Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming are checked below.

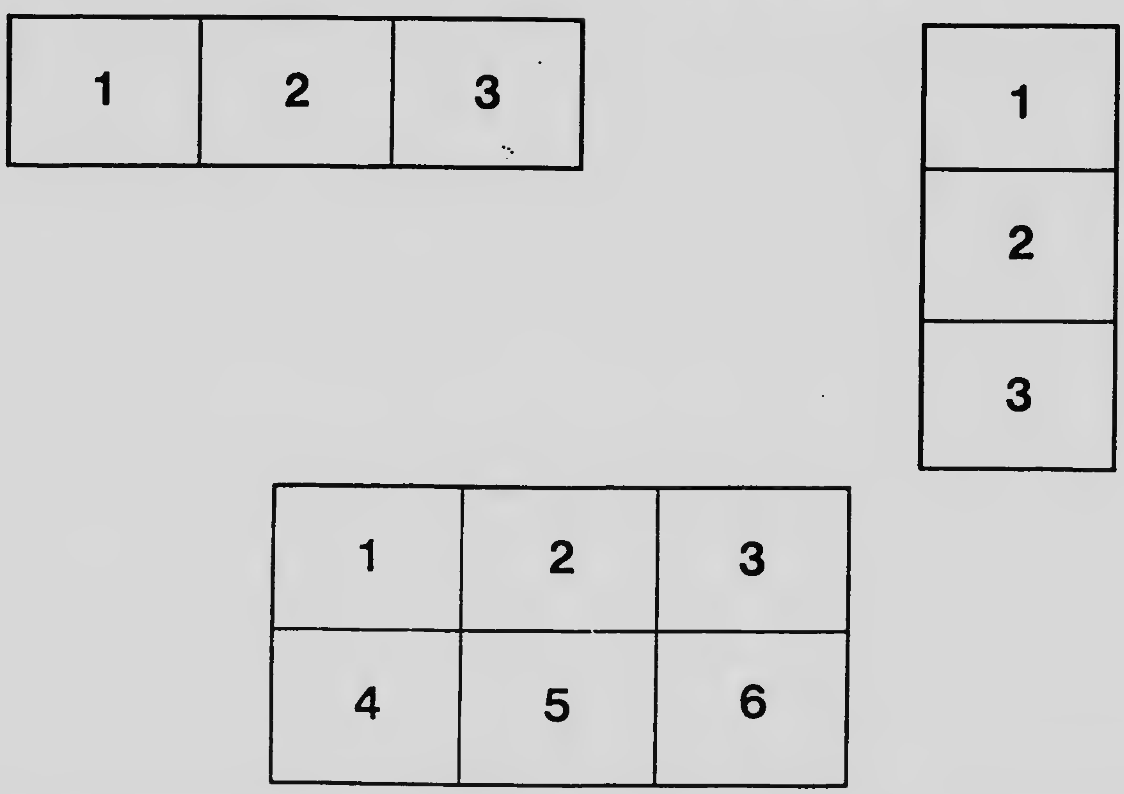
- [ ] Coloured covers / Couverture de couleur
- [ ] Covers damaged / Couverture endommagée
- [ ] Covers restored and/or laminated / Couverture restaurée et/ou pelliculée
- [ ] Cover title missing / Le titre de couverture manque
- [ ] Coloured maps / Cartes géographiques en couleur
- [ ] Coloured ink (i.e. other than blue or black) / Encre de couleur (i.e. autre que bleue ou noire)
- [ ] Coloured plates and/or illustrations / Planches et/ou illustrations en couleur
- [x] Bound with other material / Relié avec d'autres documents
- [ ] Only edition available / Seule édition disponible
- [x] Tight binding may cause shadows or distortion along interior margin / La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure.
- [ ] Blank leaves added during restorations may appear within the text. Whenever possible, these have been omitted from filming / Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.
- [ ] Additional comments / Commentaires supplémentaires:

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- [ ] Coloured pages / Pages de couleur
- [ ] Pages damaged / Pages endommagées
- [ ] Pages restored and/or laminated / Pages restaurées et/ou pelliculées
- [x] Pages discoloured, stained or foxed / Pages décolorées, tachetées ou piquées
- [ ] Pages detached / Pages détachées
- [x] Showthrough / Transparence
- [x] Quality of print varies / Qualité inégale de l'impression
- [ ] Includes supplementary material / Comprend du matériel supplémentaire
- [ ] Pages wholly or partially obscured by errata slips, tissues, etc., have been refilmed to ensure the best possible image / Les pages totalement ou partiellement obscurcies par un feuillet d'errata, une pelure, etc., ont été filmées à nouveau de façon à obtenir la meilleure image possible.
- [ ] Opposing pages with varying colouration or discolourations are filmed twice to ensure the best possible image / Les pages s'opposant ayant des colorations variables ou des décolorations sont filmées deux fois afin d'obtenir la meilleure image possible.

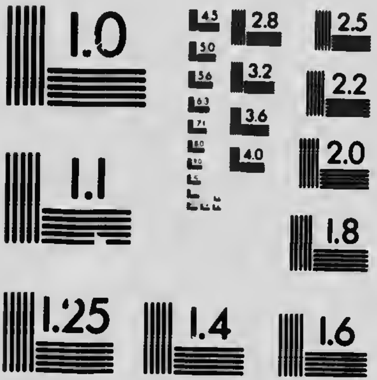
This item is filmed at the reduction ratio checked below / Ce document est filmé au taux de réduction indiqué ci-dessous.

10x	12x	14x	16x	18x	20x	22x	24x	26x	28x	30x	32x
						✓					


1
2
3
1
2
3
1
2
3
4
5
6

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



BULLETIN 130. DECEMBER, 1903.

Ontario Agricultural College and Experimental Farm.

A COMPARISON OF THE BACTERIAL CONTENT OF CHEESE CURED AT DIFFERENT TEMPERATURES.

By Prof. F. C. Harrison and Prof. W. T. Connell.

The following investigations were made partly at the Agricultural College, Guelph, and partly at the Eastern Dairy School, Kingston, the latter being done under the direction of the Commissioner of Agriculture and Dairying for the Dominion. The object was to determine the bacteriological conditions existing in Canadian Cheddar cheese when cured at different temperatures; to note the relationship existing between the bacterial contents and other curing agencies; and to learn, if possible, some lessons of practical value for those engaged in the production of cheese.

Sources of Cheese Analysed.

The cheese subjected to analysis were of two distinct groups. The first group consisted of those made and kept at the factory at Carp, Ontario, during the seasons of 1899 and 1900. This lot comprised 28 cheese in all, 14 being analysed in 1899 and 14 in 1900, each cheese being examined a number of times at various intervals. One-half the cheese examined each season was kept in an insulated curing room at a temperature varying between 60 and 65 degrees Fah., the average for both summers being 62.2 degrees Fah., the maximum recorded being 67 degrees and the minimum 56 degrees. The remaining half was kept in an ordinary curing room in which no attempt was made to control the temperature. The average temperature of this room in 1899, while containing the cheese analyzed, was as follows: Last fifteen days of June, 68.7 degrees Fah.; July, 70.5 degrees Fah.; August, 70.8 degrees Fah. The average temperature of this room in 1900 was: July, 72 degrees Fah.; August, 69 degrees Fah.

The temperature of the insulated room, which was isolated from the ordinary curing room, was regulated by a sub-earth duct and by the use of ice in racks. Full details as to methods of structure and insulation of the ordinary curing room and factory are given in the reports of the Commissioner of Agriculture and Dairying for 1899.

The second group of cheese consisted of those made at the Agricultural College factory, Guelph. The work in this group related to the effects of ripening cheese at a temperature of about 40 degrees Fah. throughout the whole period of curing, and ripening for one and two and three weeks in an ordinary curing room, and then removing to cold storage—both compared with ripening for the full period in the ordinary curing room.

In these experiments five flat Cheddar cheese were made from each curd, and were marked A, B, C, D and E. The cheese were put directly into ice cold storage, where the temperature averaged 37.8 degrees Fah., and the percentage of humidity averaged 91.6 degrees for the season. The extreme variation in the monthly average temperature of the cold storage from April to November was 4 degrees; and the variation in the humidity was 4 degrees.

The other five cheese were put into the ripening room, and transfers were subsequently made from the ripening room to cold storage, as follows: The B cheese at the end of one week; the C cheese at the end of two weeks; and the D cheese at the end of three weeks. The E cheese were left in the ripening room and ripened in the ordinary way at an average temperature of 63.8 degrees Fah. for the season. The average percentage of humidity in this room was 79.1 degrees for the season. The average monthly variations in the temperature of this room were from 86.6 degrees in July to 58.7 degrees in November. The humidity varied from 84.3 per cent. in August to 73.7 per cent. in October. The temperature of the air outside averaged 56.9 degrees for the season. The average maximum temperature outside ranged from 85.8 degrees Fah. in July to 39 degrees in November.

