

## SUMMARY

Much of the butter manufactured in Iowa shows too great a variation in chemical composition.

Frequent chemical analysis of the butter will assist the operator in controlling its composition.

The composition of 1,344 samples of butter obtained from 28 creameries during the calendar year 1933 was as follows:

Butterfat .....	80.71	percent
Moisture .....	16.17	"
Salt .....	2.38	"
Curd .....	.74	"
<hr/>		
Total .....	100.00	percent

The butter produced by one creamery contained an average fat content for one year of 80.43 percent, which was the lowest average for any creamery having every churning conform to the Federal standard.

Forty-three creameries making a satisfactory quality of butter showed an estimated gain of 103,767 pounds of butter from one year's operation as a result of utilizing regular information concerning the chemical composition of the butter.

Twenty of twenty-eight creameries manufacturing butter of a low fat content improved the composition of their butter.

Uniform methods of procedure in manufacturing will produce butter of uniform composition.

Buttermakers experience difficulties in distributing the salt uniformly throughout the butter when the salt for a churning is weighed and added as one lot. More satisfactory results were obtained when the salt for a churning was weighed in two or three lots and each lot distributed over one-half or one-third, respectively, of the butter in the churn.

It will be difficult to obtain an overrun of 23 percent in a gathered cream plant and above 20 percent in a whole milk plant.

May, 1937

Bulletin 358

# Standardization of Iowa Butter

BY M. MORTENSEN, D. F. BREAZEALE, C. H. MEYER  
AND M. B. MICHAELIAN

AGRICULTURAL EXPERIMENT STATION  
IOWA STATE COLLEGE OF AGRICULTURE  
AND MECHANIC ARTS

R. E. BUCHANAN, Director

DAIRY INDUSTRY SECTION



Dhananjayrao Gadgil Library



GIPE-PUNE-047332

AMES, IOWA

7311:73:(M).7:

1

47332

## CONTENTS

	Page
Summary .....	380
Experimental methods .....	382
Method of sampling.....	382
Method of analysis.....	383
Method of reporting results.....	385
Results .....	385
Creameries manufacturing "low-fat" butter.....	386
Creameries manufacturing "high-fat" butter .....	387
Irregularities in composition.....	390
Discussion and application of results.....	391
Economic value of project.....	391
Seasonal variations in composition.....	394
Securing samples for analysis.....	395
Condition of churn as affecting composition control.....	396
Effect of salting methods on uniformity.....	396
Composition control not difficult.....	398
A method suggested for the control of composition.....	398
Overrun is greatly affected by butter composition.....	400

## SUMMARY

Much of the butter manufactured in Iowa shows too great a variation in chemical composition.

Frequent chemical analysis of the butter will assist the operator in controlling its composition.

The composition of 1,344 samples of butter obtained from 28 creameries during the calendar year 1933 was as follows:

Butterfat .....	80.71	percent
Moisture .....	16.17	"
Salt .....	2.38	"
Curd .....	.74	"
<hr/>		
Total .....	100.00	percent

The butter produced by one creamery contained an average fat content for one year of 80.43 percent, which was the lowest average for any creamery having every churning conform to the Federal standard.

Forty-three creameries making a satisfactory quality of butter showed an estimated gain of 103,767 pounds of butter from one year's operation as a result of utilizing regular information concerning the chemical composition of the butter.

Twenty of twenty-eight creameries manufacturing butter of a low fat content improved the composition of their butter.

Uniform methods of procedure in manufacturing will produce butter of uniform composition.

Buttermakers experience difficulties in distributing the salt uniformly throughout the butter when the salt for a churning is weighed and added as one lot. More satisfactory results were obtained when the salt for a churning was weighed in two or three lots and each lot distributed over one-half or one-third, respectively, of the butter in the churn.

It will be difficult to obtain an overrun of 23 percent in a gathered cream plant and above 20 percent in a whole milk plant.

# Standardization of Iowa Butter<sup>1</sup>

BY M. MORTENSEN, D. F. BREAZEALE, C. H. MEYER  
AND M. B. MICHAELIAN

It has been a common practice for some years for Iowa creameries to send samples of butter to the Iowa Experiment Station for chemical analysis. These analyses reveal the fact that there is considerable variation in the chemical composition of butter manufactured in the various creameries. At times there are large variations in the composition of butter manufactured in the same creamery.

A project was initiated in 1930 to determine the extent of such irregularities and at the same time to assist the creameries to manufacture butter of a more uniform chemical composition. Similar work was carried on by the University of California as early as 1925; Oregon State College began a similar project in 1929. The Land O'Lakes Company, of Minneapolis, Minn., has maintained a service laboratory for its group of creameries for several years. During recent years service laboratories have been established by various butter marketing groups as well as by some of the Agricultural Experiment stations.

The buyer of butter demands quality and pays particular attention to flavor and texture. He demands in addition that the product be uniform so he may create a permanent market for it. The manufacturer of a uniform and high quality product will increase the number of satisfied customers who will be willing to pay a premium over the market quotation, and the milk producers may receive some benefit from the higher returns.

Although uniformity of the chemical composition may not at all times influence the qualities mentioned, it will influence to a greater or lesser degree the price which the creamery manager will be able to return to the producers for butterfat. It becomes, therefore, one of the essentials in determining the success or failure of a creamery.

---

<sup>1</sup>Project 109 of the Iowa Agricultural Experiment Station.

The objectives of this project were: First, to obtain information regarding the variations in the composition of Iowa butter. Second, to determine the average composition that may safely be attained, together with the variations that must be allowed for. Third, to make clear to the creamery the economic value of a regular and systematic composition control. Fourth, to interest the operators in keeping daily records of the chemical composition of their products, preferably in the form of graphs. Fifth, to present a simple method by which the composition may readily be controlled. Sixth, to make a fair estimate of a butter overrun that a creamery operating under ideal conditions may be able to maintain.

## EXPERIMENTAL METHODS

### METHOD OF SAMPLING

The creameries cooperating with the department in this work were requested to send a sample of butter from each of four churnings monthly. In order to save on transportation expense these churnings followed consecutively and comprised the first four churnings produced after the sample jars had been received at the creameries. It might have been more satisfactory for the creamery to have sent one sample weekly, but that would have increased the cost of the project materially, and it is questionable whether the weekly samples would have shown any advantage over those obtained by the method employed.

The container for the sample was a 4-ounce, cylindrical, screw top, glass jar with a rubber gasket. Four jars were sent to each creamery, monthly, in such fashion that approximately the same time intervals elapsed between consecutive lots of samples. The butter samples were taken in such a manner that one-third of the total sample came from each end of the churn and the other third from the middle. The samples were taken with a butter trier, a spoon or a knife. The creamery operators were familiar with this method; it is the same as is employed by them daily in taking samples for analyses made in their creameries.

## METHOD OF ANALYSIS

Samples ( $1.0 \pm 0.001$  gm.) were weighed into tared Mojonnier moisture dishes. The sample weights were kept within the limits 0.999 to 1.001 gm. to facilitate calculation.

