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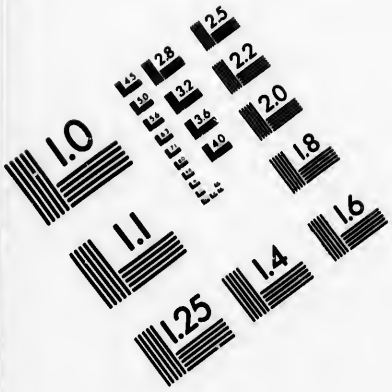

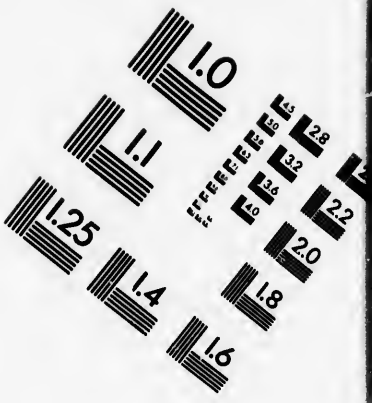

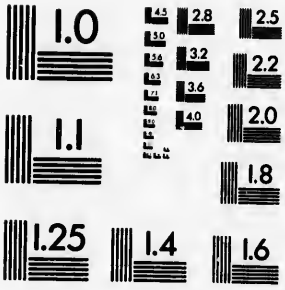

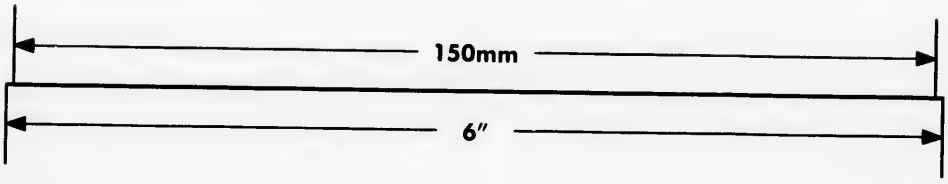

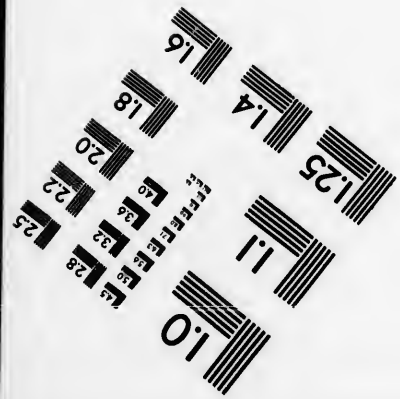

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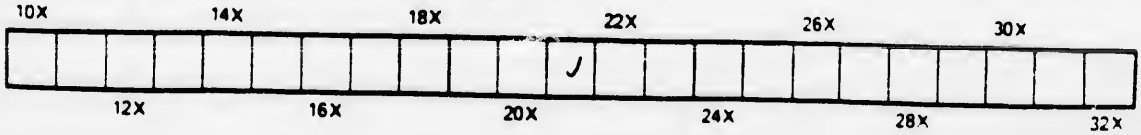

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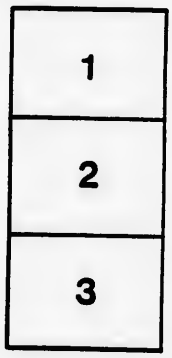

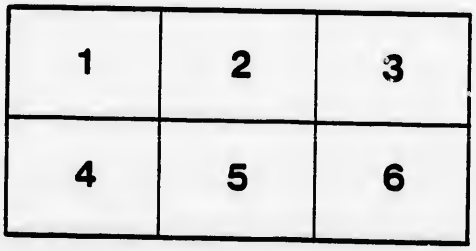

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BULLETIN XCV.

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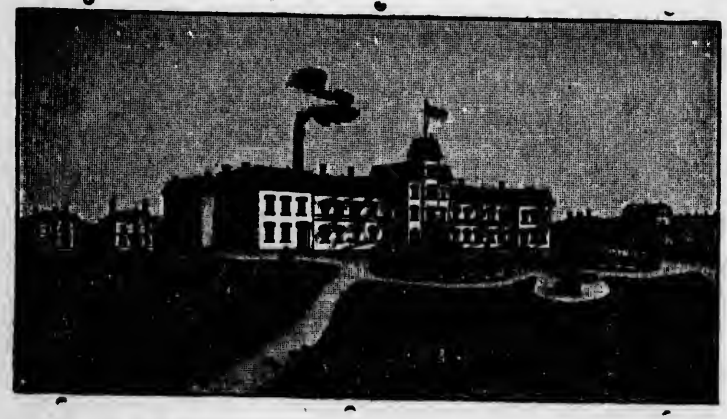

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BULLETIN XCV.

