Each sample was secured by drawing several trier-fuls of butter from top to bottom. About one inch of each plug was taken from bottom, middle, and top. The corresponding parts from each trier-ful were put together in a glass vessel, then softened, mixed and tested:

TABLE II

TABLE SHOWING ACIDITY OF BUTTER FROM THE TOP, MIDDLE, AND BOTTOM PART OF TUB

SAMPLE	Top	Middle	Bottom
Fresh butter	2.12	2.01	1.95
Fresh butter	2.02	1.91	2.05
Fresh butter	2.31	2.24	2.29
Old butter	9.00	8.45	8.84
Old butter	10.21	9.05	10.00
Old butter	5.06	3.76	5.05
Old butter	5.09	3.59	5.05
Average	5.11	4.43	5.03

The difference in acidity of the fresh butter in the different parts of the tub is small, while old butter shows the highest acidity at the top, slightly less at the bottom, and the least in the center. This is in accordance with what is already known about the rancidity of butter. When butter is exposed to the air, it deteriorates quicker than that part of the same butter not so exposed. The acidity also increases in similar proportion, as does the rancidity.

DESCRIPTION OF ETHER AND ALCOHOL BUTTER ACID-TEST

When tub butter is sampled, the sample is secured by inserting a trier about an inch from the circumference or outside of the tub, and forcing it diagonally to the bottom of the

tub. Then the sample is drawn, transferred into a glass vessel, and softened by placing it in water at about 100° F. It should not be heated so that it melts, and should be stirred and mixed thoroughly during the process. For ordinary testing, one trier-ful of butter is sufficient. Several trier-fuls, obtained from different parts of the tub, may be taken if extreme accuracy is desired. When the butter for testing is secured from the churn, a small sample should be taken from different parts. A better sample can be secured from the tub, as samples direct from the churn are not always equally well drained.

When a fair sample has been secured and prepared, a definite amount (10 grams) is weighed into a previously weighed glass beaker, or some other suitable vessel. Secondly, enough ether (20 c. c.) is added to dissolve the butter. (Squibb ether was used.) The process is hastened by stirring or mashing the butter with a small glass rod. If it is soft, the butter will dissolve at once, while if firm, a few minutes are required. When the fat is in solution, half as much alcohol (10 c. c. denatured alcohol) is added, as ether used, and the whole is mixed. The alcohol should be previously neutralized. For ordinary testing, a correction of 0.2 c. c. should be subtracted, and the results will be reasonably accurate. Then a few drops of indicator (phenolphthalein) are added, and the mixture is titrated with standard alkali (tenth normal was used satisfactorily). The addition of the alcohol causes the alkali to mix homogeneously with the remainder of the solution.

Inasmuch as the acids present in butter are unknown, which is especially true of old butter, the results are reported in number of cubic centimeters of tenth normal alkali required to neutralize the acid in 10 grams of butter.

PROVISIONAL METHOD

(Revised Bulletin 107, Bureau of Chem. U. S. Dept. of Agriculture)

The provisional method for determining the free fatty acids of butter fat is as follows:

"Weigh 20 grams of fat or oil into a flask. Add 50 c. c. of 95 per cent alcohol which has been neutralized with weak caustic soda, using phenolphthalein as indicator, and heat to the boiling point. Agitate the flask thoroughly in order to dissolve the free fatty acids as completely as possible. Titrate with tenth-normal alkali until the pink color persists after vigorous shaking.

"Express results either as percentage of oleic acid, as acid degree (cubic centimeters of normal alkali required to neutralize the free acids in 100 grams of oil or fat), or as acid value (milligrams of potassium hydroxide required to saturate the free acids in one gram of fat or oil).

"One c. c. of tenth-normal alkali equals 0.0282 gram of oleic acid."

On the assumption that the fat contained nearly all the acid in butter, this method was experimented with as a test for the amount of acid in butter, and the results obtained as compared with the ether and alcohol method are shown in the following table:

TABLE III

TABLE SHOWING COMPARISON OF ACIDITY OF 10 G. OF BUTTER AS DETERMINED WITH ETHER AND ALCOHOL METHOD AND THE PROVISIONAL METHOD

(Twenty grams of fat were used as a sample in the Provisional Method, but for the sake of comparison, results have been reduced to the basis of ten grams, the same amount as is used in the Ether and Alcohol Method.)