The samples were placed on the Mojonnier hot plate (fat side) at a temperature below  $100^{\circ}\text{C}$ . and were heated with the rheostat at zero resistance until a slight browning of the curd was perceptible (approximate temperature  $150^{\circ}\text{C}$ ). The samples were then heated in the oven (fat side) for 10 minutes at  $100^{\circ}\text{C}$ . and 20 to 22 inches vacuum. After a 5-minute period in the cooling desiccator the dishes containing the solids were weighed.

Following the moisture determinations, approximately 10 cc. of petroleum ether were added to the residues in the solids dishes. The solids in each dish were loosened with a "policeman," transferred to Jena glass crucibles with fine, fused-in, glass filtering disks and washed free from fat with petroleum ether. The crucibles were next heated for 15 minutes in a  $100^{\circ}\text{C}$ . oven to remove the last traces of petroleum ether, then cooled not less than 15 minutes in the Mojonnier cooling desiccator and weighed. The weight of the material in the crucibles at this stage represented salt and curd and was converted to percent salt and curd by multiplying by 100.

The salt and curd were washed into white porcelain casseroles by 3 or 4 successive washings with 10 cc. of hot water from a wash bottle. Final traces of salt were washed under suction from the crucibles into 150 cc. Erlenmeyer flasks with hot water. These washings were added to those in the respective casseroles, and the combined volumes were titrated with silver nitrate solution (2.906 gr. per liter), with 1 cc. of a 5-percent solution of potassium chromate as indicator. Each cubic centimeter of silver nitrate was equivalent to (1 cc. of 1% NaCl sol.) 0.1 percent salt (NaCl). The percentage of curd was obtained by subtracting the percentage of salt from the percentage of salt and curd.

The percentages of moisture and solids were calculated as follows:



1. Percent moisture = 100 — percent solids.

2. Percent solids =  $\frac{\text{weight of solids} \times 100}{\text{weight of sample}}$

The calculations involved in equation 2 can be performed mentally if the sample weights are controlled to  $1.000 \pm 0.001$  gm. When the sample weights were within these limits the solids were calculated as though a 1-gm. sample had been used, i.e., the weight of solids was multiplied by 100. Then for each 0.0001 gm. that the sample weighed less than 1.0 gm. 0.01 percent was added to this percentage of solids, or for each 0.0001 gm. the sample was heavier than 1.0 gm., 0.01 percent was subtracted. As table 1 shows all errors involved in this rapid method of calculating the percent solids are less than 0.02 percent of the weight of the sample.

TABLE 1. VARIATIONS ENCOUNTERED WHEN THE RECOMMENDED METHOD OF CALCULATION WAS EMPLOYED.

A	B	C	D	E	F	G
Weight of butter samp. gms.	Weight of total solids assumed gms.	Percent solids from B if 1 gm. samp. was assumed	Recommended correction for variation in samp. wt. gms.	Percent solids corrected	Percent solids calculated from A + B	Error in correction recommended (E-F)
0.9990	0.8400	84.0	+0.10	84.10	84.084	-0.016
0.9991	"	"	+0.09	84.09	84.076	-0.014
0.9992	"	"	+0.08	84.08	84.068	-0.012
0.9993	"	"	+0.07	84.07	84.058	-0.012
0.9994	"	"	+0.06	84.06	84.050	-0.010
0.9995	"	"	+0.05	84.05	84.042	-0.008
0.9996	"	"	+0.04	84.04	84.034	-0.006
0.9997	"	"	+0.03	84.03	84.026	-0.004
0.9998	"	"	+0.02	84.02	84.018	-0.002
0.9999	"	"	+0.01	84.01	84.008	-0.002
1.0000	"	"	+0.00	84.00	84.000	0.000
1.0001	"	"	-0.01	83.99	83.992	+0.002
1.0002	"	"	-0.02	83.98	83.982	+0.002
1.0003	"	"	-0.03	83.97	83.974	+0.004
1.0004	"	"	-0.04	83.96	83.966	+0.006
1.0005	"	"	-0.05	83.95	83.958	+0.008
1.0006	"	"	-0.06	83.94	83.950	+0.010
1.0007	"	"	-0.07	83.93	83.940	+0.010
1.0008	"	"	-0.08	83.92	83.932	+0.012
1.0009	"	"	-0.09	83.91	83.922	+0.012
1.0010	"	"	-0.10	83.90	83.916	+0.016

The percentage of fat was obtained by subtracting the sum of the percentages of salt and curd from the percentage of total solids.

In this fashion all calculations can be made mentally. This represents a considerable saving of time when from 12 to 16 analyses are made per day.

#### METHOD OF REPORTING RESULTS

A report was mailed to the creamery operator as soon as the analyses had been completed. This report gave the percentages of fat, moisture, salt and curd in the butter. This gave the operator prompt information with which he could check his own work. In addition to this report a graphic chart was mailed to each creamery operator about once in 6 months. This chart presented the analyses for the previous 6-month period in such a form that the operator could note irregularities by merely glancing at the chart.

Figures do not have the same significance to the average eye as charts. Even the bookkeeper or statistician who is accustomed to dealing with figures finds it to his advantage to transcribe his tables into charts. Many creamery operators who have participated in this project have found the charts to be of material help to them. It would be helpful to the operator if he himself would prepare charts showing the composition of his products in accordance with his own daily analysis and it should be possible for him to gradually prepare charts representing other manufacturing operations, many of which lend themselves well to that type of record.

#### RESULTS

Although 121 creameries participated in this work they did not all continue to send monthly samples during the entire 3-year period. A group of creameries from north-eastern Iowa marketing its products through the Iowa State Brand Marketing Association at Mason City discontinued because the marketing association started offering the same service to its members. Several other creameries had various reasons for not sending samples for 12 months or more. Creameries that cooperated for a shorter period than 12 months were not considered when the final results were tabulated.

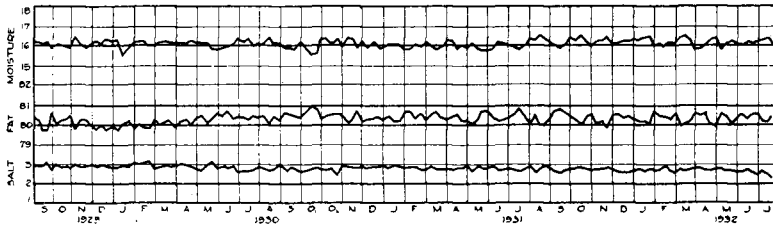


Fig. 1. The butter represented by this chart was low in composition of fat for 7 months, after which the composition was excellent.

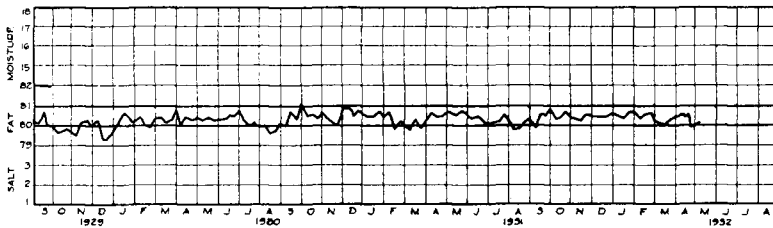


Fig. 2. This chart represents butter of very good composition of fat except for a few churnings of low-fat butter.

