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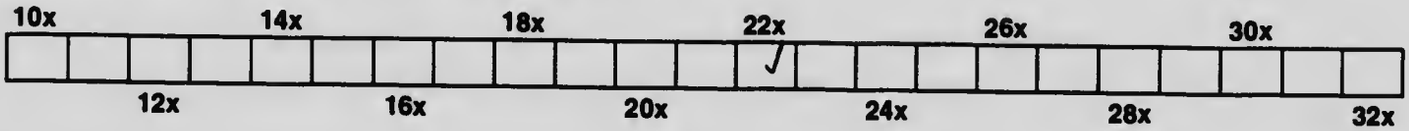

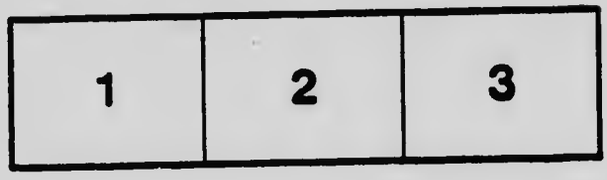

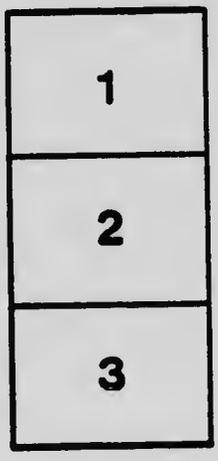

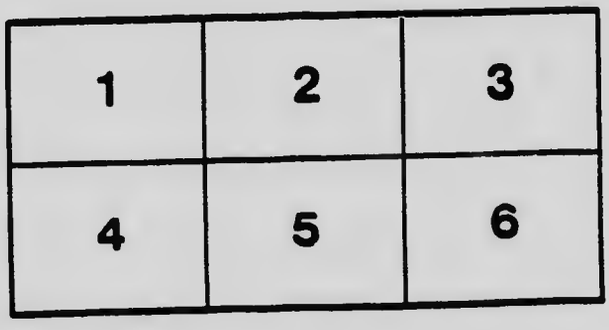

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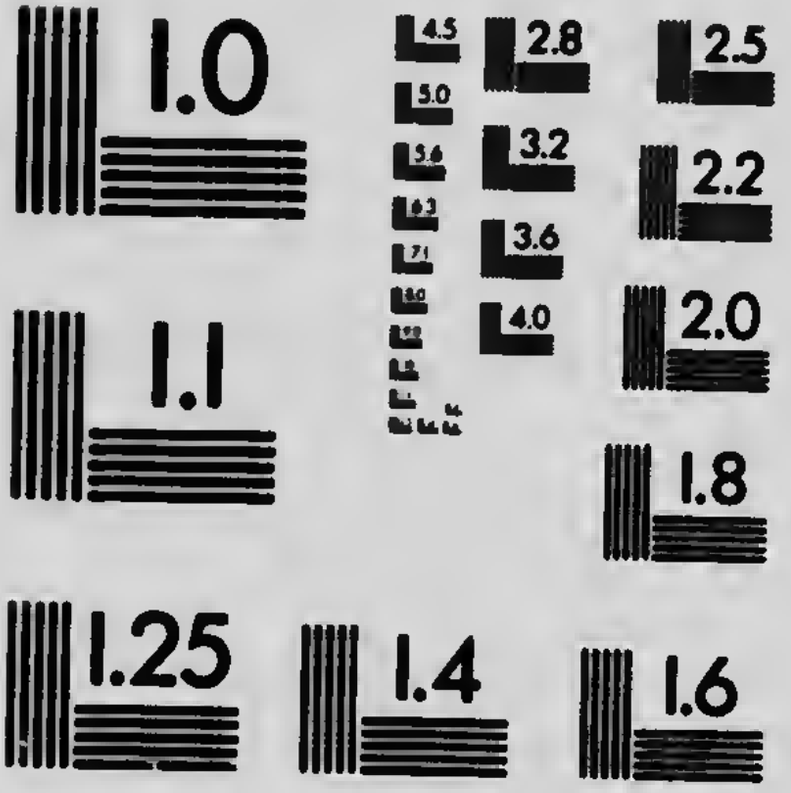

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DEPARTMENT OF AGRICULTURE
DAIRY AND COLD STORAGE COMMISSIONER'S BRANCH
OTTAWA, CANADA

THE COOLING OF MILK FOR CHEESEMAKING

BY

J. A. RUDDICK AND GEO. H. BARR

BULLETIN No. 22

Dairy and Cold Storage Commissioner's Series

Published by direction of the Hon. SYDNEY A. FISHER, Minister of Agriculture. Ottawa, Ont.