SAMPLE	C. c. n/10 alkali to neutralize acid in 10 grams of butter Ether and Alcohol Method	C. c. n/10 alkali to neutralize 10 grams of butter-fat Provisional Method
Fresh butter	2.87	1.63
Fresh butter	2.17	1.03
Fresh butter	2.12	1.02
Fresh butter	3.62	2.20
Fresh butter	2.30	1.35
Fresh butter	2.45	1.71
Fresh butter	2.67	1.57
Fresh butter	2.60	2.03
Fresh butter	2.62	1.73
Fresh butter	2.03	1.30
Fresh butter	2.03	1.20
Fresh butter	1.85	0.83
Fresh butter—Cream from morning milk	0.90	0.67
Fresh butter—Cream from morning milk	1.07	0.48
Fresh butter—Cream from morning milk	1.18	0.73
Fresh butter—Starter added to cream from morning milk	1.62	0.63
Average of fresh butter	2.13	1.26

TABLE III—CONTINUED

SAMPLE	Ether and Alcohol Method	Provisional Method
Old butter	19.83	19.30
Old butter	4.21	3.43
Old butter	17.80	18.26
Old butter	13.13	11.36
Old butter	20.57	19.08
Old butter	20.63	18.47
Old butter	11.20	9.32
Old butter	12.07	9.80
Average of old butter	14.93	13.62
Grand average of old and fresh butter	6.40	5.38

Butter is principally a mechanical mixture of the well known constituents, fat, water, curd, salt, with a few other components which, quantitatively speaking, are of minor importance. These substances other than fat contain a portion of the acids of butter. As butter becomes aged, and rancidity as well as acidity increases, the amount of acid separating with the brine of butter varies.

From the above table, it will be noticed that the provisional method for acid in butterfat produces results lower than those of the ether and alcohol method for butter. This is especially true of fresh butter. The provisional method shows the acid in the fat only, while the ether and alcohol method shows the acid in all of the constituents of butter, and not in the fat alone. Another reason which in a measure accounts for the lower results by the provisional method, is the high temperature of the fat at the time the test is made. The high temperature causes some of the volatile acids to escape. This latter factor is especially potent in connection with old, decomposed butter. The ether and alcohol test is made at room temperature, and a variation in temperature below 95° F. has no appreciable effect on the volitalization of the fatty acids.

What is termed fresh butter in the above table is butter from

the regular college creamery make. None of it is more than one week old. Some of the samples were taken fresh from the churn, and the last four samples were made from fresh morning milk. The morning milk from the college dairy herd was skimmed as soon as possible after milking. The sweet cream was cooled for about two hours and then churned. The butter made in this manner showed a greater acidity than was expected. None of this fresh cream from the morning milk at the time of churning contained over .14% of acidity, except the last one, which was ripened with the addition of a good starter, and churned when the acidity was .63% twenty-six hours after it was milked. More experiments along this line are in progress. It is interesting to note that this last sample, although ripened to a high degree of acidity, contains no greater acidity in the fat than do the other samples churned from the very freshest sweet cream.

The age of the old butter varies between two weeks and four months. It is interesting to note that the older the butter is, the greater per cent of the acid is found in the fat.

ACIDITY OF FAT AND BRINE IN BUTTER

In order to ascertain the per cent of acid in the fat and the per cent separating with the substances not fat, the following experiments were conducted:

About a pound of butter was taken in each experiment. A sample of this was taken for chemical analysis. The remainder was put into a tall cylindrical jar. This jar was put into water which was gradually warmed to 130° F. and kept at this temperature four hours, until all of the butter was melted, and the substances not fat had settled to the bottom. The fresh butter settled into three distinct layers: first, the fat on top, second, the curd in the middle, which evidently contained some brine, and third, the clearer brine at the bottom. Each of these layers was tested for the per cent of acid.