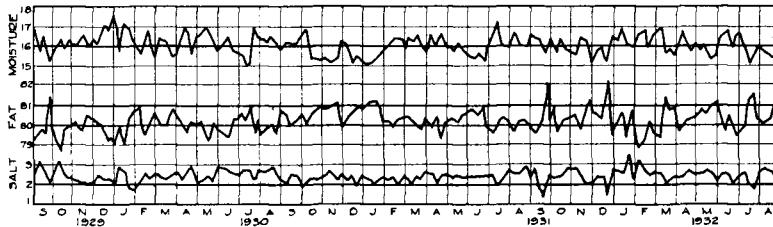


Fig. 3. The composition of this butter has been improved somewhat but remains too irregular.

#### CREAMERIES MANUFACTURING "LOW-FAT" BUTTER

The United States Food and Drug Administration<sup>2</sup> defines butter as follows: "Butter is the food product usually known as butter, and which is made exclusively from milk or cream, or both, with or without common salt, and with or without additional coloring matter and contains not less than 80 percent by weight of milk fat, all tolerances having been allowed for."

In accordance with this definition, a product containing less than 80 percent of butterfat cannot be discussed under the term "butter." It will be considered in this discussion as "low-fat" butter.

<sup>2</sup>U. S. Dept. of Agr. Food and Drug Administration. S.R.A. F.D. No. 2, Rev. 4, Page 4, 1933.

Figures 1, 2 and 3 illustrate the composition of butter from three creameries that originally manufactured products containing less than 80 percent butterfat. The butter-maker making the butter represented by fig. 1 soon rectified this error and produced butter of more nearly uniform composition than that produced by any of the other 86 buttermakers for whom records were tabulated. The butter-maker making the butter represented by fig. 2 made fair improvement. He is, however, holding closer to the danger line than his ability to control the composition will permit, and he has, therefore, an occasional churning that falls below the required standard. The buttermaker making the butter represented by fig. 3 is making an effort to improve his products but is not making a uniformly satisfactory butter.

It may be noted from table 2 that for the first 4 months of this survey 28 creameries manufactured products of which 25 percent or more of the samples failed to conform to the Federal standard: of these, 20 showed marked improvement during the second 4 months, while the products of the other eight creameries indicated that the operators apparently made no effort in that direction.

#### CREAMERIES MANUFACTURING "HIGH-FAT" BUTTER

The majority of the creameries started with a relatively high butterfat content as illustrated by figs. 4, 5 and 6. The operator represented by fig. 4 reduced the fat content materially after 2 months, but in doing so he had an occasional churning that fell below the required standard for fat. The operator represented by fig. 5 produced butter of very irregular composition for the first 7 months. The fat content of the butter varied from 82.5 percent to 78.7 percent; after that a marked improvement was noted.

Figure 6 indicates excellent control of butter composition. For 7 months the fat content followed closely the 81-percent line, but it was then reduced to approximately the 80.5-percent line. An operator who is able to control the composition of his products to the extent that this operator and the one represented by fig. 1 did is a valuable asset to his creamery.

TABLE 2. SUMMARY OF RESULTS IN 87 CREAMERIES, INCLUDING ESTIMATE OF INCREASED PROFITS IN 43 PRODUCING "HIGH FAT" BUTTER.

Sample No.	Fat content (%)		Improvement		Lbs. butter mfg.	Pounds butterfat saved		Additional pounds of butter mfg. from butterfat saved		Amount money saved		Percent of samples low in butterfat	
	1st 4 mos.	2nd 4 mos.	+	-		+	-	+	-	+	-	1st 4 mos.	last 4 mos.
2	81.25	80.95	.30	.....	210,021	630	.....	769	.....	\$ 161	\$ .....	.....	.....
3	.....	.....	.....	.....	2,369,732	.....	.....	.....	.....	.....	.....	25.00	6.25
4	80.69	80.66	.03	.....	537,200	161	.....	197	.....	41	.....	.....	.....
5	80.84	80.99	.....	.15	336,200	.....	.....	504	.....	.....	129	.....	.....
6	.....	.....	.....	.....	671,062	.....	.....	.....	.....	.....	.....	62.50	18.75
7	81.37	80.40	.97	.....	949,900	9,214	.....	11,241	.....	2,356	.....	.....	.....
8	81.29	80.95	.34	.....	16,800	57	.....	70	.....	15	.....	.....	.....
9	81.01	80.51	.50	.....	180,200	901	.....	1,099	.....	231	.....	.....	.....
10	80.98	80.52	.46	.....	739,400	3,401	.....	4,150	.....	871	.....	.....	.....
11	.....	.....	.....	.....	1,630,834	.....	.....	.....	.....	.....	.....	62.50	6.25
12	80.75	80.69	.06	.....	447,610	269	.....	328	.....	69	.....	.....	.....
13	81.78	81.40	.38	.....	164,200	624	.....	761	.....	160	.....	.....	.....
14	.....	.....	.....	.....	779,233	.....	.....	.....	.....	.....	.....	31.25	12.50
15	80.93	80.47	.46	.....	266,200	1,225	.....	1,495	.....	314	.....	.....	.....
16	.....	.....	.....	.....	936,800	.....	.....	.....	.....	.....	.....	25.00	50.00
17	.....	.....	.....	.....	294,400	.....	.....	.....	.....	.....	.....	25.00	25.00
18	.....	.....	.....	.....	663,200	.....	.....	.....	.....	.....	.....	37.50	0.00
19	.....	.....	.....	.....	790,100	.....	.....	.....	.....	.....	.....	25.00	25.00
21	81.29	81.07	.22	.....	236,600	521	.....	635	.....	133	.....	.....	.....
22	80.86	80.31	.55	.....	233,009	1,282	.....	1,563	.....	328	.....	.....	.....
24	80.69	80.79	.....	.10	834,342	.....	.....	834	.....	1,018	.....	.....	.....
25	80.89	80.95	.....	.06	266,500	.....	.....	160	.....	195	.....	.....	.....
26	.....	.....	.....	.....	566,300	.....	.....	.....	.....	.....	.....	25.00	12.50
27	81.32	81.14	.18	.....	65,600	118	.....	144	.....	30	.....	.....	.....
28	.....	.....	.....	.....	425,800	.....	.....	.....	.....	.....	.....	75.00	25.00
29	80.67	80.35	.32	.....	1,681,829	5,382	.....	6,676	.....	1,402	.....	.....	.....
30	.....	.....	.....	.....	467,900	.....	.....	.....	.....	.....	.....	43.75	18.75
31	.....	.....	.....	.....	360,326	.....	.....	.....	.....	.....	.....	25.00	6.25
32	81.02	81.09	.....	.07	360,326	.....	.....	252	.....	308	.....	.....	.....
33	.....	.....	.....	.....	580,100	.....	.....	.....	.....	.....	.....	31.25	18.75
36	81.58	81.38	.20	.....	244,100	488	.....	596	.....	125	.....	.....	.....
37	81.27	80.93	.34	.....	364,900	1,241	.....	1,514	.....	318	.....	.....	.....
39	.....	.....	.....	.....	363,800	.....	.....	.....	.....	.....	.....	25.00	50.00
40	.....	.....	.....	.....	381,200	.....	.....	.....	.....	.....	.....	50.00	83.33
42	81.04	81.00	.04	.....	2,522,926	1,009	.....	1,231	.....	259	.....	.....	.....
43	81.69	81.60	.09	.....	125,400	113	.....	139	.....	29	.....	.....	.....
44	81.31	80.16	.85	.....	1,212,600	10,307	.....	12,575	.....	2,641	.....	.....	.....
45	.....	.....	.....	.....	523,633	.....	.....	.....	.....	.....	.....	56.25	43.75
46	82.51	80.47	2.04	.....	432,663	8,826	.....	10,768	.....	2,261	.....	.....	.....
47	81.46	81.20	.26	.....	293,000	762	.....	929	.....	195	.....	.....	.....
48	81.77	81.46	.31	.....	191,100	592	.....	723	.....	152	.....	.....	.....
49	80.85	81.40	.....	.55	181,600	.....	.....	999	.....	1,219	.....	.....	.....
50	80.72	81.83	.....	1.11	187,447	.....	.....	2,081	.....	2,538	.....	.....	.....