FEBRUARY, 1910

12439—1

LETTER OF TRANSMITTAL.

The Honourable

The Minister of Agriculture.

SIR,—I have the honour to submit for your approval, the manuscript for a bulletin on 'The Cooling of Milk for Cheesemaking,' which has been prepared from the results of a series of experiments conducted under my direction by Mr. Geo. H. Barr, Chief of the Dairy Division, assisted by Mr. J. G. Bouchard, of the dairy staff.

I beg to recommend that it be printed and distributed as Bulletin No. 22 of the Dairy and Cold Storage series.

I have the honour to be, sir,

Your obedient servant,

J. A. RUDDICK,

Dairy and Cold Storage Commissioner.

OTTAWA, February 28, 1910.

THE COOLING OF MILK FOR CHEESEMAKING.

BY J. A. RUDDICK AND GEO. H. BARR.

INTRODUCTION.

The recommendations which will be found in these pages are based on the results of an extensive series of experiments which were carried out by members of the staff of the Dairy Division during the seasons of 1908 and 1909. Full details of the experiments, of which only a summary is given herein, will be found in the reports of the Dairy and Cold Storage Commissioner for 1909 and 1910, and these reports will be sent to any person who applies for them.

Inasmuch as the recommendations referred to are against the practice of aerating or exposing the milk to the air in any manner, it may be advisable to offer a few words of explanation on that point.

The aeration of milk intended for cheesemaking has been advocated for 20 years or more, and until recently it was generally believed to be beneficial. It is a rather curious fact, however, that one cannot find a single instance of a careful and reliable experiment the results of which are in favour of aeration. Belief in the practice was probably strengthened by the fact that marked improvement was noticeable in the quality of Canadian cheese during the years following the adoption of aeration. In the light of present knowledge, it is clear that this improvement should be attributed to better methods of cheesemaking, and to the work of instruction which was begun about the same time, rather than to the practice of aeration.

The process of cheese manufacture is essentially a process of fermentation. The whole art of cheese making consists in the control of those fermentations which arise from the germs that find entrance to the milk after it is drawn from the cow. The skilful cheesemaker of to-day secures the proper fermentation in the milk and cheese by the use of carefully prepared fermentation 'starters.'

At the time when the practice of aeration was first introduced, the intelligent use of the starter was quite unknown and unpracticed. Undoubtedly, the aeration of milk facilitates the introduction of the germs of fermentation, but as the introduction is uncontrolled and depends to a large extent on chance, the result is very uncertain. In addition to the uncertainty, the entrance of undesirable germs is favoured quite as much as is the entrance of those which are useful.

With the use of the starter, the aeration of milk is not only superfluous, but in most cases, positively harmful, by counteracting the beneficial effect of the starter.

As the role of bacteria in cheesemaking came to be better understood, dairy students began to realize that the practice of aeration was contrary to the principles of dairy bacteriology and to doubt its value in the handling of milk. It was found that in those dairies of England and Scotland where the very finest of Cheddar cheese is made, the milk is never aerated in the sense that it has been in this country. Observant cheesemakers have noticed that they frequently received better milk from patrons who never aerated it, than they did from those who followed the practice. By degrees leading instructors and others became convinced that aeration of milk was not only unnecessary, but might be positively harmful. Prof. Dean of Guelph, after experiments at the College, reported against aeration, and American experimentalists failed to find any benefit in the practice. There was, however, very little authoritative data upon the subject, and it was with a view of supplying this data that the experiments already referred to were undertaken.

THE EXPERIMENTS.