TABLE IV

TABLE SHOWING ACIDITY OF FAT, CLEAR BRINE, AND CURDY BRINE

(10 g. of each were used for the test)

	C. c. n/10 alkali to neutralize acid in 10g. butterfat Ether and Alcohol Method	C. c. n/10 alkali to neutralize 10g. of clear brine	C. c. n/10 alkali to neutralize 10g. of curdy brine
Fresh butter	3.62	1.73	5.16
Fresh butter	2.87	2.48	4.40
Fresh butter	2.17	2.90	4.17
Fresh butter	2.12	1.95	4.88
Average	2.69	2.66	4.65

The curdy brine has a considerably greater acidity than has the clear brine. This is evidently due to the greater per cent of casein and its compounds present in the curdy part, and the less amount of these in the clearer brine.

The brine of old butter does not separate in the same manner as does the brine of fresh butter. The brine of old butter appears more as a homogeneous mixture, evidently due to the more complete change of the casein and its compounds into substances soluble in brine.

The chief object in view in this connection was to find the per cent of acid in the fat of the butter, and the per cent of the acid separating with the brine of the butter. (The brine in these experiments comprises the mixture of the curdy and clear brine.)

To accomplish this, the butter was first analyzed chemically, then melted in tall jars at a definite temperature, as described above. Ten grams of fat and ten grams of the brine mixture from each sample were tested for acid. Having the percentage composition of the butter, and the acidity of the fat and substances not fat, the per cent of acidity present in the fat, and in the substances not fat of butter can be calculated.

The following table contains these data:

TABLE V

TABLE SHOWING PERCENTAGE OF ACID IN THE FAT AND BRINE OF FRESH AND AGED BUTTER

	Composition of Butter				C. c. n/10 alkali to neutralize acid in			
	Per Cent Water	Per Cent Fat	Per Cent Casein	Per Cent Ash	10g. of butter Ether and Alcohol Method	Fat in 10g. of butter Ether and Alcohol Method	Brine in 10g. of butter	Per cent of acid in the brine
Exp. 1....	12.16	84.13	0.79	2.72	2.40	1.20	0.67	27.92
Exp. 2....	10.43	86.65	0.71	2.47	2.50	1.56	0.68	27.20
Exp. 3....	14.50	81.56	0.90	1.50	2.70	1.31	0.74	27.40
Exp. 4....	11.21	84.38	1.17	2.82	2.70	1.86	0.43	15.93
Exp. 5....	11.18	85.50	0.80	2.14	2.70	1.59	0.61	22.59
Exp. 6....	12.73	83.45	0.79	2.82	2.10	1.08	0.61	29.05
Exp. 7....	13.42	82.83	0.77	3.04	2.10	1.16	0.64	30.48
Exp. 8....	12.53	83.62	0.81	3.01	1.95	0.84	0.57	29.73
Exp. 9....	15.46	80.62	0.83	3.00	1.70	0.56	0.52	30.59
Exp. 10....	15.66	80.45	0.90	2.93	1.00	0.56	0.14	14.00
Exp. 11....	20.69	74.66	1.67	2.75	1.15	0.60	0.23	20.00
Exp. 12....	14.22	80.33	1.04	4.42	1.30	0.60	0.14	10.76
Exp. 13....	7.91	89.68	1.20	1.16	19.90	17.67	1.26	6.33
Exp. 14....	9.34	88.05	0.97	1.88	4.30	3.17	0.45	10.47
Exp. 15....	8.04	89.42	1.00	1.62	17.90	16.90	1.01	5.64
Exp. 16....	7.91	86.89	1.08	4.12	13.30	10.25	1.35	10.15
Average..	12.33	83.88	0.96	2.65	4.98	3.82	0.64	12.80

Numbers 13, 14, 15 and 16 are old butters. The remainder are fresh, or not over a week old. Numbers 10 and 11 were churned from sweet, fresh cream containing .14% of acid. This cream was skimmed from morning milk and cooled at once for two hours and then churned.