The average minimum outside temperature ranged from 59.6 degrees in July to 24 degrees in November. The month of July was the hottest month of the season, and August was next, with maximum and minimum averages of 79.7 degrees and 56.3 degrees. June averaged 77.4 degrees and 53.5 degrees for maximum and minimum temperatures.

It should be remembered that it is not strictly accurate to take the average temperature by adding together the maximum and minimum temperatures and dividing for the average, as there is often a large variation in temperature, and the temperature for the day would, as a rule, more nearly approximate the maximum figure for a longer period of the day than the average.

Taking of Samples.

Samples from the Carp factory were taken by Mr. Woodard, the maker, under the direction of one of us. Samples were always taken of cheese of the same day's make, kept in the regulated and variable rooms, so as to have a contrast between cheeses of the same age. The samples analyzed and compared were always taken from cheese of the same day's make. The samples were taken with a thoroughly cleansed cheese borer and immediately placed with great care in sterilized test tubes, always two of each cheese, in order to have a duplicate in case any accident should befall one of the samples. The cheese borer was cleansed before using to obtain the second specimen; and the test tubes were plugged, packed on ice and forwarded to Kingston, being received about eighteen hours after they were taken.

At this point the analyses might not be entirely reliable; for while specimens usually came in good condition, still on several occasions, the ice in the packing box was completely melted, and the contents of the box were almost at the temperature of the air—which was likely due to the placing of the box in some exposed place by the carriers. The exact effects of such a change in temperature could not be accurately gauged; but when it was considered to be a factor, the results of the analysis were excluded from the tables.

The samples of cheese taken from the College factory, Guelph, were obtained in a similar way, except that it was not necessary to pack them on ice, as the laboratory is only a few minutes' walk from the factory. These samples were promptly taken from the factory to the laboratory and immediately analyzed.

A source of error in the quantitative bacteriological analysis of cheese is the fact, repeatedly determined in control analyses, that plugs from different parts of the same cheese, of the same age, vary as much as 30 per cent. in their bacterial content. Further, even in the same plug, portions of equal weight sometimes show as high as 20 per cent. of difference in the number of bacteria contained in them. A few examples of this fact may be given. A plug from cheese of July, 1902, age 12 days, gave 144,000,000 per gram. From cheese made in September, 1902, the age being 40 days, one plug gave 27,000,000 per gram; and another from a different part of the cheese gave 22,500,000 per gram. From cheese of July, 1902, age 12 days, the upper portion of a plug gave 210,000,000 [illegible] m and lower portions of the same plug gave 293,000,000.

We [illegible] oticed in abnormal cheese, made by adding a culture of a gas-prod [illegible] to the milk, that in the separate particles of curd which unite to [illegible] cheese, the exterior surface of each particle contains a larger number of bacteria than the interior thereof. Thus, in an analysis of cheese made in November, the exterior, or outer surface, of the curd particles gave 456 millions per gram, while the interior thereof gave 51 millions per gram; and again, at a later date, the exterior and interior of the curd particles in the same cheese gave respectively 67 millions and 37 millions per gram.

These examinations, which are typical of many others which we have made, show that there is not an even distribution of bacteria throughout the substance of a cheese, and it would, therefore, seem necessary to modify somewhat our methods of analyses.

Methods of Analysis, Etc.

Methods followed in the Analysis of Samples. The samples sent from Carp factory to Kingston were all subjected to an examination by the different methods of culture. Control microscopic examinations of the cheese were frequently made to determine if there were in them any forms which did not develop in the culture plates. No forms were found, however, except those which developed in the cultures.

The medium used for the culture of the bacteria contained in the cheese from the Carp factory was the ordinary beef-peptone-gelatine (12 per cent.). Agar proved entirely unsuitable for the requirements of the investigation. The cultures were made aerobically, the few cultures made anaerobically not showing the development of any forms except those found in the ordinary plates.

The medium used for the Guelph cheese was peptone-whey gelatine (10 per cent.), with or without the addition of blue litmus, precipitated chalk, or rosolic acid. Usually two plates were made from beef-peptone lactose gelatine. For each sample, from 5 to 7 plates were made.

Kingston Method.

As the methods followed at Kingston were somewhat different from those used at Guelph, we shall briefly outline them.

The Kingston Method. Usually one-tenth gram of the interior of the plug was taken and thoroughly pulverized in a sterile mortar with coarse granulated sugar. The sugar had been previously sterilized by soaking under ether for 2 to 7 days and then carefully evaporating the ether.

The finely pulverized mass was then washed with a measured amount of sterile water into a sterilized shaking bottle, and this was kept constantly agitated so as to secure a thorough and even admixture. The amount of dilution required varied with the age of the cheese. It was found that for green cheese a dilution of one part of cheese in from 20,000 to 100,000 parts of sterile water was required. This dilution was commonly effected as follows: 100 cc. of water were used to dissolve the powder and wash it into the first sterile shaking bottle. After this bottle had been thoroughly agitated for at least three minutes, 5 cc. were quickly removed with a sterile pipette and added to a second shaking bottle. To this was then added as many cc.'s as would make the dilution required. By this means one avoided the use of a large amount of diluting fluid. From the second bottle, after prolonged agitation, measured quantities were quickly added to melted gelatine. After a careful admixture with the gelatine culture was secured, plates were poured in the usual manner. These plates were incubated at from 21 to 22 degrees C. till all development had ceased. The colonies which had developed were then carefully counted over the entire surface of the culture plates, and the various colonies identified as to their species. Repeated sub-cultures in various media had often to be made to establish the identity of a species; but this work was rendered somewhat easier by the marked predominance of the bacillus acidi lactici.

Guelph Methods.

The Guelph Methods. One-half or one gram of cheese was taken and pulverized in a sterile mortar, with ten grams of powdered glass thoroughly sterilized; and 50 cc. of sterilized warm water (37 degrees C.) was gradually added, with constant stirring, to make a fine emulsion. And we think that by taking cheese in considerable quantity from different parts of the interior of the plug and pulverizing the samples with sterilized powdered glass, using ten grams of powdered glass for each gram of cheese, more accurate results were obtained than could be secured by the methods followed in former investigations. When these larger amounts of cheese were used, the quantity of the diluting fluid had to be considerably increased, and the labor of preparing the samples was much greater; but undoubtedly the results obtained were more accurate and gave a more reliable estimate of the bacterial content of the cheese For the larger number of the Guelph analyses, one gram of cheese was used. In a few instances five grams were used.

From the first dilution, one or two cc. were transferred to a measured amount of sterile water in a sterilized flask. After thorough shaking, a measured quantity was again transferred to a measured amount of sterile water in another sterilized flask; and, after further shaking, various quantities of this third dilution were added to the culture media. For transferring portions of the mixture from one dilution to another, straight-sided (Mohr) pipettes were used, and great care was taken to keep the liquid in the pipette in motion; for if not kept in motion, the particles in suspension would settle in a short time at the bottom of the p[illegible] and thus interfere with the accuracy of the results. The amount of dilution varied with the age of the cheese from 750,000 to 100,000 parts of sterile water to one part of cheese. The plates were levelled on a nivellating apparatus, cooled with ice, and subsequently placed in a cool incubator at 20 degrees C., where they remained till all development had ceased. The colonies were counted by means of a Jeffers counter; and computations were made therefrom.

De Freudenreich's method of obtaining liquefying germs by making surface cultures from the last dilution was occasionally used.

As previous work upon the bacterial flora of cheese had failed to show any obligate anaerobes, no anaerobic methods of culture were used.

Bacteria Found.

The bacteria found in the cheese at Guelph are divided into four classes:

A. True Lactic Acid Bacteria, of which several varieties differing only in slight particulars were found. All were bacilli, usually arranged as diplobacilli, at times in short chains. The commonest species was undoubtedly the B. acidi lactici (Esten).

B. Gas-forming Bacteria. These were mainly varieties of the B. coli communis and the B. lactis aerogenes, although once or twice a species which in most particulars resembled Proteus vulgaris was isolated.

C. Indifferent Bacteria. Various sarcinae, particularly Sarcina lutea, some yeasts, and torlae were found. B. subtilis and one or two other casein digestors were isolated; but their action, on account of their small numbers, must be considered insignificant. Further, none of these latter species was constantly present; so their action may be regarded as having little or no influence in the curing of the cheese.

