



PETER COLLIER, DIRECTOR.

BULLETIN No. 54—NEW SERIES.

MAY, 1893.

EXPERIMENTS IN THE MANUFACTURE OF CHEESE.

PART I. MANUFACTURE OF CHEESE FROM
NORMAL MILK RICH IN FAT.

PART II. STUDY OF CHEESE-RIPENING PROCESS.

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BULLETIN No. 54—NEW SERIES.

PART I.

MANUFACTURE OF CHEESE FROM NORMAL
MILK RICH IN FAT.

In the experiments made in the manufacture of cheese during the season of 1892, we found no milk in any considerable quantity that contained over 4.40 per cent. of fat. It was, therefore, considered desirable to supplement the work of last season by making cheese from milk containing fat varying in amount from 4 to 5 per cent. The milk used varied in its fat-content from 3.65 to 5.25 per cent. The milk containing 4.70 per cent. of fat and more came from the well-known Jersey herd of Pittsford Farms, owned by Mr. W. F. Hawley. These cows were in various stages of lactation, but those in the earlier stage predominated, the milk of strippers being excluded. The Jersey milk used came from a selected portion of the 150 animals comprising the herd. The milk used in the other experiments consisted mainly of the mixed milk of our station herd and of a herd of grade Holsteins, the cows being in various stages of lactation.

The making of the cheese was done by Mr. E. L. Stone, of Mannsville, N. Y., whose cheese-factories are justly noted for the fine quality of their product.

For details relating to previous experiments, see Bulletins 37, 43, 45, 46, 47 and 50.

ANALYSES OF MILK, WHEY AND CHEESE.

February and March, 1893.	Composition expressed in parts per hundred.							From one hundred pounds of milk.						
	Per cent. of water.	Per cent. of total solids.	Per cent. of fat.	Per cent. of casein and album'n.	Per cent. of albumen.	Per cent. of sugar, ash, etc.	Lbs. of water.	Lbs. of total solids.	Lbs. of fat.	Lbs. of casein and albumen.	Lbs. of albumen.	Lbs. of sugar, ash, etc.		
No. 107. Feb. 1.	Milk. Whey. Green cheese	85.90 92.94 33.95	14.10 7.06 66.05	4.55 0.34 35.62	3.62 0.97 23.22	3.06	5.93 5.75 7.21	100 88.97 11.90	14.10 6.22 7.88	4.55 0.30 4.25	4.62 0.85 2.77	3.06	0.56	5.93 5.07 0.86
No. 108. Feb. 2.	Milk. Whey. Green cheese	86.32 93.07 36.83	13.68 6.93 63.17	4.30 0.44 32.58	3.77 0.96 24.42	2.97	5.61 5.53 6.17	100 88.00 12.00	13.68 6.10 7.58	4.30 0.39 3.91	3.77 0.84 2.93	2.97	0.80	5.61 4.87 0.74
No. 109. Feb. 4.	Milk. Whey. Green cheese	86.24 93.16 39.92	13.76 6.84 60.08	4.50 0.28 32.77	3.62 0.99 21.23	2.96	5.64 5.57 6.08	100 87.00 13.00	13.76 5.95 7.81	4.50 0.24 4.26	3.62 0.86 2.76	2.96	0.66	5.64 4.85 0.79
No. 110. Feb. 6.	Milk. Whey. Green cheese	86.23 93.13 41.28	13.77 6.87 58.72	4.45 0.36 31.13	3.68 1.00 21.13	3.00	5.64 5.51 6.46	100 86.70 13.30	13.77 5.96 7.81	4.45 0.31 4.14	3.68 0.87 2.81	3.00	0.68	5.64 4.78 0.86
No. 111. Feb. 8.	Milk. Whey. Green cheese	86.87 92.80 39.90	13.13 7.20 60.10	3.90 0.35 32.23	3.39 0.92 22.95	2.77	5.84 5.93 4.92	100 88.80 11.20	13.13 6.40 6.73	3.90 0.31 3.59	3.39 0.82 2.57	2.77	0.62	5.84 5.27 0.57
No. 112. Feb. 9.	Milk. Whey. Green cheese	86.54 92.82 38.10	13.46 7.18 61.90	4.10 0.32 33.30	3.41 0.91 22.67	2.75	5.95 5.95 5.93	100 88.53 11.47	13.46 6.36 7.10	4.10 0.28 3.82	3.41 0.81 2.60	2.75	0.66	5.95 5.27 0.68

No. 113.	Milk.....	86.44	13.56	4.20	3.47	2.75	0.72	5.89	0.72	3.47	4.20	13.56	86.44	100	86.44	13.56	4.20	3.47	2.75	0.72	5.89
Feb. 10.	Whey.....	92.77	7.23	0.33	0.90	.....	.....	6.00	.....	88.50	0.29	6.40	82.10	88.50	82.10	6.40	0.29	0.80	.....	5.31
	Green cheese	37.74	62.26	34.00	23.22	.....	.....	5.04	.....	11.50	3.91	7.16	4.34	11.50	4.34	7.16	3.91	2.67	.....	0.58
No. 114.	Milk.....	86.70	13.30	4.25	3.38	2.68	0.70	5.67	0.70	100	4.25	13.30	86.70	100	86.70	13.30	4.25	3.38	2.68	0.70	5.67
Feb. 11.	Whey.....	92.97	7.03	0.30	0.88	.....	.....	5.85	.....	88.60	0.27	6.23	82.37	88.60	82.37	6.23	0.27	0.78	.....	5.18
	Green cheese	38.00	62.00	34.91	22.86	.....	.....	4.23	.....	11.40	3.98	7.07	4.33	11.40	4.33	7.07	3.98	2.60	.....	0.49
No. 115.	Milk.....	86.67	13.33	4.30	3.46	2.78	0.68	5.57	0.68	100	4.30	13.33	86.67	100	86.67	13.33	4.30	3.46	2.78	0.68	5.57
Feb. 13.	Whey.....	92.94	7.06	0.27	0.92	.....	.....	5.87	.....	88.37	0.24	6.24	82.13	88.37	82.13	6.24	0.24	0.81	.....	5.19
	Green cheese	39.04	60.96	34.90	22.79	.....	.....	3.27	.....	11.63	4.06	7.09	4.54	11.63	4.54	7.09	4.06	2.65	.....	0.38
No. 116.	Milk.....	86.74	13.26	4.15	3.32	2.55	0.77	5.79	0.77	100	4.15	13.26	86.74	100	86.74	13.26	4.15	3.32	2.55	0.77	5.79
Feb. 14.	Whey.....	92.92	7.08	0.32	0.91	.....	.....	5.85	.....	88.57	0.28	6.27	82.30	88.57	82.30	6.27	0.28	0.81	.....	5.18
	Green cheese	38.85	61.15	33.86	21.96	.....	.....	5.33	.....	11.43	3.87	6.99	4.44	11.43	4.44	6.99	3.87	2.51	.....	0.61
No. 117.	Milk.....	86.75	13.25	4.20	3.30	2.59	0.71	5.75	0.71	100	4.20	13.25	86.75	100	86.75	13.25	4.20	3.30	2.59	0.71	5.75
Feb. 15.	Whey.....	93.03	6.97	0.25	0.88	.....	.....	5.84	.....	88.60	0.22	6.18	82.42	88.60	82.42	6.18	0.22	0.78	.....	5.18
	Green cheese	38.00	62.00	34.90	22.10	.....	.....	5.00	.....	11.40	3.98	7.07	4.33	11.40	4.33	7.07	3.98	2.52	.....	0.57
No. 118.	Milk.....	86.75	13.25	4.10	3.23	2.44	0.79	5.92	0.79	100	4.10	13.25	86.75	100	86.75	13.25	4.10	3.23	2.44	0.79	5.92
Feb. 16.	Whey.....	92.63	7.37	0.25	0.85	.....	.....	6.27	.....	86.75	0.27	6.39	80.36	86.75	80.36	6.39	0.27	0.74	.....	5.38
	Green cheese	48.22	51.78	28.90	18.80	.....	.....	4.08	.....	13.25	3.83	6.86	6.39	13.25	6.39	6.86	3.83	2.49	.....	0.54
No. 119.	Milk.....	86.20	13.80	4.55	3.52	2.86	0.66	5.73	0.66	100	4.55	13.80	86.20	100	86.20	13.80	4.55	3.52	2.86	0.66	5.73
Feb. 17.	Whey.....	92.82	7.18	0.44	0.92	.....	.....	5.82	.....	88.57	0.39	6.36	82.21	88.57	82.21	6.36	0.39	0.81	.....	5.16
	Green cheese	34.90	65.10	36.40	23.70	.....	.....	5.00	.....	11.43	4.16	7.44	3.99	11.43	3.99	7.44	4.16	2.71	.....	0.57
No. 120.	Milk.....	86.77	13.23	4.30	3.37	2.69	0.68	5.56	0.68	100	4.30	13.23	86.77	100	86.77	13.23	4.30	3.37	2.69	0.68	5.56
Feb. 18.	Whey.....	93.03	6.97	0.51	0.89	.....	.....	5.57	.....	88.56	0.45	6.17	82.39	88.56	82.39	6.17	0.45	0.79	.....	4.93
	Green cheese	38.28	61.72	33.65	22.55	.....	.....	5.52	.....	11.44	3.85	7.06	4.38	11.44	4.38	7.06	3.85	2.58	.....	0.63

ANALYSES OF MILK, WHEY AND CHEESE—CONTINUED.

February and March. 1893.	Composition expressed in parts per hundred.							From one hundred pounds of milk.						
	Per cent. of water.	Per cent. of total solids.	Per cent. of fat.	Per cent. of casein and albumen.	Per cent. of casein.	Per cent. of albumen.	Per cent. of sugar, ash, etc.	Lbs.	Lbs. of water.	Lbs. of total solids.	Lbs. of fat.	Lbs. of casein.	Lbs. of albumen.	Lbs. of sugar, ash, etc.
No. 121. Milk. Feb. 21. Whey Green cheese	85.75 92.70 38.44	14.25 7.30 61.56	4.90 0.56 34.45	3.86 1.08 22.81	3.08	0.78	5.49 5.66 4.30	100 87.20 12.80	85.75 80.83 4.92	14.25 6.37 7.88	4.90 0.49 4.41	3.86 0.94 2.92	3.08	5.49 4.94 0.55
No. 122. Milk. Feb. 22. Whey Green cheese	86.67 92.60 39.20	13.33 7.40 60.80	4.10 0.42 33.60	3.28 0.85 22.70	2.64	0.64	5.95 6.13 4.50	100 88.90 11.10	86.67 82.32 4.35	13.33 6.58 6.75	4.10 0.37 3.73	3.28 0.76 2.52	2.64	5.95 5.45 0.50
No. 123. Milk. Feb. 22. Whey Green cheese	85.18 92.50 40.20	14.82 7.50 59.80	4.85 0.31 32.71	3.93 1.01 21.86	3.13	0.80	6.04 6.18 5.23	100 86.00 14.00	85.18 79.55 5.63	14.82 6.45 8.37	4.85 0.27 4.58	3.93 0.87 3.06	3.13	6.04 5.31 0.73
No. 124. Milk. Feb. 23. Whey Green cheese	85.13 92.56 40.20	14.87 7.44 59.80	5.10 0.34 33.87	4.00 1.04 21.90	3.18	0.82	5.77 6.06 4.03	100 85.80 14.20	85.13 79.42 5.71	14.87 6.38 8.49	5.10 0.29 4.81	4.00 0.89 3.11	3.18	5.77 5.20 0.57
No. 125. Milk. Feb. 23. Whey Green cheese	87.54 93.09 41.88	12.46 6.91 58.12	3.65 0.30 31.20	3.10 0.84 21.68	2.48	0.62	5.71 5.77 5.24	100 89.16 10.84	87.54 83.00 4.54	12.46 6.16 6.30	3.65 0.27 3.38	3.10 0.75 2.35	2.48	5.71 5.14 0.57
No. 126. Milk. Feb. 24. Whey Green cheese	85.37 92.62 39.43	14.63 7.38 60.57	5.00 0.30 34.73	3.99 1.03 22.76	3.14	0.85	5.64 6.04 3.08	100 86.38 13.62	85.37 80.00 5.37	14.63 6.38 8.25	5.00 0.27 4.73	3.99 0.89 3.10	3.14	5.64 5.22 0.42