EXPERIMENTS IN CHEESE-MAKING.

By H. H. Dean, B. S. A., Professor of Dairying.

The question, which is better, to pay patrons of cheese factories according to the percentage of fat in their milk, or to pay them according to weight of milk? having been very much discussed at dairy conventions, farmers' institutes, and in the press, it was decided to conduct, at the dairy department of the College, during the present year, a series of experiments bearing on the point at issue. Besides this, we have asked about 75 cheese-makers in different parts of the Province to co-operate with us in the work. The plan of the experiment is to make cheese at the dairy here for one week of each month throughout the season, beginning with May. The cheese-makers have been asked to make one experiment each month and send in the report on blank forms furnished by the Experimental Union in connection with the College.

We select normal milk with as wide a variation in the percentage of fat as we can get. Most of the milk used here has been supplied by our Dairy and Farm herds. In addition, we bought about 150 pounds per day from neighboring farmers. In all, five herds have contributed the milk used in the May and June experiments, which are here reported. Most of our cows give milk of good quality. We test each cow weekly by composite tests, and put the milk from all the cows testing over 3.6 per cent. into one can, and the milk testing under this into another can. To supplement this, a quantity sufficient to make up 600 pounds per day has been bought—chiefly poor milk. The chemical analyses of milk, whey, green cheese, and cured cheese are made from month to month in the chemical laboratory.

The quantity of milk in each vat was 300 pounds. Two such vats of milk were made into cheese each day, under the same conditions as far as possible. The percentage of fat in milk and whey was determined by the Babcock method at the Dairy. One ounce of rennet, diluted in 4 ounces of water, was used for each 300 pounds of milk in both May and June. No coloring was used in the milk. A rennet test was made of each vat every day. In making the test we added 1 dram of Hansen's Rennet Extract to 8 ounces of milk at a temperature of 86°F., and noted the time required for coagulation. During the month of May the rennet test varied from 9 to 18 seconds, with an average of 14 when set. In June the tests varied from 14 to 18 seconds—average 16.

The temperature at which the milk was set varied from 85° to 90°, but nearly all the vats were set in both months at 86°. The time required for coagulation varied from 11 to 28 minutes—average 19 minutes in May; in June the variation was from 20 to 30 min-

utes, with an average of 23 minutes. All the curds were heated to 98° for cooking. They were dipped on showing about one-eighth of an inch of acid on the hot iron. All curds were milled with the Harris mill, and at a time about half-way between dipping and salting. In May the salting was done at the rate of 2 pounds per 1000 lbs. of milk. During June all curds were weighed when ready and salted at the rate of 2½ pounds per 100 pounds of curd. They were put to press in 15 or 20 minutes after salting. Pressure was applied lightly at first in a "gang" press, having a "spring head;" and after 40 to 60 minutes the cheese were bandaged and put back to press for about 20 hours. All cheese were weighed green with one press cloth on, and then put into the curing room. The May cheese were weighed again on June 2nd, and the June cheese on July 2nd.

In spite of extra care taken of our own milk, some of the curds developed a peculiar flavor, and some were slightly gassy. A "starter" was used in some cases to hasten the ripening of the milk.

The table shows the difference in yield of cheese from milk with different percentages of fat for the two months. Three hundred pounds of milk were used in each case.