In this class one of us included all bacteria, not lactic acid or gas-producing

D. Digesting Bacteria. By means of surface gelatine plates and emulsions of cheese, heated in order to destroy all vegetative forms and thus leave only spore-producing species, constant endeavor was made to isolate organisms belonging to this class.

In former analyses of cheddar cheese, one of us found seven different species of digesting or liquefying germs, the commonest form being B. butyricus. In this investigation, liquefying bacteria belonging to the subtilis group, M. aureus lactis, M. varians lactis, B. fulvus and B. halofaciens were isolated. Most of these species are liquefying, chromogenic forms. According to Conn, the second named is a distinctive dairy type which he found very frequently in milk. We may add that it has been isolated from the milk-ducts; and, in this connection, may note Harding's opinion, that the enzymes from liquefying bacteria, isolated from the udder of cows, may have some influence in the ripening changes of cheddar cheese. However, as already pointed out, none of these species are constantly present in cheese. Hence their action must be insignificant.

As may be seen from the appended tables, the lactic acid bacteria were the only constant bacteria present in var[illegible] [illegible]ge numbers.

Commercial Opinions on the Kingston Cheese.

Commercial Opinions on the Kingston Cheese. Commercial examinations of the same batches as those analysed were made at different dates. Part of the cheese was examined in Montreal in November, 1899, where the cheese had been held in cold storage from the early part of September. Cheese from the non-regulated room, made on and after the 20th of July, were de stroyed by fire on the way to Montreal; so no comparison can be made between the cheese of these days' make kept in regulated and in non-regulated curing rooms.

COMMENTS OF THE JUDGES UPON KINGSTON CHEESE MADE IN 1899

†Date.	Cheese in regulated room.	Cheese in non-regulated room
June 22	Body texture and flavor better.	Tender, on verge of going off.
July 1	Better body and flavor and more waxy.	Not clean
July 7	Nearly alike; rather better body, and slightly better cheese.	Hardly clean; tender.
July 13	Clean; waxy.	Not quite clean; body tender.
July 19	Good cheese.	Pasty; not clean.
July 29	Off flavor.	Not reported owing to destruction in transit.
August 10	Good flavor.	

†For the bacterial data of these cheese, please refer to the same dates in the tables of analysis commencing on page 14

COMMERCIAL RATINGS OF THE KINGSTON CHEESE MADE IN 1900.*

Date.	Room.‡	Vat.	Body. (In Order of Merit.)	Flavor. (In Order of Merit.)	Remarks.
†July 7....	1	......	......	1	Best cheese of entire lot.
" 6....	1	......	......	2	Slightly fruity.
" 5 ...	1	......	......	3	Off flavor.
" 7....	2	......	......	4	Tallowy
" 6 ..	2	......	......	5	Fruity flavor.
" 5....	2	......	......	6	Off flavor.
" 19...	1	1	1	1	Body about alike in all cheese in room 1
" 19 ..	1	3	2	2	Off flavor.
" 19 ..	2	1	3	3	Cheese from vat 3, room 2, contained slightly more moisture than cheese from vat 1, room 2.
" 19...	2	3	4	4	
" 18...	1	1	1	1	Less moisture; better flavor than other cheese of this date.
" 18 ..	1	3	2	2	Off flavor; more moisture than in other cheese of this date.
" 18....	2	1	3	3	
" 18....	2	3	4	4	Poorest of lot. Cheese of July 19th equal to that of July 6th in flavor.

* These cheese were not scored according to any scale.

† For the bacteriological data of these cheese, please refer to the same dates in the tables of analysis commencing on page 14.

‡ No. 1 is the regulated room and No. 2, the non-regulated room.

Scorings of the Guelph Cheese.

Quality of the Guelph Cheese. These cheese were scored according to the following scale of points: Flavor, 40; closeness, 15; even color, 15; texture, 20; finish, 10; total, 100. They were all scored 10 points for finish, in order to make the results more uniform. Six prominent cheese buyers of Montreal and four Ontario buyers did the scoring; and the following table shows the average of all the scorings made by months:

†	Flavor. Max. 40 Av.	Closeness. Max. 15. Av.	Even color. Max. 15. Av.	Texture. Max. 20. Av.	Total. Max. 100. Av.
April cheese.					
A	35.7	14.7	14.2	17.6	92.3
B	35.5	14.6	14.1	17.4	91.5
C	34.5	14.7	14.1	17.4	90.7
D	35.8	14.3	14.1	17.7	91.9
E	25.6	14.1	11.5	15.5	76.7
May cheese.					
A	36.1	14.7	14.1	17.9	92.9
B	35.9	14.4	13.7	17.8	91.8
C	35.4	14.5	13.8	17.5	91.2
D	35.8	14.4	13.8	16.9	90.9
E	33.9	13.9	13.9	16.2	87.9
June cheese.					
A	33.5	14.8	14.5	17.4	90.2
E	31.6	14.1	14.0	15.2	84.9

†For the bacterial data of these cheese, please refer to the same dates in the tables of analysis commencing on page 14.

The first scoring of the cold-storage cheese (A, B, C and D in the table) was made when they were from three to four months old; and they were scored several times thereafter. The cheese ripened in the ordinary room (E in the table) were scored the first time when they were from six weeks to two months old, and again at intervals of about one month after the first scoring, until it was considered that there would be no advantage in keeping them for a longer time.

Remarks on the Analytical Results.

A study of the tables of analysis (page 14 to end) shows that each day's cheese differs in its quantitative bacterial content from the cheese of every other day's make. This is not to be wondered at, when we remember that each day's milk differs more or less from that of every other day, and that little differences in handling are of daily occurrence. Such differences in the milk, in the handling of the curd, and in the use of various temperatures, no doubt account for the differences in bacterial content. A perusal of the tables shows a very great difference in the initial number of the bacteria in cheese. The lowest number found in cheese under four days old was 110,750,000 per gram; and the highest number in cheese of the same age was 635,000,000 per gram.

It may also be noted that the bacterial content declines more rapidly in the cheese of some day's make than it does in others. This may also be due to different conditions, such as those already mentioned, and to the influence of the products of bacterial activity upon the living organisms.

The tables also show that the bacterial content of normal cheese is usually at its highest at the time of taking from the press or during the first few days after the cheese are placed in the curing room. In other words, the bacteria in cheese are the survivors of bacteria in the curd. This statement, however, does not always hold good; for we may have cheese in which the acidity has not developed to such an extent as is usually considered desirable; and in such a case there will likely be a period of bacterial development after the cheese is placed in the curing room. It has also been claimed that there is more likely to be bacterial development when the cheese are moister than usual; but, in our investigations, no difference was observed in the quantitative analysis of cheese coming from "moist" and from "ordinary" vats.

By the experimental data given here, the number of bacteria was shown to be at its maximum when the cheese were taken from the press; and following this period we had (taking into account the factors leading to error in analysis) a continuous and gradual decline in the bacterial content. This decline continued till about the 100th day, when the contents seemed to remain fairly stationary for some time. Following this period, in which the bacterial content remained at a fairly constant level, we had a gradual decline; but in some cheese a year old, from 10,000 to 500,000 lactic acid bacteria were found.

The decline was more gradual and the contents remained high for a longer period in the cheese kept in ice cold storage at an average temperature of 40 degrees than in cheese kept in an ordinary curing room. This statement, but in a lesser degree, is also true of cheese kept in cool or regulated rooms. Without exception, we found a higher bacterial content in the cheese kept in the ice cold storage and in the regulated room, and also noted that there was better body and flavor in the cheese from these rooms, than in those from the unregulated curing rooms. This factor of higher bacterial content must, therefore, be one of considerable importance, particularly as regards the flavor of the cheese. The proportion of lactic acid bacteria to undesirable organisms is much greater in cold-storage and cool-storage cheese than is usual under ordinary conditions; and this ratio remains constant for a greater length of time in the refrigerator cheese than in either of the others; and it is obvious that a cheese with the ratio of 97 lactic acid bacteria to one undesirable organism will be of better flavor than a cheese kept in an unregulated curing room with a ratio of 47 lactic acid bacteria to one undesirable one. These ratios are in some of the cases, given in the tables of analysis.

The lactic acid bacteria are practically the only organisms present in normal cheese, and certainly the only bacteria in each particle of it; so it must be the only microbe of much importance in good cheese. It is true that gas-forming bacteria and other undesirable kinds were found in nearly every cheese we examined; but they were usually present in the samples taken at an early date, and very exceptionally in those of later date. They seldom, if ever, increase in numbers.