No. 127. Milk Feb. 25. Whey	85.06	14.94	5.25	3.86	3.10	0.76	5.83 Milk	100	85.06	14.94	5.25	3.86	3.10	0.76	5.83
Green cheese	92.74	7.26	0.36	1.04	.....	.....	5.86 Whey	86.47	80.19	6.28	0.31	0.90	.....	.....	5.07
	36.00	64.00	36.51	21.88	.....	.....	5.61 Cheese	13.53	4.87	8.66	4.94	2.96	.....	.....	0.76
No. 128. Milk Feb. 27. Whey	85.37	14.63	5.10	3.94	3.12	0.82	5.59 Milk	100	85.37	14.63	5.10	3.94	3.12	0.82	5.59
Green cheese	92.85	7.15	0.40	1.04	.....	.....	5.71 Whey	86.85	80.64	6.21	0.35	0.90	.....	.....	4.96
	36.00	64.00	36.12	23.12	.....	.....	4.76 Cheese	13.15	4.73	8.42	4.75	3.04	.....	.....	0.63
No. 129. Milk Feb. 28. Whey	85.43	14.57	4.80	3.98	3.16	0.82	5.79 Milk	100	85.43	14.57	4.80	3.98	3.16	0.82	5.79
Green cheese	92.66	7.34	0.30	1.05	.....	.....	5.99 Whey	86.40	80.06	6.34	0.26	0.91	.....	.....	5.17
	39.50	60.50	33.38	22.57	.....	.....	4.55 Cheese	13.60	5.37	8.23	4.54	3.07	.....	.....	0.62
No. 130. Milk Mar. 1. Whey	85.27	14.73	5.20	4.01	3.16	0.85	5.52 Milk	100	85.27	14.73	5.20	4.01	3.16	0.85	5.52
Green cheese	92.72	7.28	0.40	1.06	.....	.....	5.82 Whey	86.18	79.91	6.27	0.34	0.91	.....	.....	5.02
	38.78	61.22	35.17	22.43	.....	.....	3.62 Cheese	13.82	5.36	8.46	4.86	3.10	.....	.....	0.50
No. 131. Milk Mar. 2. Whey	85.48	14.52	4.80	3.93	3.13	0.80	5.79 Milk	100	85.48	14.52	4.80	3.93	3.13	0.80	5.79
Green cheese	92.73	7.27	0.35	1.09	.....	.....	5.83 Whey	86.54	80.25	6.29	0.30	0.94	.....	.....	5.05
	38.85	61.15	33.43	22.22	.....	.....	5.50 Cheese	13.46	5.23	8.23	4.50	2.99	.....	.....	0.74
No. 132. Milk Mar. 3. Whey	85.60	14.40	4.70	3.83	3.00	0.83	5.87 Milk	100	85.60	14.40	4.70	3.83	3.00	0.83	5.87
Green cheese	92.75	7.25	0.30	1.07	.....	.....	5.88 Whey	86.90	80.60	6.30	0.26	0.93	.....	.....	5.11
	38.16	61.84	33.90	22.14	.....	.....	5.50 Cheese	13.10	5.00	8.10	4.44	2.90	.....	.....	0.76
No. 133. Milk Mar. 4. Whey	85.17	14.83	5.25	3.86	3.05	0.81	5.72 Milk	100	85.17	14.83	5.25	3.86	3.05	0.81	5.72
Green cheese	92.81	7.19	0.33	1.06	.....	.....	5.80 Whey	86.37	80.16	6.21	0.29	0.92	.....	.....	5.00
	36.76	63.24	36.40	21.57	.....	.....	5.27 Cheese	13.63	5.01	8.62	4.96	2.94	.....	.....	0.72
No. 134. Milk Mar. 6. Whey	85.16	14.84	4.90	3.89	3.16	0.73	6.05 Milk	100	85.16	14.84	4.90	3.89	3.16	0.73	6.05
Green cheese	92.53	7.47	0.36	1.06	.....	.....	6.05 Whey	87.18	80.67	6.51	0.31	0.92	.....	.....	5.28
	35.02	64.98	35.80	23.13	.....	.....	6.05 Cheese	12.82	4.49	8.33	4.59	2.97	.....	.....	0.77

ANALYSES OF MILK, WHEY AND CHEESE—CONCLUDED.

February and March, 1893.		Composition expressed in parts per hundred.						From one hundred pounds of milk.									
		Per cent. of water.	Per cent. of total solids.	Per cent. of fat.	Per cent. of casein and albumen.	Per cent. of albumen.	Per cent. of sugar, ash, etc.	Lbs.	Lbs. of water.	Lbs. of total solids.	Lbs. of fat.	Lbs. of casein.	Lbs. of albumen.	Lbs. of sugar, ash, etc.			
No. 135.	Milk.	85.35	14.65	4.85	3.93	3.13	0.80	5.87	Milk ...	100	85.35	14.65	4.85	3.93	3.13	0.80	5.87
Mar. 7.	Whey.	92.72	7.28	0.39	1.02	.....	.....	5.87	Whey. .	86.87	80.55	6.32	0.34	0.89	.....	.....	5.08
	Green cheese	36.56	63.44	34.35	23.15	.....	.....	5.94	Cheese.	13.13	4.80	8.33	4.51	3.04	.....	.....	0.79
No. 136.	Milk.	85.23	14.77	5.00	3.88	3.06	0.82	5.89	Milk ...	100	85.23	14.77	5.00	3.88	3.06	0.82	5.89
Mar. 8.	Whey.	92.65	7.35	0.36	1.04	.....	.....	5.95	Whey. .	86.60	80.23	6.37	0.31	0.90	.....	.....	5.16
	Green cheese	37.30	62.70	35.00	22.24	.....	.....	5.46	Cheese.	13.40	5.00	8.40	4.69	2.98	.....	.....	0.73
No. 137.	Milk.	85.63	14.37	4.75	3.73	2.96	0.77	5.89	Milk ...	100	85.63	14.37	4.75	3.73	2.96	0.77	5.89
Mar. 9.	Whey.	92.92	7.08	0.23	0.97	.....	.....	5.88	Whey. .	87.20	81.03	6.17	0.20	0.85	.....	.....	5.12
	Green cheese	35.94	64.06	35.55	22.50	.....	.....	6.01	Cheese.	12.80	4.60	8.20	4.55	2.88	.....	.....	0.77
No. 138.	Milk.	85.53	14.47	4.70	3.76	2.94	0.82	6.01	Milk ...	100	85.53	14.47	4.70	3.76	2.94	0.82	6.01
Mar. 10.	Whey.	92.83	7.17	0.32	1.01	.....	.....	5.84	Whey. .	87.10	80.85	6.25	0.28	0.88	.....	.....	5.09
	Green cheese	36.28	63.72	34.26	22.33	.....	.....	7.13	Cheese.	12.90	4.68	8.22	4.42	2.88	.....	.....	0.92
No. 139.	Milk.	85.64	14.36	4.80	3.72	3.09	0.63	5.84	Milk ...	100	85.64	14.36	4.80	3.72	3.09	0.63	5.84
Mar. 11.	Whey.	92.85	7.15	0.26	1.01	.....	.....	5.88	Whey. .	87.35	81.10	6.25	0.23	0.88	.....	.....	5.14
	Green cheese	35.90	64.10	36.13	22.45	.....	.....	5.52	Cheese.	12.65	4.54	8.11	4.57	2.84	.....	.....	0.70
No. 140.	Milk.	86.36	13.64	4.30	3.43	2.75	0.68	5.91	Milk ...	100	86.36	13.64	4.30	3.43	2.75	0.68	5.91
Mar. 12.	Whey.	92.94	7.06	0.35	0.91	.....	.....	5.80	Whey. .	88.82	82.55	6.27	0.31	0.81	.....	.....	5.15
	Green cheese	34.08	65.92	35.68	23.44	.....	.....	6.80	Cheese.	11.18	3.81	7.37	3.99	2.62	.....	.....	0.76

No. 141.	Milk.....	85.83	14.17	4.65	3.65	2.99	0.66	5.87
Mar. 13	Whey.....	92.88	7.12	0.28	0.98	.....	.....	5.15
	Green cheese	35.50	64.50	35.90	22.72	.....	.....	0.72
No. 142.	Milk.....	86.25	13.75	4.40	3.60	2.88	0.72	5.75
Mar. 14	Whey.....	93.06	6.94	0.28	0.93	.....	.....	5.06
	Green cheese	34.31	65.69	35.78	23.96	.....	.....	0.69
No. 143.	Milk.....	86.42	13.58	4.20	3.49	2.76	0.73	5.89
Mar. 15	Whey.....	93.00	7.00	0.27	0.93	.....	.....	5.12
	Green cheese	36.75	63.25	33.85	22.82	.....	.....	0.77
No. 144.	Milk.....	85.74	14.26	4.75	3.76	3.06	0.70	5.75
Mar. 16	Whey.....	92.75	7.25	0.28	0.99	.....	.....	5.22
	Green cheese	38.00	62.00	35.23	22.66	.....	.....	0.53
No. 145.	Milk.....	87.22	12.78	3.85	3.24	2.60	0.64	5.69
Mar. 16	Whey.....	93.10	6.90	0.33	0.86	.....	.....	5.15
	Green cheese	32.82	67.18	36.40	25.23	.....	.....	0.54
No. 146.	Milk.....	86.20	13.80	4.40	3.60	2.93	0.67	5.80
Mar. 17	Whey.....	92.85	7.15	0.26	0.96	.....	.....	5.22
	Green cheese	36.87	63.13	35.10	23.15	.....	.....	0.58
No. 147.	Milk.....	85.78	14.22	4.80	3.69	3.01	0.68	5.73
Mar. 18	Whey.....	92.86	7.14	0.20	0.96	.....	.....	5.21
	Green cheese	37.75	62.25	36.03	22.18	.....	.....	0.52

TABULATED STATEMENT OF THE PRINCIPAL CONDITIONS OF MANUFACTURE.