It will be noticed in the table that the sum of the acid in the brine and the fat does not equal the acid in the butter. The average shows a difference of 0.5 c. c. This difference is undoubtedly due to the escape of some of the volatile fatty acids during the heating and melting process necessary to separate the brine from the butter. The temperature at which these samples were melted and at which they were kept during the four hours' time of separation was 130° F.

THE RELATION OF ACIDITY TO QUALITY OF CREAMERY BUTTER

The results appearing in the following tables were obtained from butter made at different creameries and at different seasons. The conditions under which the butter was manufactured were reported with each entry, but are not included herewith. The factors affecting the acidity of butter are now being investigated, and will furnish more exact data than those obtained from above mentioned creamery reports. However, they may be valuable for comparative study.

The butter was judged by Messrs. G. L. McKay, W. B. Johnson, H. T. Sondergaard, J. C. Joslin and H. J. Credicott, and others, as indicated in each table.

The acid test could not possibly be a measure of the mechanical faults of the butter, such as "high and gritty salt," "weak body," "streaked and mottled color," etc. If there is any relation, it is between the flavor and the acidity. In cases where butter has been scored "off," due to mechanical defects, a statement to this effect is made in the table under the heading of "Remarks."

ENTRY I

Judged by Professor G. L. McKay, January 18, 1908.

No.	Acidity C. c. n/10 alkali to neutralize 10 grams of butter	Score 100 Perfect	Remarks
1	2.40	95.00	
2	2.80	90.00	
3	2.40	90.00	
4	2.80	93.00	
5	2.60	89.00	½ point off on color; 1 point off on package
6	2.40	92.00	½ point off on color
7	3.00	94.75	¼ point off on color
8	2.40	95.00	
9	3.20	88.50	½ point off on style
10	2.40	93.00	1 point off on color
11	3.40	93.00	
12	2.40	94.50	
13	3.20	94.00	
14	2.20	88.50	1 point off on color; ½ point off on salt
15	3.20	96.00	
16	2.80	92.00	
17	2.40	94.00	
18	2.00	94.00	
19	3.20	88.50	½ point off on color
20	2.40	93.00	
21	2.40	95.00	
22	3.00	92.00	
23	3.00	95.00	
24	1.80	93.00	½ point off on color
25	2.40	92.00	
26	1.60	93.00	
27	2.80	92.00	
28	2.80	91.00	

	Score	Acidity
Average of 16 tubs scoring 93 and above	94.08	2.55
Average of 9 tubs scoring 89 to 93	91.11	2.67
Average of 3 tubs scoring below 89	88.00	2.55
Grand average	91.70	2.39

ENTRY 2

Judged by Profssor G. L. McKay, April 3, 1908.

No.	Acidity C. c. n/10 alkali to neutralize 10 grams of butter	Score 100 Perfect	Remarks
1	2.80	91.75	
2	3.00	88.00	
3	2.60	93.00	
4	2.00	94.50	
5	1.60	93.25	
6	2.00	91.50	
7	3.20	91.00	
8	2.00	94.00	
9	2.60	92.00	
10	2.40	93.00	
11	2.60	93.00	
12	2.40	88.00	
13	2.00	95.00	
14	2.60	91.00	½ point off on salt
15	2.00	89.00	
16	2.40	89.50	
17	2.40	89.50	½ point off on color
18	2.40	93.25	½ point off on color
19	2.40	89.00	½ point off on body
20	2.40	93.25	½ point off on body
21	2.20	91.50	
22	2.60	91.50	
23	3.20	91.00	
24	2.20	91.00	½ point off on salt
25	2.20	94.75	
26	2.00	89.50	
27	2.60	90.00	
28	2.20	91.50	
29	2.20	94.50	
30	2.60	93.25	

	Score	Acidity
Average of 12 tubs scoring 93 and above	93.73	2.25
Average of 16 tubs scoring 89 to 93	90.64	2.46
Average of 2 tubs scoring below 89	88.00	2.70

ENTRY 3

Judged by W. B. Johnson on May 13, 1908.