The presence of the proteus form in the cheese of July 29th, even though it did not increase in numbers, likely accounts for the cheese of that day going "off" in flavor. Such forms are favored by the warmer temperature of the variable room; but the large numbers of the lactic acid bacteria prevent their growth and soon destroy most of them. Gas-forming bacteria do multiply and are found in large numbers in open cheese, and especially in cheese in which this taint develops early. This may be due partly to a lack of acid in the cheese, and partly to various other defects in the manufacture. Both B. Coli and B. lactis aerogenes produce mottling. Conclusive evidence of this fact was obtained from a number of our experiments, made by using starters of these gas-producing organisms and manufacturing cheese therefrom. The mottles were most marked at the places where the particles of curd came together; holes and cracks also developed at these places, and it was evident that the gas produced by these organisms, particularly the hydrogen, had a marked bleaching action upon the curd. We also found that the white particles produced by bleaching contained much larger numbers of the gas-producing organism than other portions of the cheese.

The results of more detailed experiments upon this phase of the question will be given in a subsequent publication.

The lactic acid bacteria decline most rapidly in cheese kept in a room with a variable temperature; and when such decline takes place, any other bacterial species present is likely to multiply and produce its characteristic effects. This, perhaps, accounts for cheese going "off" in flavor when they become quite old; and such an undesirable result is much more likely to occur in cheese from a room of variable temperature than from cool or cold rooms, regulated by any of the methods adopted for the purpose. It may also be possible that abnormal flavors are produced by organisms which can grow only after a certain decomposition effected by a previous organism, the first furnishing a suitable food for the second. We do not yet know whether lactic acid bacteria render cheese suitable or unsuitable for the growth of any other species. The neutralization of the lime salts of the cheese by the generated lactic acid may at times bring about a condition suitable for the development of other bacteria which may be present in a dormant condition. The metabiotic phenomena in cheese certainly require further study.

As cheese become older, the lactic acid bacteria gradually lose their power of producing lactic acid when introduced into fresh milk. No morphological change can be detected in these bacteria. Colony formation on culture media remain quite characteristic. Lloyd has obtained similar results. He, however, thinks that lactic acid formation still goes on in the centre of the cheese; but, in our opinion, these bacteria are simply persisting forms of the contained bacteria. Reference to the tables shows that, on several occasions, we had an apparent increase of bacteria in cheese, several weeks old, kept at a temperature of 40 degrees Fah.; and we explain these results as due to the unequal distribution of bacteria in the cheese; for, by a number of experiments, we proved that there could be no increase of the lactic acid bacteria in milk kept at 40 degrees Fah. Some of the experiments on this point may be referred to.

On the 26th of November, 1902, 80 cc. of sterilized milk were inoculated with 2 oese of a 24-hour old bouillon culture of the lactic acid bacillus; and plates made from this mixture gave 430 colonies per oese. On the 3rd of December, this milk, at a temperature of 40 degrees Fah., was again examined and showed 150 colonies per oese; and at the same time, one drop of the milk was diluted in 12 cc. of sterilized water and two colonies per cc. of this mixture developed. On the 16th of December, the temperature being the same, 42 colonies per cc. and 2 colonies per oese respectively developed. The milk was then transferred to the incubator at 20 degrees C., and coagulated in 24 hours. Other experiments with gas-producing germs had similar results—there was no increase in the number of bacteria held at 40 degrees Fah. This experiment was repeated with lactic acid bacteria and gas-producing bacteria, with similar results, viz., that there was no increase in the numbers of bacteria in milk held at 40 degrees Fah. Consequently, there could be no increase in the number of lactic acid and gas-producing bacteria in cheese held at this temperature.

Bacterial Contents and Ripening Phenomena.

Bacterial Contents and Ripening Phenomena. The question of the really active agent or agents in the curing of cheese is still an open one. If bacteria are the active agents, then lactic acid bacteria must be the agents in the process. De Freudenreich appears to have shown that these bacteria can produce an increase of the soluble nitrogenous products in the casein of milk, provided calcium carbonate is present. Klein and Kirsten stated that, by the use of starters, normal cheese can be made from pasteurized milk (which is free from enzymes); but Boekhout and Vries were unable to produce normal Edam cheese from aseptic milk with the addition of a culture of the lactic acid bacillus; and Chodat and Bang did not obtain an increase in the quantity of soluble nitrogen by growing lactic acid bacteria on coagulated casein; so, taking these facts into account, we are bound to admit that there still exists more or less doubt as to the ability of the lactic acid bacillus alone to produce an increase in the amount of soluble nitrogen.

Babcock and Russell attributed to Galactase (an enzyme which they discovered in milk) the principal influence in the ripening of cheese; but De Freudenreich has shown that 0.5 per cent. of lactic acid enfeebles the action of galactase; and the very considerable amount of acid in normal Canadian cheddar cheese must still more diminish the action of this ferment, as the percentage of acidity or acid salts in ordinary cheese of this kind varies at different ages from 0.76 per cent. to 1.5 per cent.

Babcock and Russell (subsequent to the discovery of Galactase) and Jensen simultaneously proved that the pepsin in rennet increased the higher decomposition products, such as albumoses and peptones, in cheese; and there is the well-known fact that cheese-makers increase the amount of rennet when they want a fast-curing cheese.

Rennet acts more quickly and better than galactase in acid solutions; and it seems that the function of the lactic acid bacteria, whose growth in milk is so carefully fostered by the cheese-maker, is to create the requisite acidity in order that the pepsin of the rennet may exercise its digestive action on the cheese; and it appears certain that the fundamental curing changes commence during the maturing of the curd in the vat, but do not make themselves manifest till later.

Production of Flavor.

Production of Flavor. The most important characteristic of cheese is its flavor. Buyers of cheddar cheese, especially, judge very largely by the flavor; and no other characteristic counts for so much in estimating the market value. It is, therefore, necessary that the factors which contribute to the production of flavor should be thoroughly understood.

B. coli, B. lactis aerogenes, Proteus, etc., are sometimes present in milk and cheese, and are to be guarded against, on account of the abnormal flavors which they produce; and other species are occasionally found, but in such small numbers that they produce little or no effect upon the flavor of the cheese; but from the analyses here presented, it is evident that the lactic acid bacillus is the only species of organism which is of much importance to cheese-makers. Generally speaking, the flavor of the cheese depends mainly upon this organism, when it is present in large numbers, and in what we ordinarily term pure culture, we get the best flavor. It is only when the cheese breaks down under the influence of the enzymes in the rennet, after the ground has been prepared by the lactic acid bacteria, that flavor develops. The rapidity and character of the ripening process, involving the life of the lactic acid bacteria, largely depend upon the temperature at which the cheese is kept; and the most important factor in the control of temperature is a well-regulated cold or cool room.

The quality of the cheese in the Guelph experiments was in the order of placing in cold storage as regards time—that put in directly from the hoops being the best. In the Kingston experiments, the cheese in the regulated room was superior to that in the ordinary non-regulated room; and in all these best cheese, the most noticeable fact was the high number of lactic acid bacteria which they contained and the length of time these organisms remained alive in them.

The similarity of germ content in the same kind of cheese, though made in various localities, has a bearing on the question; and we have found that in normal cheese from various parts of the Province, the lactic acid bacillus is the only species that is constantly found in large numbers.

Conclusions.

1. The presence of certain undesirable bacteria sometimes produces "off" flavors in cheese. The Proteus form found in the cheese of July 29th was likely the cause of the cheese of that date being abnormal in flavor.

2. In nearly all the cheese examined, gas-producing, digesting or indifferent species of bacteria were found; but they always were in insignificant numbers and soon died out.

3. Undesirable bacteria such as are found in cheese seem unable to grow at a temperature of 40 degrees Fah. Consequently, the flavors in cheese caused by the growth of bacteria therein do not increase in cold storage.

4. In normal cheese, the greatest bacterial content is usually found when it is one day old, though occasionally it is at the maximum in cheese from two to five days old. At this period the number of bacteria sometimes reaches the enormous total of 625,000,000 per gram.

5. Following this period, we have a gradual and continuous decline in the number of bacteria as the cheese get older.

6. The bacterial content remains high for the longest time, and the decline is most gradual, in cheese kept in ice cold storage, at an average temperature of 40 degrees Fahrenheit. In cheese kept in a cool, well-regulated room, similar results occur, but the decline in the number of bacteria is more rapid. As this higher bacterial content constantly corresponds with a better flavor in the cheese, we infer that it is the chief factor in determining the flavor of cheese properly made from good, pure milk.

7. Lactic acid bacilli are practically the only bacteria in normal cheese during the ripening process; and throughout the process they gradually and constantly decline in number. As the curing changes are manifested only after the lapse of some time, these changes must be influenced by the products of the early activity of the bacteria: and we believe that the fundamental curing changes begin and continue during the ripening of the curd in the vat, but do not make themselves manifest till later.

