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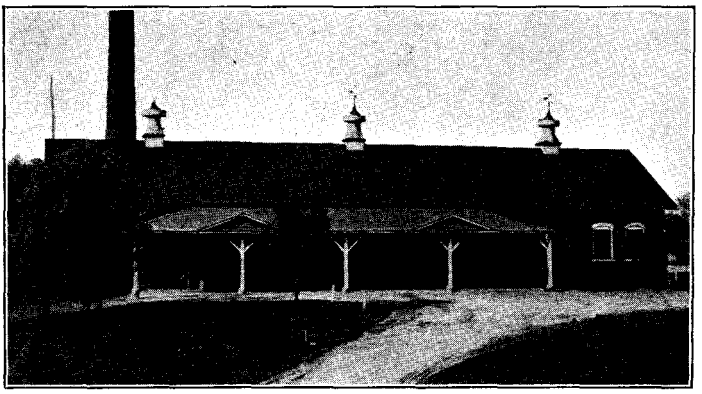
COMPOSITION OF CREAMERY BUTTER AND ITS CONTROL

BY
C. H. ECKLES, J. R. KEITHLEY, AND W. B. COMBS
DIVISION OF DAIRY HUSBANDRY



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COMPOSITION OF CREAMERY BUTTER AND ITS CONTROL

By C. H. Eckles, J. R. Keithley, and W. B. Combs

Creamery butter varies widely in both quality and composition. These variations are of tremendous commercial significance on account of the volume of the product marketed. A range of from three to five cents per pound marks the judgment of the market as to value of butter scoring 92 compared to that grading 88. The difference between an 88 and a 92 score may be due to poor workmanship as shown by defects in body or color, but unquestionably in most cases the important distinction is that of flavor. Only in extreme cases is the composition of butter an important factor in determining market grade.

Every creamery manager and operator understands the importance of quality in the product from his factory, altho it is probable that many could, with advantage, make more vigorous efforts to secure the quality demanded in return for the highest prices on the market. At the same time many overlook an equally important matter, that of properly controlling the composition of the product. A too common tendency has been to give reasonably careful attention only to the salt content and the color, as failure to do so at once brings criticism when offered on the market. Since the moisture and fat content of butter have been regulated by statute, creamery operators have ordinarily given at least some attention to controlling these in order to keep within the law.

In addition to attention to the moisture content, the best managed creameries have, during the past few years, given more and more care to regulating the entire butter composition. There are two purposes in such control. One is maintaining a standard composition, that a uniform product may be placed upon the market as uniformity is essential in marketing any product to advantage. The second purpose is to insure the maximum amount of butter from the butterfat used, taking into account standard composition. As butterfat is the most costly constituent, it is good commercial practice to produce butter having a standard fat content. It is essential that the percentage of water, salt, and curd also be standardized or controlled, as the fat content of butter varies inversely but uniformly with the other constituents.

There is a standard legal weight for a bushel of grain and the grower sells his product on that basis, the buyer not expecting to

receive more than the standard amount. The laws and regulations of the state and nation likewise have fixed the moisture and fat content of butter so that it is not only legitimate to control the composition as to closely approach that standard but it is also to the seller's advantage as he has much to lose and nothing to gain by not controlling it. The Minnesota statutes require that butter contain not less than 80 per cent of fat and not over 16 per cent of water. The same fat percentage is fixed by act of Congress.

PREVIOUS STUDIES ON COMPOSITION OF CREAMERY BUTTER

Extensive studies of creamery butter composition have been reported from several sources. In 1902 the United States Department of Agriculture[1] gathered 802 samples of creamery butter representing 400 creameries and 18 states. The average moisture content was 11.78 per cent. Figures are given showing at that time Danish butter on the English market contained an average of 14.03 per cent of water. Lee and Barnhart in 1909[2] reported analyses of 547 samples of creamery butter as it appeared on the Chicago and Elgin, Illinois, markets. The results for the total and for samples from Minnesota are given in Table I. The authors also report the analyses of 60 butter samples selected as typical of that exhibited at the National Creamery Buttermakers' meeting for 1908.

TABLE I

TYPICAL COMPOSITION OF BUTTER IN 1908

	Water	Fat	Salt	Curd and ash
	Per cent	Per cent	Per cent	Per cent
Market—547 samples	13.54	83.20	2.25	0.90
National Creamery Buttermakers' Association, 1908—60 samples	12.54	84.37	1.77	1.02
Minnesota market—average 131 samples	12.05	83.78	2.23	0.86

The market samples presumably represent typical creamery butter manufactured at that time in the leading surplus butter states. The figures show that the butter prepared especially for exhibition purposes contained 1 per cent more fat, ½ of 1 per cent less salt, and less moisture than that made for general marketing purposes. Evidently there was at that time—as figures from Minnesota show to be the case at present—a feeling among creamery operators that butter

[1] "The water content of creamery butter," U.S. Dept. Agr., Bureau of An. Ind. Cir. 39, 1903.

[2] Lee, C. E., Barnhart, J. M., "Composition of market butter," Ill. Agr. Exp. Sta. Bul. 139, 441-57, 1909.

for competitive scoring should have a salt content rather below ordinary market requirements and a fat percentage rather higher than the average, or at least the methods of making butter for exhibition purpose resulted in butter with these characteristics.

In 1912 the dairy division, U.S. Department of Agriculture[3], reported analyses of 965 samples of creamery butter from 14 states as follows:

	Water	Fat	Salt	Curd
	Per cent	Per cent	Per cent	Per cent
All sources—695 samples.....	13.90	82.41	2.51	1.18
Minnesota—223 samples	13.60	82.81	2.34	1.24

Each of these reports calls attention to wide variation in composition of the various samples analyzed. For example, in the study made by Thompson (1912) and others of 223 samples of Minnesota butter the fat percentage ranged from 77.52 to 87.39, altho the majority of samples were near the average of 82.81 per cent.

COMPOSITION OF MINNESOTA BUTTER

Source of Samples

As already pointed out uniformity of product is recognized as one of the most important factors in marketing. The Minnesota Co-operative Creameries Association recognizing this fact placed among the first objectives of the association that of obtaining a greater uniformity in Minnesota creamery butter. The division of dairy husbandry decided that the greatest service it could render the creamery industry in this connection was to direct attention to the importance of composition standardization.

The logical procedure appeared to be first, to make a study of the composition of butter as made by Minnesota creameries. It was fully recognized that samples taken from the regular make at the creamery or market would be most satisfactory. At the time there was no possibility of getting these kinds of samples in large numbers due to the expense involved. As a matter of convenience in getting a large number of samples the Educational Scoring Contest, conducted bimonthly by the Dairy and Food Commission, offered special advantages, not only for getting samples representing a large number of creameries but in addition, the scores of all lots by expert judges. To this end the co-operation of the Dairy and Food Commission was secured without which it would have been impossible to conduct the

[3] Thompson, S. C., Shaw, R. H., Norton, R. P., "The normal composition of American creamery butter," U.S. Dept. of Agr., Bureau of An. Ind., Bul. 149, 1912.

study on anything like the scale which was followed. Samples were taken of all lots exhibited in seven exhibitions, including the butter entered in the Cold Storage Exhibit at the 1922 National Dairy Show, and the general exhibit of 448 lots at that show. The cold storage exhibit butter was received in June, scored and placed in cold storage for a second scoring in October. A total of 2051 samples of exhibition butter was analyzed and the results included in the present report.