No. of Experi- ment.	Date.	Kind of cheese made.	Lbs. of milk used	Lbs. of green cheese made.	Tem- pera- ture of milk when ren- net was add'd.	Ounces of ren- net ex- tract used per 1000 lbs. of milk.	Time requir- ed for milk to begin to thick- en.	Time from add- ing rennet to cutting curd.	Tem- pera- ture to which curd was heated after cut- ting, etc.	Time taken to heat to 98° F or more.	Time from reach- ing re- quired tempe- rature to draw- ing whey.
	1893. Feb.				Fahr.		Min.	Min.	Fahr.	Min.	Min.
107	1	Stirred-curd.	570	68.0	86°	2	15	30	98°	45	240
108	2	" "	599	71.8	85°	"	16	40	100°	55	85
109	4	" "	560	72.6	86°	"	15	25	100°	50	80
110	6	" "	509	67.8	89°	"	15	30	96°	55	45
111	8	" "	845	94.7	86°	"	11	31	100°	37	56
112	9	" "	640	73.4	86°	"	20	45	99°	43	80
113	10	" "	640	73.6	87°	"	16	28	100°	48	60
114	11	" "	692	78.9	85°	"	13	27	100°	57	53
115	13	Cheddar.	906	105.4	86°	"	15	31	98°	47	53
116	14	" "	623	71.2	87°	"	15	25	98°	60	85
117	15	" "	623	71.1	85°	"	14	30	98°	55	85
118	16	" "	583	77.2	85°	"	15	30	100°	52	46
119	17	Stirred-curd.	661	75.5	85°	"	22	38	99°	58	44
120	18	" "	646	73.9	86°	"	25	60	98°	60	80
121	21	" "	414	53.0	85°	"	15	49	98°	43	104
122	22	" "	460	51.1	85°	"	11	25	98°	34	130
123	22	" "	400	56.0	85°	2½	14	26	98°	37	172
124	23	" "	514	73.0	85°	"	11	25	98°	34	130
125	23	" "	284	30.8	85°	"	20	35	99°	43	99
126	24	Cheddar.	517	70.4	85°	"	12	22	98°	39	103
127	25	Stirred-curd.	522	70.6	86°	"	15	25	98°	30	65
128	27	Cheddar.	933	122.8	85°	"	10	15	98°	50	77
129	28	Stirred-curd.	561	76.3	86°	"	21	27	98°	54	77
	Mch.										
130	1	" "	528	73.0	87°	2	21	40	98°	54	100
131	2	" "	520	70.0	85°	"	17	27	98°	43	70
132	3	" "	532	69.6	85°	"	9	20	99°	40	55
133	4	" "	523	71.3	87°	"	9	15	99°	33	70
134	6	Cheddar.	892	114.3	86°	"	13	26	98°	60	140
135	7	" "	547	71.8	85°	"	10	25	97°	60	75
136	8	" "	544	72.9	85°	"	10	20	98°	65	20
137	9	" "	494	63.2	87°	"	9	32	100°	32	53
138	10	" "	476	61.4	86°	"	11	21	98°	43	95
139	11	" "	445	56.3	85°	"	13	27	98°	66	67
140	12	" "	804	89.9	85°	"	15	26	98°	60	162
141	13	" "	863	105.9	85°	"	13	25	99°	60	110
142	14	Stirred-curd.	1018	118.1	85°	"	13	22	98°	67	65
143	15	" "	1026	120.0	87°	"	11	28	96°	60	75
144	16	Cheddar.	566	72.4	86°	"	20	40	97°	60	285
145	16	" "	445	42.9	85°	"	14	29	98°	42	360
146	17	Stirred-curd.	929	110.4	85°	"	13	31	98°	81	170
147	18	" "	696	89.5	85°	"	14	25	98°	55	78

Statement of Results.

1. The time required for the milk to begin to thicken after the addition of rennet varied from 9 to 25 minutes, and averaged 15 minutes.

2. The time from adding rennet to cutting curd varied from 15 to 60 minutes, and averaged 29 minutes.

3. The time required to heat to 98° F. after cutting and stirring curd varied from 30 to 81 minutes, and averaged 50 minutes.

4. The time from reaching 98° to drawing whey varied from 20 to 360 minutes, and averaged 100 minutes.

In general, it can be said that the behavior of the milk rich in fat was in no way different from that of ordinary milk. No special precautions had to be observed. The curd was as firm as that made from average factory milk.

THE COMPOSITION OF THE MILK USED.

In the table presented below, the composition of the milk is given for groups arranged according to the per cent. of fat in the milk. The lowest, highest and average results are given for each group and then the average of all.

TABLE SHOWING COMPOSITION OF MILK BY GROUPS.

	No. of sam- ples in gr'p.		Lbs. of water in 100 lbs. of milk.	Lbs. of solids in 100 lbs. of milk.	Lbs. of fat in 100 lbs. of milk.	Lbs. of casein and albu- men in 100 lbs. of milk.	Lbs. of casein in 100 lbs. of milk.	Lbs. of albu- men in 100 lbs. of milk.	Lbs. of sugar, ash, etc., in 100 lbs. of milk.
GROUP I. Milk contain- ing from 3.65 to 4.00 per cent. of fat.	3	Least... Greatest Average	86.87 87.54 87.21	12.46 13.13 12.79	3.65 3.90 3.80	3.10 3.39 3.25	2.48 2.77 2.62	0.62 0.64 0.63	5.69 5.84 5.74
GROUP II. Milk contain- ing from 4.00 to 4.25 per cent. of fat.	8	Least... Greatest Average	86.42 86.75 86.63	13.25 13.58 13.37	4.10 4.25 4.16	3.23 3.49 3.36	2.44 2.76 2.65	0.64 0.79 0.71	5.67 5.95 5.85
GROUP III. Milk contain- ing from 4.25 to 4.50 per cent. of fat.	8	Least... Greatest Average	86.20 86.77 86.38	13.23 13.80 13.62	4.30 4.50 4.37	3.37 3.77 3.57	2.69 3.00 2.87	0.66 0.80 0.70	5.56 5.91 5.68
GROUP IV. Milk contain- ing from 4.50 to 4.75 per cent. of fat.	7	Least... Greatest Average	85.53 86.20 85.78	13.80 14.47 14.22	4.55 4.75 4.66	3.52 3.83 3.69	2.86 3.06 2.98	0.56 0.83 0.71	5.73 6.01 5.87
GROUP V. Milk contain- ing from 4.75 to 5.00 per cent. of fat.	10	Least... Greatest Average	85.16 85.78 85.44	14.22 14.84 14.56	4.80 5.00 4.87	3.69 3.99 3.88	3.01 3.16 3.11	0.63 0.85 0.77	5.73 6.05 5.81
GROUP VI. Milk contain- ing from 5.00 to 5.25 per cent. of fat.	5	Least... Greatest Average	85.06 85.37 85.20	14.63 14.94 14.80	5.10 5.25 5.18	3.86 4.01 3.93	3.05 3.18 3.12	0.76 0.85 0.81	5.52 5.53 5.69
Average of all.			86.00	14.00	4.56	3.65	2.92	0.73	5.79

Statement of Results.

1. Pounds of solids in one hundred pounds of milk.

The amount of solids in one hundred pounds of milk varied from 12.46 to 14.94 lbs., and averaged 14.00 lbs.

2. Pounds of fat in one hundred pounds of milk.

The amount of fat in one hundred pounds of milk varied from 3.65 to 5.25 lbs., and averaged 4.56 lbs.

3. Pounds of casein and albumen in one hundred pounds of milk.

The amount of casein and albumen in one hundred pounds of milk varied from 3.10 to 4.01 lbs., and averaged 3.65 lbs.

4. Pounds of casein in one hundred pounds of milk.

The amount of casein in one hundred pounds of milk varied from 2.44 to 3.18 lbs., and averaged 2.92 lbs.

5. Pounds of albumen in one hundred pounds of milk.

The amount of albumen in one hundred pounds of milk varied from 0.56 to 0.85 lbs., and averaged 0.73 lbs.

6. Pounds of sugar, ash, etc., in one hundred pounds of milk.

The amount of sugar, ash, etc., in one hundred pounds of milk varied from 5.52 to 6.05 lbs., and averaged 5.79 lbs.

RELATION OF CASEIN TO ALBUMEN IN NORMAL MILK
RICH IN FAT.

For a discussion of this subject in connection with the results of last season's work, the reader is referred to Bulletin No. 50, pp. 40-43.

TABLE SHOWING RELATION OF CASEIN TO ALBUMEN IN MILK.

No. of Experiment.	Pounds of casein and albumen in 100 lbs. of milk.	Pounds of casein in 100 lbs. of milk.	Pounds of albumen in 100 lbs. of milk.	Pounds of casein for 100 lbs. of casein and albumen together.	Pounds of albumen for 100 lbs. of casein and albumen together.	Pounds of casein for one lb. of albumen in milk.
125	3.10	2.48	0.62	80.00	20.00	4.00
145	3.24	2.60	0.64	80.25	19.75	4.06
111	3.39	2.77	0.62	81.73	18.27	4.47
112	3.41	2.75	0.66	80.64	19.36	4.17
118	3.23	2.44	0.79	75.55	24.45	3.09
122	3.28	2.64	0.64	80.50	19.50	4.13
116	3.32	2.55	0.77	76.80	23.20	3.31
113	3.47	2.75	0.72	79.25	20.75	3.82
117	3.30	2.59	0.71	78.50	21.50	3.65
143	3.49	2.76	0.73	79.08	20.92	3.78
114	3.38	2.68	0.70	79.30	20.70	3.83
108	3.77	2.97	0.80	78.78	21.22	3.70
115	3.46	2.78	0.68	80.35	19.65	4.10
120	3.37	2.69	0.68	79.82	20.18	3.96
140	3.43	2.75	0.68	80.17	19.83	4.05
142	3.60	2.88	0.72	80.00	20.00	4.00
146	3.60	2.93	0.67	81.40	18.60	4.37
110	3.68	3.00	0.68	81.52	18.48	4.41
109	3.62	2.96	0.66	81.77	18.23	4.48
107	3.62	3.06	0.56	84.53	15.47	5.46
119	3.52	2.86	0.66	81.25	18.75	4.33
141	3.65	2.99	0.66	81.92	17.18	4.53
132	3.83	3.00	0.83	78.33	21.67	3.60
138	3.76	2.94	0.82	78.20	21.80	3.60
137	3.73	2.96	0.77	79.35	20.65	3.84
144	3.76	3.06	0.70	81.38	18.62	4.37
129	3.98	3.16	0.82	79.40	20.60	3.85
131	3.93	3.13	0.80	80.40	19.60	3.90
139	3.72	3.09	0.63	83.06	16.94	4.90
147	3.69	3.01	0.68	81.60	18.40	4.42
123	3.93	3.13	0.80	80.40	19.60	3.90
135	3.93	3.13	0.80	80.40	19.60	3.90
121	3.86	3.08	0.78	80.00	20.00	4.00
134	3.89	3.16	0.73	81.23	18.77	4.33
126	3.99	3.14	0.85	78.70	21.30	3.70
136	3.88	3.06	0.82	78.86	21.14	3.73
124	4.00	3.18	0.82	79.50	20.50	3.88
128	3.94	3.12	0.82	79.20	20.80	3.80
130	4.01	3.16	0.85	78.80	21.20	3.72
127	3.86	3.10	0.76	80.30	19.70	4.08
133	3.86	3.05	0.81	79.00	21.00	3.76

TABULATED GENERAL SUMMARY.

	Pounds of casein and albumen in 100 lbs. of milk.	Pounds of casein in 100 lbs. of milk.	Pounds of albumen in 100 lbs. of milk	Pounds of casein for one lb. of albumen in milk.
Least.	3.10	2.44	0.56	3.09
Greatest.	4.01	3.18	0.85	5.46
Average.	3.65	2.92	0.73	4.00

Statement of Results.

1. Pounds of casein in one hundred pounds of milk.

There were from 2.44 to 3.18 lbs. of casein in one hundred pounds of milk, with an average of 2.92 lbs.

2. Pounds of albumen in one hundred pounds of milk.

The amount of albumen in one hundred pounds of milk varied from 0.56 to 0.85 lbs., and averaged 0.73 lbs.

3. Pounds of casein for one pound of albumen.

For each pound of albumen in the milk the casein varied from 3.09 to 5.46 lbs., and averaged 4 lbs.

The general results compared with those of last season appear to suggest that in milk richer in fat there is a larger proportion of casein relative to albumen than in milk less rich in fat; that, in other words, in rich milk a larger proportion of the nitrogen compounds can be utilized for cheese-making. Further study is needed to confirm this statement, but our results are suggestive on this point.

RELATION OF FAT TO CASEIN IN NORMAL MILK RICH IN FAT.

For a discussion of this subject in connection with the results of last season's work, see Bulletin No. 50, pp. 43-49.

TABLE SHOWING RELATION OF FAT TO CASEIN IN NORMAL MILK.