Date.	Per cent. fat in wholemilk	Lb. cheese.		Loss in curing.	Lb. milk for 1 lb. green cheese.	Lb. green cheese for 1 lb. fat in milk.
		Green.	Cured.			
				lb.		
April 30th..	3.90	30.00	28.25	1.75	10.00	2.56
	3.35	27.50	25.50	2.00	10.91	2.74
May 1st....	3.90	29.50	27.50	2.00	10.17	2.52
	3.60	27 00	24.50	2.50	11.11	2.59
" 2nd....	3.60	29.75	27.50	2.25	10.08	2.76
	3.50	27.75	25.75	2.00	10.81	2.64
" 3rd....	3.85	29.00	27.50	1.50	10.34	2.51
	3.40	28.00	26.50	1.50	10.71	2.75
" 4th....	3.70	29.00	27.50	1.50	10.34	2.61
	3.70	29.00	27.50	1.50	10.34	2.61
" 5th....	4.00	30.00	28.75	1.25	10.00	2.50
	3.50	28.00	27.50	0.50	10.71	2.67
" 7th....	3.65	29.25	27.75	1.50	10.26	2.67
	3.30	27.50	26.00	1.50	10.91	2.75
June 4th....	4.50	33.75	31.25	2.50	8.88	2.50
	3.20	28.25	26.25	2.00	10.62	2.94
" 5th....	3.80	31.25	29.50	1.75	9.60	2.74
	3.40	30.00	28.25	1.75	10.00	2.92
" 6th....	4.10	32.75	31.00	1.75	9.16	2.66
	3.60	29.75	28.00	1.75	10.08	2.75
" 7th....	4.20	32.75	30.75	2.00	9.16	2.59
	3.80	32.50	30.50	2.00	9.23	2.85
" 8th....	4.10	32.50	30.75	1.75	9.23	2.64
	3.70	31.00	28.75	2.25	9.67	2.79
" 9th....	4.40	32.50	30.50	2.00	9.23	2.46
	3.90	29 75	28.25	1.50	10.09	2.55

The average percentage of fat for the seven days, April 30th to May 7th, was for one vat 3.80 and for the other 3.48. There were

2,100 lb. of milk used altogether in each vat. This amount of milk, testing 3.80 per cent fat, made 206.5 lb. green cheese and 194.75 lb. cured cheese. The loss in curing was 11.75 lb. The average number of lb. green cheese made from 300 lb. milk was 29.5. The lb. of milk for one pound of green cheese was 10.03—cured cheese 10.77. The lb. of green cheese made for one pound of fat in the milk were 2.59. The average loss of fat in the whey as determined by the Babcock method, was 0.26 per cent.

The other vat (2,100 lb.), averaging 3.48 per cent. fat, made 194.75 lb. green cheese—183.25 cured—loss in curing 11.5 lb. The average number of lb. of green cheese made from 300 lb. of milk was 27.82. The lb. of milk for one pound of green cheese were 10.78—cured cheese 11.46. The lb. green cheese for one lb. fat in the milk were 2.68. The average percentage of fat in the whey was 0.25.

During the June experiments the vat of "rich" milk averaged 4.18 per cent. fat. 1,800 pounds of milk were used, which made 195.5 lb. green cheese—183.75 cured—loss in curing 11.75 lb. The average lb. cheese from 300 lb. milk were 32.58 green, 30.62 cured. The average lb. milk required to make 1 lb. cheese were 9.21 green, 9.79 cured. The average amount of cheese produced for 1 lb. fat in the milk was 2.60 lb. green and 2.44 lb. cured. Per cent. of fat in whey 0.19.

The vat of "poor" milk averaged 3.60 per cent. fat. 1,800 lb. milk made 181.25 lb. green cheese—170 cured; loss 11.25 lb. 300 lb. milk made 30.21 lb. green cheese—28.33 cured. Pounds of milk to make 1 lb. cheese, 9.95 green—10.59 cured. One pound of fat made 2.80 lb. green cheese—2.62 cured. Fat in whey, 0.19 per cent.

The cheese made from the "rich" and "poor" milk was scored by two competent judges. The following is the scale of points used by them:

Flavor	35
Closeness	20
Even color	15
Texture	20
Finish	10
	100

All cheese were scored full points for finish. The average score of the two judges of the cheese made from "rich" milk (3 80 per cent. fat) in May was 83 points. Cheese from "poor" milk (3.48 per cent. fat) scored 84 points. The cheese of June experiments were judged on July 6th by the same men. The average score of "rich" milk cheese (4.18 per cent. fat) was 91; that made from milk averaging 3.60 per cent. fat scored 93 points. The two cheese which scored the highest number of points in May and June were made out of milk testing 3.2 and 3.4 per cent. fat.

It is yet too soon to draw definite conclusions from our work, but so far it would indicate:

1. An increased percentage of fat in the milk gives an increased yield of cheese, though not in the same proportion.

2. That a pound of butter-fat in milk ranging from 3.2 to 3.7 per cent. will make more cheese than a pound of fat in milk ranging from 3 6 to 4.5 per cent. of fat.

3. That there need not necessarily be more loss of fat in whey from rich milk up to 4.5 per cent. fat than from poor milk, though we did notice a little more "grease" on the hoops, press and shelves from the rich milk cheese (4.5 per cent. fat).