After analyses of samples from the Educational Scoring Contests were published a question was raised as to what extent these samples could be counted as being representative of the regular make of Minnesota creameries. As a result arrangements were made through the Minnesota Co-operative Creameries Association for its fieldmen to secure samples at creameries in their districts. By this means 152 samples, each one representing a different creamery, were secured in January 1923 and another lot of 164 in July 1923. Through association representatives 47 samples of Minnesota butter were also secured from the New York market. The analyses of the samples are given in Table II, and the distribution regarding fat and water content is shown in Tables III and IV.

In May 1925, through the courtesy of the same organization, the results of the analyses of all butter received at the warehouse in St. Paul, since the plan of analyzing shipments was begun, were made available for this study. A group of 1000 analyses was selected as typical of butter received at the warehouse during January, February, March, and April, 1925. The analyses used included about one half of the total made in the laboratory of this association. Creameries were selected at random until sufficient samples were represented to total 1000, using in each case all the analyses reported (except for unsalted butter) for the creamery for the first four months of 1925. The results are given in Table II and the distribution of the samples regarding fat and water is found in Tables III and IV.

TABLE II

AVERAGE COMPOSITION OF MINNESOTA BUTTER FROM SOURCES AS INDICATED

Sources	No. of samples	Water	Fat	Salt	Curd	Color by Nafis rod in percentage of total			
						A	B	C	D
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
May 1922, Educational Scoring Contest	264	14.69	82.58	1.96	0.76	56.3	32.5	8.8	2.3
June 1922, National Dairy Show Cold Storage Exhibit	296	14.74	82.68	1.89	0.70	13.3	77.4	8.2	1.0
July 1922, Educational Scoring contest	183	14.20	83.13	1.87	0.79	17.5	77.0	5.5	...
September 1922, Minnesota State Fair	242	13.80	83.60	1.62	0.97	45.4	49.5	3.7	1.2
October 1922, National Dairy Show	448	13.43	83.92	1.57	0.89	44.0	50.5	5.0	0.5
November 1922, Creamery Operators' Association	418	13.58	83.82	1.74	0.82	36.9	57.8	10.9	0.4
January 1923, State Dairyman's Association	200	13.10	84.17	1.88	0.87	29.0	64.5	5.5	1.0
Average all exhibition butter	2051	13.89	83.46	1.76	0.83	...	...	...	...
January 1923, samples taken at Minnesota creameries	152	15.01	81.83	2.33	0.83	34.0	56.9	9.1	...
February 1923, samples taken from New York market	47	14.08	82.97	2.17	0.78	...	...	...	...
July 1923, samples taken at creameries by fieldmen	164	14.81	82.35	2.17	0.80	18.0	80.7	1.3	...
Average of samples from market and creameries	363	14.80	82.21	2.23	0.81	25.6	...	...	...
Analyses by Minnesota Co-operative Creameries Association, January to April, 1925	1000	15.35	81.31	2.31	*1.03	...	...	...	...

* 100—fat+moisture+salt.

TABLE III

Fat Content

Distribution of Samples According to Fat Percentages

Fat	Group 1 264 samples	Group 2 296 samples	Group 3 183 samples	Group 4 242 samples	Group 5 448 samples	Group 6 418 samples	Group 7 200 samples	Group 8 152 samples	Group 9 47 samples	Group 10 164 samples	2051 Exhibition samples	363 Market samples	1000 samples January to April 1925
Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
70.5-71.5	....	....	....	....	....	.23	....	....	....	....	.05	....	....
71.5-72.5	....	....	....	....	....	....	....	....	....	....	....	....	....
72.5-73.5	....	.34	....	....	....	....	....	....	....	....	.05	....	....
73.5-74.5	....	....	....	....	....	....	....	....	....	....	....	....	....
74.5-75.5	....	....	....	....	....	....	....	....	....	....	....	....	....
75.5-76.5	....	....	....	....	.22	....	....	1.32	....	....	.05	.55	....
76.5-77.5	.76	....	.55	....	....	....	.5	.66	....	....	.20	.28	....
77.5-78.5	.38	1.01	....	.83	.45	....	....	....	....	.61	.39	.28	.50
78.5-79.5	2.27	3.39	1.64	1.65	1.12	.72	1.0	4.61	....	3.66	1.62	3.59	3.40
79.5-80.5	5.69	6.08	4.91	2.89	1.34	2.63	1.5	13.16	4.26	4.27	3.38	8.00	14.40
80.5-81.5	13.27	14.53	11.47	5.37	4.24	5.98	4.0	20.40	10.64	24.39	8.04	20.98	39.90
81.5-82.5	25.39	18.59	15.83	12.39	8.70	13.62	11.5	26.98	21.28	25.00	14.70	25.39	27.20
82.5-83.5	27.67	23.66	22.93	21.48	16.28	19.60	18.5	21.06	25.54	23.17	21.02	22.63	11.10
83.5-84.5	14.78	21.29	22.93	27.26	25.65	23.42	18.5	7.24	27.66	13.41	22.54	12.70	3.00
84.5-85.5	7.58	7.77	11.47	19.42	23.64	17.69	21.0	1.97	6.38	3.66	16.32	3.31	.40
85.5-86.5	1.52	2.37	5.46	7.43	14.27	10.99	12.5	2.63	2.13	1.83	8.53	2.21	....
86.5-87.5	.76	1.01	2.18	.83	3.12	2.87	8.0	....	2.13	....	2.60	.28	....
87.5-88.5	....	....	.55	.41	.89	1.67	2.5	....	....	....	.88	....	....
88.5-89.5	....	....	....	....	....	.48	.5	....	....	....	.15	....	....
89.5-90.5	....	....	....	....	....	....	....	....	....	....	....	....	.10

