THE RIPENING OF CHEDDAR CHEESE

by

N. H. Ingledew

and

W. J. C. Tait

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THE RIPENING OF CHEDDAR CHEESE.

INTRODUCTION.

Arising from the general trend to improve and standardize dairy products, recent years have seen a movement towards the pasteurization of milk for cheddar cheese-making. From the observations of Atkinson (1) and Stevenson (2) the pasteurization of milk for cheese-making results in an increased yield of cheese, a more uniform product, and an improved quality more suited to longer periods of storage. Sammis and Bruhn (3) showed that pasteurization (Flash at 160°F.) reduced the variations in the quality of the cheese from day to day by nearly one half and in ninety-six percent of the cases under their observations the cheese from pasteurized milk scored higher than those made from raw milk. These results are substantiated by Price (4) who pasteurized at 145°F. for thirty minutes.

Other workers claim definite disadvantages for pasteurization. In the reports of the Department of Scientific and Industrial Research of New Zealand (5) the opinion is expressed that in using the "Holder Method" of pasteurization at a temperature of 150°F. a distinct influence was evident in the flavour of the cheese; the cheese did not mature in the ordinary way and at four months had a bitter taste. Moir (6) using the Flash Method at temperatures ranging from 165°F. to 185°F.

concluded that pasteurization produced a bitter flavour in the resulting cheese and the ultimate protein decomposition products were reduced. Atkinson (1) expressed the opinion that pasteurizing milk for cheese-making results in a slower maturing cheese than that made from raw milk.

These investigations have shown that only low temperatures of pasteurization were satisfactory for cheese-making; high temperatures of pasteurization were apparently detrimental to the resulting cheese.

Considering the disadvantages of high temperature pasteurization, it has seemed advisable to endeavour to obtain some data in regard to the influence of pasteurization on the microflora of the resulting cheese; and to determine whether or not the disadvantages previously mentioned can be attributed to differences in fermentation or to other changes, physical or chemical, resulting directly from the high temperatures of pasteurization, or from a combination of both.

HISTORICAL.

Evans, Hastings and Hart (7), 1924, found that the predominating organisms at the different stages of the ripening of raw milk cheddar cheese were included in four groups, Bacterium lactis acidi, Bacterium casei, Streptococcus, and Micrococuss, and that the flora of pasteurized milk cheese, with the exception of B. casei was similar to the types of organisms in the starter used in making the cheese. They state: "The B. casei group is apparently responsible for the pungent

taste which develops late in the ripening period of both raw and pasteurized milk cheeses." Further they showed that when only B. lactis acidi was used as starter in making cheese from pasteurized milk, no cheddar flavour was obtained. However, when both B. lactis acidi and B. casei were added to pastuerized milk for cheese-making a sour flavour was produced during the early part of the ripening process. In conclusion they state: "It does not seem unreasonable to hope that starters may be obtained, which will give the characteristic flavour to cheese made from pasteurized milk."

To overcome lack of flavour in cheddar cheese made from pasteurized milk, Hastings and Sammis (8) 1920, used a special starter, which, in addition to the lactic acid bacteria characteristic of starters used in cheese-making, contained other organisms which they did not define, isolated from soil and faeces. The cheese developed flavour more rapidly than did the control cheese made from pasteurized milk with starter which did not contain these organisms isolated from soil and faeces.

Panfilov (9) 1928, in a study of the effect of pasteurized milk on the microflora of cheese, subjected batches of milk to temperatures of 70°C for twenty minutes, 65°C for thirty minutes, and 63°C for fifty minutes. At the lower temperature a greater percentage of the lactic acid organisms, especially B. casei, were to be found in the resulting cheese. Moreover, the cheese made from milk pasteurized at 63°C for

fifty minutes ripened more quickly than those made from milk pasteurized at the higher temperatures.

METHODS OF PROCEDURE.

All milk used was obtained from the herd of the University of British Columbia, (chiefly Ayrshire). The milk of the previous night and of the morning of each day of cheese-making, was thoroughly mixed and divided between two vats. A series of six lots of cheese was made from milk treated as indicated in Table I.

TABLE I

Nov. 15/30	Lot 1	Raw milk.
Nov. "	Lot 2	Pasteurized 140°F. - 30 min.
Nov. 22/30	Lot 3	Pasteurized 150°F. - 30 min.
Nov. "	Lot 4	Pasteurized 160°F. - 30 min.
Nov. 29/30	Lot 5	Pasteurized 140°F. - 30 min.
Nov. "	Lot 6	Pasteurized 150°F. - 30 min.

The pasteurizer used was a glass-lined "Pfaudler" of the holder type with a capacity of sixty gallons.

PROCESS OF MANUFACTURE.

The cheese were manufactured after the manner of th the cheddar process following in detail the usual procedure of the Dairy Department Laboratories- a process very similar to the Western Ontario method. Complete records of the process of manufacture are given in Table 11.

The starter, cheese color and rennet were the standard commercial products of the Hansen Laboratories. No attempt was made to determine the types of organisms present in these products. However, from the results of work done by students in the advanced course in Dairy Bacteriology under the supervision of Professor W. Sadler, on the types of organisms present in the starter, showed that only coccus types characteristic of cheese starter were to be found.

It is to be seem from Table 11. that the effect of the pasteurizing temperature on the cheese-making process did not become evident until the milk was heated to 160°F. When this temperature was used, however, a very soft coagulum was obtained requiring two hours to firm sufficiently for cutting. The curd on the rack was spongy, held moisture and difficult to mat.

PROCESS OF RIPENING.