8. The lactic acid bacteria in cheese, not only decrease in number with the lapse of time, but gradually lose their acid-producing power; and this circumstance, with the fact that the most rapid decline in the number of these bacilli takes place in cheese in the ordinary curing room, may give rise to a condition which is favorable to the development of any taint-producing species which may be present. Hence the cheese from a cold storage or a well regulated cool room ought to keep better than cheese from the ordinary curing room.

9. The flavor of cheese depends mainly on the breaking down of the casein under the influence of the curing agent (likely the pepsin of the rennet), aided by the acidity and other conditions produced by the growth of the lactic acid bacilli; while the most important factor in the control of these conditions is the temperature—a regular and cold or cool temperature being necessary for the best results.

10. As may be seen from the conclusions and remarks of the judges of the cheese analysed, cheese kept in cold storage at about 40 degrees Fah., and also those kept in a well-regulated cool room, were better in flavor and body and of much greater commercial value than cheese kept in the ordinary curing room with its variable and generally too high temperature.

Cheese of June 22nd, 1899, (Kingston).

Dates of Exam.	Age in days.	Max. °	Min. °	Av. °	Lactic Acid Bact.	Gas formers.	Other Bact.
		Date and Age.	**Temperature F.**		**Cheese from regulated room.**		
June 24.	2	65	61	62.5	628,750,000	800,000(a)	300,000(b)
July 4	12	65	56	61.1	106,560,000		
" 18.	26	64	58	61.5	98,750,000		
Aug. 22	61	65	56	62.5	15,000,000		
Sept. 5.	75	67	60	63.2	11,200,000		
" 18.	88	62	49	56	1,400,000		
" 25.	95	65	51	59	2,430,000		
Oct. 3	103	63	44	54	1,715,000		
" 16.	116	64	45	55	1,650,000		
Nov. 23.	152			50	415,000		

Dates of Exam.	Max. °	Min. °	Av. °	Lactic Acid Bact.	Gas formers.	Other Bact.
	Temperature F.			**Cheese from variable room.**		
June 24.	74	61	67	628,750,000	800,000(a)	300,000(b)
July 4	78	58	68.5	78,937,500		
" 18.	79	60	71.6	63,125,000		40,000(c)
Aug. 22	81	56	69.1	4,500,000		
Sept. 5.	78	62	70.5	1,042,000		
" 18.						
" 25.						
Oct. 3						
" 16.						
Nov. 23.						

Cheese of July 1st, 1899, (Kingston).

Dates of Exam.	Age in days.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Other Bact.
		Temperature F.			**Cheese from regulated room.**		
July 4	3	63	61	62	461,500,000	2,500,000(a)	
" 11.	10	64	58	61.7	148,120,000		1,500,000(b)
" 25.	24	63	57	61	115,000,000	570,000(a)	
Aug. 1	31	64	58	62	78,315,000		
" 15.	45	65	56	61.8	43,386,000		
" 30.	60	67	57	62.5			115,300(d)
Sept. 18	79	66	54	58	11,020,000		
" 25	86	65	51	59	6,750,000		
Oct. 3	94	63	44	54	15,400,000	40,000(a)	
" 16.	107	64	45	55	11,300,000		
" 30.	121	65	50	55	5,800,000		
Nov. 23.	145			50	2,030,000		10,000(c)

Dates of Exam.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Other Bact.
	Temperature F.			**Cheese from variable room.**		
July 4	78	62	71.3	454,000,000	1,750,000(a)	
" 11.	79	62	72.3	128,600,000		1,600,000(a)
" 25.	77	55	68.3	44,875,000		
Aug. 1	80	58	73	49,300,000	400,000(a)	200,000(a)
" 15.	79	56	68.5	16,750,000		
" 30.	81	58	70.3	6,275,000	75,000(a)	
Sept. 18						
" 25						
Oct. 3						
" 16.						
" 30.						
Nov. 23.						

Cheese of July 7th 1899, (Kingston).

Dates of Exam.	Age in days.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Other Bact.
		Temperature F.			**Cheese from regulated room.**		
July 11.	4	62	58	61	146,322,000	68,000(a)	504,000([illegible])
" 18	11	63	58	61.3	48,250,000		100,000(e)
" 25	18	63	57	60.5	21,625,000		
Aug. 1.	25	64	58	62	24,850,000		

Dates of Exam.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Other Bact.
	Temperature F.			**Cheese from variable room.**		
July 11.	79	62	70.6	110,750,000	100,000(a)	375,000(e)
" 18	77	60	70.3	51,460,000		50,000(g)
" 25						
Aug. 1.	80	55	69.1	10,250,000		90,000(h)

" 23	46	65	56	62	9,850,000	.....	.....					.....	.....
Sept. 20	75	66	49	60	460,000	.....	.....	81	56	69	5,600,000	.....	.....
Oct. 16	102	64	44	55	527,500	.....	4,000(b)	.....	.....	.....	.....	.....	.....
Nov. 23	140	.....	.	50	525,000	.....	5,000(g)	.....	.....	.....	.....	.....	.....
CHEESE OF JULY 13TH, 1899. (KINGSTON).													
July 18	5	63	58	61.5	385,000,000	.....	.....	77	60	70.3	30,865,400	260,000 (a)	.....
" 25	12	63	57	60.5	.....	.....	.....	74	55	66	27,083,000	.....	.....
Aug. 1	19	64	58	62	39,353,000	150,000 (a)	80,000 (b)	80	58	73	19,440,000	.....	100,000 (b)
Aug 15	33	65	56	61.8	22,040,000	150,000 (a)	.....	79	56	68.5	22,937 500	.....	.....
Aug. 29	47	67	57	62.5	.....	.....	.....	81	58	70.3	5,000,000	.....	.....
Sept. 18	67	66	54	58	2,510,000	.....	.....	.....	.....	.....	.....	40,000 (a)	.....
" 25	74	65	51	59	2,880,000	2,600 (a)	.....	.....	.....	.....	.....	.....	.....
Oct. 3	82	63	44	54	6,070,000	.....	.....	.....	.....	.....	.....	.....	.....
" 16	95	64	45	55	3,256,000	.....	4,000 (d)	.....	.....	.....	.....	.....	.....
Nov 23	133		.....	50	5[illegible]5,000	.....	.....	.....	.....	.....	.....	.....	.....
CHEESE OF JULY 19TH, 1899. (KINGSTON).													
July 25	6	63	57	60.5	158,150,000	.....	1,000,000 (i)	74	55	66	108,555,000	700,000 (a)	.....
Aug. 1	13	64	58	62	41,500,000	200,000 (a)	.....	80	58	73	89,777,000	120,000 (a)	.....
" 15	27	65	56	61.8	89,066,000	.....	200,000 (i)	79	56	68.5	61,500,000	.....	.....
" 22	34	64	57	62	86 600,000	.....	.....	81	58	70	53,000,000	.....	100,000 (i)
" 29	41	67	60	63.2	42,800,000	.....	20,000 (i)	78	62	70.5	23,100,000	.....	20,000 (i)
Sept 20	63	66	54	58	7,500,000	.....	.....	.....	.....	.....	.....	.....	.....
Oct 3	76	65	44	55	15,116,000	.....	.....	.....	.....	.....	.....	.....	.....
Oct. 30	193	64	44	54	5,091,000	.....	40,000 (i)	.....	.....	.....	.....	.....	.....
Nov. 23	127	.		50	1,170,000	.....	10,000 (i)	.....	.....	.....	.....	.....	.....
CHEESE OF JULY 29TH, 1899. (KINGSTON).													
Aug. 1	3	63	58	61.1	348,400,000	2,000,000(j)	.....	80	58	70.3	453,333,000	1,000,000 (j)	.....
" 15	17	65	56	61.8	231,800,000	1,000 000(j)	.....	79	56	68.5	193,500,000	.....	.....
" 22	24	64	57	62	152 614,000	.....	.....	81	58	70	.....	.....	.....
" 29	31	67	60	63.2	145 000 000	.....	.....	78	62	70.5	103,000,000	.....	.....
Sept 16	49	66	54	58	41,000,000	.....	.....	.....	.....	.....	.....	.....	.....

(a) B. coli communis
(b) Sarcina lutea.
(c) A white yeast.
(d) Partly Sarcina lutea and partly yeasts.
(e) B. subtilis.
(f) Torula rosea.
(g) Micrococcus alba
(h) Orange Micrococcus
(i) A small bacillus—producing a yellow colony—non-liquefying, etc. Species not determined. Is not active in milk.
(j) Bacillus related to Proteus group.