In 1908 the experiments were carried out with the milk of two herds numbering 35 cows. The two men in charge of the experiments were always present at the evening milking and they personally handled the milk, keeping accurate records of temperature, &c. The milk of each cow was divided equally into two parts and each part was treated differently. The morning's milk was strained into separate cans and not aerated or cooled in any way.

A complete equipment of cheesemaking apparatus, including two small cheese vats, was installed in a spare room of the Rideau Queen cheese factory at Smith's Falls, Ont., of which the owners of the herds were patrons. When the milk was delivered at the factory, careful tests were made for fat, acidity and flavour, the fermentation curd test being used to determine the flavour. The milk, according to the treatment which it had received, was placed in two vats and each lot made up separately. That part of the evening's milk from both farms that had been cooled only was put into one vat, while the part that had been treated differently was put into the other one. The morning's milk from both farms was divided equally between the two vats. The curds were carefully watched for the development of gas and flavours, and photographs were taken of sections from the curd in each vat to show the difference in texture between the two. (Fig. 1, Plate II.)

The cheese were cured in the ordinary way and for the usual period, after which they were shipped to cold storage, where they were examined from time to time as to quality.

The results of the 1908 experiments, carried on during June, July and August, are summarized in the following table:—

TABLE I.—Experiments on the Care of Milk.—Defects in Curds and Cheese.

—	Milk aerated by dipping.	Milk run over an aerator.	Milk aerated and cooled.	Milk cooled with water in shotgun can.	Milk cooled in tub of water.
No. Curd Tests—	18	22	18	10	30
Not Clean Flavour.....	83·4%	68·2%	44%	10%	6·6%
Gassy Texture.....	77·8%	68·2%	44%	20%	6·6%
No. of Curds—	9	12	10	5	15
Not Clean Flavour.....	88·9%	50·0%	40%	.....	
Gassy Texture.....	77·8%	50·0%	20%	.....	
Cheese—					
Not Clean Flavour.....	77·8%	75·0%	60%	20%	13·3%

In 1909 a different plan was followed. The milk supplied by the 40 patrons of the factory was used. The patrons were divided into two groups, and each group was asked to treat the milk day by day as required for the various tests. For instance, No. 1 group was instructed to cool the evening's milk with as little exposure to the air as possible, and not to dip or stir it, while the other group was to aerate by pouring, dipping, &c. The instructions to the two groups were reversed from time to time to eliminate as far as possible any interference with the results by other factors. These experiments covered the period between June 11 and August 12, 1909.

The results in 1909 confirmed in every respect those obtained in 1908, and some additional information regarding the loss in yield from overripe milk and 'gassy' milk was secured.

FIG. 1.

On this stand 71 per cent of the curd tests were good when the milk was cooled without aeration. None were good when it was dipped. The milk cooled and dipped on this stand was the cause of the gassy condition in the curd marked 3-A in Fig. 1, Plate II.

FIG. 2.

On the above stand 70 per cent of the curd tests were clean in flavour when the milk was cooled without aeration and only 17 per cent were clean when the milk was dipped without cooling.