TABLE IV

WATER CONTENT

Distribution of Samples According to Water Percentages

Water	Group 1 264 samples	Group 2 296 samples	Group 3 183 samples	Group 4 242 samples	Group 5 448 samples	Group 6 418 samples	Group 7 200 samples	Group 8 152 samples	Group 9 47 samples	Group 10 164 samples	2351 Exhibition samples	363 Market samples	1000 samples January to April 1925
Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
8.25- 8.75	....	....	....	....	....	.24	....	....	....	....	.05	....	....
8.75- 9.25	....	....	....	....	....	.24	....	....	....	....	.05	....	....
9.25- 9.75	....	....	....	....	....	....	1.0	....	....	....	.10	....	....
9.75-10.25	....	....	....	....	.22	.96	1.0	....	....	....	.34	....	....
10.25-10.75	....	....	.55	.41	.67	1.20	2.0	....	....	....	.69	....	....
10.75-11.25	....	1.01	1.64	.83	1.34	2.63	5.0	....	2.13	....	1.72	.28	....
11.25-11.75	.76	1.01	....	2.07	4.46	2.63	10.0	1.32	2.13	.61	2.99	1.10	.10
11.75-12.25	1.90	.34	3.82	6.61	9.81	11.23	12.0	1.97	....	2.44	7.01	1.93	....
12.25-12.75	2.65	2.37	6.01	8.67	11.37	9.32	9.0	.66	10.64	1.22	7.60	2.21	.40
12.75-13.25	6.06	6.76	11.47	16.11	17.39	12.19	16.5	2.63	10.64	3.05	12.64	3.86	2.10
13.25-13.75	10.23	12.84	14.20	12.80	16.50	13.86	11.0	5.26	10.64	9.76	13.52	8.00	3.40
13.75-14.25	14.40	12.17	15.84	19.82	16.73	12.91	12.5	11.84	14.90	12.81	14.95	12.70	7.80
14.25-14.75	17.43	14.53	14.72	11.15	7.81	12.67	7.5	17.77	19.15	15.86	12.05	17.11	9.90
14.75-15.25	17.43	16.56	10.92	10.74	6.47	9.08	6.0	19.74	14.90	18.30	10.78	18.49	21.40
15.25-15.75	12.51	11.83	7.64	4.96	2.90	5.98	2.0	12.50	8.51	15.25	6.66	13.25	24.90
15.75-16.25	7.58	8.79	6.01	2.48	2.23	1.67	1.0	8.55	4.26	12.81	4.02	9.94	19.30
16.25-16.75	3.41	6.08	3.28	.83	.22	1.43	2.5	9.12	....	5.49	2.30	6.35	6.40
16.75-17.25	2.27	2.37	2.18	1.24	.67	.72	....	4.61	2.13	....	1.27	2.21	2.60
17.25-17.75	1.90	1.69	1.09	.41	.22	.48	.5	1.97	....	.61	.83	1.10	1.30
17.75-18.25	.38	.68	....	.41	.67	.24	....	.66	....	1.83	.39	1.10	.10
18.25-18.75	....	.34	....	.41	....	....	....	1.32	....	....	.10	.55	.30
18.75-19.25	.38	....	....	....	....	....	....	....	....	....	.05	....	....
19.25-19.75	....	.34	.39	....	....	....	....	....	....	....	.05	....	....
19.75-20.25	.76	....	....	....	....	....	.5	....	....	....	.15	....	....
20.25-20.75	....	....	....	....	.22	....	....	....	....	....	.05	....	....
20.75-21.25	....	....	.55	....	....	....	....	....	....	....	.05	....	....
21.25-21.75	....	....	....	....	....	.24	....	....	....	....	.05	....	....
21.75-22.25	....	....	....	....	....	....	....	....	....	....	....	....	....
22.25-22.75	....	....	....	....	....	....	....	....	....	....	....	....	....
22.75-23.25	....	....	....	....	....	....	....	....	....	....	....	....	....
23.75-24.25	....	.34	....	....	....	....	....	....	....	....	.05	....	....

METHODS OF SAMPLING AND ANALYSIS

A sample was taken from each twenty-pound tub of exhibition butter at the time it was scored by the official judges. These samples were obtained by using a twelve-inch trier which drew a plug of butter the full depth of the tub. Two or three plugs were drawn from each tub perpendicularly or diagonally about two inches apart. Upon removal of the filler trier the loose moisture on the back was removed before transferring the plug (less one inch at the top) to a four-ounce bottle which was then tightly closed to prevent evaporation. The fieldmen of the Minnesota Co-operative Creameries Association taking the samples were instructed to follow the same plan. These samples were stored in a refrigerated room at a temperature of approximately 35° F. until analyzed.

The samples were taken from the refrigerator at time of analysis, softened by setting in a water bath at about 100° F., and then worked into a homogenous condition. Ten grams of this thoroly mixed sample were weighed out, using the Kohman method with some modifications. (The procedure for using this method is given in a later paragraph.) The data obtained from the Minnesota Co-operative Creameries Association represent essentially the same methods of sampling and analyzing.

COMPOSITION OF EXHIBITION BUTTER COMPARED TO MARKET SAMPLES

The data contained in Table II indicate that there is some justification for criticizing the use of analyses of butter prepared for exhibition purposes as typical of the composition of butter manufactured for regular market purposes. Table II shows an average fat precentage in 2051 exhibition samples of 83.46, compared with 82.21 per cent in 363 market samples taken in 1923, and 81.31 per cent for 1000 samples representing market butter in 1925. The same tendency of a higher fat content in exhibition butter is shown in Table I, giving results of analyses of butter exhibited at the National Creamery Buttermakers' Association in 1908 compared with market samples. In this case the exhibition samples contained about 1 per cent more fat and 1 per cent less moisture than the market samples. The salt was also lower by 0.48 per cent in the exhibition samples. The conclusion from the given facts is that on the average butter entered in competitive scoring contests may be expected to contain at least 1 per cent more fat than that made by same operators for market purposes, and also that the water and salt will be lower. The question may be raised concerning the reason for this higher fat content in exhibition butter. It would appear that the exhibitors are of the opinion that a

salt content somewhat below the average is favorable for getting a good score (see Table I). The average salt content of 2051 exhibition samples was 1.76 per cent compared with an average of 2.23 per cent from 363 market samples taken in 1923, and 2.31 per cent for 1000 samples analyzed by the Minnesota Co-operative Creameries Association during the first four months of 1925.

COMPOSITION OF MARKET BUTTER

Table II gives the average composition of 363 samples made for market in Minnesota during 1923, also for 1000 churnings of butter as analyzed in the Minnesota Co-operative Creameries Association laboratory in 1925. The percentage distribution regarding fat and moisture may be studied in Tables III and IV.

The results of the analyses made in 1925 indicate a noticeable change from 1923 towards better standardization. The fat content is practically 1 per cent lower, the moisture correspondingly higher, while the salt remains practically the same.

Table III shows that range of variation in fat content is also decidedly less than in 1923, indicating much more care in properly controlling the amount of this constituent. The range of water percentage as found in Table IV also shows an improvement. Altho the extreme range is not much reduced the number that approach the average is decidedly increased.

RELATION OF COMPOSITION TO SCORE

Previous paragraphs show that butter as prepared for exhibition purposes has a higher fat content but a lower salt content than that made for the general market. The buttermaker who is at times an exhibitor will be interested in a more detailed study of the relation of butter composition to the score received. In order to study in more detail the relation of score to fat percentage 2031 samples, of which scores were available, were grouped according to score as follows:

Score	No. of Samples	Average Fat Per Cent
Below 90.5	230	82.89
90.5 to 92.5	889	82.96
Above 92.5	912	83.86

The figures show evidence of some relation between fat content and score. It is clear that not only is butter as made for exhibition somewhat higher in fat content than market samples but the higher scoring butter has a higher fat percentage than the lower scoring.[4]

[4] The correlation coefficient between the fat percentage and the score of 2031 samples was found to be $+.2415 \pm .01409$; between the salt percentage and the score, $-.3949 \pm .01263$.