No.	Acidity C. c. n/10 alkali to neutralize 10 grams of butter	Score 100 Perfect	Remarks
1	2.20	93.00	
2	2.60	89.00	
3	2.00	92.50	
4	1.80	92.50	
5	1.20	88.00	3 points off on body
6	2.00	93.00	
7	1.80	92.75	¼ point off on salt
8	2.40	90.50	
9	2.40	93.50	
10	1.80	92.50	
11	1.80	93.00	
12	2.00	92.50	
13	2.00	90.50	
14	1.80	90.50	
15	2.60	87.00	
16	2.00	93.00	
17	2.60	88.00	
18	2.20	89.00	
19	1.80	89.00	
20	1.80	92.50	
21	1.60	88.50	
22	2.00	94.50	
23	1.40	92.00	
24	1.80	92.50	
25	2.00	93.50	

	Score	Acidity
Average of 7 tubs scoring 93 and above	93.35	2.06
Average of 14 tubs scoring 89 to 93	91.30	1.94
Average of 4 tubs scoring below 89	87.88	2.00
Grand average	91.33	1.98

ENTRY 4

Judged by J. C. Joslin on June 17, 1908.

No.	Acidity C. c. n/10 alkali to neutralize 10 grams of butter	Score 100 Perfect	Remarks
1	1.60	94.00	
2	1.90	91.00	
3	2.00	90.50	
4	2.20	92.00	
5	1.60	92.50	
6	1.70	90.50	½ point off on body
7	2.00	90.50	½ point off on salt
8	2.00	92.00	
9	2.00	93.50	
10	2.20	91.50	½ point off on color
11	2.00	94.50	
12	1.60	91.00	
13	2.00	93.00	
14	1.80	90.00	
15	1.80	93.50	
16	1.45	92.00	
17	2.20	94.50	
18	1.80	90.00	
19	1.60	91.00	½ point off on body
20	2.00	91.50	
21	1.40	93.00	
22	2.00	94.00	
23	2.00	93.50	
24	1.20	91.50	
25	1.65	92.00	1 point off on color
26	1.60	91.00	

	Score	Acidity
Average of 9 tubs scoring 93 and above	93.72	1.89
Average of 17 tubs scoring 89 to 93	91.21	1.78
Grand average	92.08	1.82

ENTRY 5

Judged by C. Larsen on August 18, 1908.

No.	Acidity C. c. n/10 alkali to neutralize 10 grams of butter	Score 100 Perfect	Remarks
1	2.05	89.00	½ point off on salt
2	2.20	91.00	
3	1.60	90.00	1 point off on body
4	2.20	87.50	1 point off on body; ½ off on color
5	1.60	90.50	½ point off on body
6	1.45	93.00	
7	2.05	87.50	½ point off on body
8	1.85	86.50	½ point off on body; 1 off on salt
9	1.65	91.00	
10	1.65	91.50	
11	1.80	90.00	1 point off on salt
12	1.80	87.00	½ point off on body
13	1.80	89.00	2 points off on color
14	2.60	89.00	
15	1.80	90.50	½ point off on body; ½ off on color
16	1.80	91.00	
17	1.60	92.00	
18	1.80	92.50	
19	2.00	90.00	
20	1.45	88.00	1 point off on body
21	2.00	90.00	1 point off on body
22	2.00	92.00	
23	1.85	91.00	½ point off on body

	Score	Acidity
Average of 1 tub scoring 93 and above	93.00	1.45
Average of 17 tubs scoring 89 to 93	90.59	1.87
Average of 5 tubs scoring below 89	87.30	1.87
Grand average	89.98	1.85

ENTRY 6

Judged by H. Sondergaard on September 6, 1908.