No. of experiment.	Pounds of fat in 100 lbs. of milk.	Pounds of casein in 100 lbs. of milk.	Pounds of fat for one pound of casein in milk.
125	3.65	2.48	1.47
145	3.85	2.60	1.48
111	3.90	2.77	1.41
112	4.10	2.75	1.49
118	4.10	2.44	1.68
122	4.10	2.64	1.55
116	4.15	2.55	1.63
113	4.20	2.75	1.53
117	4.20	2.59	1.62
143	4.20	2.76	1.52
114	4.25	2.68	1.58
108	4.30	2.97	1.45
115	4.30	2.78	1.55
120	4.30	2.69	1.60
140	4.30	2.75	1.56
142	4.40	2.88	1.53
146	4.40	2.93	1.50
110	4.45	3.00	1.48
109	4.50	2.96	1.52
107	4.55	3.06	1.49
119	4.55	2.86	1.59
141	4.65	2.99	1.56
132	4.70	3.00	1.57
138	4.70	2.94	1.60
137	4.75	2.96	1.60
144	4.75	3.06	1.55
129	4.80	3.16	1.52
131	4.80	3.13	1.53
139	4.80	3.09	1.55
147	4.80	3.01	1.59
123	4.85	3.13	1.55
135	4.85	3.13	1.55
121	4.90	3.08	1.59
134	4.90	3.16	1.55
126	5.00	3.14	1.59
136	5.00	3.06	1.63
124	5.10	3.18	1.60
128	5.10	3.12	1.63
130	5.20	3.16	1.65
127	5.25	3.10	1.69
133	5.25	3.05	1.72

TABULATED GENERAL SUMMARY.

	Pounds of fat in 100 lbs. of milk.	Pounds of casein in 100 lbs. of milk.	Pounds of fat for one pound of casein.
Least.....	3.65	2.44	1.41
Greatest....	5.25	3.18	1.72
Average.....	4.56	2.92	1.56

Statement of Results.

For each pound of casein in the milk, the amount of fat varied from 1.41 to 1.72 lbs., and averaged 1.56 lbs. As compared with the results of last season's work with milk varying in fat-content from 3.05 to 4.40 per cent., it shows a much closer agreement than might be anticipated. [See Bulletin No. 50., pp 44-47.] Over eighty per cent. of these results are within one-tenth of a pound of the average of last season's work.

COMPOSITION OF THE WHEY.

TABULATED SUMMARY, GIVING COMPOSITION OF WHEY.

	Pounds of water in 100 lbs. of whey.	Pounds of solids in 100 lbs. of whey.	Pounds of fat in 100 lbs. of whey.	Pounds of casein and al- bumen in 100 lbs. of whey.	Pounds of sugar, ash, etc. in 100 lbs. of whey.
Least.	92.50	6.84	0.20	0.84	5.51
Greatest.	93.16	7.50	0.56	1.09	6.27
Average.	92 85	7.15	0.33	0.97	5.85

A comparison of these results with those secured last season, shows very close agreement in fat, and fairly close uniformity in respect to the other constituents. [See Bulletin No. 50, p. 58.]

COMPOSITION OF THE GREEN CHEESE.

We present below the composition of the cheese arranged in groups corresponding to the composition of the milk, as given on page 236.

TABLE SHOWING COMPOSITION OF GREEN CHEESE.

		Lbs. of water in 100 lbs. of cheese.	Lbs. of solids in 100 lbs. of cheese.	Lbs. of fat in 100 lbs. of cheese.	Lbs. of casein and albumen in 100 lbs. of cheese.	Lbs. of sugar, ash, etc. in 100 lbs. of milk.
GROUP I.						
Cheese made from milk containing from 3.65 to 4.00 per cent. of fat.	Least.	32.82	58.12	31.13	21.13	5.24
	Greatest.	41.88	67.18	36.40	25.23	6.46
	Average.	38.65	61.35	32.91	22.68	5.76
GROUP II.						
Cheese made from milk containing from 4 to 4.25 per cent. of fat.	Least.	36.75	51.78	28.90	18.80	4.08
	Greatest.	48.22	63.25	34.91	23.22	6.58
	Average.	39.36	60.64	33.42	22.14	5.08
GROUP III.						
Cheese made from milk containing from 4.25 to 4.50 per cent. of fat.	Least.	34.08	58.72	31.13	21.13	3.27
	Greatest.	41.28	65.92	35.78	24.42	6.80
	Average.	37.58	62.42	33.95	22.83	5.64
GROUP IV.						
Cheese made from milk containing from 4.50 to 4.75 per cent. of fat.	Least.	33.95	61.84	33.90	22.14	4.11
	Greatest.	38.16	66.05	36.40	23.70	7.21
	Average.	36.10	63.90	35.27	22.75	5.88
GROUP V.						
Cheese made from milk containing from 4.75 to 5.00 per cent. of fat.	Least.	35.02	59.80	32.71	22.18	3.08
	Greatest.	40.20	64.98	36.13	23.15	6.05
	Average.	37.90	62.10	34.60	22.54	4.96
GROUP VI.						
Cheese made from milk containing from 5.00 to 5.25 per cent. of fat.	Least.	36.00	59.80	33.87	21.57	3.62
	Greatest.	40.20	64.00	36.51	23.12	5.61
	Average.	37.55	62.45	35.61	22.18	4.66
Average of all.		37.83	62.17	34.35	22.52	5.30

Statement of Results.

1. Pounds of water in one hundred pounds of green cheese.

The amount of water in one hundred pounds of green cheese varied from 32.82 to 48.22 lbs., and averaged 37.83 lbs.

2. Pounds of fat in one hundred pounds of green cheese.

The amount of fat in one hundred pounds of green cheese varied from 28.90 to 36.51 lbs., and averaged 34.35 lbs.

3. Pounds of casein and albumen in one hundred pounds of cheese.

The amount of casein and albumen in one hundred pounds of cheese varied from 18.80 to 25.23 lbs., and averaged 22.52 lbs.

RELATION OF FAT TO CASEIN IN CHEESE MADE FROM NORMAL
MILK RICH IN FAT.

For a discussion of this subject in connection with the results of last season's work, see Bulletin No. 50, pp. 63-65.

TABLE SHOWING RELATION OF FAT TO CASEIN IN CHEESE.

No. of Experiment.	Pounds of fat in 100 lbs. of milk.	Pounds of fat in 100 lbs. of green cheese.	Pounds of casein in 100 lbs. of green cheese.	Pounds of fat for one pound of casein in cheese.
125	3.65	31.20	21.68	1.44
145	3.85	36.40	25.23	1.44
111	3.90	32.23	22.95	1.40
112	4.10	33.30	22.67	1.46
118	4.10	28.90	18.80	1.54
122	4.10	33.60	22.70	1.48
116	4.15	33.86	21.96	1.54
113	4.20	34.00	23.22	1.46
117	4.20	34.90	22.10	1.58
143	4.20	33.85	22.82	1.48
114	4.25	34.91	22.86	1.53
108	4.30	32.58	24.42	1.34
115	4.30	34.90	22.79	1.53
120	4.30	33.65	22.55	1.49
140	4.30	35.68	23.44	1.52
142	4.40	35.78	23.96	1.49
146	4.40	35.10	23.15	1.50
110	4.45	31.13	21.13	1.47
109	4.50	32.77	21.23	1.52
107	4.55	35.62	23.22	1.50
119	4.55	36.40	23.70	1.54
141	4.65	35.90	22.72	1.58
132	4.70	33.90	22.14	1.53
138	4.70	34.26	22.33	1.53
137	4.75	35.55	22.50	1.58
144	4.75	35.23	22.66	1.55
129	4.80	33.38	22.57	1.48
131	4.80	33.43	22.22	1.50
139	4.80	36.13	22.45	1.60
147	4.80	36.03	22.18	1.60
123	4.85	32.71	21.86	1.50
135	4.85	34.35	23.15	1.48
121	4.90	34.45	22.81	1.51
134	4.90	35.80	23.13	1.54
126	5.00	34.73	22.76	1.53
136	5.00	35.00	22.24	1.57
124	5.10	33.87	21.90	1.55
128	5.10	36.12	23.12	1.56
130	5.20	35.17	22.43	1.57
127	5.25	36.51	21.88	1.66
133	5.25	36.40	21.57	1.68

TABULATED GENERAL SUMMARY.

	Pounds of fat in 100 lbs. of cheese.	Pounds of casein in 100 lbs. of cheese.	Pounds of fat for one pound of casein in cheese.
Least.....	28.90	18.80	1.40
Greatest.....	36.51	25.23	1.68
Average.....	34.35	22.52	1.52

Statement of Results.

For each pound of casein in the cheese, the amount of fat varied from 1.40 to 1.68 lbs., and averaged 1.52 lbs.

LOSS OF MILK-CONSTITUENTS IN CHEESE-MAKING.

TABLE SHOWING AMOUNT OF MILK-SOLIDS LOST AND RECOVERED IN CHEESE-MAKING.

No. of Experiment.	Pounds of solids in 100 lbs. of milk.	Pounds of milk-solids lost in whey for 100 lbs. of milk.	Pounds of milk-solids recovered in cheese for 100 lbs. of milk.	Per cent. of milk-solids lost in whey.	Per cent. of milk-solids recovered in cheese.
125	12.46	6.16	6.30	49.44	50.56
145	12.78	6.23	6.55	48.75	51.25
111	13.13	6.40	6.73	48.74	51.26
112	13.46	6.36	7.10	47.25	52.75
118	13.25	6.39	6.86	48.23	51.77
122	13.33	6.58	6.75	49.36	50.64
116	13.26	6.27	6.99	47.28	52.72
113	13.56	6.40	7.16	47.20	52.80
117	13.25	6.18	7.07	46.64	53.36
143	13.58	6.18	7.40	45.50	54.50
114	13.30	6.23	7.07	46.85	53.15
108	13.68	6.10	7.58	44.60	55.40
115	13.33	6.24	7.09	46.81	53.19
120	13.23	6.17	7.06	46.63	53.37
140	13.64	6.27	7.37	46.00	54.00
142	13.75	6.13	7.62	44.60	55.40
146	13.80	6.30	7.50	45.65	54.35
110	13.77	5.96	7.81	43.30	56.70
109	13.76	5.95	7.81	43.24	56.76
107	14.10	6.22	7.88	44.10	55.90
119	13.80	6.36	7.44	46.10	53.90
141	14.17	6.25	7.92	44.10	55.90
132	14.40	6.30	8.10	43.75	56.25
138	14.47	6.25	8.22	43.20	56.80
137	14.37	6.17	8.20	42.93	57.07
144	14.26	6.32	7.94	44.32	55.68
129	14.57	6.34	8.23	43.50	56.50
131	14.52	6.29	8.23	43.32	56.68
139	14.36	6.25	8.11	43.52	56.48
147	14.22	6.22	8.00	43.74	56.26
123	14.82	6.45	8.37	43.52	56.48
135	14.65	6.32	8.33	43.14	56.86
121	14.25	6.37	7.88	44.70	55.30
134	14.84	6.51	8.33	43.90	56.10
126	14.63	6.38	8.25	43.60	56.40
136	14.77	6.37	8.40	43.13	56.87
124	14.87	6.38	8.49	42.90	57.10
128	14.63	6.21	8.42	42.45	57.55
130	14.73	6.27	8.46	42.57	57.43
127	14.94	6.28	8.66	42.03	57.97
133	14.83	6.21	8.62	41.88	58.12

Statement of Results.

1. Pounds of solids in one hundred pounds of milk.

The solids in one hundred pounds of milk varied from 12.46 to 14.94 lbs., and averaged nearly 14 lbs.

2. Pounds of solids lost in whey for one hundred pounds of milk.

The amount of solids lost in whey varied from 5.95 to 6.58 lbs., and averaged 6.27 lbs.