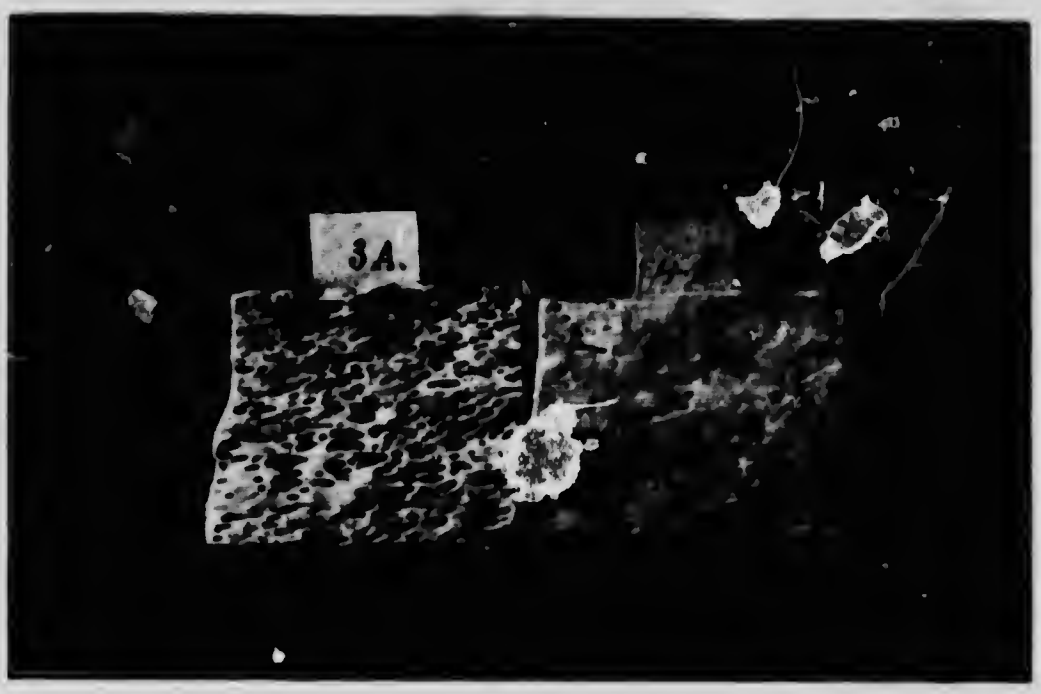

FIG. 1.

3 A—Curd made from milk cooled and dipped by half of the patrons.
4 A—Curd made from milk cooled without aeration by the other half of the patrons on August 3, 1909.

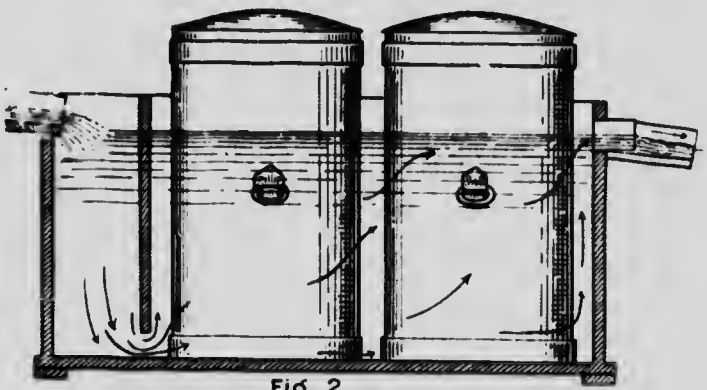

Fig. 2.

Tank for Cooling Milk in Cans

It must not be assumed that the mere cooling of the milk insured a good flavour in every case. Table I. shows that it did not always give that result. Cooling will not correct the bad effect of a lack of cleanliness in milking, or the use of rusty or dirty cans or utensils, any more than aeration will. The point to remember is this: *cooling only in nearly every case gave decidedly better results than cooling and aeration or aeration alone. In no case did the cooled milk produce cheese that was inferior in flavour to that which was aerated or aerated and cooled.* The plan of cooling only has the additional advantage that it is the easiest and simplest method of handling the milk.

Losses from Overripe or Tainted Milk.

The losses which result to patrons of cheese factories from overripe and tainted milk are very serious, and deserve more attention than they have received from those interested.

TABLE II.—Comparison of the yield from 4 vats of normal milk with the yield from 4 vats of overripe milk. The fat and casein tests were the same in all vats.

	Acidity of Milk.	Lbs. Milk.	Lbs. Cheese.	Lbs. Milk to 1 lb. Cheese.
Normal Milk	·21	15,969	1,437½	11·11
Overripe Milk	·24	15,715	1,401	11·21

Total loss on 15,715 lbs. of overripe milk equal to 148½ lbs. of milk, or 13·36 lbs. of cheese.

TABLE III.—Comparison of the yield from 4 vats of normal milk with the yield from 4 vats of 'gassy' or tainted milk. The fat and casein tests were the same in all vats.