During the first fourteen days of ripening the cheese were held at approximately 62°F.; subsequent ripening was carried on at approximately 49°F. The constancy in temperature of the ripening rooms in which the cheese were held,

CHEDDAR CHEESE
RECORD OF PROCESS OF MANUFACTURE

EXPERIMENT

TABLE II

	Date Made	Series Number	MILK a.m.	MILK p.m.	MILK Weight lbs.	MILK Fat %	STARTER Acidity %	STARTER Ozs. Per 100 lbs.	STARTER Amount Ozs.	STARTER Time Added		MILK AT TIME RENNET ADDED: Rennet Test secs.	Acidity %	Rate of Rennet, drams to lbs.	Amount of Rennet drams	Time	Temp. °F.	*CUT TIME	STARTED TO STIR: Time	Acidity %	SCALD: Time Started	Acidity %	Time Finished	Acidity %	Final Temp. °F.	PITCHED: Time	Acidity %	WHEY DRAWN: Hours from Setting	Time	Start Acidity %	Finish Acidity %	CUT IN CUBES AND TURNED: Time	Acidity %	TURNED AND PILED: Time	Acidity %	TURNED AND PILED: Time	Acidity %	TURNED AND PILED: Time	Acidity %
Raw	15/11/30	1	48 hrs		185	4.3	.82	1½%	40	9/25																														
Past. 140°F.	15/11/30	2	48 hrs		185	4.3	.82	1½%	40	10/55	Same		.18	1-25	7½	9/40	86°	10/25	10/30	.115	10/45	.115	11/30	.125	98°	12/20	.14	4/5	1/45	.18	.35	2/15	.47	2/45	1"	3/15	1½"	3/45	2"
Past. 150°F.	22/11/30	3	48 hrs		175	4.2	.91	1½%	42	10/10	Starter		.185	1-25	7½	11/10	86°	12/00	12/15	.115	12/15	.115	1/30	.125	98°	2.05	.15	4/10	3/20	.18	.39	3/50	.51	4/20	1"	4/50	1"	5/20	2"+
Past. 160°F.	22/11/30	4	48 hrs		180	4.2	.91	1½%	43	11/15	used	24	.165	1-25	7	10/30	86°	11/10	11/15	.105	11/30	.105	12/15	.125	98°	1/15	.145	3/40	2/10	.18	.27	2/50	.47	3/20	3/4"	3/50	1"	4/20	2"
Past. 140°F	29/11/30	5	48 hrs		235	4.2	.98	1½%	43	11/25	for	37	.165	1-25	7	11/30	86°	1/30	1/35	.13	1/50	.13	2/35	.16	99°	3/15	.2	3/50	3/20	.2	.26	4/50	.37	5/20	.52	5/50	.72	5/20	1½"
Past. 150°F.	29/11/30	6	48 hrs		232	4.2	.98	1½%	43	10/40	all	23½	.195	1-25	9	12/05	86°	12/40	12/45	.12	12/55	.125	1/40	.14	98°	2/25	.165	2/40	2/45	.18	.22	3/20	.305	3/50	3/4"	4/20	1 3/4"	4/50	2"
											cheese.	23½	.195	1-25	9	11/00	86°	11/40	11/45	.125	12/00	.125	12/45	.14	98°	1/25	.165	3/15	1/55	.175	.23	2/30	.38	3/00	.425	3/30	1"	4/00	1½"
Average																																							

*Cut three times, allowing 10-minute intervals.

Continued on Table

CHEDDAR CHEESE
RECORD OF PROCESS OF MANUFACTURE

EXPERIMENT

TABLE H

Series Number	MILLED						PUT TO PRESS			*TURNED		TURNED INTO FINE CLOTHS		Pressure Off	Bandaged	~~Architectural Glasses~~ Number of Cheese	GREEN CHEESE		RIPE CHEESE		Shrinkage %	REMARKS
	Hours from Setting	Time	Iron Test	Acidity %	Curd lbs.	Salt Ozs.	Time	Acidity %	Pressure lbs.	Time	Pressure lbs.	Time	Pressure lbs.				Date	Weight lbs. ozs.	Date	Weight lbs. ozs.		
1	6.35	4/15	2"		22	7	4/45	.91	500	5/15	1500			15 hrs.		2						
2	6.30	5/40	2 1/4"		21	7	6/15	.98	500	6.45	1500			15 hrs.		2						
3	6/05	4/35	2"		22	7	5/20	.97	500	5/50	1500			15 hrs.		2						
4	6/45	6/15	2"		23½	8	6/40	.85	500	7/10	1500			15 hrs.		2						
5	5/5	5/10	2"		32	11	6/00	.95	500	6/30	1500			15 hrs.		3						Soft coagulum
6	5/45	4/45	2"		30½	10	5/25	.9	500	5/55	1500			15 hrs.		3						
Continued from Table																						
Average																						

may be seen when the figures giving the maximum and minimum variations are considered.

Table 111.

Temperature of Ripening Rooms.

	HIGH ROOM			LOW ROOM		
Monthly	Mean Temp.	Monthly °F.	Max. °F.	Min. °F.	Mean Temp.	Monthly °F.	Max. °F.	Min. °F.
Nov.'30		61.5	64	58		50.8	59	43
Dec.'30		61.1	63	58		48.8	54	43
Jan.'31		60.4	63	58		48.6	59	44
Feb.'31		63.0	66	60		47.1	51	43
Mar.'31		63.4	66	60		48.6	59	42

BACTERIOLOGICAL EXAMINATION.

The cheese were sampled for bacteriological examination at the age of thirty days and again at seventy-three days.

Sampling: In sampling the cheese the surface was seared with a,hot iron and a bore was taken with a sterile trier and transferred to a sterile petri dish.

Dilutions: Representative portions of the bore amounting to one gram, were taken and transferred to a sterile grinder containing 9c.c. of water and thoroughly emulsified. From this grinder the required dilutions were made for the plate method of examination. The dilutions found most satisfactory in practice, using plates five and one half inches in diameter, were 1:100,000 for the first examination and 1:10,000 for

the second.

Media and Incubation Temperatures: The medium used in plating throughout the experiment was Peptonized Milk Gelatin, at a P.H. 6.0. All dilutions were plated in duplicate and incubated at room temperature (21°-23°c) for ten days.

Depending on the number of colonies on a plate, either a complete plate or a representative portion of a plate was picked. The colonies were transferred directly into litmus milk containing 0.15% yeast extract,* and were incubated at 30°C. All cultures, as soon as clotted, were removed from the incubator and held at room temperature. Slides were made of all cultures at twenty-four hours and were stained by Grams' method to determine the Morphological characteristics of the organisms. These cultures were also inoculated into 10c.c. quantities of milk and yeast-milk and incubated with controls, for fourteen days, coccus forms at 23°C, rod forms at 30°C. When incubation was completed, the cultures were titrated with N/4 sodium hydroxide using phenolphthalein as indicator; the titration of the controls deducted and the results worked out and recorded as grams lactic acid per mille. It can be seen, that in the manner of incubating, titrating, and recording of results we have followed procedure employed by Orla-Jensen.