There is some question, however, as to the significance of this higher fat percentage. It may not have anything to do directly with the score received. It appears more likely that the relation between a high fat content and the score is through the salt percentage. As is well known, and as shown by Table IX, a lower salt content in butter as a rule means a higher fat percentage.

TABLE V
RELATION OF SCORE TO SALT PERCENTAGE
Exhibition Samples

Score	Number samples	Average salt percentage
87.5-88.5	41	2.24
88.5-89.5	65	2.06
89.5-90.5	124	1.86
90.5-91.5	338	1.88
91.5-92.5	556	1.82
92.5-93.5	541	1.54
93.5-94.5	289	1.34
94.5-95.5	64	1.12
95.5-96.5	11	1.10
96.5-97.5	2	0.60
Total and average	2031	1.68

Table V shows in a striking way that there is a direct relation between the salt content of exhibition butter and the score received. Note in this table that almost a regular decrease in salt content is shown with the increase in score. Beginning with 2.24 per cent in the butter scoring between 87.5 and 88.5 the salt decreases to an average of 1.54 for the 541 samples scoring between 92.5 and 93.5, and to 0.6 per cent for the two samples scoring over 96.5.

The difference in the salt content perhaps was not an important factor influencing the score, it being possible that the lowest scoring butter would not have been scored much higher if less salt were used. It would be interesting to know what score would have been given those samples scoring near the top had the salt content been the average of market butter in place of only about half. It is clear that so long as butter judging is kept on the present basis that creamery operators preparing samples for exhibition will do well to keep the salt at least below 1.25 per cent.

On the assumption that the average salt content of butter, as put on the general market (that is around 2.25 per cent), meets the market demand, in other words is the proper amount, it appears reasonable to raise a question regarding the present practice of judging which puts in the front rank butter with less than one half the salt called for by the general market.

SIGNIFICANCE OF COMPOSITION CONTROL

The Minnesota Dairy and Food Commissioner reports the butter production in Minnesota for 1923 at 214,954,816 pounds. A compilation from this figure and the percentage distribution of the 363 market samples regarding fat content as given in Table III gives a total of 3,826,095 pounds as a probable amount of fat used in Minnesota during the year 1923 in excess of that required had the butter containing above 80.5 per cent of fat been standardized at that figure. However, apparently 12.5 per cent of the product was below 80.5 per cent fat and to bring this up to that figure would have used 429,909 pounds. It is clear that had the entire butter product of the state been standardized at 80.5 per cent fat the amount saved would be the difference between these two figures, or 3,396,186 pounds. Assuming a value of 45 cents per pound for butterfat, it is fair to estimate that in 1923 $1,528,283 could have been saved in Minnesota by proper standardization of butter to 80.5 per cent butterfat. On the average this is a saving of $7.13 for every 1000 pounds of butter made in the state.

TABLE VI
FAT CONTENT UNNECESSARILY HIGH
Analyses, January to April, 1925

Creamery A	Creamery B	Creamery C	Creamery D	Creamery E	Creamery F	Creamery G
Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
84.6	85.7	84.8	84.5	84.5	82.6	84.0
83.0	86.3	83.5	83.8	83.2	82.5	85.3
85.1	84.9	85.9	83.0	84.6	83.9	82.8
87.1	86.5	84.6	82.3	83.5	84.5	87.7
85.5	84.6	84.1	82.9	83.2	82.8	86.2
85.0	83.8	82.1	82.4	82.0	84.8	85.4
83.9	83.5	82.1	83.2	84.4	85.3	82.3
84.1	83.8	81.9	83.0	82.7	83.0	81.6
...	83.3	82.8	82.9	83.0	83.8	82.6
...	84.3	84.1	82.4	...	...	83.4
...	...	82.0	83.2	...	...	84.4
...	...	...	83.0	...	...	82.4
...	...	...	...	...	...	83.4
...	...	...	...	...	...	84.1
Average—						
84.8	84.6	83.4	83.0	83.5	83.7	83.9

It is interesting to note that the average fat percentage of 1923 market butter was 82.21 compared with 83.78 per cent in 1908. Evidently the attention directed in recent years towards the importance of composition control has resulted in a more careful supervision of the product and a composition nearer the standard. In July, 1924, the Minnesota Co-operative Creameries Association began analyzing each shipment received at the St. Paul warehouse. The results of the analyses with the score is sent to the creamery where the butter was manufactured. The result has undoubtedly been to stimulate the creamery operators to exercise a more careful supervision over their

product. The average of 1000 samples, representing 58 creameries as given in Table II, indicates the average composition of the butter as received by the Minnesota Co-operative Creameries Association during the first four months of 1925 to be, fat, 81.31 per cent; moisture, 15.35 per cent; and salt, 2.31 per cent. This is approaching an ideal average for present market and standard requirements. Tables III and IV, last columns, give the distribution of samples in regard to fat and water. It will be noted that the range is noticeably less than for the market samples taken in 1923 and decidedly less than for exhibition samples.

There is, however, still some chance for improvement. A few samples were below the standard, which is a serious mistake, while some were unnecessarily high in fat. For example, 11.1 per cent of the samples analyzed by the Minnesota Co-operative Creameries Association contained between 82.5 and 83.5 per cent of fat. Had the butter represented by these 1000 analyses been standardized to 80.5 per cent of fat, a saving would have resulted of 0.88 pound for each 100 pounds of butter. Assuming that these 1000 samples fairly represent the product of the creameries of the state, it would appear that a more careful control of the composition would make possible a further saving of about 1,890,000 pounds of fat.

WHAT LACK OF CONTROL MAY MEAN TO A PARTICULAR CREAMERY

Small savings when applied to the product of an entire state make a striking showing. Each creamery, however, is far more concerned in knowing what the conditions are concerning the product it is sending to the market as many of the best managed factories are already controlling the composition of their product so closely that the chance of further savings by these means are unimportant. Unquestionably the extensive publicity already given the importance of composition control in connection with the results given in this publication were responsible for a fuller realization of the importance of such control and a marked improvement.

Table VI shows what failure properly to control butter composition means to certain creameries. In this table are given the detailed records of the analyses of the butter from seven creameries which are included among those supplying the 1000 samples. In each case all the analyses are given for each creamery during the months covered, January to April, 1925. The creameries supplying the data in Table VI were selected as representing a group producing butter with a fat content unquestionably higher than necessary, in fact having a fat percentage in their product of over 83. The creameries represented in Table VI used on the average 3 pounds more fat for each 100

pounds of butter manufactured than did those, the figures for which are found in Table VII. This means 30 pounds of fat on a churning of 1000 pounds. Counting butterfat at 45 cents a pound it is evident the operator of the plants represented in Table VI were losing $13.50 on each 1000 pounds churned compared with the operators represented in Table VII. In presenting this material the assumption has been made that a fat percentage of 80.5 in butter is fair to both the consumer and producer.