Cheese of July 29th, 1899.—(*Continued.*)

Date and Age.		Temperature.			Cheese from regulated room.			Temperature.			Cheese from variable room.		
Dates of exam.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Other Bact.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Other Bact.
		°	°	°				°	°	°			
Oct. 2	65	65	44	55	10,000,000	....	....	....	....	...	....	....	....
Oct. 16	79	64	45	55	9,750,000	....	....	...	....	....	....	....	....
Oct 30	93	65	50	55	10,890,000	....	....	....	....	....	....	....	....
Nov. 23	117	...		50	3,520,000	....	....	....	....	...	....	....	....

Cheese of August 10th, 1899 (Kingston).

Dates of exam.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Other Bact.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Other Bact.
Aug. 15 ...	5	65	56	62.4	536,400,000	100,000 (*a*)	....	79	56	68.6	323,250,000	200,000 (*a*)	....
Aug. 22....	12	64	57	62	....	....	....	81	58	70	206,400,000	....	....
Aug 29 ...	19	67	60	63.2	125,000,000	....	400,000 (*b*)	78	62	70.5	122,300,000	....	
Sept. 20....	41	66	54	58	14,148,000	....					....	....	200,000 (*b*)
Oct. 2 ...	53	65	44	55	22,200,000	....	....	.....	.	.....	....	....	....
" 30....	81	64	44	54	10,935,000	....	....	.....	....	....	....	....	....
Nov. 23.....	105	.....	.....	50	2,780,000	....	50,000 (*b*)	.....	.....		....	....	....

Cheese of July 5th, 1900. (Kingston).

Dates of exam.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Other Bact.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Other Bact.
July 11	6	64	60	62	387,500,000	....	1,000,000(*g*)	82	61	70	202,135,000	....	500,000 (*g*)
" 20.. ...	15	64	60	62.5	121,500,000	....	640,000(*g*) 300,000(*h*)	83	62	72	73,750,000	....	250,000 (*g*) 75,000 (*g*)(*h*)
" 26......	21	65	59	62.5	56,100,000	....	500,000(*g*)	82	63	74	29,800,000	....	350,000 (*g*) 200,000 (*h*)
Aug. 1......	27	64	59	62.5	36,100,000	....	10,000(*i*)	79	60	71	19,800,000	....	20,000
" 8.......	34	64	59	61	22,755,000	....	....	78	58	68	11,430,000	....	15,000 (*g*) 15,000 (*h*)
" 13......	39	65	59	62.5	23,071,600	....	10,000(*i*)	83	62	74	6,630,000	....	
" 20.	46	66	58	62	16,125,000	....	....	81	64	73	4,812,500	....	....
Sept. 4....	61	65	56	61	4,935,000	....	90,000(*h*)	82	60	70	3,500,000	....	108,000 (*h*)

Cheese of July 6th, 1900 (Kingston).

July 11.....	5	64	60	62	300,000,000	2,600,000	....	82	61	70	181,800,000	1,260,000	....
" 20.....	14	64	60	62.5	164,166,000	1,200,000	{ 240,000(g) 240,000(h)	83	62	72	70,568,000	240,000	60,000(g)
" 26.....	20	65	59	62.5	144,762,000	100,000	400,000(g)	82	68	74	78,154,000	408,000	200,000(i)
Aug. 1.....	26	64	59	62.5	84,300,000	....	....	79	60	71	36,250,000	....	....
" 8	33	64	59	61	68,520,000	....	125,000(g)	78	58	68	33,127,500	....	20,000(j)
" 13.....	38	65	59	62.5	40,365,000	....	{ 125,000(g) 125,000(h)	83	62	74	15,400,000	... .	10,000(k)
" 20.....	45	66	58	62	22,105,000	....	220,000(g)	81	64	73	2,380,000	....	5,000(i)
" 27.....	52	65	59	62	4,520,000	.. ..	....	82	60	70	1,100,000	... .	....

Cheese of July 7th, 1900 (Kingston).

July 11.....	4	64	60	62	242,200,000	.. ..	....	82	61	71	236,250,000	....	....
" 20.. ...	13	64	60	62.5	197,500,000	....	{ 1,360,000(g) 112,000(h)	83	62	72	64,881,000	... .	900,000(g)
" 26.....	19	65	59	62.5	66,364,000	....	360,000(g)	82	68	74	52,600,000	....	200,000(h)
Aug. 1.....	25	64	59	62.5	69,560,000	160,000	320,000(g)	79	60	71	21,400,000	....	200,000(g)
" 8	32	64	59	61	70,300,000	....	50,000	78	58	68	9,600,000	....	200,000(h)
" 13.....	37	65	59	62.5	42,500,000	....	30,000(k)	83	62	74	5,700,000	....	{ 100,000(g) 50,000
" 20.....	44	66	58	62	41,700,000	....	25,000(k)	81	64	73	4,942,000	... .	....
Sept. 4.....	59	65	56	61	11,827,000	....	....	82	60	70	2,290,000	. .....	20,000(g)

Cheese of July 18th, 1900. Vat 1.

July 26.....	8	65	59	62.5	337,750,000	*	....	82	68	74	161,917,000	*	....
Aug. 1.....	14	64	59	62.5	244,800,000	....	....	79	60	71	115,200,000	....	....
" 8.....	21	64	59	61	....	....	....	78	58	68	101,800,000	....	....
" 13.....	26	65	59	62.5	107,400,000	... .	....	83	62	74	45,333,000	.. ..	....
" 20.....	33	66	58	62	62,000,000	....	....	81	64	73	17,752,000	....	....
Sept. 4.....	48	65	56	61	14,226,000	....	....	82	60	70	4,225,000	....	....

(a) B. coli communis. (l) Sarcina lutea.
(g) A bacillus, non-liquefying, producing a light yellow pigment. (h) B. fluorescens liquefaciens. (i) Torula alba.
(j) B. megatherium. (k) A liquefying streptococcus. * The bacteria apart from the Lactic acid bacteria were not calculated.

CHEESE OF JULY 18TH. VAT. 3.

Date and Age.		Temperature.			Kept in regulated room.			Temperature.			Kept in ordinary room.		
Date.	Age.	Max.	Min.	Aver.	Lactic acid Bact.	Gas formers.	Other Bact.	Max.	Min.	Aver.	Lactic acid Bact.	Gas formers.	Other Bact.
		°	°	°				°	°	°			
July 26....	8	65	59	62.5	161,430,000	....	....	82	68	74	344,375.000	....	....
Aug. 1......	14	64	59	62.5	....	....	....	79	60	71	210,000.000	....	....
" 8.....	21	64	59	61	331,250,000	....	....	78	58	68	62,000,000	....	....
" 13......	26	65	59	62.5	173.000,000	....	....	83	62	74	48,420,000	....	....
" 20......	33	66	58	62	92,300,000	....	....	81	64	73	....	....	....
Sept. 4......	48	65	56	61	40,950.000	....	....	82	60	70	12,420,000	....	....

CHEESE OF JULY 19TH, VAT 1. (KINGSTON).

Date.	Age.	Max.	Min.	Aver.	Lactic acid Bact.	Gas formers.	Other Bact.	Max.	Min.	Aver.	Lactic acid Bact.	Gas formers.	Other Bact.
July 26....	7	65	59	62.5	331,666,000	....	....	82	68	74	290,000,000	....	....
Aug. 1......	13	64	59	62.5	198,000,000	....	....	79	60	71	226,000,000	....	....
" 8.....	20	64	59	61	89,773,000	....	....	78	58	68	156,750,000	....	....
" 13......	25	65	59	62.5	35.000,000	....	....	83	62	74	26,563,500	....	....
" 20......	32	66	58	62	69,000.000	....	....	81	64	73	7,725,000	....	....
Sept. 1......	43	65	58	61	17,520,000	....	....	82	60	70	2,781.000	....	....

CHEESE OF JULY 1ST, 1900.

Date.	Age.	Max.	Min.	Aver.	Lactic acid Bact.	Gas formers.	Other Bact.	Max.	Min.	Aver.	Lactic acid Bact.	Gas formers.	Other Bact.
July 26.....	7	65	59	62.5	344,950,000	....	....	82	68	74	382,750,000	....	....
Aug. 1......	13	64	59	62.5	90,450,000	....	....	79	60	71	228,365,000	....	....
" 8....	20	64	59	61	110,625,000	....	....	78	58	68	73,145,000	....	....
" 13.....	25	65	59	62.5	125,000,000	....	....	88	62	74	22,550,000	....	....
" 20......	32	66	58	62	57,500,000	....	....	81	64	73	11,775,000	....	....
Sept. 1......	43	65	58	61	18,057.142	....	....	82	60	70	3,750,000	....	....

Cheese of April 26th—A. Refrigerator. (Guelph).