3. Per cent. of solids in milk lost in whey.

The per cent. of solids in milk that was lost in whey varied from 41.88 to 49.44, and averaged 44.80.

It appears from these results, and from those secured last season, that the amount of milk-solids lost for a hundred pounds of milk is fairly constant, being between 6 and 6.5 lbs. The amount of milk-solids recovered in cheese varied much more, ranging from 5.31 to 8.66 lbs. for milk containing from 3 to 5.25 per cent. of fat. It appears that when the milk-solids increase, the cheese-producing solids, the fat and casein, increase, while the whey-solids, the albumen, sugar, and ash, increase very little in comparison. It, therefore, results that in rich milk a larger proportion of the solids is utilized in cheese-making than in the case of poorer milk; in other words, there is a smaller proportion of loss of milk-solids in making rich milk into cheese.

TABLE SHOWING AMOUNT OF FAT RECOVERED AND LOST IN CHEESE-
MAKING.

No. of Experiment.	Pounds of fat in 100 lbs. of milk.	Pounds of fat lost in whey for 100 lbs. of milk.	Pounds of fat recovered in cheese for 100 lbs. of milk.	Per cent. of fat in milk lost in whey.	Per cent. of fat in milk recovered in cheese.
125	3.65	0.27	3.38	7.40	92.60
145	3.85	0.30	3.55	7.80	92.20
111	3.90	0.31	3.59	7.95	92.05
112	4.10	0.28	3.82	6.83	93.17
118	4.10	0.27	3.83	6.59	93.41
122	4.10	0.37	3.73	9.02	90.98
116	4.15	0.28	3.87	6.75	93.25
113	4.20	0.29	3.91	6.90	93.10
117	4.20	0.22	3.98	5.24	94.76
143	4.20	0.24	3.96	5.70	94.30
114	4.25	0.27	3.98	6.35	93.65
108	4.30	0.39	3.91	9.07	90.93
115	4.30	0.24	4.06	5.58	94.42
120	4.30	0.45	3.85	10.47	89.53
140	4.30	0.31	3.99	7.20	92.80
142	4.40	0.25	4.15	5.68	94.32
146	4.40	0.23	4.17	5.23	94.77
110	4.45	0.31	4.14	6.97	93.03
109	4.50	0.24	4.26	5.55	94.45
107	4.55	0.30	4.25	6.60	93.40
119	4.55	0.39	4.16	8.57	91.43
141	4.65	0.24	4.41	5.16	94.84
132	4.70	0.26	4.44	5.53	94.47
138	4.70	0.28	4.42	5.96	94.04
137	4.75	0.20	4.55	4.20	95.80
144	4.75	0.24	4.51	5.05	94.95
129	4.80	0.26	4.54	5.40	94.60
131	4.80	0.30	4.50	6.25	93.75
139	4.80	0.23	4.57	4.80	95.20
147	4.80	0.17	4.63	3.54	96.46
123	4.85	0.27	4.58	5.57	94.43
135	4.85	0.34	4.51	7.00	93.00
121	4.90	0.49	4.41	10.00	90.00
134	4.90	0.31	4.59	6.32	93.68
126	5.00	0.27	4.73	5.40	94.60
136	5.00	0.31	4.69	6.20	93.80
124	5.10	0.29	4.81	5.70	94.30
128	5.10	0.35	4.75	6.86	93.14
130	5.20	0.34	4.86	6.54	93.46
127	5.25	0.31	4.94	5.90	94.10
133	5.25	0.29	4.96	5.52	94.48

Statement of Results.

1. Pounds of fat in one hundred pounds of milk.

The fat in the milk varied from 3.65 to 5.25 lbs. in one hundred pounds of milk, and averaged 4.56 lbs.

2. Pounds of fat lost for one hundred pounds of milk.

The amount of fat lost in the whey varied from 0.17 to 0.49 lbs., and averaged 0.29 lbs. for one hundred pounds of milk.

3. Per cent. of fat in milk lost in whey.

The per cent. of fat in milk that was lost in the whey in the process of manufacture varied from 3.54 to 10 per cent., and averaged 6.36 per cent.

In general, there was every appearance of slight loss of fat in making cheese from the milk rich in fat; the whey was clear and the loss in press was exceedingly small. These indications were confirmed by the results of analysis. The general results of our last season's work are fully confirmed, and all the facts secured go to show that milk rich in fat can be made into cheese with a smaller proportion of loss than milk less rich in fat.

TABLE SHOWING AMOUNT OF CASEIN AND ALBUMEN RECOVERED AND
LOST IN CHEESE-MAKING.

No. of Experiment.	Pounds of casein and albumen in 100 lbs. of milk.	Pounds of casein and al- bumen lost in whey for 100 lbs. of milk.	Pounds of casein and al- bumen recov- ered in whey for 100 lbs. of milk.	Per cent. of casein and al- bumen in milk lost in whey.	Per cent. of casein and al- bumen in milk recovered in cheese.
125	3.10	0.75	2.35	24.19	75.81
145	3.24	0.78	2.46	24.07	75.93
111	3.39	0.82	2.57	24.19	75.81
112	3.41	0.81	2.60	23.75	76.25
118	3.23	0.74	2.49	22.91	77.09
122	3.28	0.76	2.52	23.17	76.83
116	3.32	0.81	2.51	24.40	75.60
113	3.47	0.80	2.67	23.05	76.95
117	3.30	0.78	2.52	23.64	76.36
143	3.49	0.82	2.67	23.47	76.53
114	3.38	0.78	2.60	23.06	76.94
108	3.77	0.84	2.93	22.28	77.72
115	3.46	0.81	2.65	23.41	76.59
120	3.37	0.79	2.58	23.44	76.56
140	3.43	0.81	2.62	23.63	76.37
142	3.60	0.82	2.78	22.78	77.22
146	3.60	0.85	2.75	23.61	76.39
110	3.68	0.87	2.81	23.64	76.36
109	3.62	0.86	2.76	23.76	76.24
107	3.62	0.85	2.77	23.48	76.52
119	3.52	0.81	2.71	23.00	77.00
141	3.65	0.86	2.79	23.56	76.44
132	3.83	0.93	2.90	24.28	75.72
138	3.76	0.88	2.88	23.40	76.60
137	3.73	0.85	2.88	22.80	77.20
144	3.76	0.86	2.90	22.87	77.13
129	3.98	0.91	3.07	22.86	77.14
131	3.93	0.94	2.99	23.92	76.08
139	3.72	0.88	2.84	23.65	76.35
147	3.69	0.84	2.85	22.76	77.24
123	3.93	0.87	3.06	22.14	77.86
135	3.93	0.89	3.04	22.65	77.35
121	3.86	0.94	2.92	24.35	75.65
134	3.89	0.92	2.97	23.65	76.35
126	3.99	0.89	3.10	22.30	77.70
136	3.88	0.90	2.98	23.20	76.80
124	4.00	0.89	3.11	22.25	77.75
128	3.94	0.90	3.04	22.84	77.16
130	4.01	0.91	3.10	22.70	77.30
127	3.86	0.90	2.96	23.32	76.68
133	3.86	0.92	2.94	23.83	76.17

Statement of Results.

1. Pounds of casein and albumen in one hundred pounds of milk.

The amount of casein and albumen varied from 3.10 to 4.01 lbs., and averaged 3.65 lbs. in one hundred pounds of milk.

2. Pounds of casein and albumen lost in whey for one hundred pounds of milk.

The amount of casein and albumen lost in the whey varied from 0.74 to 0.94 lbs., and averaged 0.85 lbs. in one hundred pounds of milk.

3. Per cent. of casein and albumen lost in whey.

The per cent. of casein and albumen in milk that was lost in the whey varied from 22.14 to 24.40 per cent., and averaged 23.30 per cent.

It will be seen that the proportion of loss was very uniform and entirely within the limits of our last season's work with factory milk. All the facts thus far secured indicate that the proportion of casein and albumen lost in cheese-making is apt to be somewhat less in rich than in poorer milk.

INFLUENCE OF COMPOSITION OF MILK ON YIELD OF CHEESE.

TABLE SHOWING RELATION OF MILK-CONSTITUENTS TO YIELD OF CHEESE.

No of Experiment.	Lbs. of fat in 100 lbs. of milk.	Pounds of casein in 100 lbs. of milk.	Pounds of green cheese made from 100 lbs. of milk.	Pounds of water in cheese made from 100 lbs. of milk.	Pounds of fat in cheese made from 100 lbs. of milk.	Lbs. of casein in cheese made from 100 lbs. of milk.	Lbs. of sugar, ash, etc.
125	3.65	2.48	10.84	4.54	3.38	2.35	0.57
145	3.85	2.60	9.75	3.20	3.55	2.46	0.54
111	3.90	2.77	11.20	4.47	3.59	2.57	0.57
112	4.10	2.75	11.47	4.37	3.82	2.60	0.68
118	4.10	2.44	13.25	6.39	3.83	2.49	0.54
122	4.10	2.64	11.10	4.35	3.73	2.52	0.50
116	4.15	2.55	11.43	4.44	3.87	2.51	0.61
113	4.20	2.75	11.50	4.34	3.91	2.67	0.58
117	4.20	2.59	11.40	4.33	3.98	2.52	0.57
143	4.20	2.76	11.70	4.30	3.96	2.67	0.77
114	4.25	2.68	11.40	4.33	3.98	2.60	0.49
108	4.30	2.97	12.00	4.42	3.91	2.93	0.74
115	4.30	2.78	11.63	4.54	4.06	2.65	0.38
120	4.30	2.69	11.44	4.38	3.85	2.58	0.63
140	4.30	2.75	11.18	3.81	3.99	2.62	0.76
142	4.40	2.88	11.60	3.98	4.15	2.78	0.69
146	4.40	2.93	11.88	4.38	4.17	2.75	0.58
110	4.45	3.00	13.30	5.49	4.14	2.81	0.86
109	4.50	2.96	13.00	5.19	4.26	2.76	0.79
107	4.55	3.06	11.93	4.05	4.25	2.77	0.86
119	4.55	2.86	11.43	3.99	4.16	2.71	0.57
141	4.65	2.99	12.28	4.36	4.41	2.79	0.72
132	4.70	3.00	13.10	5.00	4.44	2.90	0.76
138	4.70	2.94	12.90	4.68	4.42	2.88	0.92
137	4.75	2.96	12.80	4.60	4.55	2.88	0.77
144	4.75	3.06	12.80	4.86	4.51	2.90	0.53
129	4.80	3.16	13.60	5.37	4.54	3.07	0.62
131	4.80	3.13	13.46	5.23	4.50	2.99	0.74
139	4.80	3.09	12.65	4.54	4.57	2.84	0.70
147	4.80	3.01	12.85	4.85	4.63	2.85	0.52
123	4.85	3.13	14.00	5.63	4.58	3.06	0.73
135	4.85	3.13	13.13	4.80	4.51	3.04	0.79
121	4.90	3.08	12.80	4.92	4.41	2.92	0.55
134	4.90	3.16	12.82	4.49	4.59	2.97	0.77
126	5.00	3.14	13.62	5.37	4.73	3.10	0.42
136	5.00	3.06	13.40	5.00	4.69	2.98	0.73
124	5.10	3.18	14.20	5.71	4.81	3.11	0.57
128	5.10	3.12	13.15	4.73	4.75	3.04	0.63
130	5.20	3.16	13.82	5.26	4.86	3.10	0.50
127	5.25	3.10	13.53	4.87	4.94	2.96	0.76
133	5.25	3.05	13.63	5.01	4.96	2.94	0.72

YIELD OF GREEN CHEESE FROM ONE HUNDRED POUNDS OF MILK.

The yield of green cheese from one hundred pounds of milk varied from 9.75 to 14.20 lbs., and averaged 12.35 lbs.