4. That milk containing the same per cent. of fat, does not always give the same yield of cheese, especially when comparing one day with another or one month with another. April 30th, 300 lb. of 3.9 per cent. milk made 28¼ lb. cured cheese; May 1st, same quantity and quality of milk made 27½ lb.; June 9th it made 28¼ lb. May 1st, 300 lb. of 3.60 per cent. milk made 24½ lb. cured cheese; May 2nd, 27½ lb.; June 6th, 28 lb. May 4th both vats tested 3.7 per cent. and each made 27½ lb. cured cheese. June 8th, 3.7 per cent. milk made 28¾ lb. cheese.

This question has been a vexing one in factories, where payment by test has been adopted. It has been found that the yield of cheese does not always increase with the fat, and the discrepancy is doubtless due to differences in conditions of milk, methods of making, and state of the weather.

As some of our factories are still in doubt as to the advisability of distributing proceeds among patrons according to the percentage of fat in the milk, perhaps the following table will throw some light on the question:

Patron.	lb. milk.	Per cent. fat in milk.	Wt. cheese. lb.	Amount of money each would receive if cheese sold for 10c. per lb.				
				Paying by wt. of milk.	By per cent. fat.	By Reading + 1 per cent.	By Reading + 2 per cent.	By wt. of cheese made.
				$ c.	$ c.	$ c.	$ c.	$ c.
May:								
H.	2,100	3.80	194.75	18.90	19.73	19.54	19.44	19.475
L.	2,100	3.48	183.25	18.90	18.06	18.25	18.37	18.325
June:								
H.	1,800	4.18	183.75	17.685	19.01	18.73	18.56	18.37
L.	1,800	3.60	170.00	17.685	16.36	16.64	16.81	17.00
July:								
H.	1,800	3,84	184.00 (green)	17.41	18.91	18.58	18.37	18.40
L.	1,800	3.23	164.25 (green)	17.41	15.91	16.24	16.45	16.42

In the table we have assumed that H. and L. are patrons, and during the months of May, June, and July they furnished milk with the percentages of fat given. This milk was made up separately, so that we know how much cheese was made in each vat, or was furnished by each patron. Assuming that all the cheese netted the patrons ten cents a pound, if we divided the money between them according to the amount of milk sent, both of them would receive exactly the same amount of money, because the same quantity of milk was used in each vat. As the milk was made up separately (which would be the correct way in a factory if it were practicable, as every patron would have just the quantity and quality of cheese his milk entitled him to) we know the money value of the milk used in the vats. This is seen in the last column. If we compare the amounts of money in the first and second columns with those in the last, we find that neither of them gives justice, though the second (that according to the per cent. of fat in the milk) is much nearer than the first.

It has been felt by practical men that paying according to the fat alone, gives the patron who furnishes rich milk more than his just share of the proceeds, and the patron sending poor milk less than he is entitled to. The table would seem to indicate that this view is correct.

To overcome this difficulty it has been suggested by one of our prominent young dairymen of western Ontario, to add one per cent. to each man's butter-fat reading. For instance, a patron who sends an average of 4 per cent. milk, call his test 5 per cent.; and one who sends 3 per cent. milk call it 4; and so on with all the tests. When this was first suggested, I was not favorably inclined towards the plan; but the results as seen in the table would seem to indicate that adding one or even two per cent. to the fat readings in these tests is more nearly correct than paying by weight of milk or by the fat alone.

We shall have further data on this point, and in the meantime we ask the co-operation of all cheese-makers and factories who are paying by test to help to settle the question, as it is one that affects all patrons. Every factory that has a tester, should select the patrons' milk and put the poor milk in one vat and the rich in another. Note the per cent. fat, weight of milk used, yield and quality of cheese made from each, and send the results to the Dairy Department of the Ontario Agricultural College, Guelph. From the data thus secured we can more nearly arrive at the just method for all. Let every factory be a small experiment station until this point is settled.

BULLETIN XCVI.

THE COMPOSITION OF MILK, CHEESE, AND WHEY IN RELATION TO ONE ANOTHER.

By A. E. Shuttleworth, B.S.A., Professor of Chemistry.