* Standard Products of the Digestive Ferments Co. Detroit, U. S. A.

SCORING OF CHEESE.

The cheese at the age of three months were scored by a judge,* who has several times taken part in Dominion competitions. These scores are submitted in Table IV.

TABLE IV.

SCORE OF CHEDDAR CHEESE. Feb. 23, 1931.

No. of cheese		1	2	4	5	6
Milk past. °F.		raw	140°F.	160°F.	140°F.	150°F.
Flavour.	45	43.5	43.25	43.25	44.25	43.0
Texture.	25	24.0	23.75	22.75	24.5	24.25
Closeness.	15.0	15.0	14.75	13.0	14.75	14.5
Color.	10	9.75	9.5	9.5	9.8	9.7
Finish.	5	5	5	5	5	5
Total.	100.0	97.25	96.25	93.0	98.4	96.65
Remarks.		Pasty.		Crumbly.		Bitter.

EXPRESSION OF RESULTS.

The titrations of the cultures in 10c.c. quantities of milk and yeast-milk respectively, are given in grams, per mille in Charts 1.--X. There is also to be seen a brief resume of the procedure followed throughout the determinations.

Tables V. and VI. give a summary of the results of the bacterial examination of the cheese at thirty and seventy-three days respectively, and further give the number and percentage of coccus forms whose vital activity in

* A.P. Slade of A.P. Slade and Co., Vancouver, B.C. Canada.

TABLE 5

SUMMARY OF THE PREVAILING TYPES OF ORGANISMS AT 30 DAYS

Cheese No.	Date of Make	Date of Examination	Date of Past. °F 30 min.	Total Count per Gram	Colonies Picked	Morphology* %					Organisms Responding to the Addition of Y.E.		Organisms Not Responding to the Addition of Y.E.	
						A	B	C	D	E	No.	%	No.	%
1.	15/11/30	15/12/30	Raw	31,200,000	125	61.8	37.4	0.8	-	-	4	3.6	105	96.4
2.	15/11/30	15/12/30	140°F	32,400,000	127	72.7	22.3	--	-	-	4	3.1	122	96.9
4.	22/11/30	22/12/30	160°F	16,800,000	85	50.5	44.8	4.7	-	-	24	29.6	57	70.4
5.	29/11/30	29/12/30	140°F	10,200,000	96	21.1	72.9	6.0	-	-	29	38.1	47	61.9
6.	29/11/30	29/12/30	150°F	21,300,000	96	25.0	72.8	2.2	-	-	19	21.1	71	78.9

* A = Coccus forms in pairs.
B = Coccus forms in pairs and short chains.
C = Coccus forms in long chains.
D = Short rod forms.
E = Long rod forms.

TABLE 6

SUMMARY OF THE PREVAILING TYPES OF ORGANISMS AT 73 DAYS

Cheese No.	Date of Make	Date of Examination	Date of Past. °F 30 min.	Total Count per Gram	Colonies Picked	Morphology * %					Organisms Responding to the Addition of Y.E.		Organisms Not Responding to the Addition of Y.E.	
						A	B	C	D	E	No.	%	No.	%
1.	15/11/30	27/1/31	Raw	1,180,000	118	10.0	10.9	0.9	53.6	23.6	6	25.0	18	75.0
2.	15/11/30	27/1/31	140°F.	800,000	80	37.8	54.0	8.2	--	--	59	79.7	15	20.3
4.	22/11/30	3/2/31	160°F.	600,000	56	36.5	63.5	--	--	--	41	100.0	--	--
5.	29/11/30	11/2/31	140°F.	2,040,000	127	5.5	66.1	26.7	1.7		24	19.2	101	80.8
6.	29/11/30	11/2/31	150°F.	2,570,000	161	21.4	77.6	0.9	--	--	97	86.6	15	13.4

* A = Coccus forms in pairs.
B = Coccus forms in pairs and short chains.
C = Coccus forms in long chains.
D = Short rod forms.
E = Long rod forms.

⊖ Rod forms not included.

milk was increased by the addition of yeast extract.

INTERPRETATION OF TABLES.

From an examination of Table 1V. it is to be seen that: (1) Cheese 5, pasteurized to 140°F. for thirty minutes, scored highest.

(2) Pasteurizing temperatures had no direct correlation with the flavour scores of the cheese, due possibly to the fact that it was impossible to make all the cheese on the same day from the same milk.

(3) Cheese 4, pasteurized to 160°F. for thirty minutes, had a faulty texture, this faulty texture may very probably be attributed to the temperature of pasteurization since, as is to be seen in the making of the cheese, Table 11., the action of the rennet was appreciably delayed, thus affecting the entire process of manufacture. This is in accord with the investigations of numerous other workers, who have shown that high temperatures of pasteurization affect the physical and chemical nature of the milk to the detriment of the quality of the resulting cheese.

Table V. shows that at thirty days, the organisms isolated from all the cheese were entirely coccus types chiefly in pairs; comparatively high counts were obtained. However, cheese 5 was an exception to this and had, at this age, a lower count per gram, consisting chiefly of coccus forms in pairs and short chains. Moreover, when the titrations of the organisms isolated from this cheese are considered, it

is to be seen that a larger proportion of organisms, showing the yeast incidence were found. When the work of Sadler and Eagles (10) on the ripening of the Kingston Cheese is considered, the possibility suggests itself that the finding of a large proportion of organisms, at this age, showing the incidence of yeast extract might, in a measure, account for the high score.

It is to be seen from Table VI. that:

(1) The total count per gram of all the cheese, was much less at seventy-three days than it was at thirty days.

(2) At the second examination of the raw milk cheese the prevailing type found were rod forms; in all the other cheese, the prevailing type found were coccus forms in pairs and short chains.

(3) Cheese 5, the highest scoring cheese, is distinct again, both in the number and types of bacteria found. Between the time time of the first and second examinations the count per gram had decreased relatively less than that of any of the other cheese. Distinct from the picture presented in the case of cheeses No's 1,2,4,6, it is to be seen that among the organisms isolated from cheese 5 there were found an appreciable number which morphologically were large celled organisms in long chains, resembling those of commercial starter. Moreover, the number of organisms showing the incidence of yeast extract has relatively decreased rather than increased as in the other cheese. We also find indications of the appearance of rod organisms in this cheese.