No.	Acidity C. c. n/10 alkali to neutralize 10 grams of butter	Score 100 Perfect	Remarks
1	1.60	93.50	
2	1.20	91.50	
3	2.00	90.00	
4	2.20	94.00	
5	1.80	92.00	
6	2.40	93.50	1 point off on color
7	1.60	93.00	
8	1.40	95.00	½ point off on color
9	1.40	93.00	
10	1.60	95.00	
11	2.40	90.50	
12	2.00	90.00	
13	1.60	94.00	
14	1.60	90.00	1 point off on color
15	2.80	89.00	
16	2.20	91.50	½ point off on salt
17	1.60	93.00	
18	1.80	90.50	
19	1.80	89.00	
20	3.00	88.00	1 point off on body
21	1.60	92.50	
22	2.40	87.00	
23	2.00	93.50	
24	1.80	96.50	
25	2.40	87.00	

	Score	Acidity
Average of 10 tubs scoring 93 and above	93.90	1.78
Average of 12 tubs scoring 89 to 93	90.67	1.88
Average of 3 tubs scoring below 89	87.33	2.60
Grand average	91.56	1.93

ENTRY 7

Judged by C. Larsen and T. H. Lund, March 12, 1909.

No.	Acidity C. c. n/10 alkali to neutralize 10 grams of butter	Score 100 Perfect	Remarks
1	2.00	95.50	
2	2.40	94.75	¼ point off on color
3	2.00	93.50	
4	1.60	93.50	½ point off on color
5	2.20	93.00	½ point off on body
6	2.00	92.50	
7	2.00	92.50	½ point off on color
8	1.60	92.50	
9	1.60	92.50	
10	2.80	92.00	
11	1.60	91.75	¼ point off on body
12	2.00	91.50	
13	1.60	91.00	
14	1.80	90.00	
15	2.00	90.00	
16	1.60	88.00	

	Score	Acidity
Average of 5 tubs scoring 93 and above	94.05	2.04
Average of 10 tubs scoring 89 to 93	91.62	1.90
Average of 1 tub scoring below 89	88.00	1.60
Grand average	92.16	1.93

ENTRY 8

Judged by C. Larsen and T. H. Lund, May 3, 1909.

No.	Acidity C. c. n/10 alkali to neutralize 10 grams of butter	Score 100 Perfect	Remarks
1	2.00	94.25	
2	2.20	93.00	
3	2.00	92.50	
4	1.20	96.25	
5	1.40	89.50	
6	2.00	92.25	
7	1.80	92.00	
8	1.80	93.00	¼ point off on color
9	1.80	91.00	
10	2.20	95.25	
11	1.60	91.25	
12	2.00	91.50	
13	1.40	89.50	1 point off on salt
14	1.60	89.75	¾ point off on color
15	1.40	89.75	¾ point off on salt
16	1.80	92.50	
17	2.00	93.00	½ point off on color
18	2.00	91.50	¼ point off on color; ¼ on salt
19	2.00	92.00	
20	1.40	92.50	
21	2.60	90.00	

	Score	Acidity
Average of 6 tubs scoring 93 and above	94.13	1.90
Average of 15 tubs scoring 89 to 93	91.17	1.79
Grand average	92.01	1.82

ENTRY 9

Judged by C. Larsen and T. H. Lund, June 29, 1909.

No.	Acidity C. c. n/10 alkali to neutralize 10 grams of butter	Score 100 Perfect	Remarks
1	2.00	91.00	
2	1.40	89.00	1 point off on body
3	1.20	91.25	½ point off on body
4	1.80	93.50	¾ point off on body
5	2.20	91.00	½ point off on body
6	1.95	82.00	
7	2.60	94.00	
8	1.60	93.00	
9	1.80	95.00	
10	2.00	91.50	½ point off on body
11	1.80	93.00	½ point off on body
12	1.80	92.50	
13	1.85	95.50	
14	1.85	93.00	
15	2.20	91.50	
16	2.20	93.00	
17	1.50	92.00	
18	1.60	94.00	
19	2.30	87.00	
20	1.70	93.00	
21	2.30	91.50	
22	1.60	91.00	
23	2.10	92.00	
24	1.80	91.50	

	Score	Acidity
Average of 10 tubs scoring 93 and above	93.70	1.88
Average of 12 tubs scoring 89 to 93	91.31	1.84
Average of 2 tubs scoring below 89	84.50	2.12
Grand average	91.74	1.88

Judged by H. J. Credicott, June 9, 10, 11, 1909.