An extensive chemical analysis of milk, cheese, and whey was begun by us early in May last, to study the constituents of milk in their relation to the yield of cheese. This line of study was suggested by the excellent work upon the investigation of cheese commenced at Geneva, N.Y., in 1891, and by important conclusions drawn therefrom. It is to study this question from the standpoint of Ontario conditions, as well as to bring new facts to light, that this line of chemical investigation has been entered into.

The principal points of the present investigation are:

1st. The degree of uniformity in the proportion of fat to casein in our milk.

2nd. The relation of the fat contained in our milk to its cheese-producing power.

3rd. The proportion of the fat of the milk lost in whey by our method of cheese-making.

4th. Fat as a basis in apportioning dividends to patrons.

5th. The average composition of our milk, cheese, and whey.

Compounds Contained in Milk, Cheese, and Whey.

Water. Milk contains about 87.6, cheese 34.6, and whey 93.4 per cent. of water.

Fat. The fat of milk, cheese, and whey is a mixture of glycerol salts of several acids, and is the same substance that forms so large a portion of natural butter. Milk contains about 3.5, cheese 35.5, and whey 0.24 per cent. of fat.

Casein. This is the chief nitrogenous substance in milk, and is commonly called curd. This curd or casein can be precipitated in milk by acids or by the use of rennet. Milk contains about 2.3, cheese 22.1, and whey 0.13 per cent. of casein.

Albumen. Albumen is similar in composition to casein; but, unlike it, is not thrown down or made insoluble by acids or the action of rennet. In cheese-making, the albumen passes more or less completely into the whey. The amount in milk is about 0.7, in cheese 1, and in whey 0.76 per cent.

Total Solids. By this term are meant all the compounds (except water) taken together.

Lot H.	Per cent. of water.			Per cent. of solids.			Per cent. of fat.		
	Milk.	Cheese.	Whey.	Milk.	Cheese.	Whey.	Milk.	Cheese.	Whey.
May 2nd I	87.756	36.061	93.170	12.244	63.939	6.830	3.474	33.775	.125
II	88.235	35.752	93.747	11.765	64.248	6,253	4.325	31.619	.183
Average	87.995	35.906	93.458	12.005	64.090	6.542	3.899	32.697	.154
May 7th I	87.743	35.931	93.180	12.257	64.069	6.820	3.462	32.994	.406
II	88.061	36.089	94.902	11.837	63.911	5.098	3.908	..	.350
Average.....	87.902	36.010	94.042	12.098	63.990	5.958	3.685	32.994	.375
June 4th..... I	87.343	34.700	92.920	12.657	65.300	7.080	4.387	37.687	.216
II	86.710	34.052	92.952	13.290	65.948	7.048	4.290	38.601	.191
Average.....	87.026	34.376	92.936	12.973	65.624	7.064	4.338	38.144	.203
June 6th I	86.893	33.628	.....	13.108	66.372	.....	3.660	36.546	.....
II	86.875	33.287	.....	13.125	66.713	.....	3.650	35.437	....
Average.....	86 883	33.457	.....	13.116	66.543	.....	3.655	35.991	.....
June 8th I	87.081	34.747	93.269	12.919	65.253	6.731	4.004	34.274	.186
II	87.142	35.115	.....	12.858	64.885	.....	3.996	33.961	.210
Average.....	87.111	34.931	93.269	12.888	65.069	6.731	4.000	34.117	.198
Average of all	87.383	34.936	93.426	12.616	65.063	6.574	3.915	34.788	.232
Lot L.									
May 2nd I	87.897	35.216	93.175	12.103	64.784	6.825	3.446	33.806	.120
II	87.951	35.167	93.200	12.049	64.833	6.800	3.518	34.456	.164
Average.....	87.924	35.191	93.187	12 076	64.809	6.813	3.482	34.131	.142
May 7th.... I	88.086	36.117	93.196	11.914	63.883	6.804	3.237	33.221	.249
II	88.166	36.167	93.191	11.834	63.833	6.809	3.149	32.201	.325
Average.....	88.126	36.142	93.193	11.874	63.858	6.807	3.193	32.211	.287
June 4th I	88.113	35.682	.....	11.887	64.318	.....	3.091	33.872	.214
II	88.119	35.001	95.180	11.881	64.999	4.820	3.070	34.525	.210
Average.....	88.116	35.341	95.180	11.884	64.659	4.820	3.080	34.196	.212
June 6th I	87.837	35.021	.....	12.163	64.979	.....	3.140	35.126	.....
II	87.680	34.779	.....	12.320	65.221	.....	3.248	35.087	.....
Average.....	87.758	34.900	.....	12.194	65.100	.....	3.194	35.106	.....
June 8th I	87.469	35.700	94.032	12.521	64.300	5.968	3.564	33.584	.205
II	87.425	35.804	93.399	12.575	64.196	6.601	3.564	33.468	.235
Average.....	87.447	35.752	93.715	12.548	64.248	6.284	3.564	33.526	.220
Average of all	87.874	35.465	93.819	12.115	64.535	6.181	3.302	33.834	.215

Milk, Cheese and Whey.