	Acidity of Milk.	Lbs. Milk.	Lbs. Cheese.	Lbs. Milk to 1 lb. Cheese.
Normal Milk	·212	15,311	1,366¼	11·20
Gassy Milk	·217	14,673	1,294¼	11·33

Loss on 1,000 lbs. gassy milk equal to 1·03 lbs. cheese.

These losses are avoided if the milk is sufficiently cooled in hot weather to prevent it from becoming overripe. In this connection, it should be understood that milk is overripe from a cheesemaking standpoint, before it reaches the stage of tasting sour.

We are justified in saying that the losses in these experiments were not as great as they often are in ordinary factory practice, for the reason of the greater skill and experience of those in charge of the work, as compared with the average cheesemaker, and for the further reason that there was plenty of help to handle the milk to best advantage.

THE ILLUSTRATIONS.

Fig. 1, Plate I. shows a milk stand on one of the farms included in these experiments. This stand would be generally considered to have a good location. It is surrounded by a comparatively large area of clean, grass covered yard and is some distance from the stables or manure heaps. Notwithstanding these favourable conditions, it is a fact that when the milk was exposed to the air on this stand by dipping or pouring, it was invariably 'gassy' as shown in the illustration. (Fig. 1, Plate II). When it was cooled without exposure to the air, and the cover put on the can as soon as milking was finished, there was no evidence of gas. Fig. 2 shows a stand, not quite so well located, being nearer to the stable yard, where the same results were obtained. These examples—and we have many others—indicate clearly that no matter how 'good' the location of the milk stand is, there is always danger of infection of the milk, unless exposure to the air is avoided.

Fig. 1, Plate II. is a photograph of two pieces of curd, the particulars of which are given in the note accompanying the cut. It may be necessary to explain, for the benefit of those who are not familiar with the processes of cheese manufacture, that the piece of curd marked '3A' is what is known as a 'gassy' curd, on account of the numerous holes in it, caused by the development of gas, which is a product of the growth of a certain class of germ that get into the milk after it is drawn from the cow. The piece of curd marked '4A' shows none of these gas holes. The holes which appear in it are merely mechanical holes, which are always present in curd. This illustration shows very clearly the bad effect of exposing the milk to the air.

Fig. 2 Plate II. shows a convenient arrangement for cooling milk by placing the cans in a tank which is filled with cold water. The cold water is conducted to the bottom of the tank and the overflow is from the top. If water is pumped for stock, the overflow from the tank can be carried to the water trough.

RECOMMENDATIONS.

1. Evening's milk intended for the manufacture of cheese should be placed in the cans as soon as possible after milking. In warm weather, the milk should be cooled by surrounding the milk cans with cold water, or water and ice. A tub made from a barrel cut in two will serve the purpose, or a special tank, like the one in the illustration, may be made to hold several cans. If the supply of water is limited, ice may be used with advantage. Where there is plenty of cold well water, ice is not absolutely necessary, except when the milk is to be kept over Sunday. Do not dip or pour the milk.

2. The cover should be placed on the cans as soon as the milking is finished and left there for the night. There will be no clotted cream on the surface of the milk when the milk is cooled and the can is covered.

3. It is advisable to deliver the evening's and the morning's milk in separate cans, but if for any reason the two milkings must be delivered in the same can, and the morning's milk is not cooled, the evening's milk should be cooled to 60 degrees or under. If the two milkings are delivered in separate cans, or if the morning's milk is cooled to 75 degrees, the evening's milk need not be cooled lower than 65 degrees under ordinary circumstances. The morning's milk need not be cooled when it is delivered in a separate can, and it should not be dipped or aerated in any case.

4. When milk is to be kept over Sunday, it should be cooled to 50 degrees or under.

5. A thermometer should be used to determine the temperature. Use only the special dairy thermometers made wholly of glass, and known as 'float' thermometers.

NOTES.

Covering the Cans.

Our advice to put the covers on the cans as soon as milking is finished, is contrary to what has been the usual practice among cheese factory and creamery patrons. It has been popularly supposed that the milk should be left uncovered to facilitate the escape of 'animal heat,' 'animal odours,' and so on. On the other hand, in the high class dairies where milk is bottled for direct consumption, the practice is to put the milk in a tightly stoppered bottle as soon as possible after milking. Our experiments proved that the best results were obtained by covering the milk. It protects it from insects, dust, falling leaves, or other dirt which may find entrance and thus carry to the milk many injurious germs of one kind and another.