TABLE VII
FAT CONTENT WELL CONTROLLED
Analyses, January to April, 1925

Creamery H	Creamery I	Creamery J	Creamery K	Creamery L	Creamery M	Creamery N
Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
80.3	81.5	81.6	81.5	81.7	81.1	80.5
80.2	81.6	81.3	80.8	80.8	81.0	81.0
80.7	80.3	81.1	80.8	81.1	81.2	81.4
81.0	82.9	80.9	80.8	80.2	81.5	80.8
81.2	82.0	80.4	80.7	80.0	80.5	80.2
79.9	82.0	80.9	81.1	81.6	81.6	80.7
80.6	80.9	80.0	80.9	80.9	81.1	82.4
81.3	80.9	81.5	81.3	80.2	80.6	80.1
80.8	80.8	81.6	80.9	81.9	80.6	81.3
81.1	81.7	81.9	81.1	81.0	81.5	80.0
80.4	...	80.4	80.6	81.7	81.2	81.6
80.9	...	80.6	81.0	80.5	80.7	...
...	...	...	80.2	81.7	81.1	...
...	...	...	80.9	80.4	80.1	...
...	...	...	81.0	81.2	...	...
Average—						
80.7	81.4	81.0	80.8	80.9	80.9	80.1

It is an easy matter for an unskilled or careless operator to lose more than his salary daily by failure to give attention to this matter of composition control. Assuming it is both possible and practical to maintain the fat percentage close to 80.5 the following figures show the loss which will result when butter is made with a fat content of from 81.5 to 84.5 per cent.

Fat in butter	Excess fat used per 1000 lbs. butter	Loss per 1000 lbs. butter, butterfat at 45 cents per lb.
Percent	Lbs.	
81.5	10	$ 4.50
82.5	20	9.00
83.5	30	13.50
84.5	40	17.50

POSSIBILITIES OF CONTROLLING BUTTER COMPOSITION

Some creamery operators admit the importance of making butter of a uniform and standard composition but are doubtful as to the practicability of exercising such control under factory conditions. The figures given in Table VII show that it is not only possibble but that it is being done successfully by many Minnesota creameries. Table VII gives all the analyses available of butter shipped to the Minnesota Co-operative Creameries Association during the months of January, February, March, and April, 1925, by seven creameries. This group was selected as illustrating especially satisfactory composition control altho many others could have been added that were doing almost as well. Notice should be taken that the average fat content of each of the seven is between 80 and 81 per cent. Only four samples out of a total of 108 are above 82 per cent fat and only one below 80.

TABLE VIII

EXAMPLES OF GOOD AND POOR CONTROL OF THE SALT CONTENT OF BUTTER

Analyses, January to April, 1925

Well controlled			Poorly controlled		
Creamery* 1	Creamery 2	Creamery 3	Creamery 4	Creamery 5	Creamery 6
Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
2.2	2.0	2.4	3.0	1.4	2.1
2.7	2.5	2.3	3.9	2.7	3.8
2.4	2.3	2.3	3.3	1.3	2.0
3.1	2.1	2.5	4.0	1.7	2.5
1.2	2.7	2.3	2.6	2.1	1.7
2.2	3.3	2.7	1.2	1.9	2.6
2.3	2.0	2.3	3.3	2.5	2.4
2.7	2.2	2.0	2.5	1.5	2.2
2.2	2.2	2.5	3.7	1.4	0.9
3.2	2.2	2.2	1.6	1.8	0.9
2.0	2.4	2.5	2.7	1.3	2.2
2.9	2.2	2.0	1.7	2.5	1.2
2.5	2.3	2.3	3.8	2.4	1.6
2.8	2.3	2.2	2.6	3.0	2.5
2.2	2.4	2.2	1.1	2.7	3.3
2.2	2.6	2.3	1.9	2.3	2.1
2.4	2.4	2.3	..	3.0	2.1
Average—					
2.4	2.4	2.4	2.6	2.1	2.1

* The numbers assigned to creameries in this table are not those used by the Minnesota Co-operative Creameries Association.

The salt content of butter also shows considerable variations, in fact in proportion to the amount contained in butter these variations are greater than for the fat. Table VIII gives examples of the good and poor control of the salt content. Creameries Nos. 1, 2, and 3 are selected as showing a reasonably well controlled percentage. The figures given include all the analyses made of butter manufactured

by the creameries in question during the months of January, February, March, and April, 1925. Even with these selected as among the best in regard to uniformity of salt, the range appears unnecessarily wide. Creamery No. 1, for example, shows a variation of from 1.2 to 3.2 per cent. Creamery No. 3 shows the greatest uniformity, the variation being from 2.0 to 2.7 per cent. Creameries Nos. 4, 5, and 6 were selected to illustrate the lack of good control in the salt content. Creamery No. 4 shows a variation from 1.1 to 4 per cent and Creamery No. 6 from 0.9 to 3.8 per cent. Certainly such variations are unnecessary and cannot be explained on the basis of meeting market demands as the product all went through the same channels. All that can be said is that such variations show a lack of care or skill and are inexcusable in the product of a well managed factory.

COMPOSITION OF UNSALTED BUTTER

The demand for unsalted butter appears to be increasing and the manufacture of this type is becoming more common in Minnesota. As salt constitutes about 2.25 per cent of salted butter as manufactured at present in this state, it follows that where no salt is used the composition must be changed and the percentage of the other constituents increased.

Table IX shows the composition of unsalted butter as placed on the market at present in this state. The 394 samples average 83.44 per cent of fat and 16.3 per cent of water, showing that the salt omission evidently results on the average in both higher fat and water content. The analyses given in Table II of 1000 samples of salted butter by the Minnesota Co-operative Creameries Association show an average fat percentage of 81.31, or 2.1 below that of the unsalted. Table IX also shows that the water content in many cases exceeded the standard. Evidently with unsalted butter one of the problems of the operator is to make certain that the product is not below the standard. The statutes of Minnesota fix a maximum of 16 per cent of water and do not recognize any difference between salted and unsalted butter. Table IX shows considerable variation in the composition of butter from different creameries. Some appear to be exercising an excellent control of their product, while others need to watch the composition more carefully so it will not fall below standard. Assuming the extensive data given are typical of Minnesota creamery products, it appears that 100 pounds of unsalted butter will, as a rule, contain about 3 pounds more fat than an equal amount of salted butter.

TABLE IX

COMPOSITION OF UNSALTED BUTTER

(Analyses by Minnesota Co-operative Creameries Association July 1924 to April 1925)

Creamery*	No. of samples	Average water content	Average fat content
		Per cent	Per cent
1	7	18.5	80.5
2	22	16.5	82.9
3	43	16.1	82.9
4	4	16.6	82.4
5	5	16.7	82.3
6	8	17.8	81.2
7	20	16.3	82.7
8	21	15.2	83.8
9	5	15.1	83.9
10	19	14.9	84.1
11	5	15.1	83.9
12	20	16.8	82.1
13	5	16.1	82.8
14	30	16.3	82.7
15	13	15.6	83.4
16	10	16.7	82.3
17	21	15.5	83.5
18	11	15.2	83.8
19	16	17.5	81.5
20	23	16.1	82.8
21	21	16.7	82.3
22	18	15.9	81.0
23	23	17.0	82.1
24	16	16.5	82.5
25	4	15.1	83.9
26	4	16.5	82.5
Total and average	394	16.3	83.44

* The numbers in this column are not the numbers assigned by the Minnesota Co-operative Creameries Association.