Sample No.	Fat content (%)		Improvement		Lba. butter mfg.	Pounds butterfat saved		Additional pounds of butter mfg. from butterfat saved		Amount money saved		Percent of samples low in butterfat	
	1st 4 mos.	2nd 4 mos.	+	-		+	-	+	-	+	-	1st 4 mos.	last 4 mos.
53	80.75	80.70	.05	.....	148,697	74	.....	91	.....	19	.....	50.00	25.00
54	.....	.....	.....	.....	325,100	.....	.....	.....	.....	.....	.....	.....	.....
55	81.64	80.81	.83	.....	695,574	5,773	.....	7,043	.....	1,479	.....	.....	.....
56	80.88	80.62	.26	.....	1,487,642	3,868	.....	4,719	.....	991	.....	.....	.....
58	81.63	81.26	.37	.....	437,800	1,618	.....	1,974	.....	415	.....	.....	.....
59	80.93	81.14	.....	.21	386,700	.....	812	.....	991	208	.....	.....	.....
61	81.01	80.52	.49	.....	274,865	1,347	.....	1,643	.....	345	.....	.....	.....
63	81.73	80.77	.96	.....	67,100	644	.....	786	.....	163	.....	33.33	0.00
64	.....	.....	.....	.....	258,800	.....	.....	.....	.....	.....	.....	.....	.....
66	81.52	81.62	.....	.10	213,600	.....	214	.....	262	55	.....	.....	.....
67	81.07	81.03	.04	.....	767,300	307	.....	380	.....	80	.....	62.50	43.75
68	.....	.....	.....	.....	381,200	.....	.....	.....	.....	.....	.....	.....	.....
69	80.42	80.78	.36	.....	312,500	.....	1,125	.....	1,373	288	.....	.....	.....
70	80.89	81.48	.....	.59	214,713	.....	1,267	.....	1,546	325	.....	.....	.....
71	80.95	80.80	.15	.....	363,417	545	.....	665	.....	140	.....	.....	.....
72	82.05	81.61	.44	.....	461,274	2,030	.....	2,476	.....	520	.....	37.50	6.25
73	.....	.....	.....	.....	1,160,800	.....	.....	.....	.....	.....	.....	62.50	25.00
77	.....	.....	.....	.....	516,188	.....	.....	.....	.....	.....	.....	.....	.....
78	81.55	80.94	.61	.....	243,700	1,487	.....	1,814	.....	381	.....	.....	.....
79	81.46	81.19	.27	.....	793,000	2,141	.....	2,612	.....	549	.....	.....	.....
81	80.78	80.85	.....	.07	235,500	.....	163	.....	199	42	.....	.....	.....
83	80.91	80.71	.20	.....	118,900	238	.....	290	.....	61	.....	.....	.....
88	80.99	81.10	.....	.11	1,689,560	.....	1,859	.....	2,267	476	.....	25.00	25.00
89	.....	.....	.....	.....	1,108,400	.....	.....	.....	.....	.....	.....	.....	.....
91	81.02	80.81	.21	.....	232,700	489	.....	591	.....	125	.....	.....	.....
93	81.02	81.00	.02	.....	312,400	62	.....	76	.....	18	.....	.....	.....
94	80.88	81.37	.....	.49	352,300	.....	1,726	.....	2,150	452	.....	.....	.....
95	80.97	81.47	.....	.50	751,000	.....	3,755	.....	4,581	962	.....	.....	.....
97	80.91	80.31	.60	.....	414,165	2,485	.....	3,032	.....	637	.....	.....	.....
98	81.00	80.65	.35	.....	2,461,900	8,617	.....	10,512	.....	2,208	.....	.....	.....
99	81.14	80.33	.81	.....	311,679	2,525	.....	3,080	.....	647	.....	.....	.....
100	80.84	80.74	.10	.....	456,990	457	.....	558	.....	117	.....	.....	.....
103	.....	.....	.....	.....	834,804	.....	.....	.....	.....	.....	.....	37.50	0.00
106	81.24	81.22	.02	.....	171,000	34	.....	42	.....	9	.....	.....	.....
107	80.55	80.84	.....	.29	476,600	.....	1,382	.....	1,686	354	.....	.....	.....
109	80.85	80.70	.15	.....	408,700	613	.....	748	.....	157	.....	25.00	31.25
110	.....	.....	.....	.....	532,400	.....	.....	.....	.....	.....	.....	31.25	6.25
112	.....	.....	.....	.....	234,200	.....	.....	.....	.....	.....	.....	.....	.....
114	80.85	80.95	.....	.10	266,600	.....	257	.....	813	66	.....	25.00	37.50
116	.....	.....	.....	.....	199,800	.....	.....	.....	.....	.....	.....	.....	.....
117	81.05	80.44	.61	.....	176,600	1,077	.....	1,814	.....	276	.....	.....	.....
119	.....	.....	.....	.....	514,000	.....	.....	.....	.....	.....	.....	31.25	6.25
120	.....	.....	.....	.....	2,924,500	.....	.....	.....	.....	.....	.....	25.00	0.00
121	80.58	80.40	.18	.....	782,324	1,408	.....	1,718	.....	361	.....	.....	.....

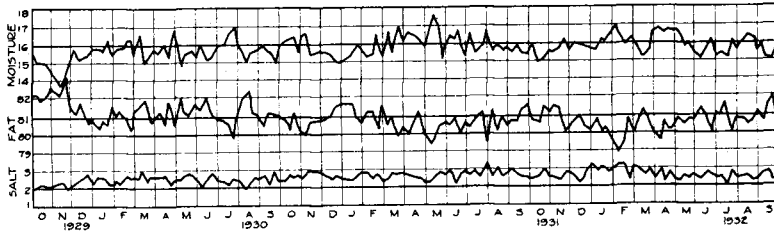


Fig. 4. The composition of this butter is gradually changing from extremely high to more nearly normal fat content.

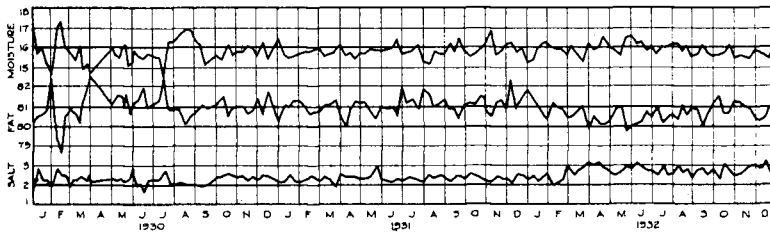


Fig. 5. The composition of the butter represented by this chart has gradually improved and become more uniform.