Per cent. of casein.			Per cent. of albumen.			Pounds green cheese from 100 lb. milk.	Ratio of cheese to milk.	Lot H.
Milk.	Cheese.	Whey.	Milk.	Cheese.	Whey.			
2.181	17.337	.356	.744	.....	.412	.....	.....	I, II} .....May 2nd.
.....	.....	.355	.....	.....	.332	.....	.....	
2.181	17.337	.355	.744	.....	.372	9.91	1:10.0	.....Average.
2.280	21.712	.068	.757	2.356	.800	.....	.....	I, II} .....May 7th.
2.230	22.725	.068	.588	1.037	.813	.....	.....	
2.255	22.218	.068	.672	1.697	.806	9.75	1:10.2	.....Average.
2.445	20.981	.039	.561	.956	.892	.....	.....	I, II} .....June 4th.
2.445	20.800	.071	.742	.900	.822	.....	.....	
2.445	20.890	.055	.651	.928	.857	11.25	1: 8.8	.....Average.
2.556	22.903	.....	.725	.609	.....	.....	.....	I, II} .....June 6th.
2.181	22.868	.....	1.056	.713	.....	.....	.....	
2.368	22.885	.....	.891	.661	.....	10.91	1: 9.1	.....Average.
2.631	22.025	.143	.491	.706	.757	.....	.....	I, II} .....June 8th.
2.162	22.356	.151	.971	.837	.744	.....	.....	
2.396	22.190	.147	.781	.772	.750	10.83	1: 9.2	.....Average.
2.329	21.104	.156	.747	1.064	.696	10.53	1: 9.4	.....Average of all.
								Lot L.
2.131	17.212	.200	.694	.....	.....	.....	.....	I, II} .....May 2nd.
2.081	.....	.187	.637	.....	.....	.....	.....	
2.106	17.212	.193	.665	2.568	.....	9.25	1:10.8	.....Average.
2.380	21.931	.100	.651	.....	.800	.....	.....	I, II} .....May 7th.
2 460	.....	.093	.477	.....	.913	.....	.....	
2.420	21.931	.096	.564	1.572	.875	9.19	1:10.8	.....Average.
2 176	22.162	.065	.730	1.769	.985	.....	.....	I, II} .....June 4th.
2.256	23.034	.065	.556	1.103	.891	.....	.....	
2.216	22.598	.065	.643	1.436	.938	9.42	1:10.6	.....Average.
1.993	22.381	.....	.....	.725	.....	.....	.....	I, II} .....June 6th.
2.100	21.525	.....	.....	2.100	.....	.....	.....	
2.046	21.953	.....	.779	1.412	.. ..	9.92	1:10.0	.....Average.
2.3 62	20 637	.068	.831	.....	.889	.....	.....	I, II} .. ..June 8th.
2.2 93	.....	.059	.963	.....	.890	.....	.....	
2.3 27	20.637	.063	.897	1.359	.889	10.33	1: 9.6	.....Average.
2.223	20.866	.104	.709	1.669	.900	9.62	1:10.3	....Average of all.

Plan of Securing Samples for Analysis.

The milk used was from our herd of 20 cows. Each cow's milk was tested with a Babcock tester as soon as drawn, and the milk from the herd divided into two lots according as it indicated a high or a low per cent. of fat. Lot L. represented milk low in fat; lot H. milk high in fat. In addition, milk was purchased from two or more neighboring farmers and added to lot L. or H., according to whether the per cent. of fat was low or high. After being thoroughly mixed, 300 pounds were taken from each lot and put into separate vats to be made into cheese. From each vat a sample for chemical analysis was taken; and to replace these samples, equal quantities from lots L. and H. were added to their respective vats. The milk of each vat, being exactly 300 pounds, was made into cheese by a skilful maker, under exactly similar conditions. Cheese was made in this way every day during the first week of May and of June. Samples of milk were taken for analysis on the 2nd and 7th days of May, and 4th, 6th, and 8th days of June. The cheese and whey of these dates were also sampled and analyzed. The preceding tables give duplicate analyses of these samples of milk, cheese and whey.