This data would seem to suggest, that there may be three possible factors to one of which may be attributed the superiority of cheese 5.

(1) The difference in the types of coccus forms found at the two examinations.

(2) Rod organisms may have been present in appreciable numbers, sufficient to have influenced the ripening of the cheese, at the time the cheese were judged.

(3) Or a combination of both these factors.

But in order to determine to which of these factors the superiority of cheese 5 is to be attributed, it would be necessary to examine the cheese more frequently over a longer period of time, to classify the organisms isolated, to determine at the various examinations the amount of protein breakdown in the cheese and to correlate this with the casein splitting powers of the organisms isolated.

CONCLUSIONS.

The pasteurizing temperature of 160°F. for thirty minutes had a decided detrimental effect on the rennet clot of the milk and on the texture of the resulting cheese.

Rod forms were the prevailing type at seventy-three days in cheddar cheese made from raw milk.

Rod forms were not found to be present at seventy-three days in cheddar cheese made from milk pasteurized to 150°F. and 160°F. for thirty minutes.

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Cheese 1 (Raw Milk)
Made 15/11/30
Examined 15/12/30
Age 30 days.
Ripened 14 days at 65°F. and remainder at 50°F.
Media P.M.G. at PH6.0
Incubated 21-23°C. for ten days.
Counts: dil. 1/100,000
316-312
½ plate picked into litmus milk. Incubated at 30°C.
Transferred to 10 cc tubes of milk and yeast milk for titration.
Incubated at 23°C. for 14 days.

Culture No.	Milk	Y. Milk
89	0.2	0.5
56	0.2	0.7
34	0.2	7.0
20	0.2	7.2
65	0.2	7.2
81	0.7	3.4
80	1.1	1.8
95	1.4	2.9
96	2.5	4.5
2	5.2	7.0
66	6.3	6.8
71	6.3	6.8
72	6.3	6.8
108	6.3	7.0
73	6.3	7.4
106	6.5	0.7
43	6.5	6.8
77	6.5	6.8
116	6.5	6.8
40	6.5	7.0
57	6.5	7.0
97	6.5	7.0
22	6.5	7.7
37	6.8	6.1
30	6.8	6.5
4	6.8	6.8

Culture No.	Milk	Y. Milk
11	6.8	6.8
12	6.8	6.8
17	6.8	6.8
26	6.8	6.8
27	6.8	6.8
42	6.8	6.8
44	6.8	6.8
45	6.8	6.8
49	6.8	6.8
53	6.8	6.8
54	6.8	6.8
58	6.8	6.8
69	6.8	6.8
76	6.8	6.8
78	6.8	6.8
86	6.8	6.8
91	6.8	6.8
93	6.8	6.8
99	6.8	6.8
101	6.8	6.8
105	6.8	6.8
110	6.8	6.8
119	6.8	6.8
124	6.8	6.8
21	6.8	7.0
35	6.8	7.0

Culture No.	Milk	Y. Milk
38	6.8	7.0
50	6.8	7.0
59	6.8	7.0
60	6.8	7.0
67	6.8	7.0
70	6.8	7.0
87	6.8	7.0
94	6.8	7.0
103	6.8	7.0
115	6.8	7.0
121	6.8	7.0
41	6.8	7.2
62	6.8	7.2
64	6.8	7.2
68	6.8	7.4
74	6.8	7.4
75	6.8	7.4
5	7.0	6.8
6	7.0	6.8
7	7.0	6.8
9	7.0	6.8
24	7.0	6.8
25	7.0	6.8
31	7.0	6.8
36	7.0	6.8
46	7.0	6.8

Culture No.	Milk	Y. Milk
51	7.0	6.8
55	7.0	6.8
63	7.0	6.8
82	7.0	6.8
83	7.0	6.8
84	7.0	6.8
85	7.0	6.8
88	7.0	6.8
92	7.0	6.8
107	7.0	6.8
111	7.0	6.8
113	7.0	6.8
114	7.0	6.8
117	7.0	6.8
118	7.0	6.8
122	7.0	6.8
16	7.0	7.0
102	7.0	7.0
104	7.0	7.0
112	7.0	7.0
13	7.0	7.2
1	7.2	6.3
33	7.2	6.5
15	7.2	6.8
18	7.2	6.8
19	7.2	6.8

Culture No.	Milk	Y. Milk
32	7.2	7.2
52	7.2	7.0
3	7.2	7.2
100	7.2	7.4
39	7.4	7.0
123	7.4	7.0
109	7.4	7.4

Culture No.	Milk	Y. Milk

Cheese 1 (Raw milk)
Made 15/11/30.
Examined 27/1/31.
Age 73 days.
Ripened 14 days at 65°F. and remainder at 50°F.
Media P.M.G. at PH 6.0
Incubated 21-23°C for 10 days.
Counts: dil. 1/10,000
118-118
One complete plate picked into yeast litmust milk. Incubated 30°C. Transferred to 10 cc tubes of milk and yeast milk for titration. Coccus forms incubated at 23°C. and root forms at 30°C for 14 days.

Culture No.	Milk	Y. Milk
7	0.0	4.7
115	0.2	4.3
59	2.3	7.4
21	2.3	8.6
8	2.5	9.2
31	2.5	9.2
64	2.7	7.2
26	2.7	7.4
38	2.7	7.4
62	2.7	7.7
71	2.7	9.5
78	2.7	9.5
34	2.7	9.7
68	2.7	9.7
42	2.9	7.4
107	2.9	7.7
69	2.9	7.9
27	2.9	8.3
98	2.9	8.3
106	2.9	8.3
85	2.9	9.0
56	2.9	9.5
19	2.9	9.7
86	3.2	6.5
53	3.2	7.2
104	3.2	7.2

Culture No.	Milk	Y. Milk
18	3.4	7.2
84	3.4	7.2
2	3.4	7.4
3	3.4	7.4
13	3.4	8.1
66	3.4	8.3
4	3.4	9.0
67	3.4	9.0
65	3.6	0.8
81	3.6	7.2
12	3.6	7.4
50	3.6	7.7
32	3.6	8.8
17	3.8	6.8
105	3.8	6.8
89	3.8	7.0
28	3.8	7.2
29	3.8	7.2
72	3.8	7.2
75	3.8	7.2
77	3.8	7.2
88	3.8	7.2
93	3.8	7.2
101	3.8	7.2
109	3.8	7.2
9	3.8	7.4