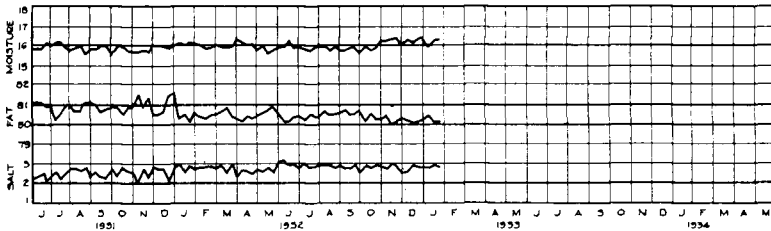


Fig. 6. The buttermaker making the butter represented by this chart has gradually improved the composition of the butter and has succeeded in gaining excellent control of the composition.

### IRREGULARITIES IN COMPOSITION

Figures 7 and 8 represent butter made by men who, either because of carelessness or lack of ability, made no effort to improve their products. The maker of butter represented by fig. 8 continued to send samples until April, 1931, when he wrote that he desired to discontinue.

Figures 7 and 8 show the outstanding examples of inefficiency encountered in the operation of some of the Iowa creameries. There were a few others that nearly approached the same degree of inefficiency. It is discouraging that several such creameries, after they had submitted samples for analysis for some time and found that the workmanship

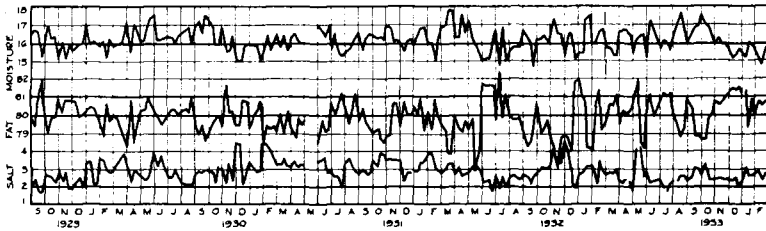


Fig. 7. This chart represents butter of very poor composition.



Fig. 8. This chart represents butter of extremely poor composition.

was below standard, would discontinue sending samples rather than make an effort to improve.

## DISCUSSION AND APPLICATION OF RESULTS

### ECONOMIC VALUE OF PROJECT

It is impossible to present a statement giving accurate information as to the economic value to the creameries of such a process of standardization. However, table 2 contains certain information that should emphasize to the creamery operator the importance of keeping a daily record of the composition of his products.

Table 2 has been prepared from all the analyses of legal butter submitted regularly from creameries for at least 1 year. The average of the fat content of all samples of legal butter from the first 4 months was recorded under "1st 4 mos." A similar average was recorded for samples submitted during the last 4 months. No creameries submitting samples for less than 12 consecutive months were included. The amount of butter manufactured by each creamery during 1933, the last year of the experiment, was recorded. The amount of butterfat gained or lost was determined as follows: Creamery No. 2 manufactured butter during the first 4 months with an average fat content of 81.25 percent.



The average for the last 4 months was 80.95, a saving of .3 of a pound of butterfat on every 100 pounds of butter manufactured. Since the annual output of that creamery was 210,021 pounds, the creamery could save for 1 year, on account of improved composition,  $210,021 \times .003 = 630$  pounds of fat. If this creamery obtained a normal overrun of 22 percent then the total saving of manufactured butter would amount to 769 pounds. The average price for New York extras in 1933 was 21.64 cents. This was considerably below the average New York quotation of 36.23 cents from 1925 to 1934, but using the 1933 average price this creamery, by manufacturing a good quality of butter, should have obtained a price of about 21 cents per pound for butter f.o.b. the creamery. At this price the creamery would have added to its income  $769 \times \$0.21 = \$161$ . The total net gain to the creamery will fall slightly below this figure since the cost of supplies for the additional amount of butter manufactured should be deducted. This item will vary slightly with the different creameries depending largely on the type of package used. Some creameries selling print butter charge enough extra to pay for wrappers, cartons and cost of printing. Other factory expenses should not be considered since the comparatively small amount added to the output daily would not increase the operating expenses.

In preparing table 2 it was considered that it would be misleading to include creameries that manufactured a high percentage of low-fat butter during the first 4 months. It was decided, therefore, to omit creameries that manufactured 25 percent or more of such butter during that period. Their problem was one of increasing the fat content of the butter so that it would conform to legal standards. The "improvement" made in the output from these creameries is indicated in the last two columns of the table.

It will be noted from table 2 that some of the creameries, other than those producing low-fat butter, have increased instead of decreased the fat content. This may be accounted for in two ways: First, some of the creameries were originally making butter of such satisfactory composition that there was no room for improvement; second, others did not

fully appreciate the value of standardizing their products. It will be noted that such cases are more frequent among the higher numbers (table 2). These creameries initiated the work at a later date and, therefore, had not had as long a time to correct their errors as the creameries represented by the lower numbers.

Of the 87 creameries reported, 28 were excluded because 25 percent or more of the analyses of butter from these plants during the first 4 months indicated low-fat butter. Of these, 20 creameries showed improvement, 3 started and finished with the same number of low-fat samples, and 5 finished with a greater number of low-fat samples.

Forty-three creameries producing high-fat butter show an estimated annual gain of 103,767 pounds of butter as a result of their efforts to operate closer to the required standard. This, at a net value of 21 cents per pound, would represent to these creameries an additional income of \$21,791 for the year. If the value of the butter were considered at the average quotation of New York extras for the past 10 years (36.235 cents), and if it were assumed that the creameries would receive  $\frac{1}{2}$  cent above that quotation, i.e., a net price (freight deducted) of about 35 cents per pound, these 43 creameries would have received \$36,318 above the return they would have obtained if the butter had had the composition represented by the analyses during the first 4 months.

Sixteen creameries manufactured butter which contained a higher fat content at the close of the period than at the beginning. The average fat content of the samples submitted by this group of creameries was 80.86 percent for the first 4 months and 81.16 percent for the last 4 months. This presents a striking contrast to the group of 43 that started with an average of 81.19 percent and finished with an average of 80.81 percent fat. The group of 16 creameries manufactured 21,261 pounds of butter less than they would have manufactured had they continued to adhere to the composition of the butter they manufactured during the first 4 months. Figuring the butter at 21 cents per pound the income for those creameries would have been \$4,465 greater

(or at 35 cents per pound \$7,441 greater) had they maintained their original composition.

#### SEASONAL VARIATIONS IN COMPOSITION

It seems to be the opinion of some operators that there exists a certain seasonal variation in the composition of butter, resulting from factors such as feeding conditions of the animals, lactation period, etc. There are several such factors that would influence the composition if the manufacturing methods employed were always the same, but most buttermakers are fully aware of these conditions and change their methods of manufacture so as to counteract changes brought about by seasonal causes.

In order to measure the extent of such changes, 28 creameries that fairly well represented the average creamery of the state were selected. Each creamery submitted four samples of butter monthly for 12 months during the year 1933. The results of the analyses are presented in table 3.