AMOUNT OF WATER RETAINED IN CHEESE MADE FROM ONE HUNDRED POUNDS OF MILK.

The amount of water retained in the cheese made from one hundred pounds of milk varied from 3.20 to 6.39 lbs., and averaged 4.70 lbs. The variation in amount of water retained in cheese is governed more or less by the composition of the milk; that is, the larger the amount of fat and casein in one hundred pounds of milk, the larger will be the amount of water that the fat and casein will retain in the cheese; but serious variations are caused by difference in conditions of manufacture, and it is possible so to influence the amount of water retained in the cheese that the latter will have no definite relation to the composition of the milk. It is undoubtedly true that the fat and casein have a different capacity for retaining moisture, and that casein, naturally, under like conditions, will retain more moisture than the same amount of fat; but the results of our work do not suffice to show that the amount of water retained in the cheese bears any definite relation to the amount of casein in the cheese.

AMOUNT OF FAT RETAINED IN CHEESE MADE FROM ONE HUNDRED POUNDS OF MILK.

The amount of fat retained in the cheese made from one hundred pounds of milk varied from 3.38 to 4.96 lbs., and averaged 4.27 lbs. When the fat in the milk increased, the amount of fat retained in the cheese very closely followed the increase of fat in the milk.

AMOUNT OF CASEIN RETAINED IN CHEESE MADE FROM ONE HUNDRED POUNDS OF MILK.

The amount of casein retained in one hundred pounds of cheese varied from 2.35 to 3.11 lbs., and averaged 2.80 lbs.

TABLE SHOWING RELATION OF FAT IN MILK TO YIELD OF GREEN CHEESE.

No. of Experiment.	Lbs. of fat in 100 lbs. of cheese.	Lbs. of cheese made from 100 lbs. of milk.	Lbs. of cheese from one pound of fat in milk.	Lbs. of cheese containing 36.5 per cent. of water made from 100 lbs. of milk.	Lbs. of cheese containing 36.5 per cent. of water for 100 lbs. of fat in milk.
125	3.65	10.84	2.97	9.93	2.72
145	3.85	9.75	2.53	10.32	2.68
111	3.90	11.20	2.87	10.61	2.72
112	4.10	11.47	2.80	11.19	2.73
118	4.10	13.25	3.23	10.81	2.64
122	4.10	11.10	2.71	10.64	2.60
116	4.15	11.43	2.75	11.02	2.66
113	4.20	11.50	2.71	11.28	2.69
117	4.20	11.40	2.71	11.14	2.65
143	4.20	11.70	2.80	11.66	2.78
114	4.25	11.40	2.68	11.14	2.62
108	4.30	12.00	2.79	11.95	2.78
115	4.30	11.63	2.70	11.17	2.60
120	4.30	11.44	2.66	11.12	2.60
140	4.30	11.18	2.60	11.62	2.70
142	4.40	11.60	2.64	12.01	2.73
146	4.40	11.88	2.70	11.82	2.70
110	4.45	13.30	2.99	12.31	2.77
109	4.50	13.00	2.89	12.31	2.74
107	4.55	11.93	2.62	12.42	2.73
119	4.55	11.43	2.51	11.73	2.58
141	4.65	12.28	2.64	12.48	2.69
132	4.70	13.10	2.80	12.77	2.72
138	4.70	12.90	2.75	12.95	2.76
137	4.75	12.80	2.70	12.92	2.72
144	4.75	12.80	2.70	12.51	2.64
129	4.80	13.60	2.84	12.97	2.70
131	4.80	13.46	2.80	12.97	2.70
139	4.80	12.65	2.64	12.78	2.67
147	4.80	12.85	2.68	12.61	2.63
123	4.85	14.00	2.89	13.19	2.72
135	4.85	13.13	2.71	13.13	2.71
121	4.90	12.80	2.61	12.45	2.54
134	4.90	12.82	2.61	13.13	2.68
126	5.00	13.62	2.72	13.00	2.60
136	5.00	13.40	2.68	13.24	2.65
124	5.10	14.20	2.78	13.40	2.68
128	5.10	13.15	2.58	13.27	2.60
130	5.20	13.82	2.66	13.35	2.57
127	5.25	13.53	2.58	13.66	2.60
133	5.25	13.63	2.60	13.63	2.60

Statement of Results.

The amount of cheese made for each pound of fat in milk varied from 2.53 to 3.23 lbs. and averaged 2.71 lbs. If we calculate the yield for cheese containing the same amount of water (36.5 per cent.) as the average of our last season's experiments, the yield varied from 2.54 to 2.78 lbs. and averaged 2.65 lbs. Arranging the results contained in the above table by groups, we have the following table:

		Lbs. of fat in 100 pounds of milk.	Lbs. of cheese made from 100 pounds of milk.	Lbs. of cheese made for one pound of fat in milk.	Lbs. of cheese contain- ing 36.5 per cent. of water made from 100 pounds of milk.	Lbs. of cheese contain- ing 36.5 per cent. for one pound of fat in milk.
GROUP I.						
Milk containing	Least....	3.65	9.75	2.53	9.93	2.68
from 3.65 to 4.00	Greatest..	3.90	11.20	2.97	10.61	2.72
per cent. of fat.	Average..	3.80	10.60	2.79	10.29	2.71
GROUP II.						
Milk containing	Least....	4.10	11.10	2.68	10.64	2.60
from 4.00 to 4.25	Greatest..	4.25	13.25	3.23	11.66	2.78
per cent. of fat.	Average..	4.16	11.65	2.80	11.11	2.67
GROUP III.						
Milk containing	Least....	4.30	11.18	2.60	11.12	2.60
from 4.25 to 4.50	Greatest..	4.50	13.30	2.99	12.31	2.78
per cent. of fat.	Average..	4.37	12.00	2.75	11.79	2.70
GROUP IV.						
Milk containing	Least....	4.55	11.43	2.51	11.73	2.58
from 4.50 to 4.75	Greatest..	4.75	13.10	2.80	12.95	2.76
per cent. of fat.	Average..	4.66	12.46	2.67	12.54	2.69
GROUP V.						
Milk containing	Least....	4.80	12.65	2.61	12.61	2.54
from 4.75 to 5.00	Greatest..	5.00	14.00	2.89	13.24	2.72
per cent. of fat.	Average..	4.87	13.23	2.72	12.95	2.66
GROUP VI.						
Milk containing	Least....	5.10	13.15	2.58	13.27	2.57
from 5.00 to 5.25	Greatest..	5.25	14.20	2.78	13.66	2.68
per cent. of fat.	Average..	5.18	13.67	2.64	13.46	2.60

TABULATED SUMMARY OF RESULTS.

No. of Experiments.	Pounds of fat in 100 lbs. of milk.	Pounds of fat lost in whey for 100 lbs. of milk.	Per cent. of fat in milk lost in whey.	Pounds of casein and albumen in 100 lbs. of milk.	Pounds of casein and albumen lost in whey for 100 lbs. of milk.	Per cent. of casein and albumen lost in whey.	Pounds of casein in 100 lbs. of milk.	Pounds of albumen in 100 lbs. of milk.	Pounds of casein for one pound of albumen in milk.	Pounds of fat for one pound of casein in milk.
125.....	3.65	0.27	7.40	3.10	0.75	24.19	2.48	0.62	4.00	1.47
145.....	3.85	0.30	7.80	3.24	0.78	24.07	2.60	0.64	4.06	1.48
111.....	3.90	0.31	7.95	3.39	0.82	24.19	2.77	0.62	4.47	1.41
112, 118, 122.....	4.10	0.31	7.56	3.31	0.77	23.26	2.61	0.70	3.73	1.57
116.....	4.15	0.28	6.75	3.32	0.81	24.40	2.55	0.77	3.31	1.63
113, 117, 143.....	4.20	0.25	5.95	3.42	0.82	23.98	2.70	0.72	3.75	1.55
114.....	4.25	0.27	6.35	3.38	0.78	23.06	2.68	0.70	3.83	1.58
108, 115, 120, 140.....	4.30	0.35	8.14	3.51	0.81	23.08	2.80	0.71	4.00	1.54
142, 146.....	4.40	0.24	5.45	3.60	0.83	23.05	2.90	0.70	4.14	1.52
110.....	4.45	0.31	6.97	3.68	0.87	23.64	3.00	0.68	4.41	1.48
109.....	4.50	0.24	5.55	3.62	0.86	23.76	2.96	0.66	4.48	1.52
107, 119.....	4.55	0.34	7.48	3.57	0.83	23.25	2.96	0.61	4.85	1.54
141.....	4.65	0.24	5.16	3.65	0.86	23.56	2.99	0.66	4.53	1.56
132, 138.....	4.70	0.27	5.75	3.80	0.88	23.16	2.97	0.83	3.58	1.58
137, 144.....	4.75	0.22	4.63	3.75	0.86	22.84	3.01	0.74	4.07	1.58
129, 131, 139, 147.....	4.80	0.24	5.00	3.83	0.89	23.24	3.10	0.73	4.25	1.55
123, 135.....	4.85	0.30	6.20	3.93	0.88	22.40	3.13	0.80	3.90	1.55
121, 134.....	4.90	0.40	8.16	3.88	0.93	23.97	3.12	0.76	4.10	1.57
126, 136.....	5.00	0.29	5.80	3.94	0.90	22.85	3.10	0.84	3.70	1.61
124, 128.....	5.10	0.32	6.27	3.97	0.90	22.67	3.15	0.82	3.84	1.62
130.....	5.20	0.34	6.54	4.01	0.91	22.70	3.16	0.85	3.72	1.65
127, 133.....	5.25	0.30	5.71	3.86	0.91	23.60	3.08	0.78	3.95	1.70

TABULATED SUMMARY OF RESULTS—CONCLUDED.

No. of Experiments.	Pounds of fat in 100 lbs. of green cheese.	Pounds of casein in 100 lbs. of green cheese.	Pounds of water in 100 lbs. of green cheese.	Pounds of fat for one pound of casein in cheese.	Pounds of green cheese made from 100 lbs. of milk.	Pounds of water in cheese from 100 lbs. of milk.	Pounds of fat in cheese from 100 lbs. of milk.	Pounds of casein in 100 lbs. of milk.	Pounds of cheese made for one pound of fat in milk.	Pounds of milk required to make one pound of cheese.
125.....	31.20	21.68	41.88	1.44	10.84	4.54	3.38	2.35	2.97	9.23
145.....	36.40	25.23	32.82	1.44	9.75	3.20	3.55	2.46	2.53	10.25
111.....	32.23	22.95	39.90	1.40	11.20	4.47	3.59	2.57	2.87	8.93
112, 118, 122.....	31.93	21.39	41.84	1.49	11.94	5.04	3.79	2.54	2.91	8.37
116.....	33.86	21.96	38.85	1.54	11.43	4.44	3.87	2.51	2.75	8.76
113, 117, 143.....	34.25	22.71	37.50	1.51	11.53	4.32	3.95	2.62	2.75	8.69
114.....	34.91	22.86	38.00	1.53	11.40	4.33	3.98	2.60	2.68	8.77
108, 115, 120, 140.....	34.20	23.30	37.06	1.46	11.56	4.29	3.95	2.70	2.69	8.65
142, 146.....	35.44	23.55	35.09	1.50	11.74	4.18	4.16	2.77	2.67	8.52
110.....	31.13	21.13	41.28	1.47	13.30	5.49	4.14	2.81	2.99	7.52
109.....	32.77	21.23	39.92	1.52	13.00	5.19	4.26	2.76	2.89	7.70
107, 119.....	36.00	23.46	34.45	1.52	11.68	4.02	4.20	2.74	2.57	8.56
141.....	35.90	22.72	35.60	1.58	12.28	4.36	4.41	2.79	2.64	8.14
132, 138.....	34.03	22.24	37.22	1.53	13.00	4.84	4.43	2.89	2.77	7.70
137, 144.....	35.39	22.58	36.97	1.57	12.80	4.73	4.53	2.89	2.70	7.81
129, 131, 139, 147.....	34.74	22.36	38.00	1.55	13.14	5.00	4.56	2.94	2.74	7.61
123, 135.....	33.53	22.50	38.38	1.49	13.56	5.22	4.55	3.05	2.80	7.37
121, 134.....	35.12	22.97	36.73	1.52	12.81	4.70	4.50	2.95	2.61	7.80
126, 136.....	34.87	22.50	38.37	1.55	13.51	5.19	4.71	3.04	2.70	7.40
124, 128.....	35.00	22.51	38.10	1.56	13.68	5.22	4.78	3.08	2.68	7.31
130.....	35.17	22.43	38.78	1.57	13.82	5.36	4.86	3.10	2.66	7.25
127, 133.....	36.45	21.72	36.38	1.67	13.58	4.94	4.95	2.95	2.59	7.35

GENERAL SUMMARY OF THE RESULTS OF EXPERIMENTS IN THE MANUFACTURE OF CHEESE FROM NORMAL MILK, RICH IN FAT.