Culture No.	Milk	Y. Milk
11	3.8	7.4
16	3.8	7.4
24	3.8	7.4
25	3.8	7.4
33	3.8	7.4
43	3.8	7.4
41	3.8	7.7
47	3.8	7.7
54	3.8	7.7
58	3.8	7.7
60	3.8	7.7
61	3.8	7.7
6	3.8	7.9
46	3.8	7.9
49	3.8	7.9
114	3.8	7.9
83	3.8	8.1
111	3.8	8.3
40	3.8	8.6
1	4.1	7.2
112	4.1	7.2
45	4.1	7.4
52	4.1	7.4
79	4.1	7.4
39	4.1	7.7
63	4.1	7.7

Culture No.	Milk	Y. Milk
91	4.1	7.7
35	4.1	7.9
37	4.1	7.9
80	4.3	7.2
90	4.3	7.3
96	4.3	7.2
102	4.3	7.2
5	4.3	7.4
117	4.3	7.7
10	4.5	7.2
44	4.5	7.4
108	4.7	7.2
48	4.7	7.4
14	5.6	6.5
51	5.6	6.5
87	5.6	6.5
99	5.6	6.5
70	5.9	7.4
94	6.1	6.5
30	6.3	6.5
36	6.3	6.5
103	6.3	6.5
15	6.3	6.8
92	6.3	6.8
97	6.3	6.8
110	7.2	7.2

Culture No.	Milk	Y. Milk
73	7.2	7.7
55	7.2	8.3
74	7.4	7.2
76	7.7	8.3
95	7.7	8.3
20	7.9	7.9

Culture No.	Milk	Y. Milk

Cheese 2 (Past.140 °C.)
Made 15/11/30.
Examined 15/12/30.
Age 30 days.
Ripened 14 days at 65 °F. and remainder at 50 °F.
Media P.M.G. at PH 6.0
Incubated at 21-23°C for 10 days.

Counts: dil. 1/100,000
324-464

½ plate picked into litmus milk. Incubated at 30°C. Transferred to 10 cc tubes of milk and yeast milk for titration.
Incubated at 23°C for 14 days.

Culture No.	Milk	Y. Milk
1	0.2	0.2
46	0.2	0.2
75	0.2	0.2
78	0.2	0.2
100	0.2	0.2
122	0.2	0.5
20	0.2	2.3
10	0.2	7.0
9	0.2	7.2
83	1.8	5.0
47	6.3	6.8
59	6.3	6.8
39	6.3	7.2
80	6.5	6.5
50	6.5	7.0
60	6.5	7.0
55	6.5	7.0
62	6.5	7.2
99	6.5	7.2
17	6.8	6.6
118	6.8	6.5
3	6.8	6.8
6	6.8	6.8
16	6.8	6.8
26	6.8	6.8
36	6.8	6.8

Culture No.	Milk	Y. Milk
67	6.8	6.8
108	6.8	6.8
109	6.8	6.8
111	6.8	6.8
115	6.8	6.8
2	6.8	7.0
44	6.8	7.0
73	6.8	7.0
42	6.8	7.2
74	6.8	7.4
89	6.8	7.4
7	7.0	0.2
5	7.0	6.5
12	7.0	6.6
24	7.0	6.6
58	7.0	6.6
63	7.0	6.6
76	7.0	6.6
88	7.0	6.6
95	7.0	6.6
106	7.0	6.6
113	7.0	6.6
114	7.0	6.6
116	7.0	6.6
117	7.0	6.6
120	7.0	6.6

Culture No.	Milk	Y. Milk
121	7.0	6.6
123	7.0	6.6
124	7.0	6.6
125	7.0	6.6
126	7.0	6.6
127	7.0	6.6
11	7.0	6.8
16	7.0	6.8
18	7.0	6.8
26	7.0	6.8
28	7.0	6.8
31	7.0	6.8
33	7.0	6.8
40	7.0	6.8
43	7.0	6.8
66	7.0	6.8
66	7.0	6.8
69	7.0	6.8
70	7.0	6.8
77	7.0	6.8
87	7.0	6.8
94	7.0	6.8
102	7.0	6.8
110	7.0	6.8
112	7.0	6.8
4	7.0	7.0

Culture No.	Milk	Y. Milk
13	7.0	7.0
19	7.0	7.0
21	7.0	7.0
34	7.0	7.0
48	7.0	7.0
77	7.0	7.0
96	7.0	7.0
101	7.0	7.0
8	7.0	7.2
65	7.0	7.2
68	7.0	7.2
82	7.0	7.2
23	7.2	6.6
35	7.2	6.6
54	7.2	6.6
61	7.2	6.6
84	7.2	6.6
27	7.2	6.8
29	7.2	6.8
32	7.2	6.8
45	7.2	6.8
49	7.2	6.8
52	7.2	6.8
53	7.2	6.8
67	7.2	6.8
72	7.2	6.8

Culture No.	Milk	Y. Milk
90	7.2	6.8
98	7.2	6.8
107	7.2	6.8
41	7.2	7.0
51	7.2	7.0
85	7.2	7.0
86	7.2	7.0
103	7.2	7.0
105	7.2	7.0
14	7.2	7.2
64	7.2	7.2
93	7.2	7.2
22	7.2	7.4
81	7.4	6.5
104	7.4	6.5
119	7.4	6.5
30	7.4	6.8
37	7.4	6.8
91	7.4	6.8
79	7.4	7.0
92	7.4	7.0
97	7.4	7.2
38	7.4	7.2

Culture No.	Milk	Y. Milk

Cheese-2 (Past.140°F.)
Made 15/11/30.
Examined 27/1/31.
Age 73 days.
Ripened 14 days at 65°F. and remainder at 50°F.
Media P.M.G. at PH 6.0
Incubated 21-25°C for 10 days.
Counts: dil. 1/10,000 80- 84

One complete plate picked into yeast litmus milk. Incubated at 30°C. Transferred into 10 cc. tubes of milk and yeast milk for titration. Incubated at 23°C. for 14 days.