TABLE 3. MONTHLY AVERAGES OF ANALYSES OF BUTTER FROM 28 REPRESENTATIVE CREAMERIES.

Month	Percent butterfat	Percent moisture	Percent salt	Percent curd
Jan.	80.64	16.16	2.50	.70
Feb.	80.74	16.13	2.49	.64
March	80.71	16.09	2.56	.64
April	80.75	16.24	2.44	.57
May	80.69	16.23	2.37	.71
June	80.74	16.34	2.27	.65
July	80.72	16.19	2.32	.77
Aug.	80.70	16.17	2.34	.79
Sept.	80.72	16.15	2.32	.81
Oct.	80.77	16.17	2.27	.79
Nov.	80.73	16.01	2.36	.90
Dec.	80.67	16.15	2.34	.84
Average	80.71	16.17	2.38	.74

Variations reported are so insignificant that it can be stated that under our present system of manufacture there are no appreciable seasonal variations in the composition of creamery butter.

The average composition of 1,344 samples from the 28 creameries for the 12 months was as follows:

Butterfat .....	80.71 percent
Moisture .....	16.17 percent
Salt .....	2.38 percent
Curd .....	.74 percent
TOTAL .....	100.00 percent

This composition may be considered a fair average for our good creameries. Some creameries are able to come somewhat closer to the 80 percent fat limit without violating the legal standard. The operator represented by fig. 1 obtained, for 1 year, an average fat content of 80.43 percent and kept the fat content of all churnings within the legal requirements. It would seem logical that our most progressive operators should aim at a standard near 80.5 percent fat. It is important that the operator test his own ability to control composition before deciding on a definite standard for his product, and he should make complete analyses of each churning before offering the butter for sale.

#### SECURING SAMPLES FOR ANALYSIS

It is a common practice in most creameries to secure the butter sample for analysis from the churn by taking equal portions of the sample from three separate places in the churn. A sample is generally taken from the butter at each end of the churn and one from the middle. These samples together form a composite sample on which the analyses are made. To determine the accuracy of this method of securing a sample, a series of tests was made in the college creamery. Samples were secured at various times when the churn was operating under normal conditions. Separate samples were thus secured from the butter at each end of the churn and from the middle.

It will be noted (table 4) that the composition of butter taken from the various locations in the churn differed widely.

TABLE 4. ANALYSIS OF BUTTER SAMPLED FROM THREE POSITIONS IN EACH OF SIX CHURNINGS. THE SALT WAS DISTRIBUTED IN THE USUAL MANNER.

Churning No.	Fat (%)			Moisture (%)			Salt (%)			Curd (%)		
	G.E.*	Mid-dle	B.M. E.**	G.E.	Mid-dle	B.M. E.	G.E.	Mid-dle	B.M. E.	G.E.	Mid-dle	B.M. E.
1	82.14	79.75	79.73	15.66	16.84	16.17	1.55	2.81	3.46	.65	.60	.64
2	81.58	80.07	81.37	15.87	16.17	15.57	1.85	3.03	2.42	.70	.73	.64
3	80.06	79.88	81.52	16.40	16.53	15.91	2.90	2.91	1.93	.64	.67	.64
4	80.97	80.84	80.91	16.33	16.33	15.87	2.14	2.12	2.60	.56	.71	.62
5	81.01	80.68	80.36	15.87	16.29	15.91	2.35	2.32	2.90	.77	.71	.83
6	80.86	80.54	81.45	16.21	16.23	15.75	2.32	2.58	2.14	.61	.65	.66

\*Gear end of churn.

\*\*Buttermilk outlet end of churn.

This is a serious matter to the operator, because such conditions will not assure him of a uniform overrun, and, what is even of greater importance, one tub of butter may be satisfactory in composition while another tub of butter taken from the same churning may be low in fat content and pronounced illegal by the Federal inspector. It is, therefore, not safe for the operator to depend on the results from the analysis of a composite sample of butter until such a time as he is able to produce a churning of butter that is uniform throughout, and even then he should check on his work at regular intervals by making separate analyses from samples taken from different parts of the churn.

#### CONDITION OF CHURN AS AFFECTING COMPOSITION CONTROL

Most buttermakers control the composition of butter by controlling moisture and salt; the curd content is kept fairly constant. The moisture content may vary as a result of various causes such as insufficient draining before working, sticky churns, etc., but most often because the churn is not level. It is evident that if the churn is not absolutely level any free moisture that may be present will flow to the low end of the churn and will become incorporated into the butter in that end during the working process. The lower end of the churn will likewise contain more butter than the higher end, and unless the butter is uniformly distributed throughout the churn it becomes impossible to distribute the salt so the butter will be uniformly salted.

#### Effect of Salting Methods on Uniformity

Churnings 1, 2 and 3 (table 4) appear more irregular in composition than the three following churnings. The buttermaker distributed the salt uniformly in a trench made in the butter, but before working the first three churnings he poured the water required for standardizing the composition into the trench. With the last three churnings only enough water was added to the salt to moisten it; the rest of the water was poured to the bottom of the churn. By the latter system the salt remained more uniformly distributed, although the difference in composition of the samples of butter taken from the same churnings was still too great.

In an attempt to obtain greater uniformity in the chemical composition of the butter, the salt to be added was weighed into two equal lots and the roll of butter in the churn was divided into two equal parts by measure with a ruler. Each lot of salt was distributed carefully over one-half of the butter. This procedure resulted in greater uniformity as will be noted in table 5.

TABLE 5. ANALYSIS OF BUTTER SAMPLED FROM TWO POSITIONS IN EACH OF SIX CHURNINGS. THE SALT WAS DIVIDED INTO TWO EQUAL PARTS AND EACH PART DISTRIBUTED OVER ONE-HALF OF THE BUTTER.

Churn- ing No.	Fat (%)		Moisture (%)		Salt (%)		Curd (%)	
	G.E.*	B.M.E.**	G.E.	B.M.E.	G.E.	B.M.E.	G.E.	B.M.E.
1	80.41	81.20	16.40	15.60	2.29	2.28	0.90	0.92
2	80.50	80.50	15.70	15.60	2.50	2.70	1.30	1.20
3	80.55	80.45	15.85	15.85	3.10	3.10	0.50	0.60
4	81.20	80.60	15.50	16.20	2.35	2.20	0.95	1.00
5	80.70	80.30	15.70	16.00	2.50	2.70	1.10	1.00
6	80.50	80.50	16.10	16.10	2.50	2.70	0.90	0.70

### Composition Control Not Difficult

It is not at all difficult for the experienced operator to control the composition of butter. Whenever he fails, it is generally the result of faulty technique. Table 7 presents the analyses of butter made by the students in dairy industry after they had passed through eight laboratory exercises in the college creamery. Only 30 percent of the students had the advantage of any previous practical experience. They were instructed to make butter containing 80.5 percent fat and 2.5 percent salt. This report indicates that the ability required on the part of the operator may be acquired without any great difficulty.

TABLE 7. ANALYSIS OF BUTTER MADE BY STUDENTS IN BUTTERMILKING AT IOWA STATE COLLEGE.