I. The Composition of Normal Milk, Rich in Fat.

1. *Pounds of Solids in One Hundred Pounds of Milk.*

The milk-solids in one hundred pounds of milk varied from 12.46 to 14.94 lbs., and averaged 14.00 lbs.

2. *Pounds of Fat in One Hundred Pounds of Milk.*

The fat in one hundred pounds of milk varied from 3.65 to 5.25 lbs., and averaged 4.56 lbs.

3. *Pounds of Casein and Albumen in One Hundred Pounds of Milk.*

The casein and albumen in one hundred pounds of milk varied from 3.10 to 4.01 lbs., and averaged 3.65 lbs.

4. *Pounds of Casein in One Hundred Pounds of Milk.*

The casein in one hundred pounds of milk varied from 2.44 to 3.18 lbs., and averaged 2.92 lbs.

5. *Pounds of Albumen in One Hundred Pounds of Milk.*

The albumen in one hundred pounds of milk varied from 0.56 to 0.85 lbs., and averaged 0.73 lbs.

6. *Relation of Casein to Albumen in Normal Milk.*

For each pound of albumen in the milk, the casein varied from 3.09 to 5.46 lbs., and averaged 4.00 lbs.

7. *Relation of Fat to Casein in Normal Milk.*

For each pound of casein in the milk, the fat varied from 1.41 to 1.72 lbs., and averaged 1.56 lbs.

II. The Composition of Whey.

1. *Pounds of Solids in One Hundred Pounds of Whey.*

The amount of solids in one hundred pounds of whey varied from 6.84 to 7.50 lbs., and averaged 7.15 lbs.

2. *Pounds of Fat in One Hundred Pounds of Whey.*

The amount of fat in one hundred pounds of whey varied from 0.20 to 0.56 lbs., and averaged 0.33 lbs.

3. *Pounds of Casein and Albumen in One Hundred Pounds of Whey.*

The amount of casein and albumen in one hundred pounds of whey varied from 0.84 to 1.09 lbs. and averaged 0.97 lbs.

III. The Composition of Green Cheese made from Normal Milk.

1. *Pounds of Water in One Hundred Pounds of Green Cheese.*

The amount of water in one hundred pounds of green cheese varied from 32.82 to 48.22 lbs., and averaged 37.83 lbs. It was the most variable constituent of the cheese.

2. *Pounds of Fat in One Hundred Pounds of Green Cheese.*

The amount of fat in one hundred pounds of green cheese varied from 28.90 to 36.51 lbs., and averaged 34.35 lbs.

3. *Pounds of Casein in One Hundred Pounds of Green Cheese.*

The amount of casein in one hundred pounds of green cheese varied from 18.80 to 25.23 lbs., and averaged 22.52 lbs.

4. *Relation of Fat to Casein in Cheese.*

For each pound of casein in the cheese, the amount of fat varied from 1.40 to 1.68 lbs., and averaged 1.52 lbs.

IV. Loss of Milk-Constituents in Cheese-Making.

1. *Loss of Milk-Solids in Cheese-Making.*

a. The amount of milk-solids in one hundred pounds of milk that was lost in the whey in cheese-making varied from 5.95 to 6.58 lbs., and averaged 6.27 lbs.: this was equivalent to from 41.88 to 49.44 per cent. of the solids in the milk, with an average of 44.80 per cent.

b. The per cent. of solids in the milk lost in the whey diminished as the fat increased.

2. *Loss of Fat in Cheese-Making.*

a. The amount of fat in one hundred pounds of milk that was lost in the whey in cheese-making varied from 0.17 to 0.49 lbs., and averaged 0.29 lbs. (nearly 5 ounces); this was equivalent to from 3.54 to 10 per cent. of the fat in milk, with an average of 6.36 per cent.

b. The proportion of fat in milk that was lost in cheese-making was entirely independent of the amount of fat in the milk. The variations in loss were due either to the condition of the milk or to some special conditions employed in manufacture.

3. *Loss of Casein and Albumen in Cheese-Making.*

a. The amount of casein and albumen in one hundred pounds of milk that was lost in the whey in cheese-making varied from 0.74 to 0.94 lbs., and averaged 0.85 lbs.: this was equivalent to from 22.14 to 24.40 per cent. of the casein and albumen in the milk, with an average of 23.30 per cent.

b. The proportion of casein and albumen lost in cheese-making was, in general, very uniform and was little influenced by variation in the conditions of manufacture.

V. *Influence of Composition of Milk on Yield of Cheese.*

1. *Yield of Green Cheese from One Hundred Pounds of Milk.*

From one hundred pounds of milk, there were made from 9.75 to 14.20 lbs. of green cheese, the average being 12.35 lbs.

2. *Pounds of Milk required to make One Pound of Cheese.*

There were from 7.04 to 10.25 lbs. of milk required to make one pound of cheese, 8.10 lbs. being the average.

3. *Amount of Water retained in Cheese made from One Hundred Pounds of Milk.*

The amount of water retained in the cheese made from one hundred pounds of milk varied from 3.20 to 6.39 lbs., and averaged 4.70 lbs.

4. *Amount of Fat retained in Cheese made from One Hundred Pounds of Milk.*

The amount of fat retained in cheese made from one hundred pounds of milk varied from 3.38 to 4.96 lbs., and averaged 4.27 lbs. The variation in the amount of fat retained in the cheese made from one hundred pounds of milk followed very closely the variation of fat in one hundred pounds of milk.

5. *Amount of Casein and Albumen retained in Cheese made from One Hundred Pounds of Milk.*

The amount of casein and albumen retained in the cheese made from one hundred pounds of milk varied from 2.35 to 3.11 lbs., and averaged 2.80 lbs.

6. *Relation of Fat in Milk to Yield of Green Cheese.*

Each pound of fat produced from 2.53 to 3.23 lbs. of cheese, the average being 2.71 lbs.

BULLETIN No. 54—NEW SERIES.

PART II.

STUDY OF THE CHEESE-RIPENING PROCESS.

In Bulletin No. 37, pp. 705-711, are given the results of a preliminary study of the cheese-ripening process, and the reader is referred to the above Bulletin for a general discussion of the chemical changes produced by the ripening of cheese and the causes of such changes.

In October, 1892, several cheeses were made under different conditions with special reference to studying in them the chemical changes that take place in the ripening process. The details of the experiments are described in Bulletin No. 47, Part II, pp. 276-306. These cheeses were kept under the same conditions. After the first month the temperature of the room in which they were kept averaged 60° F., without extreme variations.

The special conditions of manufacture to which it is desired to call attention in this connection are given below:

Experiment No. 101. The milk from which this cheese was made contained added cream. (See Bulletin No. 47, Part II, p. 276.)

Experiment No. 102. The milk from which this cheese was made had nearly half of its fat removed. (See Bulletin No. 47, Part II, p. 276.)

Experiment No. 103. In this experiment a portion of the milk had been exposed to foul air. (See Bulletin No. 47, Part II, p. 276.)

Experiment No. 104. By the conditions of manufacture employed, an excessive amount of moisture was retained in the cheese.

Experiments No. 105 and 106 were alike in every respect except in amount of rennet used; in 105, 3 ounces of Hansen's rennet extract were used, while in 106 9 ounces of the same extract were used.

In the table below is given the composition of the different cheeses when green and when five months old.

TABLE SHOWING COMPOSITION OF GREEN CHEESE AND AT FIVE MONTHS' AGE.

		Composition expressed in parts per hundred.							From one hundred pounds of milk.							
		No. of cheese of ex- periment when analyzed.	Per cent. of water.	Per cent. of total solids.	Per cent. of fat.	Per cent. of casein and album'n.	Per cent. of albumen and soluble casein.	Per cent. of sugar, ash, etc.	Lbs.	Lbs. of water.	Lbs. of total solids.	Lbs. of fat.	Lbs. of casein and albumen.	Lbs. of casein.	Lbs. of albumen and soluble casein.	Lbs. of sugar, ash, etc.
Green.....	101	38.15	61.85	38.13	19.53	18.89	0.64	4.19	5.40	8.76	5.40	2.77	2.68	0.09	0.59	
	Five months	101	29.85	70.15	44.33	21.53	13.30	8.23	3.64	8.54	5.40	2.62	1.62	1.00	0.52	
Green.....	102	42.71	57.29	23.13	28.10	26.94	1.16	6.06	4.27	5.73	2.31	2.81	2.69	0.12	0.61	
	Five months	102	38.10	61.90	27.22	30.09	21.21	8.88	3.28	5.34	2.34	2.59	1.83	0.76	0.41	
Green.....	103	37.58	62.42	35.44	23.60	22.58	1.02	3.38	4.40	7.30	4.15	2.76	2.65	0.11	0.39	
	Five months	103	31.94	68.06	39.95	25.39	17.22	8.17	3.23	6.87	4.03	2.56	1.74	0.82	0.28	
Green.....	104	42.90	57.10	30.84	22.91	21.29	1.62	3.35	5.34	7.10	3.84	2.81	2.61	0.20	0.45	
	Five months	104	33.79	66.21	36.65	26.21	18.74	7.47	3.48	6.82	3.77	2.70	1.93	0.77	0.35	
Green.....	105	39.60	60.40	32.12	23.81	23.00	0.81	4.47	4.67	7.13	3.79	2.81	2.71	0.10	0.53	
	Five months	105	35.69	64.31	36.32	25.52	16.02	9.50	3.71	6.69	3.78	2.65	1.66	0.99	0.26	
Green.....	106	39.56	60.44	32.20	24.31	23.55	0.76	3.93	4.60	7.04	3.75	2.83	2.70	0.09	0.46	
	Five months	106	34.67	65.33	36.36	25.39	13.36	12.03	3.61	6.79	3.78	2.64	1.39	1.25	0.37	

TOTAL LOSS OF WEIGHT IN THE RIPENING OF CHEESE.

TABLE SHOWING LOSS OF WEIGHT IN FIVE MONTHS.

No. of Experiment.	Cheese made from 100 lbs of milk.			
	Weight when green.	Weight when five months old.	Loss of weight in five months.	Pounds of loss in weight for 100 lbs of cheese in five months.
101	14.16	12.18	1.98	14.00
102	10.00	8.62	1.38	13.80
103	11.70	10.10	1.60	13.68
104	12.44	10.30	2.14	17.20
105	11.80	10.40	1.40	11.87
106	11.64	10.40	1.24	10.65

Statement of Results.

1. The loss of weight for five months varied from 10.65 to 17.20 lbs. for one hundred pounds of cheese and averaged 13.53 lbs.