A creamery that controls the composition of salted butter to a fat percentage of 80.5 should receive about 4 per cent more for unsalted butter in order to be on the same market basis.

BUTTER COMPOSITION CONTROL

The term composition control, when applied to butter, includes the control of the moisture, butterfat, salt, and curd. It has been the practice of the creamery operator to give attention to the moisture content of butter, but only too often the fat, salt, and curd content receive little attention unless suggested and criticized by the market.

Selecting a Standard Composition

To manufacture butter of a uniform composition the first essential is to decide upon a composition which is to be approached as closely as is found practical. The percentage of moisture and butterfat are limited by federal and state laws. Federal regulations require a minimum of 80 per cent fat and Minnesota laws require at least 80

per cent butterfat and less than 16 per cent water. There are no rulings regarding the per cent of salt or curd. The public demand is for a butter ranging from 2.25 to 3 per cent of salt, altho a tendency is evident toward a lower salt content. The percentage of curd in butter should not be excessive as the keeping qualities may be lowered. Normal butter contains 1 per cent or less of curd.

In controlling butter composition the first consideration is butterfat. It is not advisable for the operator to set his standard at 80 per cent as the lowest limit permitted by law. However, it is practical for him to set a standard of 80.5 per cent and to turn out regularly a product closely approximating this figure. The moisture content should not exceed 15.9 per cent; a practical standard being 15.8 per cent. With a fat percentage of 80.5 and a moisture of 15.8 per cent there remains 3.7 per cent to be made up of salt and curd. If 0.95 per cent of curd is allowed, this permits 2.75 per cent salt. The salt may be raised to 3 per cent and the curd reduced to 0.7 per cent if the public does not object. It is recommended the operator set as a standard to be approached as closely as possible, 80.5 per cent fat, 15.8 per cent moisture, 2.75 to 3 per cent salt, 0.7 to 0.95 per cent curd.

Problems Involved in Controlling Butter Composition

Controlling butter composition is a problem involving a knowledge of the properties of butterfat. The practical operator is well aware of the effects of the season of the year on churning temperature. Butterfat is a mixture of fats, each of which melts and solidifies at a different point. In the spring butterfat contains a predominance of fats with a low melting point. Every buttermaker knows that it is necessary to lower the churning temperature during the spring and summer months in order to obtain firm, waxy butter.

Composition control is largely a problem of moisture control and involves several factors, any combination of which will affect the results. These factors generally result in a tendency toward a high moisture content in butter during the spring and summer months and a low moisture content during the late fall and winter months. The problem of the buttermaker is to avoid an excess of moisture in spring and summer and the other extreme during fall and winter. On account of the number of factors involved it is very difficult to outline a rule of procedure which will insure a uniform composition. The only way the desired result may be attained is for the operator to fully master the subject and through this knowledge be prepared to handle the conditions as they develop from day to day. For this reason the statements and recommendations made should be considered as applying to the problem only in a general way.

Calculating Pounds of Fat in the Churn

One of the first essentials in attempting composition control is the adoption of some plan whereby the exact number of pounds of butterfat in the churn may be known. A measuring stick makes it possible after weighing varying amounts of cream into the vat to determine the pounds per inch. In this manner the total pounds of cream may be determined. With this figure and the fat analysis, the pounds of fat in the vat may be calculated. If it is possible to keep an accurate record of the cream as dumped into the vat, the total weights may be quickly secured at the finish. A fat test of the contents of the vat will give the per cent of fat in the cream from which the pounds of fat may be easily calculated. The main advantage of using a metal rule is that when a vat is only partially emptied it is possible to calculate the pounds of cream removed. By making a few careful checks a reasonably accurate estimate may be made by this system of cream and fat entering the churn. Records of this nature are also important when the buttermaker wishes to check the total pounds of fat received and paid for against the pounds of fat going into and out of the churn.

Churning of the Cream

Cream should be placed in the churn at a temperature such as will require from 50 to 60 minutes to churn sweet cream and from 30 to 40 minutes for ripened cream. The proper churning temperature is affected not only by the composition of the butterfat but also by the time the cream is held previous to churning. The shorter the holding period the lower the churning temperature necessary for the desired results. During the early spring and summer months cream is sometimes cooled to 40° F., held 15 to 20 minutes and churned; others may cool it to 48° F. and hold for two hours before churning.

The churn should be thoroly chilled by giving it several revolutions partly filled with cold water before adding the cream. It is a good practice to fill the churn from one-third to one-half full, and to churn until the butter granules reach the size of large wheat grains or small corn kernels. After the churning is completed and the buttermilk drawn, the butter and inside of the churn are sprinkled with water at the same temperature as the butter. As a matter of convenience this is generally done with a hose and should be continued until the water runs clear from the churn gate. The temperature of the butter may be taken by inserting a thermometer in the butter while the buttermilk is being drawn. After rinsing the butter with a stream of water the churn is filled about half full of water and the butter washed.

The temperature of the wash water is dependent upon the condition of the butter. When butter has a firm, waxy appearance, it is

well to wash with water one or two degrees below the butter temperature, but if it is warm and too soft it will be necessary to use colder water. Too sudden a change in temperature is injurious to the body of the butter and for this reason, if considerable reduction in temperature is desired, it is best to add colder water to the churn and allow it to set with the doors closed until the butter becomes firm enough to handle. Six or eight revolutions of the churn on high gear are sufficient as a rule for washing. The fact that sweet cream butter is not high in flavor makes it advisable to retain as much flavor as possible. Recognizing this, many buttermakers gently wash the butter with the churn in low gear.

Methods of Salting Butter

After washing, the butter is ready for salting. The methods are (1) dry, (2) salt brine, and (3) wet mash method.

When using the dry method the salt is either sprinkled over the small butter granules, or the churn is set in motion in low gear with the workers in operation, gathering the butter into a roll. This roll is then split and dry salt poured into the trench. The trench is then closed and the butter worked. When the second method is used a brine is prepared of salt and water, which is dumped into the churn and worked into the butter. This plan results in a considerable loss of salt which makes it a rather questionable method. The wet mash or third method is usually preferred as the dampened salt enters more readily with the water contained in the butter. In using this method the salt is placed in a butter tub and dampened with water which when thoroly mixed is distributed in a trench made in the butter. After closing the trench the working proceeds.

Calculation of Salt Required

The amount of salt added to butter will depend upon the per cent desired in the finished product. The following table gives the pounds of salt recommended to be used where a butter is to be made containing 80.5 per cent of butterfat, 15.8 per cent moisture, and varying salt content ranging from 2.5 to 3 per cent.

Per cent salt desired	Salt required per 100 lbs. fat (No loss assumed) Lbs.	Average salt required per 100 lbs. fat (Including losses) Lbs.
2.5	3.1	3.3
2.7	3.4	3.6
3.0	3.7	3.9

The last column gives the actual pounds of salt required on the average to secure the desired salt percentage in the finished butter. This covers the slight loss of salt which occurs during working. Should

the loss appear less or more the buttermaker should act accordingly. To use the above table the buttermaker need only to divide the pounds of fat in the churn by 100 and multiply by the rate of salt required per hundred pounds of fat to give the salt percentage desired.

