

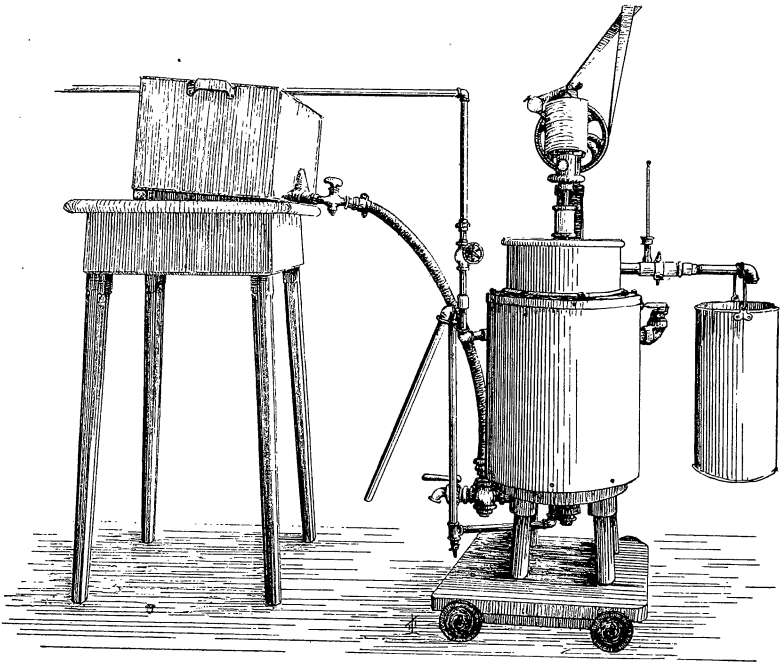
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CONTINUOUS PASTEURIZATION OF MILK.

F. H. HALL, H. A. HARDING AND L. A. ROGERS.

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*Connected with Fertilizer Control.

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POPULAR EDITION*

OF

BULLETIN NO. 172.

CONTINUOUS PASTEURIZATION OF MILK.

F. H. HALL.

Danish butter is the standard of excellence wherever it is known. It may not be better than **Pasteurization a proved process.** the *best* butter of American makers, but it is *always* very good; while even New York State, the home of good buttermakers, sends to the markets much *excellent* butter, more that is merely *edible* and some that is *execrable*.

Why is there this difference?

Because Danish methods and New York methods are different.

In Denmark the necessity for absolute cleanliness is thoroughly understood by all dairymen and neatness is consistently sought by all who engage in buttermaking. Natural cleanliness is also supplemented by processes which destroy most of the germs which might cause bad flavor and substitute for them mixtures of bacteria known to produce butter flavor that is uniformly good.

New York buttermakers are fast learning the necessity of cleanliness, though many of them have still much to do before perfect purity characterizes milker, pail and can. Few of them, though, practice or even know those processes which the Danish

* This is a brief review of Bulletin No. 172 of this Station, on The Efficiency of a Continuous Pasteurizer at Different Temperatures, by H. A. Harding and L. A. Rogers. Anyone specially interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete bulletin. The names of those who so request will be placed on the Station mailing list to receive future bulletins, popular or complete as desired. Bulletins are issued at irregular intervals, as investigations are completed, not monthly.

dairymen have found so valuable an addition to their natural neatness.

Few creameries or butter factories in Denmark are without pasteurizers. The milk is run through these machines to free the milk from most of the germs it may contain, is then separated, and the cream is "started" with a mixture of bacteria of which each species is a source of good butter flavor. The united efforts of the several species, developing in cream made practically germ-free, rarely fail to secure fine flavor in the butter. The uniformity of Danish dairy products is proof that pasteurization there is both practical and profitable. Why has it not come into more general use in America?

All the ordinary fermentations and decays are due to the growth of minute plants within the fermenting or decaying materials. Souring of milk, ropiness of cream, gas bubbles in cheese and many butter faults are due to the life processes of these little plants which multiply with great rapidity in so favorable a medium as milk.

We speak only of fermentations of dairy products; but the same conditions are found in meat, vegetables, fruit, wine and all organized bodies.

Like plants of higher orders, these tiny little fellows, only a single cell, are susceptible to heat and cold. Some of them will stand much more than others; but all can be killed by heating them to a greater or less degree for a short or long time. Cold checks their growth, but does not kill them. The process by which *most* of them can be destroyed, by the use of a moderate degree of heat, is known as pasteurization. The process by which *all* are destroyed, by more intense, more prolonged or repeated heating, is known as sterilization.

Pasteurization is not a new process though the name is recent. More than a century ago a Swedish chemist found that heating vinegar improves its keeping qualities; and early in the nineteenth century, the same process was applied to the preservation of fruits, vegetables, etc. Our method of household canning is really pasteurization; but it was not until

in the last half of the century, when Pasteur gained such success in checking undesirable fermentations of wine and beer by heating, that the process received its present name.