BUTTER FROM DIFFERENT STATES TESTED AND SCORED IN THE CHICAGO MARKET

No.	Acidity C. c. n/10 alkali to neutralize 10 grams of butter	Score 100 Perfect	No.	Acidity C. c. n/10 alkali to neutralize 10 grams of butter	Score 100 Perfect
1	1.40	94.00	45	2.60	87.00
2	1.20	93.00	46	1.40	88.00
3	1.20	93.00	47	1.20	92.00
4	1.40	93.50	48	1.40	92.00
5	2.00	94.00	49	2.60	87.00
6	1.40	93.00	50	1.20	92.00
7	2.20	89.00	51	2.00	87.00
8	1.60	93.00	52	1.80	88.00
9	1.60	89.00	53	3.00	87.00
10	1.80	88.00	54	2.60	92.00
11	1.60	94.00	55	1.80	91.00
12	1.40	94.00	56	1.40	87.00
13	3.20	92.00	57	2.20	89.00
14	2.20	91.00	58	2.00	90.00
15	1.60	94.00	59	2.20	87.00
16	1.80	93.50	60	1.80	92.00
17	1.80	91.00	61	1.60	91.00
18	1.40	88.00	62	1.60	90.00
19	1.60	93.00	63	1.40	91.00
20	1.40	94.50	64	1.20	89.00
21	1.40	94.00	65	1.80	91.00
22	1.60	93.00	66	2.00	92.00
23	1.40	92.00	67	1.80	92.00
24	1.80	93.00	68	1.60	92.00
25	1.80	92.00	69	1.40	93.00
26	2.20	87.00	70	1.60	93.50
27	2.00	93.00	71	1.40	87.00
28	1.80	91.00	72	1.20	89.00
29	1.60	93.00	73	1.80	88.00
30	1.20	89.00	74	1.00	86.00
31	1.40	91.00	75	2.00	93.00
32	1.20	91.00	76	2.20	89.00
33	1.40	88.00	77	1.40	88.00
34	1.80	93.00	78	1.20	90.00
35	1.60	93.00	79	2.00	89.00
36	1.60	91.00	80	1.80	87.00
37	1.40	91.00	81	1.80	86.00
38	1.40	89.00	82	1.60	89.00
39	1.40	88.00	83	1.60	88.00
40	1.60	85.00	84	1.80	87.00
41	6.40	84.00	85	1.40	88.00
42	1.20	83.00	86	2.60	82.00
43	2.20	88.00	87	1.80	89.00
44	1.60	87.00			

	Score	Acidity
Average of 23 tubs scoring 93 and above	93.39	1.58
Average of 36 tubs scoring 89 to 93	90.61	1.70
Average of 28 tubs scoring below 89	86.82	1.96
Grand average	90.13	1.75
Grand total average of 99 tubs scoring 93 and above	93.73	1.97
Grand total average of 158 tubs scoring 89 to 93	90.94	1.93
Grand total average of 48 tubs scoring below 89	87.07	2.08

From these results it will be noticed that there is little or no uniform relation existing between the quality and the acidity of fresh butter.

The faults of butter, as concerning us in this connection, may be divided as follows: First, the defects due largely to faulty methods of manufacture, and usually are manifested in the color, texture, and salt. They can be determined only by close examination of the butter and through the senses. Second, the undesirable flavors which can not be determined by an acid test. They are chiefly absorbed taints, and are transmitted through the cream and from the surroundings. Third, the undesirable flavors which are in, and develop in the butter, and are due to substances acid in character, volatile and non-volatile, and which can be measured by an acid test.

In fresh butter, this latter class of substances is, according to these investigational results, not present in so large and uniform proportion as to make an acid test of any aid in judging the quality of the fresh butter. The defects associated with the body, color, and salt, and the flavors of a non-acid character, none of which can be measured by an acid test, evidently constitute the chief faults of fresh butter.

When fresh butter has once been judged and a certain score put upon it, and the same butter retained to be tested for keeping quality, experiments completed, and others now in progress, show that an acid test is by far the better criterion as to the extent and rapidity of deterioration. In this connection, the butter acid test is a valuable aid, being much more sensitive and exact than are a person's senses.