It also prevents the evaporation from the surface of the milk that causes the formation of a tough, leathery surface of cream, much of which is lost in the process of cheesemaking.

Water for Cooling.

The quantity of water that is required to sufficiently cool a given quantity of evening's milk depends on several conditions, such as the temperature of the water itself, whether the evening is a cool one or a warm one, and at what hour the milk is delivered at the factory in the morning. The latter point is important. Milk that is delivered at the factory at 6 a.m., as is the practice at many factories, does not require as much cooling as it would if delivery were delayed two or three hours.

Generally speaking, if deep well water is available at a temperature of 50 degrees or under, a quantity equal to that of the milk will be sufficient for the purpose. If the water is warmer, a larger quantity will be required. If the supply of water is limited, ice can be used in it to good advantage. One pound of ice has a cooling power in this connection equal to 8 to 10 pounds of the coldest well water.

Water a Better Cooling Medium than Air.

Water is a better cooling medium than air is. Thus, if the milk cans are surrounded with water at a temperature of 50 degrees, cooling is effected more quickly than if the cans are surrounded with air at the same temperature. Quick cooling is important.

GENERAL.

No attempt is made in this bulletin to deal with other phases of the production of milk for the manufacture of butter or cheese. While we desire at this time to draw special attention to the importance of cooling milk and to the advisability of discontinuing the practice of aeration, we do not wish to minimize the importance of good health in the cows, of suitable feeds, of sanitary conditions in stables and yards, of cleanliness in milking and in the care of utensils.

These experiments relate to the manufacture of cheese, but the principles laid down apply also to the handling of milk for buttermaking, or for direct consumption.

Managers of creameries or cheese factories may obtain copies of this bulletin in French or English for each patron, by application to the Dairy and Cold Storage Commissioner, Ottawa. Requests for Bulletins should state the number required.

LIST OF PUBLICATIONS

OF THE

DAIRY AND COLD STORAGE COMMISSIONER'S BRANCH.

Date Issued.	No.	Title.
1905	1	List of Some British Importers of Farm Products.
1905	†2	Care of Milk for Cheese Factories.
1905	†3	Care of Milk for Creameries.
1905	†4	Some Phases of Dairying in Denmark.
1905	5	Improvement of Dairy Herds.
1905	6	Chemical Investigations Relating to Dairying in 1904.
1905	7	List of Exporters of Some Canadian Products.
1906	8	Some of the Factors that Control the Water Content of Butter.
1906	†9	Instructions for Testing Individual Cows, &c.
1906	10	Creamery Cold Storage.
1906	11	General Instructions *re* Fruit Marks Act as Amended, 1902, 1906 and 1908.
1906	12	Cow Testing Associations, with Some Notes on the Sampling and Testing of Milk.
1907	13	Sweet-Cream Butter.
1907	14	Apparatus for the Determination of Water and Fat in Butter.
1907	*15	Gathered Cream for Butter Making.
1907	16	Subsidies for Cold Storage Warehouses.
1907	17	Buttermaking on the Farm.
1907	†18	Co-operation in the Marketing of Apples.
1907	19	The Packing of Apples in Barrels and Boxes.
1907	*20	The Use of Ice on the Farm.
1907	†21	Report of the Cow Testing Associations.
1906		Report of the Dairy Commissioner, January, 1905, to March, 1906.
1907		Report of the Dairy and Cold Storage Commissioner, 1907.
1908		Report of the Dairy and Cold Storage Commissioner, 1908.
1909		Report of the Dairy and Cold Storage Commissioner, 1909.
1907		Map Showing the Location of Cheese Factories and Creameries in Canada.

Any of these publications will be sent free of charge on application to the Dairy and Cold Storage Commissioner, Ottawa, Ont.

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* A sufficient number of bulletins No. 15 and 20 will be sent to the manager of any cheese factory or creamery to supply one to each patron.

† Out of print.