Student No.	Percent butterfat	Percent moisture	Percent salt	Percent curd
1	80.4	16.3	2.7	.6
2	80.6	16.1	2.4	.9
3	81.1	15.8	2.5	.6
4	80.6	16.0	2.6	.8
5	80.2	16.5	2.5	.8
6	79.8	16.8	2.6	.8
7	79.2	17.8	2.4	.6
8	80.8	16.2	2.4	.6
9	80.6	16.1	2.4	.9
10	81.1	15.7	2.4	.8
11	80.9	15.8	2.4	.9
12	80.3	16.4	2.4	.9
13	80.4	16.2	2.5	.9
14	80.7	16.2	2.5	.6
15	80.4	16.0	2.5	1.1
16	80.6	16.2	2.4	.8
17	80.8	16.1	2.4	.7
18	81.8	15.7	2.5	1.0
19	80.4	16.4	2.5	.7
20	80.4	15.9	2.7	1.0
21	79.7	17.4	2.3	.6
22	81.0	15.7	2.5	.8
23	80.7	15.9	2.6	.8
24	80.4	16.4	2.5	.7

### A Method Suggested For the Control of Composition

Various methods, possibly equally satisfactory, are employed by the different operators for the purpose of controlling the general chemical composition of butter. The following has been employed successfully at Iowa State College.

When the butter granules are of the desired size the buttermilk is drawn and the butter is sprinkled with water of the same temperature as the buttermilk. This is con-

tinued until the liquid coming from the buttermilk outlet is quite clear. The buttermilk outlet is then closed and an amount of water equal to and of the same temperature as the buttermilk is added. If the cream was rather rich (35 percent fat or more) more water should be added. The churn is now revolved at slow speed about six to eight revolutions, when it is brought to a stop and drained until the water runs out in a stream about the size or somewhat less than the size of a common lead pencil. The buttermilk gate is then closed and the churn is revolved in working gear for a few revolutions until the butter is in a compact mass. The number of revolutions depends on the kind of churn used and the condition of the butter. The churn is now drained as completely as possible through the buttermilk outlet, and a sample of butter is taken for moisture analysis. While the sample is being analyzed, the churn is placed in position so the remaining liquid will drain out through the cover.

To determine the amount of salt to add, the buttermaker should know quite definitely the amount of salt lost during the working process. This should be figured in percentage of the total amount of salt added. This loss is nearly constant if uniform methods of handling the butter are employed. It should never exceed 10 percent, and many operators will hold that loss below 5 percent. The buttermaker should have furthermore some definite percentage of fat in mind and strive to reach that in the finished product. If he desires to make butter containing 80.5 percent butterfat and 2.5 percent salt and he knows from experience that he will lose 7 percent of the salt added, then the amount of salt to be added for every 100 pounds of butterfat in the churn

is equal to  $2.5 \times \frac{100}{80.5} \times \frac{100}{100-7} = 3.34$  pounds.

After the moisture test has been completed a trench is made in the butter, and the salt is distributed uniformly along the trench. Part of the water required for standardizing the composition of the butter is added to the salt until that has become fairly moist so it will go into solution more readily during the working process; if any water is left it



is poured into the churn. The trench is closed to prevent the salt from falling out on the sides and rolls of the churn. The churn is then started in working gear.

It was found by Farr<sup>3</sup> (see following table) that after the first few revolutions the moisture content of the butter increases gradually as working progresses, while the percentage of butterfat will naturally decrease in the same proportion. When the working is completed a fat determination should be made. The moisture test alone does not assure reliable results.

Moisture before working.....	15.20	percent
“ after 5 rev.....	13.95	“
“ “ 10 “.....	14.14	“
“ “ 15 “.....	14.20	“
“ “ 20 “.....	14.41	“
“ “ 25 “.....	14.52	“
“ “ 30 “.....	14.66	“
“ “ 35 “.....	14.88	“
“ “ 40 “.....	15.04	“
“ “ 45 “.....	15.15	“

#### OVERRUN IS GREATLY AFFECTED BY BUTTER COMPOSITION

Since the composition of the butter influences to a great extent the amount of butter overrun, and since a satisfactory overrun is essential to the success of a creamery, the necessity of a definite control of the chemical composition of the butter becomes obvious. Butter containing 81 percent

fat would produce an overrun of  $\frac{100 - 81}{81} \times 100$  or 23.46

percent if no other losses were considered. Butter containing 82 percent fat would, under the same conditions, produce a 21.95 percent overrun, while butter containing 83 percent fat would produce a 20.48 percent overrun. These overruns would not be possible, however, since there are other losses encountered which reduce the overrun. The most important of such losses are fat losses in skimmilk and buttermilk, miscellaneous fat losses and shrinkage in butter manufactured.

The Iowa State law is rather liberal when it defines a legal overrun at 24.5 percent, but since the law stipulates that weighing and testing of the milk and cream must be done

<sup>3</sup>Clifford G. Farr. A study of the factors influencing the chemical composition of the butter granules. Unpublished thesis. Iowa State College. 1922.

accurately it may be possible to prove that an overrun of 24.5 percent will be difficult to obtain.

In order to make this discussion practical and readily understood, it will be assumed that there are two lots of cream, each weighing 1,000 pounds, one lot testing 25 percent and the other 35 percent butterfat. It is furthermore assumed that the average fat content of the butter made from these creams is 80.43 percent, which was the lowest legal average for one year recorded from 1,344 analyses of good creamery butter. It is also taken for granted that 4 ounces of butter are allowed for overweight for every 63 pounds of butter. This is less than it is customary to allow, but it is possible to make butter of such texture that this amount is sufficient.

Experiments at this station indicate that buttermilk produced from a 35 percent cream when tested with the butyl alcohol method will contain about 0.7 percent butterfat, while the buttermilk from a 30 percent cream will average about 0.58 percent and from a 25 percent cream about 0.55 percent. The miscellaneous losses, in accordance with Minnesota experiments,<sup>4</sup> are about 0.5 percent of the total amount of fat received when handling whole milk. By most careful handling this loss may be reduced to about 0.2 percent for the creamery handling gathered cream. The fat test of the skimmilk after the milk had been skimmed with an Alfa separator was reported by Hansen and Jensen of the Danish Experimental Creamery<sup>5</sup> to be 0.057 percent. This separator was operated under ideal conditions.

Employing the above figures for calculating a possible overrun one should bear in mind that the figures are the lowest that one can expect to obtain, and that in most cases the losses will be greater and the overrun reduced accordingly.

The amount of buttermilk held in the butter is about equal to the amount of butterfat  $\times \frac{20}{100}$ , or the total amount of buttermilk will be equal to pounds of cream — (pounds of

<sup>4</sup>Minnesota Exp. Sta. Bul. 177. 1918.

<sup>5</sup>A. P. Hansen and Johs. Jensen. Statens Forsogsmejers, 10 Beretning. 1932.

butterfat  $\times 1.20$ ) which in this case is equal to  $1,000 - (250 \times 1.20) = 700$  pounds. The amount of butterfat lost in the buttermilk is  $700 \times .0055$  or 3.85 pounds. The miscellaneous losses amount to  $250 \times .002 = .5$  pounds. The amount of butterfat in the finished butter is equal to  $250 - (3.85 + .5) = 245.65$  pounds. This amount of fat will produce  $245.65 \times \frac{100}{80.43} = 305.42$  pounds of butter. Allowing 4 ounces per tub for shrinkage the amount of butter paid for on the market is equal to  $305.42 \times \frac{63}{63.25} = 304.21$  pounds.