Date.	Age.	Temperature. Max.	Min.	Av.	Lactic acid Bact.	Gas formers.	Digestors.	Other Bact.
		°	°	°				
April 26	1	38	35	36.5	543,000,000	....	....	....
May 18.......	17	38	36	37	566,000,000	....	....	180,000
" 21.......	25	38	36	37	547, [illegible]00	....	....	238,000
" 28.......	32	38	38	37	448,[illegible]00,000	....	....	270,00[illegible]
June 6	41	39	37	38	504,300,000	....	....	120,000
" 1[illegible]	48	40	37	38.5	477,000,000	....	....	....
" 22	57	42	38	40	155,500,000	....	....	....
July 16.......	81	42	39	40.5	44,500,000	....	....	....
Aug. 5........	101	42	38	40	44,250,000	....	....	....

Cheese of April 26th,—B. One Week in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic acid Bact.	Gas formers.	Digestors.	Other Bact.
April 26	1	65	55	60	543,000,000	....	....	....
May 6........	10	65	55	60	390,000,000	....	2,000,000(*g*)	....
" 28.....	32	38	38	38	123,800,000	....	400,000(*g*)	....
June 6......	41	39	37	38	166,800,000	....	....	....
" 13.....	48	40	37	38.5	117,300,000	....	....	....
" 22.....	57	42	38	40	27,200,000	....	....	....

Cheese of April 26th,—C. Two Weeks in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic acid Bact.	Gas formers.	Digestors.	Other Bact.
April 26.....	1	65	55	60	543,000,000	....	....	....
May 11.......	16	65	55	60	146,500,000	....	310,000(*g*)	....
" 28.......	32	38	38	38	123,700,000	....	70,000(*g*)	....
June 6	41	39	37	38	124,200,000	....	....	....
" 13	48	40	37	38.5	74,000,000	....	....	....
" 22.......	57	42	38	40	32,000,000	....	....	....

Cheese of April 26th,—E. Ordinary Curing Room.

Date.	Age.	Max.	Min.	Av.	Lactic acid Bact.	Gas formers.	Digestors.	Other Bact.
April 26......	1	65	55	60	543,000,000	....	....	....
May 28.......	32	70	65	63	122,000,000	....	400,000(*g*)	....
June 6	41	70	62	66	28,250,000	....	105,000(*g*)	....
" 13	48	73	58	64	26,000,000	....	72,000(*g*)	....
" 22	57	74	58	67	9,234,000	....	....	....
July 16.......	81	80	68	75	3,430,000	....	....	....

Cheese of April 29th,—A. Refrigerator. (Guelph).

Date.	Age.	Max.	Min.	Av.	Lactic acid Bact.	Gas formers.	Digestors.	Other Bact.
May 2.......	3	38	37	37.5	486,000,000	582,000(*a*)	194,000(*b*)	1,500,000
" 21.......	22	38	36	37	541,000,000	210,000(*a*)	....	630,000
" 28	29	38	38	38	519,000,000	....	....	....
June 6.......	38	39	37	38	482,000,000	....	....	182,000
" 12.......	44	40	37	38.5	310,000,000	....	91,000(*b*)	....
" 22.	54	42	38	40	261,000,000	....	....	....
July 16.......	78	42	39	40.5	73,800,000	....	....	....
Aug. 7.	100	42	38	40	42,300,000	....	....	....

(*a*) B. lactis aërogenes. (*b*) Partly M. aureus lactis. [illegible]tilis group.

Cheese of April 29th,—B. One Week in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Temperature. Max.	Min.	Av.	Lactic acid Bact.	Gas formers.	Digestors.	Other Bact.
May 2..	3	65°	55°	60°	486,000,000	582,000(a)	194,000(b)	1,500,000
" 7...	8	65	55	60	160,000,000	...	132,000(b)	760,000
" 28...	29	38	38	38	138,000,000	...	...	186,200
June 6...	38	39	37	38	106,800,000	...	...	...
" 13...	45	40	37	38.5	93,800,000	...	...	...
" 22...	54	42	38	40	88,150,000	...	126,000(b)	...

Cheese of April 29th,—C. Two Weeks in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic acid Bact.	Gas formers.	Digestors.	Other Bact.
May 2...	3	65	55	60	486,000,000	582,000(a)	194,000(b)	1,500,000
" 14...	15	66	55	61	117,600,000	...	...	...
" 28..	29	38	38	38	77,700,000	...	...	...
June 6...	38	39	37	38	75,500,000	...	...	...
" 13..	45	40	37	38.5	57,000,000	...	...	...
" 22...	54	42	38	40	54,000,000	...	...	...

Cheese of April 29th,—D. Three Weeks in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic acid Bact.	Gas formers.	Digestors.	Other Bact.
May 2..	3	65	55	60	486,000,000	582,000(a)	194,000(b)	1,500,000
" 21...	22	70	55	63	129,000,000	...	...	...
" 28...	29	38	38	38	120,100,000	...	...	...
June 6..	38	39	37	38	119,600,000	...	...	...
" 13..	45	40	37	38.5	35,000,000	...	...	...
" 22...	54	42	38	40	30,500,000	...	...	...

Cheese of April 29th,—E. Ordinary Curing Room.

Date.	Age.	Max.	Min.	Av.	Lactic acid Bact.	Gas formers.	Digestors.	Other Bact.
May 2...	3	65	55	60	486,000,000	582,000(a)	194,000(b)	1,500,000
June 6...	38	70	62	66	45,000,000	119,000(a)	...	...
" 13...	45	73	58	64	39,700,000	...	...	...
" 22...	54	74	58	67	5,300,000	...	...	...
July 16...	78	80	68	75	2,750,000	...	...	...

Cheese of May 6th,—A. Refrigerator. (Guelph.)

Date.	Age.	Max.	Min.	Av.	Lactic acid Bact.	Gas formers.	Digestors.	Other Bact.
May 6...	1	39	37	38	523,000,000	1,000,000(a)	...	500,000
" 21...	15	38	36	37	489,000,000	500,000(a)	...	...
" 29...	23	38	38	38	482,000,000	...	...	...
June 4...	29	39	37	38	475,000,000	...	...	...
" 19...	44	42	38	40	397,000,000	...	...	...
" 29...	54	42	38	40	471,000,000	...	...	...
July 16...	71	42	39	40.5	473,000,000	...	...	...
Aug. 7...	93	42	38	40	437,000,000	...	...	...

(a) B. lactis aërogenes. (b) Partly M. aureus lactis.

Cheese of May 6th,—B. One Week in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Temperature.			Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
		Max.	Min.	Av.				
		°	°	°				
May 6..	1	64	56	60	523,000,000	1,000,000(a)	....	500,000
" 14...	8	65	55	60	263,000,000	750,000(a)	....	....
" 29...	23	38	38	38	274,000,000	....	....	....
June 4...	29	39	37	38	255,100,000	....	....	....
" 12...	37	40	37	38.5	200,270,000	....	....	....
" 20...	45	42	38	40	118,000,000	....	....	....
" 29...	54	42	38	40	110,000,000	....	....	....

Cheese of May 6th,—C. Two Weeks in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 6...	1	64	56	60	523,000,000	1,000,000(a)	....	500,000
" 21...	15	70	55	63	145,000,000	....	....	....
" 29..	23	38	38	38	152,000,000	....	....	....
June 4..	29	39	37	38	141,500,000	....	....	....
" 12...	37	40	37	38.5	128,700,000	....	....	....
" 29...	54	42	38	40	109,000,000	....	....	....

Cheese of May 6th,—D. Three Weeks in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 6...	1	64	56	60	523,000,000	1,000,000(a)	....	500,000
" 14...	8	65	55	60	263,000,000	750,000(a)	....	....
" 21...	15	70	55	63	145,000,000	....	....	....
" 29...	23	69	58	64	195,000,000	....	....	....
June 4...	29	39	37	38	161,000,000	....	....	....
" 12...	37	40	37	38.5	102,000,000	....	....	....
" 20...	45	42	38	40	104,500,000	....	....	....
" 29...	54	42	38	40	72,500,000	....	....	....

Cheese of May 6th —E. Ordinary Curing Room.

Date.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 6....	1	64	56	60	523,000,000	1,000,000(a)	....	500,000
" 14...	8	65	55	60	263,000,000	750,000(a)	....	....
" 21...	15	70	55	63	145,000,000	560,000(a)	....	....
" 29...	23	69	58	64	....	....	....	....
June 4..	29	70	62	66	97,000,000	....	....	....
" 12..	37	73	58	64	82,600,000	....	....	....
" 20..	45	74	58	67	37,000,000	....	....	....
" 29..	54	68	57	64	12,000,000	....	....	....
July 16..	71	80	68	75	4,100,000	....	....	....