Two methods. Pasteurization of milk has been commonly practiced in America for several years; chiefly upon milk for household consumption, the main object being to kill the germs of tuberculosis or other diseases which might be in the milk. The milk has been made to keep longer by this heating; that is, the germs, or bacteria, causing souring were largely destroyed and fermentation thus checked; but this was only an incidental feature in most cases. Destruction of disease germs was the principal object sought. Many ways of accomplishing this have been tested, differing principally in the method of applying the heat, the degree of heat required and the time of exposure; but all involving the use of vessels of milk immersed in or surrounded by hot water. Heating to 140°F. for 30 minutes is now probably most in favor; as this assures death to the tubercle bacillus without seriously affecting the flavor of the milk.

This method however, is not suitable for handling large quantities of milk rapidly; as would be necessary where pasteurization is made an adjunct of butter making. Here, some provision must be made for the continuous operation of the pasteurizing apparatus; and the Danes have met the necessity by using a machine similar to the one shown on the title page of this bulletin. This consists of a steam-jacketed chamber into which the milk flows from below. A stirrer, revolving rapidly, spreads the milk in a thin layer upon the inner wall of the steam jacket. The milk may be made to reach a high temperature before it flows from the outlet at the top. The temperature may be altered by increasing or diminishing the rapidity of flow of the milk or the supply of steam in the steam chamber.

Failures of continuous pasteurizers. Some experiments have been made at American stations to test the efficiency of these machines; but, hitherto, the results have not been satisfactory. The butter made from milk treated in this way was not sufficiently improved in quality to repay the additional outlay. Study of the

conditions under which these tests were made, however, indicates that the milk was not really *pasteurized*. The temperatures used, from 155° to 165° F., were too low to secure perfect pasteurization in a continuous machine.

In experiments with the discontinuous system—heating a quantity of milk at once and holding the temperature for some time—it was found that milk heated to more than 158° has a disagreeable, cooked flavor. Accordingly, in previous experiments with the continuous pasteurizer this temperature was considered the highest one safe to use; notwithstanding the experience of the Danes, who employ temperatures at least 25° higher than this and frequently 35° higher.

In consequence of this low “pasteurizing temperature” taken for tests of the continuous flow machines, very imperfect germ-killing effect was secured. Sometimes only 40 per ct. of the bacteria were killed, so that enough were left to overcome any good effect of a “pure culture” starter afterward used.

The discredit thus cast upon these machines as pasteurizers was due to running them at too low temperatures; and the use of the low temperature was based on improper reasoning: First, the principal cause of the cooked flavor is not the high temperature, so much as the exposure of the hot milk to the oxygen in the air. When the milk heated in a Danish pasteurizer is quickly cooled, very little of the cooked taste is noticed. Second, the milk passing through a continuous machine starts at a low temperature and only reaches the “pasteurizing temperature” for a fraction of a minute just before it leaves the machine; hence the effect of heating to any given temperature is far less than heating to the same temperature and holding the milk at that degree for from 15 minutes to an hour. The Danes take as the minimum temperature for continuous pasteurization 185° F., which is 25° higher than the temperature used in most of the American tests. This degree has been found necessary to kill all the bacilli of tuberculosis.

Guided by these considerations, it seemed best to make new trials of the Danish system. These have been carried on during the past summer, fall and winter.

Low temperature not necessary.

New tests made.

The mixed milk of the Station herd, with some milk purchased from outside parties, has been passed through the machine at various temperatures. Effort was made to approximate ordinary factory conditions, no special pains being taken to secure cleanliness. The milk was allowed to stand a day, a day and a half and even two days in some cases, was then mixed with that of following milkings, and heated to about summer heat in a tempering vat. The bacteria were thus allowed to grow for some time under quite favorable conditions; so the unpasteurized milk contained vast numbers of these little fermentation producers. Frequently the milk contained $\frac{2}{10}$ of 1 per ct. of lactic acid from their action; and laboratory investigation of different samples revealed the presence of from tens of thousands to millions of bacteria in each cubic centimeter of milk (about one-third of a teaspoonful).

When this milk was run through the pasteurizing machine at such a rate and with such steam supply in the chamber that temperature of the milk just before it left the outlet was 158° F., the effectiveness of germ destruction varied greatly. Occasionally the samples taken as the milk left the machine would show very few living germs; but usually there were from a thousand to sixty-thousand or more left in each cubic centimeter of milk.

When the temperature was raised to 176° F., the effect was excellent. The numbers of bacteria present were reduced from hundreds of thousands and even millions to two or three hundred at most, usually to a much smaller number.

At a temperature of 185° , but few more of the bacteria were killed, though the reduction in number was perhaps a little more uniform, and the use of this temperature made certain the destruction of the germs of tuberculosis.

Butter made from milk heated momentarily to 185° F. and then quickly cooled, had a very slight cooked taste when first made; but this soon entirely disappeared. Whether this taste appears at all or not depends upon the treatment of the milk after pasteurizing.

Previous American tests of the continuous pasteurizers have been made at too low temperatures.

Perfectly satisfactory results with this method can not be secured below 176° F.

Heating milk momentarily to 185° F. insures death to the bacilli of tuberculosis; reduces to a negligible quantity the other bacteria in milk; and does not give a permanent cooked taste to the butter.