After adding salt to the churn the butter should be worked 15 to 20 revolutions in a two-roll churn and 25 to 35 revolutions in a single-roll churn. After doing this a sample should be taken for moisture determination, following carefully the sampling methods given in the directions for analysis of butter.

Moisture Control

Should the analysis show moisture content too high, the working process should be continued with the churn gate open and the doors slightly ajar. The churn should be stopped at intervals with the doors at the bottom to allow draining of the water. If the butter is in a firm, waxy state it can be worked from 30 to 40 revolutions in a two-roll churn or from 40 to 60 revolutions in a single-roll churn without damaging the body of the butter. However, if more working is required to eliminate the moisture it is a good practice to release the workers and allow the churn to revolve on low gear. This will raise the butter and allow it to drop to the bottom of the churn, thus eliminating considerable water. The moisture test should be repeated and water eliminated until the desired per cent, 15.8 per cent, is obtained. If the moisture test of the butter at the churn is below 15.8 per cent on making the analysis, it is necessary to calculate the amount of water the butter is lacking, place it in the churn and work until the butter is dry, or until all of the added water has been incorporated into the butter.

The following example will serve to illustrate the calculations necessary. Assume there are 800 pounds of fat in the churn. It is desired to make a butter containing 80.5 per cent fat, 3 per cent salt, 0.7 per cent curd, and 15.8 per cent moisture. The first analysis shows 13.8 per cent moisture.

Step. 1. Calculate composition overrun.—(The composition overrun differs from the overrun commonly referred to by the creamery operator as it is calculated from the composition of the butter rather than from the pounds of fat in the churn and the pounds of butter resulting from the churning.)

In 100 pounds of the finished butter there will be 80.5 pounds of fat since the butter is to test 80.5 per cent fat. From this 100 pounds subtract 80.5 pounds of fat (100—80.5) giving 19.5 pounds of butter in excess of the butterfat. To get the per cent composition overrun divide the pounds of butter in excess of the butterfat (19.5) by the

pounds of fat (80.5) in 100 pounds of butter. Multiply this result (0.2422) by 100 to get result in percentage terms, (100×.2422) equals 24.22 per cent composition overrun.

Step 2. Calculate pounds of butter expected from churn.—If there are 800 pounds of butterfat in the churn and 24.22 per cent overrun is obtained, to calculate the pounds of butter that may be expected multiply the pounds of fat (800) by the expected per cent overrun (24.22) and add the result to the pounds of butterfat in the churn.

Multiply 800 by .2422 (place decimal 2 points to the left when dropping the per cent sign) equals 193 plus 800 equals 993 pounds of butter expected from the churn.

Step 3. Calculate moisture lacking in butter.—Calculate difference between the moisture present in butter and the moisture desired. Subtract the moisture found (13.8) in the butter from the desired per cent (15.8), the result (2 per cent) is the per cent lacking in the butter. Multiply the per cent of moisture lacking (2 per cent) by number of pounds expected from the churn (993). The resulting figures will be accurate enough for all practical purposes.

The pounds of butter expected (993) times .02 equals 19.86 pounds of water required to result in a butter testing approximately 15.8 per cent moisture.

Relation of Churn to Composition Control

There are a number of makes of churns on the market, all of which when properly operated give good results. Regardless of the make, it is essential that the churn be perfectly level and firmly attached to a base. Butter accumulates at the lowest point in an unlevel churn, which results in an uneven distribution of moisture and salt, thus affecting the entire composition. The butterworkers should be straight sided and parallel with one another or with the nearest shelf in the churn. If the butterworkers are set at any angle and are not parallel to one another or the shelf the result is a gathering of a large quantity of butter in one end and a small amount in the other end of the churn. It is impossible to work the butter properly and evenly distribute the salt and moisture under this condition. Variations in the composition of different tubs of butter from the same churning are largely attributed to the churn not being level or to faulty workers. It should be clearly understood, however, that other factors such as not sufficient working, a too cold temperature at churning, overloading the churn, uneven distribution of salt, and of water, etc. may cause a variation in the composition of butter coming from the same churning.

Complete Analysis Essential

When churning is complete the buttermaker should make a complete analysis. By closely studying the results obtained on each churning from day to day slight changes may be made in the operations until a product of uniform composition may be manufactured. Without a complete analysis it is impossible to know the entire composition of butter churned. The efficient operator recognizes the importance of controlling the entire composition.

ANALYSIS OF BUTTER AT CREAMERY

For all practical purposes butter consists of butterfat, moisture, salt, and curd. Butter also contains a small amount of milk ash and milk sugar, but in creamery analysis these ingredients are not determined separately but are included with the protein under the designation of "curd." The buttermaker is concerned primarily at present with the moisture and fat analysis, yet it is recognized that a complete analysis is essential when attempting to manufacture butter of a uniform composition.

Sampling Butter

Care should be taken to secure a representative sample when testing butter at the churn. It is good practice to take the sample from several points along the butter roll. The surface of the roll should be scraped with a butter ladle at the points where the samples are to be taken and a small portion of butter removed by means of a metal blade or spoon which should be placed in a clean, dry glass jar or tumbler. In securing a sample from a tub or box of butter a trier should be used and the sample taken diagonally through the bulk. Free moisture adhering to the trier should be wiped off before placing the butter in the sample jar.

Preparation of Sample

When the butter to be analyzed has just been removed from the churn it is sufficiently soft to allow working with a steel blade until thoroly mixed. If the sample is leaky or too firm for proper mixing, as may be the case after butter has been held in the cold room, it should be melted slowly and rehardened by setting the jar in a cold water bath and stirring it slowly.

Moisture Test

Equipment required.—

1 Steel blade or spoon
1 Butter trier
1 Alcohol lamp or other means of heating sample
2 Aluminum cups (tall aluminum measuring cups will serve)
1 Accurate moisture balance
1 Iron tripod, height 5 inches, diameter 4 inches
1 Asbestos center wire gauze square, 5 inches square

Operation of the Test

Ten grams of butter are weighed into an aluminum cup. The butter is then heated over a low flame until it ceases foaming and a light brown color appears. It is advisable when heating the sample to place the aluminum cup on an asbestos center wire gauze placed on a tripod. This tends to distribute the heat evenly to all points on the bottom of the cup. After the moisture is driven from the butter, the sample is allowed to cool and is reweighed. The loss in weight divided by the original weight of the sample multiplied by 100 gives the per cent moisture contained. Some scales on the market read directly the per cent of moisture.

Salt Analysis (Cornell Method)

Equipment required.—

1 500 cc. bottle marked at the upper surface of the liquid when the bottle contains 300 cc. of water
1 Cream or butter test balance
1 17.6 cc. milk pipette
1 White cup
1 Glass stirring rod
1 25 cc. burette graduated in tenths of a cubic centimeter
1 Glass funnel
1 Petcock
1 Aluminum measuring cup
1 100 cc. graduated cylinder

Reagents required.—

1 Small bottle (50 to 100 cc.) potassium chromate solution prepared by placing 10 grams of potassium chromate in a graduated cylinder and adding water to bring contents to 100 cc. mark
1 Liter bottle of standard tenth normal silver nitrate, prepared by dissolving 17.5 grams of chemically pure silver nitrate in water and making up to a volume of 1000 cc.