2. The proportion of total loss of weight was practically the same in the cream cheese as in the skim-milk cheese.

3. The loss of weight was greatest in cheese No. 104, which contained, when green, the largest amount of water of any cheese made from normal milk.

LOSS OF WATER IN RIPENING OF CHEESE.

TABLE SHOWING LOSS OF WATER IN FIVE MONTHS.

No. of Experiment.	In cheese made from 100 lbs. of milk.				
	Pounds of water in green cheese.	Pounds of water in cheese when five months old.	Pounds of water lost in five months.	Per cent. of water in green cheese lost in five months.	Pounds of water lost in five months for 100 lbs. of cheese.
101	5.40	3.64	1.76	32.60	12.43
102	4.27	3.28	0.99	23.20	9.90
103	4.40	3.23	1.17	26.60	10.00
104	5.34	3.48	1.86	34.83	14.95
105	4.67	3.71	0.96	20.56	8.14
106	4.60	3.61	0.99	21.52	8.50

Statement of Results.

1. The per cent. of water in the cheese that was lost in five months varied from 20.56 to 34.83 per cent. and averaged 26.58 per cent.

2. The cream-cheese lost more water than the skim-milk cheese, but these results are not fully comparable, because the cream-cheese was made into two small cheeses and the skim-milk cheese was made into a single cheese, and the cream-cheese, therefore, had considerably greater surface in proportion to its weight.

3. Cheese No. 104, which when green contained the largest amount of water of any of the cheeses made from normal milk, lost a larger proportion of its water than any other cheese.

4. The amount of water lost in five months for one hundred pounds of green cheese varied from 8.14 to 14.95 lbs. and averaged 10.60 lbs.

LOSS OF SOLIDS IN RIPENING OF CHEESE.

TABLE SHOWING LOSS OF SOLIDS IN FIVE MONTHS.

No. of Experiment.	In cheese made from 100 lbs. of milk.				
	Pounds of solids in cheese when green.	Pounds of solids in cheese when five months old.	Pounds of solids lost in five months.	Per cent. of solids in cheese lost in five months.	Pounds of solids lost for 100 lbs of green cheese.
101	8.76	8.54	0.22	2.50	1.57
102	5.73	5.34	0.39	6.80	3.90
103	7.30	6.87	0.43	5.90	3.68
104	7.10	6.82	0.28	4.00	2.25
105	7.13	6.69	0.44	6.17	3.73
106	7.04	6.79	0.25	3.55	2.15

Statement of Results.

1. The per cent. of solids in the cheese that was lost in five months varied from 2.50 to 6.80 per cent. and averaged 4.82 per cent.

2. The skim-milk cheese lost more than twice the amount of solids lost by the cream-cheese and a larger amount than any other cheese. The cream cheese lost a smaller amount of solids than any other cheese.

3. Of the cheeses made from normal milk cheese No. 104 which, when green, contained the largest amount of water and in ripening lost the largest amount of water, lost the smallest amount of solids except one.

4. The amount of solids lost for one hundred pounds of green cheese varied from 1.57 to 3.90 lbs. and averaged 2.88 lbs.

LOSS OF FAT AND CASEIN IN RIPENING OF CHEESE.

TABLE SHOWING LOSS OF FAT AND CASEIN IN FIVE MONTHS.

No. of Experiment.	In cheese made from 100 lbs. of milk.						
	Pounds of fat in green cheese.	Pounds of fat in cheese when five months old.	Pounds of casein in green cheese.	Pounds of casein in cheese when five months old.	Pounds of casein lost in five months.	Per cent. of casein in cheese lost in five months.	Pounds of casein lost for 100 lbs. of green cheese.
101	5.40	5.40	2.77	2.62	0.15	5.42	1.06
102	2.31	2.34	2.81	2.59	0.22	7.83	2.20
103	4.15	4.03	2.76	2.56	0.20	7.25	1.71
104	3.84	3.77	2.81	2.70	0.11	4.00	0.90
105	3.79	3.78	2.81	2.65	0.16	5.69	1.35
106	3.75	3.78	2.83	2.64	0.19	6.71	1.63

Statement of Results.

1. A comparison of the second and third columns in the table above shows that there was no loss of fat in ripening. The cream-cheese at no time showed any leakage of fat, as the temperature was kept sufficiently low to prevent such loss.

2. In every case there was a loss of casein or nitrogen compounds, varying in amount from 0.11 to 0.22 lbs. and averaging 0.17 lbs. for the cheese made from one hundred pounds of milk; or, calculating the loss of casein for one hundred pounds of cheese, the amount varied from 0.90 to 2.20 lbs. and averaged 1.48 lbs.

3. The loss of casein was greatest in the skim-milk cheese and least, with one exception, in the cream-cheese.

4. The loss of casein was a little greater in the cheese which contained the larger amount of rennet.

CHEMICAL CHANGES PRODUCED IN CASEIN BY RIPENING OF CHEESE.

TABLE SHOWING AMOUNT OF NITROGEN IN DIFFERENT FORMS IN CHEESE.

No. of Experiment.	In one hundred pounds of cheese.						
	Age of cheese when analyzed.	Pounds of nitrogen.	Pounds of nitrogen in forms insoluble in water.	Pounds of nitrogen in forms soluble in water.	Pounds of nitrogen in form of albuminoids.	Pounds of nitrogen in form of amides.	Pounds of nitrogen in form of ammonium compounds.
101	Green.....	3.09	2.99	0.10	—	—	—
101	Five months.	2.92	1.80	1.12	2.64	0.28	0.078
102	Green.....	4.43	4.25	0.18	—	—	—
102	Five months.	4.09	2.89	1.20	3.61	0.48	0.103
103	Green.....	3.73	3.57	0.16	—	—	—
103	Five months.	3.46	2.35	1.11	3.09	0.37	0.101
104	Green.....	3.62	3.36	0.26	—	—	—
104	Five months.	3.43	2.45	0.98	3.17	0.26	0.083
105	Green.....	3.76	3.63	0.13	—	—	—
105	Five months.	3.55	2.22	1.33	3.11	0.44	0.124
106	Green.....	3.84	3.72	0.12	—	—	—
106	Five months.	3.59	1.89	1.70	3.09	0.50	0.126

Statement of Results.

1. Comparing the cheese when green and when five months old, we see that the amount of nitrogen compounds soluble in water has largely increased.

2. The amount of nitrogen compounds insoluble in water had largely decreased.

4. The cheese when green contained no nitrogen in the form of amide compounds, while it contained from 0.26 to 0.50 per cent. of these compounds at five months.

4. The cheese when green contained no nitrogen in the form of ammonium compounds, while it contained 0.078 to 0.126 per cent. at five months.

In the table below, we give the percentages of nitrogen in cheese in the different forms, or the pounds of nitrogen in

different forms for one hundred pounds of nitrogen (or casein) in the cheese.

TABLE SHOWING POUNDS OF NITROGEN IN DIFFERENT FORMS FOR
ONE HUNDRED POUNDS OF NITROGEN IN CHEESE.

No. of Experiment.	Age of cheese when analyzed.	Per cent. of nitrogen in cheese soluble in water.	Per cent. of nitrogen in cheese in form of albuminoid compounds.	Per cent. of nitrogen in cheese in form of amide compounds.	Per cent. of nitrogen in cheese in form of ammonium compounds.
101	Green	3.24	—	—	—
101	Five months..	38.36	90.40	9.60	2.67
102	Green	4.06	—	—	—
102	Five months..	29.34	88.26	11.74	2.52
103	Green	4.32	—	—	—
103	Five months..	32.08	89.30	10.70	2.92
104	Green	7.19	—	—	—
104	Five months..	28.57	92.42	7.58	2.42
105	Green	3.46	—	—	—
105	Five months..	37.46	87.60	12.40	3.50
106	Green	3.12	—	—	—
106	Five months..	47.33	86.07	13.93	3.51

Statement of Results.

1. With a single exception, the cheese made from skim-milk contained the smallest proportion of soluble nitrogen compounds at five months.

2. The cheese made from milk containing added cream contained, with a single exception, the largest proportion of soluble nitrogen compounds at five months.

3. The cheese containing the largest amount of rennet contained considerably more of the soluble nitrogen compounds than did any other cheese at five months.

4. The amount of soluble nitrogen compounds varied from 28.57 to 47.33 per cent. of the total nitrogen in the cheese and averaged 35.52 per cent.

5. The per cent. of nitrogen in the form of albuminoid compounds, at five months, varied from 86.07 to 92.42 per

cent. of the total nitrogen in the cheese and averaged 88.34 per cent.

6. The per cent. of nitrogen in the form of amide compounds varied from 7.58 to 13.93 per cent. of the total nitrogen in the cheese and averaged 11.66 per cent.

7. The per cent. of nitrogen in ammonium compounds varied from 2.42 to 3.51 per cent. and averaged 2.92 per cent. of the total nitrogen in the cheese.

GENERAL SUMMARY OF RESULTS RELATING TO THE CHANGES THAT TAKE PLACE IN THE RIPENING OF CHEESE.

I. Total Loss of Weight in Ripening of Cheese.

In five months the loss of weight varied from 10.65 to 17.20 lbs. for one hundred pounds of cheese and averaged 13.53 lbs.

II. Loss of Water in Ripening of Cheese.

In five months the loss of water for one hundred pounds of cheese varied from 8.14 to 14.95 lbs. and averaged 10.60 lbs.; this was equivalent to from 20.56 to 34.83 per cent. of the water in the cheese, with an average of 26.58 per cent.

III. The Loss of Solids in Ripening of Cheese.

In five months the loss of solids for one hundred pounds of cheese varied from 1.57 to 3.90 lbs. and averaged 2.88 lbs.; this was equivalent to from 2.50 to 6.80 per cent. of the solids in the cheese, with an average of 4.82 per cent.

IV. Loss of Fat in Ripening of Cheese.

There was practically no loss of fat in five months.

V. Loss of Casein in Ripening of Cheese.

In every case there was a loss of casein (nitrogen compounds) varying in amount from 0.90 to 2.20 lbs. for one hundred pounds of cheese, and averaging 1.48 lbs.; this was equivalent to from 4 to 7.83 per cent. of the total casein in the cheese, with an average of 6.15 per cent.

VI. Changes in Form of Casein in Ripening of Cheese.

1. In every case the amount of soluble nitrogen compounds increased very much in five months. In the cheese, when green, the amount of nitrogen in soluble form varied from 0.10 to 0.26 lbs. in one hundred pounds of cheese, and averaged 0.16 lbs., which is equivalent to from 3.12 to 7.19 per cent. of the total nitrogen in the cheese, with an average of 4.23 per cent. When five months old, the amount of soluble nitrogen varied from 0.98 to 1.70 lbs. in one hundred pounds of cheese and averaged 1.24 lbs., which is equivalent to from 28.57 to 47.33 per cent. of the total nitrogen in the cheese, with an average of 35.52 per cent.

2. The cheese, when green, contained no nitrogen in the form of amide compounds, while, at five months, there were contained from 0.26 to 0.50 lbs. in one hundred pounds of cheese, with an average of 0.39 lbs., which was equivalent to from 7.58 to 13.93 per cent. of the total nitrogen in the cheese with an average of 11.66 per cent.

3. The cheese, when green, contained no nitrogen in the form of ammonium compounds, while, at five months, there were contained from 0.078 to 0.126 lbs. in one hundred pounds of cheese, with an average of 0.103 lbs., which was equivalent to from 2.42 to 3.51 per cent. of the total nitrogen in the cheese, with an average of 2.92 per cent.

4. The cheese, in the manufacture of which the largest amount of rennet was used, contained considerably more of the soluble nitrogen compounds than did any other cheese at five months.

5. The cheese made from partially skimmed milk contained the smallest proportion of soluble nitrogen compounds at five months, while the cheese made from milk containing added cream contained, with a single exception, the largest proportion of soluble nitrogen compounds.