Culture No.	Milk	Y. Milk	Culture No.	Milk	Y. Milk	Culture No.	Milk	Y. Milk
45	0.0	5.2	46	0.0	6.1	64	0.2	6.3
51	0.0	5.2	53	0.0	6.1	59	0.2	6.5
54	0.0	5.2	56	0.0	6.1	25	0.2	6.8
68	0.0	5.2	57	0.0	6.1	77	0.5	5.2
4	0.0	5.4	67	0.0	6.1	10	0.5	5.4
13	0.0	5.4	72	0.0	6.1	39	0.5	5.9
55	0.0	5.4	47	0.0	6.5	20	0.5	6.1
69	0.0	5.4	24	0.2	4.7	29	0.5	6.1
70	0.0	5.4	44	0.2	5.2	31	0.7	6.3
75	0.0	5.4	61	0.2	5.2	2	1.4	1.6
78	0.0	5.4	79	0.2	5.4	27	6.1	6.5
6	0.0	5.6	80	0.2	5.4	28	6.1	6.5
7	0.0	5.6	15	0.2	5.6	36	6.1	6.8
50	0.0	5.6	48	0.2	5.6	41	6.1	6.8
65	0.0	5.6	60	0.2	5.6	74	6.3	6.1
66	0.0	5.6	11	0.2	5.9	23	6.3	6.5
3	0.0	5.9	14	0.2	5.9	26	6.3	6.5
22	0.0	5.9	17	0.2	5.9	35	6.3	6.8
52	0.0	5.9	18	0.2	5.9	42	6.3	6.8
62	0.0	5.9	71	0.2	5.9	63	6.3	6.8
5	0.0	6.1	8	0.2	6.1	75	6.5	6.1
16	0.0	6.1	21	0.2	6.1	34	6.5	7.0
19	0.0	6.1	33	0.2	6.1	30	6.8	6.8
37	0.0	6.1	49	0.2	6.1	43	6.8	6.8
38	0.0	6.1	32	0.2	6.3			

Cheese 4 (Past. 160°C.)
Made 22/11/30.
Examined 22/12/30.
Age 30 days.
Ripened 14 days at 65°F. and remainder at 50°F.
Media P.M.G. at PH 6.0.
Incubated at 21-23°C for 10 days.
Counts: dil. 1/100,000 168-168
½ plate picked into yeast litmus milk. Incubated at 30°C. Transferred to 10 cc tubes of milk and yeast milk for titration. Incubated at 23°C for 14 days.

Culture No.	Milk	Y. Milk
35	0.0	3.2
37	0.0	3.2
46	0.0	5.4
31	0.0	6.1
21	0.0	6.3
57	0.0	6.5
81	0.0	6.8
84	0.0	7.4
77	0.0	7.7
80	0.2	0.5
19	0.2	6.1
54	0.2	6.1
82	0.2	6.3
13	0.2	6.5
59	0.2	6.8
65	0.2	6.8
83	0.2	6.8
10	0.5	1.4
12	0.5	3.8
7	0.5	6.1
8	0.5	6.3
20	0.5	6.3
9	0.5	6.5
3	0.5	6.8
11	0.5	7.0
85	5.6	6.9

Culture No.	Milk	Y. Milk
4	6.3	7.2
68	6.3	7.2
53	6.5	6.8
36	6.5	7.0
27	6.8	6.8
34	6.8	6.8
69	6.8	6.8
71	6.8	6.8
26	6.8	7.0
41	6.8	7.0
70	6.8	7.0
73	6.8	7.0
18	6.8	7.2
29	6.8	7.2
58	6.8	7.2
49	6.8	7.4
56	6.8	7.4
40	6.8	7.7
61	7.0	6.8
62	7.0	6.8
64	7.0	6.8
15	7.0	7.0
24	7.0	7.0
44	7.0	7.0
50	7.0	7.0
52	7.0	7.0

Culture No.	Milk	Y. Milk
55	7.0	7.0
66	7.0	7.0
48	7.0	7.2
63	7.0	7.2
45	7.0	7.7
25	7.0	8.3
47	7.0	8.6
17	7.2	6.8
28	7.2	6.8
43	7.2	6.8
67	7.2	6.8
72	7.2	6.8
5	7.2	7.7
30	7.2	7.7
22	7.2	7.9
14	7.2	9.2
38	7.4	7.0
32	7.4	7.4
1	7.4	7.7
2	7.4	7.9
78	7.4	8.3
51	7.4	8.8
16	7.7	7.7
39	7.7	7.7
23	7.7	9.5
75	7.9	7.7

Culture No.	Milk	Y. Milk
42	7.9	7.9
60	7.9	7.9
74	7.9	10.6
33	8.1	7.7

Culture No.	Milk	Y. Milk

Culture No.	Milk	Y. Milk

Cheese 4 (Past. 160°F.)
Made 22/11/30.
Examined 3/2/31.
Age 73 days.
Ripened 14 days at 65°F. and remainder at 50°F.
Media P.M.G. at PH 6.0
Incubated at 21-23°C for 10 days.
Counts: dil. 1/10,000 60-61
One complete plate picked into yeast litmus milk. Incubated at 30°C.
Transferred to 10 cc tubes of milk and yeast milk for titration.
Incubated 21-23°C for 14 days.

Culture No.	Milk	Y. Milk	Culture No.	Milk	Y. Milk	Culture No.	Milk	Y. Milk
38	0.0	2.5	43	0.5	6.3			
25	0.0	6.8	30	0.5	6.5			
29	0.0	6.8	6	0.5	6.8			
37	0.0	7.0	19	0.5	7.2			
40	0.0	7.2	11	0.5	7.4			
41	0.0	7.2	12	0.5	7.4			
27	0.0	7.7	33	0.5	7.4			
32	0.0	7.9	21	0.5	7.7			
36	0.0	7.9	54	0.5	7.7			
42	0.0	7.9	8	0.5	7.9			
16	0.0	8.1	47	0.5	7.9			
28	0.0	8.3	53	0.5	8.1			
17	0.2	4.5	1	0.5	8.8			
46	0.2	6.1	22	0.7	8.1			
9	0.2	6.8	24	0.9	7.4			
39	0.2	6.8						
50	0.2	6.8						
2	0.2	7.2						
10	0.2	7.2						
14	0.2	7.4						
23	0.2	7.4						
52	0.2	7.4						
7	0.2	7.7						
35	0.2	7.9						
34	0.2	8.6						
51	0.5	5.9						

Cheese 5 (Past. 140°F)
Made 29/11/30.
Examined 29/12/30.
Age 30 days.
Ripened 14 days at 65°F. and remainder at 50°F.
Medium P.M.G. at PH 6.0
Incubated 21-25°C for 10 days
Counts: dil. 1/100,000
102=117
One complete plate picked into yeast litmus milk. Incubated 30°C. Transferred to 10 cc tubes of milk and yeast milk for titration. Incubated at 23°C for 14 days.