Lot H. represents the rich milk, in which the per cent. of fat is 3.915. It took an average of 9.4 pounds of this milk to make one pound of cheese. Lot L. represents the poor milk, containing 3.302 per cent. of fat and requiring 10.3 pounds of milk to make one pound of cheese. Out of the preceding tables we have selected all the full duplicate analyses and have made from them our general averages for milk, whey, green cheese, and cheese one month old. In table given below these averages are compared with American averages.

Table showing average composition of milk, whey, and cheese.

	Water.	Total solids.	Fats.	Casein.	Albumen.	Sugar, ash, etc.
Milk.						
Average of 18 duplicate determinations of 9 distinct samples	87.687	12.318	3.546	2.279	0.704	5.789
Average for 1893 at 48 American factories	87.280	12.72	3.77	2.48	0.69	5.78
Whey.						
Average of 12 duplicate determinations of 6 distinct samples	93.435	6.564	−0.239	0.130	0.759	5.436
Average for 1893 at 48 American factories	93.00	7.00	0.38	0.86		5.76
Green Cheese.						
Average of 10 duplicate determinations of 5 distinct cheeses	34.601	65.399	35.511	22.103	1.082	6.703
Average for 1893 at 48 American factories	36.84	63.16	33 90	23.32	.....	5.94
Cheese one month old.						
Average of 12 duplicate determinations of 6 distinct cheeses	32.529	67.471	36.061	18.607	5.328	7.475

The above table shows a marked degree of uniformity between Canadian and American averages.

As a check upon the amount of the fat of the milk retained in the cheese, fat determinations of cheese were made directly, and also by difference between the fat lost in the whey and that contained in the milk. Making allowances for the difficulty of determining accurately the fat in cheese, owing to its somewhat uneven distribution, the figures in the last two columns of the following table, obtained by direct determination and by difference, agree closely, and point to a conclusion entirely in accordance with that arrived at by the Geneva station, viz., that "the loss of fat in cheese-making is quite independent of the amount of fat in milk." Another feature brought out in this table, and one which reflects credit upon the maker, is the small amount of the fat of the milk lost in the whey.

Table showing pounds of fat in cheese and whey from 300 pounds of milk.

	Date.	Pounds of milk.	Per cent. of fat in milk.	Pounds of fat in 300 pounds of milk.	P'nds of cheese from 300 p'nds of milk.	Pounds of fat in yield of whey.	P'nds of fat in yield of cheese.	
							By direct determinat'n.	By difference.
L.....	June 4.....	300	3.080	9.24	28.25	.58	9.66	8.66
	May 7.....	300	3.193	9 58	27.50	.78	8.86	8.80
	June 6.....	300	3.194	9.58	29.75	.....	10.44	.....
	May 2.....	300	3.482	10.45	27.75	.39	9.47	10.06
	June 8.....	300	3.564	10.69	31.00	.59	10.39	10.10
H.....	June 6.....	300	3.655	10.97	32.75	.....	11.79	.....
	May 7.....	300	3.685	11.06	29.25	1.02	9.65	10.04
	May 2.....	300	3.899	11.70	29.75	.41	9.73	11.29
	June 8.....	390	4.000	12.00	32.50	.53	11.09	11.47
	June 4.....	300	4.338	13 01	33.75	.54	12.87	12.47

The best method of paying for milk delivered at cheese factories is a subject of great importance to cheese-makers and patrons of cheese factories. Certainly the old method, viz., that of paying for milk according to weight alone, is not satisfactory. Of late there is a tendency, particularly among American cheese men, to pay according to the amount of fat contained in the milk. The justice of this method evidently depends upon the constancy between the per cent. of fat and the yield of cheese.