The final overrun is equal to  $\frac{304.21 - 250}{250} \times 100 = 21.68$  percent.

The following is a summary of the estimated loss in fat responsible for the reduction in overrun below the theoretical overrun of 25 percent which would be obtainable only if it were possible to produce butter containing 80 percent butterfat and prevent all losses during the process of manufacturing:

Fat lost in buttermilk.....	3.85	pounds
Miscellaneous losses .....	0.50	"
Additional fat required to produce butter containing 80.43 percent fat.....	1.31	"
Overweight of 4 ounces to a 63-pound tub of butter.....	0.97	"
<b>Total .....</b>	<b>6.63</b>	<b>pounds</b>

**Percentage of This Loss Attributed to the Various Factors**

Fat lost in buttermilk.....	58.07	percent
Miscellaneous losses .....	7.54	"
Composition of the finished butter.....	19.76	"
Overweight .....	14.63	"
<b>Total .....</b>	<b>100.00</b>	<b>percent</b>

**Effect of the Various Factors on Final Overrun**

Fat losses in buttermilk reduced the overrun.....	1.92	percent
Miscellaneous losses reduced the overrun.....	.25	"
Composition of the finished butter reduced the overrun.....	.66	"
Overweight reduced the overrun.....	.49	"
<b>Total .....</b>	<b>3.32</b>	<b>percent</b>

Employing the same method for figuring the overrun when churning a cream containing 35 percent of butterfat gives the following results (350 pounds of butterfat are contained in the cream):

$$\begin{aligned} \text{Pounds of buttermilk} &= 1,000 - (350 \times 1.20) = 580 \text{ pounds} \\ \text{Fat lost in the buttermilk} &= 580 \times .007 = 4.06 \text{ pounds} \\ \text{Miscellaneous losses} &= 350 \times .002 = 0.7 \text{ pounds} \\ \text{Amount of fat in finished butter} &= 350 - 4.06 + 0.7 = 345.24 \text{ pounds} \\ \text{Amount of butter manufactured} &= 345.24 \times \frac{100}{80.43} = 429.24 \text{ pounds} \\ \text{Pounds of butter paid for on the market} &= 429.24 \times \frac{63}{63.25} = 427.54 \text{ pounds} \\ \text{Final overrun} &= \frac{427.54 - 350}{350} \times 100 = 22.15 \text{ percent} \end{aligned}$$

The following is a summary of the estimated fat losses when churning cream containing 35 percent butterfat:

Fat lost in buttermilk.....	4.06 pounds
Miscellaneous losses .....	0.70 "
Additional fat required to produce butter containing 80.43 percent fat.....	1.85 "
Overweight of 4 ounces to a 63-pound tub of butter.....	1.36 "
<b>Total .....</b>	<b>7.97 pounds</b>

#### Percentage of This Loss Attributed to the Various Factors

Fat lost in buttermilk.....	50.94 percent
Miscellaneous losses .....	8.78 "
Composition of the finished butter.....	23.21 "
Overweight .....	17.07 "
<b>Total .....</b>	<b>100.00 percent</b>

#### Effect of the Various Factors on the Final Overrun

Fat losses in buttermilk reduced the overrun.....	1.45 percent
Miscellaneous losses reduced the overrun.....	0.25 "
Composition of the finished butter reduced the overrun.....	0.66 "
Overweight reduced the overrun.....	0.49 "
<b>Total .....</b>	<b>2.85 percent</b>

Although the overrun is higher on higher testing cream because of a smaller amount of buttermilk, it would not be advisable to recommend cream of too high a test, because, as a result of its higher viscosity, it will evidently cause a greater amount of butterfat to be lost in pipes, vats and utensils.

The creameries receiving whole milk for buttermaking experience another loss of butterfat, namely, the amount lost in the skimmilk. The method of calculating the amount of skimmilk obtained appears rather difficult to the average operator because of the present system of operating such plants. The following simple formula will, however, assist

the operator in determining the amount of skimmilk, using figures that should be available in every whole milk plant.

Let  $M$  represent pounds of whole milk received  
 $S$  represent pounds of skimmilk obtained  
 $p$  represent the average test of whole milk received  
 $P$  represent the average test of cream  
 $a$  represent the average test of skimmilk

$$\text{Then } S = \frac{M (P - p)}{P - a}$$

Assume that a creamery receives 10,000 pounds of milk, daily, testing 3.8 percent fat, that a cream is produced testing 25 percent fat, and that the skimmilk test is 0.057 percent; then the overrun may be calculated as follows:

$$S = \frac{10,000 \times (25 - 3.8)}{25 - 0.057} = 8,499.38 \text{ pounds of skimmilk}$$

Amount of fat lost in skimmilk =  $8,499.38 \times .00057 = 4.845$  pounds,  
 and  $10,000 - 8,499.38 = 1,500.62$  pounds 25 percent cream

Amount butterfat for churning =  $1,500.62 \times .25 = 375.16$  pounds  
 Amount of buttermilk =  $1,500.62 - (375.16 \times 1.20) = 1,050.43$  pounds

Fat lost in the buttermilk =  $1,050.43 \times .0055 = 5.78$  pounds

Miscellaneous losses =  $375.16 \times .005 = 1.88$  pounds

Amount of fat in finished butter =  $375.16 - (5.78 + 1.88) = 367.50$  pounds

Amount of butter manufactured =  $367.50 \times \frac{100}{80.43} = 456.92$  pounds

Pounds of butter paid for on the market =  $456.92 \times \frac{63}{63.25} = 455.11$  pounds

Final overrun =  $\frac{455.11 - 380}{380} \times 100 = 19.77$  percent

The following is a summary of estimated fat losses in a creamery receiving milk testing 3.8 percent fat and producing butter from cream testing 25 percent fat.

Fat lost in skimmilk.....	4.84	pounds
Fat lost in buttermilk.....	5.78	"
Miscellaneous losses .....	1.88	"
Additional fat required to produce butter containing 80.43 percent fat.....	1.96	"
Overweight of 4 ounces to a 63-pound tub of butter.....	1.45	"

Total .....15.91 pounds

#### Percentage of This Loss Attributed to the Various Factors

Fat lost in skimmilk.....	30.42	percent
Fat lost in buttermilk.....	36.33	"
Miscellaneous losses .....	11.82	"
Composition of the finished butter.....	12.32	"
Overweight .....	9.11	"

Total .....100.00 percent

**Effect of the Various Factors on Final Overrun**

Fat losses in skimmilk reduced the overrun.....	1.59	percent
Fat losses in buttermilk reduced the overrun.....	1.90	"
Miscellaneous losses reduced the overrun.....	0.62	"
Composition of the finished butter reduced the overrun....	0.64	"
Overweight reduced the overrun.....	0.48	"
Total .....	5.23	percent

Any monthly overrun obtained exceeding the overruns calculated above should be scrutinized most carefully by the operator, as too high or too low overruns indicate that there is something in the operation of the plant that needs immediate attention.