Method of Conducting Test

Ten grams of butter are weighed into an aluminum cup. The butter is melted and poured into a bottle through a glass funnel. Hot distilled water (or rain water) is placed in the aluminum cup and the rinsings poured into the bottle. This procedure is repeated until all the butter in the cup is transferred. Hot water is added to the bottle sufficient to bring the liquid to the 300 cc. mark. Place the stopper in the bottle and shake it vigorously for about one-half minute. This is allowed to stand for five minutes to permit the butterfat to rise, and by means of a milk pipette 17.6 cc. of the clear portion is pipetted from the bottle. This is accomplished by holding the index finger over the end of the pipette when inserting it to the bottom of the bottle where the sample is taken. The pipetted portion is placed in a white

cup and a few drops of potassium chromate solution added. Standard tenth normal silver nitrate solution is run from a burette into the sample in the cup, stirring constantly, until a permanent brownish red color appears. Each cc. of standard silver nitrate solution required represents one per cent of salt in the original sample of butter.

BUTTER ANALYSIS BY THE KOHMAN METHOD

A practical method for the complete analysis of butter has been introduced by Kohman,[5] by which butter may be analyzed for fat, salt, moisture, and curd in a comparatively short time. In conducting the test the following equipment and materials are essential:

Equipment

Butter test scale (torsion type most generally used)
2 Half-pint aluminum measuring cups (handles removed)
1 Ten-gram weight
1 Steel blade or spoon
1 Alcohol lamp
1 Liter bottle
Indicator bottle, glass stopper
1 Pair tongs
200 cc. graduated cylinder

Chemicals

Distilled or filtered rain water (rain water free of sediment)
Filtered gasoline
Wood alcohol for alcohol lamp
Chromate indicator (10 grams potassium chromate made up to 100 cc. by the addition of distilled water)
Silver nitrate solution (29.062 grams silver nitrate with distilled water added to make 1000 cc.)

Operation of the Kohman Method

Place the aluminum cup on the right hand pan of the scale and balance it with the weight on the 10 per cent beam placed at the 10 per cent mark. (By placing the 10 per cent weight as indicated makes possible later the weighing of the salt and curd.) Weigh into the cup 10 grams of butter.

The moisture contained in the butter is now driven off by slowly heating the sample over an alcohol flame until it becomes a light brown color and ceases sputtering. (The cup is held by the tongs during the heating.) After allowing the cup to cool it is placed on the scale and the moisture loss measured by pushing the weight on the 20 per cent beam from zero to such a point as will balance the scale. The reading represents the per cent of moisture contained in the butter.

[5] Kohman, E. F., "Rapid and accurate method for butter analysis suitable for factory control work." Jour. Ind. Eng. Chem., Vol. 2, No. 1. 1919.

The liquid fat is then treated with 100 cc. of gasoline to dissolve the butterfat. This is accomplished by stirring vigorously and allowing it to stand for four minutes. The gasoline containing the dissolved fat is then carefully poured off and the procedure repeated. With the second extraction the sample is allowed to stand but two minutes. The remaining residue consists of the salt and curd contained in the butter sample.

Next, the sample is heated to dryness and after the sample cools it is again placed on the balance. The weight on the 20 per cent beam is returned to zero and the 10 gram weight is removed, the scale being brought to a balance by pushing the weight on the 10 per cent beam toward the zero mark. This reading subtracted from 10 indicates the per cent of salt and curd contained in the sample. The difference between the total moisture, salt, and curd and 100 represents the per cent of fat.

The dry residue is then dissolved in 176 cc. of warm distilled (or clean rain) water, and stirred thoroly. Pipette 17.6 cc. of the solution into a white cup and add a few (3 to 5) drops of the potassium chromate solution. Titrate with silver nitrate (29.062 gr. made up to 1000 cc. with distilled water) solution until a permanent brownish color appears. The cc. of silver nitrate solution used indicates the percentage of salt in the butter. By subtracting the per cent of salt from the per cent of salt and curd, the per cent of curd is determined.

Example of Method of Calculations

Moisture, per cent	15.8
Salt and curd, per cent	3.2
Total per cent—moisture, salt, and curd	19.0

To determine the per cent of fat subtract 19 (total moisture, salt, and curd) from 100, which equals 81, the per cent of fat in the sample.

The dry residue may be washed from the dish with hot water and the salt test completed by the Cornell method. The main difference between the method outlined above and the Cornell salt test is the strength of the silver nitrate solution used in the test.

Curd Determination

The amount taken for the salt determination, 17.6 cc., represents one tenth of the original sample of 1 gram of butter. When titrated with the silver nitrate solution, made up as directed, each cc. of silver nitrate used represents 1 per cent of salt. If for example the salt and curd percentage is found to be 3.2 and the salt 2.6, the per cent of curd is the difference between these two figures or 0.6.

SUMMARY

Analyses of 2051 lots of butter prepared for exhibition purposes showed an average of 83.46 per cent fat compared with 82.21 per cent for 363 market samples taken in 1923, and 81.31 per cent for 1000 market samples manufactured during the first four months of 1925.

The average salt content of 2051 exhibition samples was 1.76 per cent; for 363 market samples in 1923, 2.23 per cent; for 1000 samples of market butter in 1925, 2.31 per cent.

The higher scoring lots showed a slightly higher fat percentage than those receiving a lower score. This relation is apparently due to the lower salt content which usually accompanies a high fat content rather than to a direct relation between the fat percentage and the score.

The data presented show a direct and significant relation between the salt percentage and the score. The 230 samples scoring below 90.5 contained 1.98 per cent of salt compared to 1.29 per cent in 366 samples scoring above 93.5.

Assuming that 363 market samples taken in 1923 fairly represented the creamery butter made in Minnesota for that year, it is shown that over three million pounds of fat were used in excess of that needed, had the composition been controlled to 80.5 per cent fat. The data show clearly that a decided improvement has been made in the control of butter composition during the past two years.

A calculation based upon analyses of market samples in 1925 shows certain creameries were at the time losing $13.50 per 1000 pounds of butter as the result of not controlling the composition of their product.

Analyses of butter made by certain creameries are given showing the possibilities of controlling butter composition. Analyses of every shipment by seven selected creameries showed only 4 samples out of 108 analyzed above 82 per cent fat and 1 below 80 per cent.

Wide variations are shown in salt content of butter as now placed on the market. The relatively small variations in salt content in the product of certain creameries show the possibility of obtaining a reasonable uniformity in this constituent.

A total of 394 samples of unsalted butter showed an average of 83.44 per cent fat and 16.3 per cent moisture. More care is needed in making unsalted butter to keep the moisture content below the legal limit.

Methods to be followed in controlling butter composition are described together with directions for making butter analyses in the creamery.