	Per cent. of fat.	Per cent. of casein.	Ratio of fat to casein.
L.....	3.080.....	2.216	1 : 0.71
	3.193.....	2.420	1 : 0 75
	3.194.....	2.046	1 : 0.64
	3.482.....	2.106	1 : 0.60
	3.564.....	2.327	1 : 0.65
L., average	3.302.....	2.223	1 : 0.67
H.....	3.655.....	2.368	1 : 0.65
	3.685.....	2.255	1 : 0 61
	4.000.....	2.396	1 : 0.59
	4.338.....	2.445	1 : 0.56
H., average	3.919.....	2.366	1 : 0.60

In this table the percentages of fat are arranged in the order of their amounts in both L. and H., giving a range from 3.080 in L. to 4.338 in H. In this table also the L. and H. samples are separately grouped to give an average for L. samples, representing milk low in fat, and for H. samples, representing milk high in fat. An examination of the figures under "ratio of fat to casein" reveals a gradual decrease with some variation in the proportion of casein to fat as the milk increases in richness. By comparing the groups it will be seen that L., with an average of 3.302 per cent. of fat, gives on an average 0.67 of one pound of casein to one pound of fat; and H., with an average of 3.919 per cent. of fat, gives on an average 0.60 of one pound of casein to one pound of fat. While it would not do to conclude hastily from these tests, covering only one week in each of two months, that milk containing 4 per cent. of fat contains less casein in proportion to its fat, than milk which contains 3 per cent. of fat, still it must be admitted that these results point in that direction. Below is given the results of tests along this same line made by the Geneva Station (Bulletin 68, New Series). Samples of milk were collected once each week through the entire season from the herd which gave milk richest in fat and also from the herd which gave milk poorest in fat. The average results secured from each of these two herds during the season were as follows:

—	Average per cent. of fat in milk.	Average per cent. of casein in milk.	Pounds of casein for one pound of fat in milk.
Herd giving milk poorest in fat	3.33	2.20	0.66
Herd giving milk richest in fat	4.08	2.57	0.63

These results show that the milk poorest in fat contained a trifle more casein for each pound of fat in milk; but, for all practical purposes, the results may be regarded as showing uniformity in the relation of fat to casein in factory milk from different herds.

Our averages for the milk poorest in fat and for the milk richest in fat are practically the same as those of the Geneva poorest and richest milk; their tests cover one day of every week throughout the season and our tests cover the first week of May and of June; the conclusions drawn from their results and from ours are the same, viz., that the poorest milk contains more casein for each pound of fat, but Geneva found a difference of 0.03, while we found a difference of 0.07.

Table showing relation of fat in milk to yield of cheese.

	Date.	Per cent. of fat in milk.	Pounds of fat in 300 pounds of milk.	Pounds of green cheese made from 300 pounds of milk.	Ratio of fat to green cheese.
L	June 4	3.080	9.240	26.25	1 : 3.0
	May 7	3.193	9.579	27.50	1 : 2.8
	June 6	3.194	9.582	29.75	1 : 3.1
	May 2	3.482	10.446	27.75	1 : 2.6
	June 8	3.564	10.692	31.00	1 : 2.8
Total			49.539	144.25	1 : 2.9
H	June 6	3.655	10 965	32.75	1 : 2.9
	May 7	3.685	11.055	29.25	1 : 2.6
	May 2	3.899	11.697	29.75	1 : 2.5
	June 8	4.000	12.000	32.50	1 : 2.7
	June 4	4.338	13.014	33.75	1 : 2.5
Total			58.731	158.00	1 : 2.6

From the milk having more casein for each pound of fat, more cheese for each pound of fat would be expected, than from the milk having less casein for each pound of fat. What are the facts? Fifteen hundred pounds of milk L., containing an average of 3.302 per cent. of fat or a total of 49.539 pounds, yields 144.25 pounds of green cheese, being 2.9 pounds of cheese for each pound of fat. The same weight of milk H., containing an average of 3.919 per cent. of fat or a total of 58.731 pounds, yields 158 pounds of green cheese, being 2.6 pounds of cheese for each pound of fat. Under exactly similar conditions of handling, the rich milk yields $13\frac{3}{4}$ pounds more cheese than the poor milk, but the poor milk makes $\frac{3}{10}$ of one pound of cheese more for every pound of fat than does the rich milk.

Suppose L. and H. to represent two patrons, each supplying 1,500 pounds of milk. L.'s milk yields 144.25 pounds of cheese and H.'s milk 158. Then, if the cheese nets 9 cents, patron L. should receive 144.25×9 or $12.98; and H., 158×9 or $14.22. Had these patrons been paid according to weight of milk alone, each would have received equal shares. In all, 302.25 pounds of cheese were made, netting 9 cents a pound, $302.25 \times 9 = \$27.20$ would be divided equally, each patron receiving $13.60. Accordingly, patron L., supplying the poor milk, would be paid 62 cents too much, and patron H. 62 cents too little.