Culture No.	Milk	Y. Milk	Culture No.	Milk	Y. Milk	Culture No.	Milk	Y. Milk
19	0.0	0.2	78	0.5	7.2	70	6.8	7.4
18	0.0	6.5	26	0.5	7.7	89	6.8	7.4
41	0.0	6.5	27	0.5	7.7	1	6.8	7.7
14	0.0	6.8	66	0.5	7.9	47	6.8	7.7
28	0.0	7.0	61	1.1	7.7	63	7.0	6.5
29	0.0	7.0	38	6.5	6.5	76	7.0	6.5
17	0.0	7.2	93	6.5	6.5	58	7.0	6.8
34	0.0	7.2	4	6.5	6.8	67	7.0	6.8
43	0.0	7.2	32	6.5	7.0	62	7.0	7.0
6	0.0	7.7	8	6.5	8.8	83	7.0	7.0
11	0.0	7.7	31	6.8	6.8	90	7.0	7.0
39	0.0	7.7	36	6.8	6.8	91	7.0	7.0
42	0.0	7.7	57	6.8	6.8	85	7.2	6.8
37	0.0	8.1	64	6.8	6.8	60	7.2	7.0
15	0.0	8.3	73	6.8	6.8	72	7.2	7.2
40	0.0	8.3	77	6.8	6.8	84	7.2	7.2
2	0.0	8.6	13	6.8	7.0	96	7.2	8.1
7	0.0	8.6	59	6.8	7.0	94	7.4	7.2
12	0.2	0.5	79	6.8	7.0	68	7.4	7.4
50	0.2	7.2	88	6.8	7.0	30	7.4	8.3
48	0.2	8.1	92	6.8	7.0	9	7.7	7.2
69	0.2	8.6	49	6.8	7.2	95	7.7	7.7
51	0.5	1.8	71	6.8	7.2	75	7.9	7.7
24	0.5	4.7	80	6.8	7.2	35	8.1	8.1
87	0.5	5.2	81	6.8	7.2			
46	0.5	6.3	82	6.8	7.2			

Cheese 5 (Past. 140°F)
Made 29/11/30.
Examined 11/2/31.
Age 73 days.
Ripened 14 days at 65°F remainder at 50°F.
Medium L.M.C. at PH 6.0
Incubated 21-25°C for 10 days.
Counts: dil.1/10,000 204-209
2 plate picked into yeast litmus milk and incubated at 30°C.
Transferred to 10 cc tubes of milk and yeast milk for titration.
Incubated 21-25°C for 14 days.

Culture No.	Milk	Y. Milk
98	0.0	3.8
66	0.0	4.1
2	0.0	4.3
29	6.5	4.3
71	0.0	6.8
42	0.0	4.5
123	0.0	4.7
35	0.0	5.0
129	0.0	5.2
49	0.0	5.9
124	0.2	4.1
53	0.2	4.6
80	0.2	4.7
103	0.2	4.7
45	0.2	6.2
61	0.2	5.4
72	0.2	5.9
60	0.2	6.3
52	0.2	6.5
51	0.2	6.8
43	0.5	6.1
54	0.5	6.3
63	0.7	1.8
115	0.9	5.2
28	6.3	6.8
24	6.5	6.5

Culture No.	Milk	Y. Milk
84	6.3	6.5
16	6.3	6.8
20	6.3	6.8
85	6.3	6.8
88	6.3	6.8
93	6.3	6.8
102	6.3	6.8
104	6.3	6.8
112	6.3	6.8
126	6.3	6.8
12	6.3	7.0
119	6.3	7.0
57	6.5	5.6
7	6.5	6.5
16	6.5	6.6
48	6.5	6.5
79	6.5	6.5
6	6.5	6.8
11	6.5	6.8
17	6.5	6.8
18	6.5	6.8
22	6.5	6.8
23	6.5	6.8
26	6.5	6.8
36	6.5	6.8
38	6.5	6.8

Culture No.	Milk	Y. Milk
47	6.6	6.8
65	6.5	6.8
67	6.5	6.8
69	6.5	6.8
71	6.5	6.8
82	6.5	6.8
90	6.5	6.8
94	6.5	6.8
100	6.5	6.8
109	6.5	6.8
113	6.5	6.8
116	6.5	6.8
117	6.5	6.8
118	6.5	6.8
120	6.5	6.8
128	6.5	6.8
130	6.5	6.8
132	6.5	6.8
134	6.5	6.8
1	6.5	7.0
25	6.5	7.0
27	6.5	7.0
33	6.5	7.0
37	6.5	7.0
70	6.5	7.0
73	6.5	7.0

Culture No.	Milk	Y. Milk
87	6.6	7.0
91	6.5	7.0
107	6.5	7.0
114	6.5	7.0
127	6.5	7.0
92	6.5	7.4
125	6.5	7.4
3	6.8	6.8
10	6.8	6.8
64	6.8	6.8
68	6.8	6.8
14	6.8	7.0
19	6.8	7.0
21	6.8	7.0
46	6.8	7.0
50	6.8	7.0
59	6.8	7.0
89	6.8	7.0
95	6.8	7.0
96	6.8	7.0
105	6.8	7.0
106	6.8	7.0
131	6.8	7.0
133	6.8	7.0
111	7.0	7.0
13	7.0	7.0

Culture No.	Milk	Y. Milk
41	7.0	6.8
86	7.0	6.8
101	7.0	6.8
108	7.0	6.8
124	7.0	6.8
40	7.0	7.0
56	7.0	7.0
58	7.0	7.0
99	7.0	7.0
110	7.0	7.0
83	7.0	7.2
9	7.0	7.4
76	7.2	7.0
135	7.2	7.0
136	7.2	7.0
32	7.2	7.4
34	7.4	6.8
77	7.4	7.4
81	7.4	7.4
8	7.9	7.0
74	7.9	7.9
76	8.1	8.8
44	8.3	8.3