(a) B. lactis aërogenes.

Cheese of May 13th,—Refrigerator. (Guelph).

Date.	Age.	Temperature. Max.	Temperature. Min.	Temperature. Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
		°	°	°				
May 13..	1	38	36	37	623,000,000	1,200,000(a)	2,400,000(d)(g)	1,200,000
" 21..	8	38	36	37	612,000,000	800,000(a)	1,600,000(d)(g)	......
" 29..	16	38	38	38	615,000,000	......	710,000(d)(g)	......
June 6...	24	39	37	38	596,600,000	450,000(a)	900,000(d)(g)	......
" 12..	30	40	37	38.5	561,500,000	......	......	......
" 21..	39	42	38	40	461,000,000	......	......	......
" 24..	42	42	38	40	360,000,000	......	......	......
July 16..	64	42	39	40.5	431,000,000	......	......	......
Aug. 7...	86	42	38	40	358,000,000	......	......	......

Cheese of May 13th,—B. One Week in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 13..	1	65	55	60	623,000,000	1,200,000(a)	2,400,000(d)(g)	1,200,000
" 21..	8	70	55	63	290,000,000	400,000(a)	800.000(d)(g)	800,000
" 29..	16	38	38	38	162,000,000	......	......	......
June 5...	23	39	37	38	135,000,000	270,000(a)	......	......
" 12..	30	40	37	38.5	147,000,000	......	......	......
" 21..	39	42	38	40	209,000,000	......	......	......
" 28..	46	42	38	40	171,000,000	......	......	......

Cheese of May 13th,—C. Two Weeks in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 13..	1	65	55	60	623,000,000	1,200,000(a)	2,400,000(d)(g)	1,200 000
" 21.	8	70	55	63	290,000,000	400,000(a)	800,000(d)(g)	800,000
" 29..	16	69	58	64	229,000,000	......	220,000(d)(g)	......
June 5...	23	39	37	38	155,000 000	175,000(a)	......	......
" 12..	30	40	37	38.5	162,000,000	......	......	......
" 21..	39	42	38	40	137,000,000	......	......	......
" 28..	46	42	38	40	133,000,000	......	......	......

Cheese of May 13th,—D. Three Weeks in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 13...	1	65	55	60	623,000,000	1,200,000(a)	2.400,000(d)(g)	1,200,000
" 21..	8	70	55	63	290.000.000	400,000(a)	800,000(d)(g)	800,000
" 29..	16	69	58	64	229,000,000	......	200,000(d)(g)	......
June 4...	22	70	62	66	94,000,000	145,000(a)	......	......
" 12.	30	40	37	38.5	104,000.000	......	......	......
" 21..	39	42	38	40	106,000,000	......	......	......
" 28..	46	42	38	40	87,000.000	......	......	......

Cheese of May 13th,—E. In Ordinary Curing Room.

Date.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 13..	1	65	55	60	623,000,000	1,200,000(a)	2,400,000(d)(g)	1,200,000
" 21..	8	70	55	63	290 000,000	400,000(a)	800,000(d)(g)	800,000
" 29..	16	69	58	64	229,000,000	......	220,000(d)(g)	......
June 4. .	22	70	62	66	154,000,000	175.000(a)	......	......
" 11..	29	73	58	64	90,000,000	90,000(a)	......	......
" 21..	39	74	58	67	86,000,000	......	......	......
" 29..	47	68	57	64	24,000,000	......	......	......
July 16...	64	80	68	75	17 000,000	......	......	......

(a) B. lactis aërogenes. (d) M. varians lactis. (g) B. subtilis.

Cheese of May 20th,—A. Refrigerator. (Guelph).

Date.	Age.	Temperature. Max.	Temperature. Min.	Temperature. Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
		°	°	°				
May 20...	1	38	36	37	500,000,000	1,000,000(c)	95,000(e)	....
" 28..	8	38	38	38	473,000,000	....	....	....
June 4...	15	39	37	38	490,000,000	....	....	....
" 11..	22	40	37	38.5	446,000,000	125,000(c)	....	....
" 18...	29	42	38	40	496,000,000	....	....	....
" 27...	38	42	38	40	491,000,000	....	....	....
July 18...	59	42	39	40.5	445,000,000	....	....	....
Aug. 7....	79	42	38	40	431,000,000	....	....	....

Cheese of May 20th,—B. One Week in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 20...	1	70	55	63	500,000,000	1,000,000(c)	98,000(e)(d)	....
" 28...	8	69	58	64	456,000,000	620,000(c)	310,000(e)(d)	....
June 4...	15	39	37	38	455,000,000	....	....	....
" 11...	22	40	37	38.5	350,000,000	123,000(c)	....	....
" 18..	29	42	38	40	378,000,000	....	....	....
" 28...	39	42	38	40	296,000,000	....	....	....

Cheese of May 20th,—C. Two Weeks in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 20...	1	70	55	63	500,000,000	1,000,000(c)	95,000(c)	....
" 28...	8	69	58	64	456,000,000	620,000	310,000(c)(d)	....
June 4...	15	70	62	66	329,000,000	200,000	....	....
" 11...	22	40	37	38.5	313,000,000	....	....	....
" 19...	30	42	38	40	289,000,000	....	....	....
" 29...	40	42	38	40	216,000,000	....	....	....

Cheese of May 20th.—D. Three Weeks in Ordinary Curing Room and then into Refrigerator.

Date.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 20...	1	70	55	63	500,000,000	1,000,000(c)	95,000(e)	....
" 28...	8	69	58	64	456,000,000	620,000(c)	310,000(e)(d)	....
June 4...	15	70	62	66	320,000,000	200,000(c)	....	....
" 11...	22	73	58	64	172,000,000	....	....	....
" 19...	30	42	38	40	139,000,000	....	....	....
" 29...	40	42	38	40	116,000,000	....	....	....

Cheese of May 20th,—E. Ordinary Curing Room.

Date.	Age.	Max.	Min.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 20...	1	70	55	63	500,000,000	1,000,000(c)	95,000(c)	....
" 28...	8	69	58	64	337,000,000	....	....	....
June 18..	29	74	58	67	123,000,000	210,000(c)	....	....
" 29..	40	68	57	64	41,000,000	....	82,000(d)	....
July 9....	50	80	68	74	3,000,000	....	....	....

(c) B. coli and B. lactis aërogenes. (d) M. varians lactis. (e) B. fulvus.

Cheese of May 27th,—A. Refrigerator (Guelph).

Date.	Age	Temperature. Min.	Max.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
		°	°	°				
May 27...	1	38	38	38	635,000,000	....	....	....
June 4...	8	39	37	38	520,000,000	....	....	....
" 11...	15	40	37	38.5	475,000,000	....	....	....
" 18...	22	42	38	40	477,000,000	....	....	....
" 25...	29	42	38	40	494,000,000	....	....	....
July 18...	52	42	39	40.5	253,000,000	....	....	....
Aug. 7...	72	42	38	40	255,000,000	....	....	....

Cheese of May 27th—E. Ordinary Curing Room.

Date.	Age	Min.	Max.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
May 27...	1	69	58	64	635,000,000	....	....	....
June 4...	8	70	62	66	273,000,000	....	....	....
" 11...	15	73	58	64	264,000,000	....	....	....
" 25...	29	74	58	67	175,000,000	....	....	....
Aug. 7...	72	71	62	67	32,000,000	....	....	....

Cheese of June 3rd,—A. Refrigerator (Guelph).

Date.	Age	Min.	Max.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
June 3...	1	39	37	38	584,000,000	7,000,000(c)	800,000(g)	....
" 11..	8	40	37	38.5	494,000,000	2,000,000(c)	....	....
" 18...	15	42	68	40	366,000,000	420,000(c)	....	....
" 24...	21	42	88	40	308,000,000	114,000(c)	....	....
July 15...	45	42	39	40.5	302,000,000	....	....	....

Cheese of June 3rd,—E. Ordinary Curing Room.

Date.	Age	Min.	Max.	Av.	Lactic Acid Bact.	Gas formers.	Digestors.	Other Bact.
June 3...	1	70	62	66	584,000,000	7,000,000(c)	800,000(g)	....
" 11...	8	73	58	64	341,000,000	1,630,000(c)	....	....
" 18...	15	74	58	67	291,000,000	1,212,000(c)	....	....
" 24...	21	74	58	67	209,000,000	80,000(c)	....	....
July 15...	45	80	68	75	161,000,000	523,000(c)	....	....
" 25...	55	77	61	69	87,000,000	....	....	....
Aug. 9...	70	71	62	67	4,200,000	....	....	....

(c) B. coli and B. lactis aërogenes.
(g) B. subtilis and B. halofaciens.