Culture No.	Milk	Y. Milk

Cheese 6 (Past. 150°F.)
Made 29/11/30.
Examined 29/12/30.
Age 30 days.
Ripened 14 days at 65°F. and remainder at 50°F.
Medium L.M.G. at PH 6.0
Incubated at 21-23°C for 10 days.
Counts: Bil. 1/100,000
213-215
½ plate picked into yeast litmus milk. Incubated 30°C. Cultures inoculated into 10 cc tubes of milk and yeast milk for titration. Incubated 25°C for 14 days

Culture No.	Milk	Y. Milk
16	0.0	0.2
93	0.0	5.6
83	0.0	6.3
40	0.0	6.5
19	0.0	6.8
9	0.0	7.0
22	0.0	7.7
59	0.0	7.7
23	0.0	7.9
51	0.2	0.2
91	0.2	0.2
18	0.2	2.0
85	0.2	6.8
17	0.2	7.2
62	0.2	7.4
43	0.2	7.7
15	0.2	8.1
81	0.5	6.5
86	0.5	7.2
79	0.5	7.4
95	0.7	5.9
44	0.7	7.2
13	6.5	6.5
31	6.5	6.5
38	6.6	6.5
71	6.5	6.6
76	6.5	6.5
80	6.5	6.5
84	6.5	6.5
4	6.5	6.8
5	6.5	6.8
10	6.5	6.8
14	6.5	6.8
41	6.5	6.8
50	6.5	6.8
60	6.5	7.0
35	6.5	7.2
63	6.5	7.7
1	6.8	6.5
32	6.8	6.5
37	6.8	6.5
74	6.8	6.5
78	6.8	6.5
12	6.8	6.8
21	6.8	6.8
26	6.8	6.8
27	6.8	6.8
46	6.8	6.8
48	6.8	6.8
70	6.8	6.8
88	6.8	6.8
24	6.8	7.0
42	6.8	7.0
45	6.8	7.0
57	6.8	7.0
69	6.8	7.0
3	6.8	7.2
8	6.8	7.2
20	6.8	7.2
28	6.8	7.2
36	6.8	7.2
90	6.8	7.2
7	6.8	7.4
39	6.8	7.4
53	6.8	7.4
11	7.0	6.5
64	7.0	6.8
72	7.0	6.8
61	7.0	7.0
33	7.0	7.2
77	7.0	7.2
82	7.0	7.2
49	7.0	7.4
47	7.0	7.7
2	7.0	8.6
55	7.2	6.8
68	7.2	7.0
73	7.2	7.4
54	7.2	7.7
56	7.4	5.9
89	7.4	7.0
66	7.4	7.4
52	7.4	7.7
25	7.4	8.8
75	7.7	6.8
96	7.7	7.4
67	7.7	7.9
92	7.7	7.9
94	8.1	7.9
58	8.8	7.0

Culture No.	Milk	Y. Milk

Culture No.	Milk	Y. Milk

Cheese 6 (Past. 150°F)
Made 29/11/30
Examined 11/2/31.
Age 73 days.
Ripened 14 days at 65°F remainder at 50°F.
Medium P.M.G. at PH 6.0.
Incubated 21-25°C for 10 days.
Counts: dil. 1/10,000 257-261-
1 plate picked into yeast lactose milk and incubated at 30°C. Transferred into 10 cc tubes of milk and yeast milk for titration.
Incubated at 25°C for 14 days.

Culture No.	Milk	Y. Milk
63	0.0	2.5
14	0.0	3.4
19	0.0	3.4
40	0.0	3.4
57	0.0	3.4
64	0.0	3.4
9	0.0	3.6
21	0.0	3.6
58	0.0	3.6
67	0.0	3.6
106	0.0	3.6
59	0.0	3.8
60	0.0	3.8
81	0.0	3.8
139	0.0	3.8
7	0.0	4.1
23	0.0	4.5
15	0.0	7.4
61	0.2	2.9
39	0.2	3.4
49	0.2	3.4
56	0.2	3.4
96	0.2	3.4
27	0.2	3.6
32	0.2	3.6
87	0.2	3.6

Culture No.	Milk	Y. Milk
116	0.2	3.6
137	0.2	3.6
155	0.2	3.6
161	0.2	3.6
11	0.2	3.8
20	0.2	3.8
34	0.2	3.8
50	0.2	3.8
72	0.2	3.8
117	0.2	3.8
95	0.2	4.1
45	0.2	4.3
90	0.2	4.3
6	0.2	4.5
75	0.2	4.5
37	0.2	4.7
97	0.2	4.7
112	0.2	4.7
74	0.2	5.0
150	0.2	5.0
65	0.2	5.2
79	0.2	5.2
55	0.2	5.4
86	0.2	5.4
103	0.2	5.4
154	0.2	5.4

Culture No.	Milk	Y. Milk
2	0.2	6.3
121	0.2	6.3
16	0.5	2.9
31	0.5	3.2
38	0.5	3.4
42	0.5	3.4
54	0.5	3.4
149	0.5	3.4
119	0.5	3.6
126	0.5	3.6
132	0.5	3.6
147	0.5	3.6
157	0.5	3.6
159	0.5	3.6
92	0.5	3.8
130	0.5	3.8
148	0.5	3.8
53	0.5	4.1
99	0.5	4.1
101	0.5	4.1
48	0.5	4.3
78	0.5	4.3
80	0.5	4.3
131	0.5	4.3
133	0.5	4.3
83	0.5	4.5

Culture No.	Milk	Y. Milk
158	0.5	4.7
114	0.5	5.2
107	0.5	5.4
135	0.5	5.4
144	0.5	5.4
146	0.5	5.4
156	0.5	5.4
142	0.5	5.6
36	0.5	6.9
141	0.5	5.9
143	0.5	5.9
151	0.5	5.9
77	0.5	6.1
68	0.5	6.3
127	0.5	6.3
140	0.7	3.6
108	0.7	4.7
122	0.7	5.0
85	0.7	5.6
136	6.1	6.5
82	6.1	6.8
30	6.1	7.2
22	6.3	6.5
71	6.3	6.5
44	6.3	7.2
73	6.5	6.5

Culture No.	Milk	Y. Milk
84	6.5	6.8
115	6.8	7.0
88	6.8	7.2
89	6.8	7.2
92	6.8	7.2
46	7.0	5.0
47	7.0	7.0
110	7.2	7.2

Culture No.	Milk	Y. Milk