THESIS.

The Best methods of preserving milk

S. W. Tracy. 1896

-: T H E S I S :-

on

THE BEST METHODS OF PRESERVING MILK.

S. W. Tracy.

August 12th, 1896

THESIS

THE BEST METHODS OF PRESERVING MILK.

In this experiment it has been my aim to make a test of the different ways of preventing the rapid souring of milk, and thereby to show how the profits of the dairy business may be greatly increased. The modern ways of preserving milk have made very rapid advancements. Discovery after discovery has been made until now one may find a great amount of literature on the subject. The practicability of the methods and the great benefits it gives to mankind makes it a work that an unselfish scientist would delight in doing. It requires no logical syllogism to show that if we can invent means by which we can preserve milk twice as long as it is kept now, we would greatly improve the present economic conditions. If one wishes to make a study of this subject he can do no better than read the life of Louis Pasteur to give him greater stimulus and aspirations to investigate. The great army of bacteriologists, of which Pasteur has been the leader, has done much in solving the complicated questions that arise concerning the souring of milk.

It is well known that milk undergoes a most rapid change which in a short time renders it worthless as food to the human race. Such a change, the bacteriologist tells us, is due to the presence of some forms of bacteria. To destroy or at least impair the vigor of the growth of these minute organisms would necessarily prevent, for a time at least, the rapid souring of milk. The different ways of rutrance of the bacteria to the milk is a question too complicated and

altogether too long for me to treat here, except to say briefly that bacteria are found everywhere; they permeate the atmosphere the world over. Bacteria are found everywhere to such an extent that it would be impossible to have conditions where milk would not be subject to that influence. But we can greatly lessen the activity of developement of germ life by being most scrupulously careful and clean in the dairy at all times and at all places; yet no matter how great care we take, we can not absolutely destroy all these minute organisms.

As it is quite impossible to prevent germs getting into the milk, it then remains for us to take the alternative, which is the destruction of the germs that have already infected it. With the above facts relative to the prevalence and power of these germs in souring milk, I began my experiment in checking the growth of germs in the milk. There are two principal ways, namely by the use of

1st, Chemical Agents.

2nd, Physical Agents.

On account of the short time and lack of the supply of certain reagents and apparatus, I found it quite impossible to make extendedexperiments by the use of chemical agents. Such being the case I performed the majority of methods by the use of physical agents. This being the case I will dwell but briefly upon the first division.

The great trouble with the use of chemicals as preventives to the growth of germs is that the chemicals are so

strong as to give the milk a bitter acid taste, thus making the cure worse than the desease. Such disinfectants as carbolic acid, mercury, iodine, etc., cannot be used in the experiment. Prof. Russell very properly divides the chemicals that can be used into two classes.

1st, Those that unite chemically with certain products of germ growth and form more or less inert substances in the milk.

2nd, Those that restrict or inhibit the developement of fermentative organism in the milk.

As representatives of the first kind we have the alkaline salts that combine with the acid formed in the milk. These salts neutralize the acidity of the milk caused by the growth of germs. But this neutralization of the milk does not kill the germs, and as some germs that cause souring can develope better in an alkaline medium, hence this means is of little practical use and is not worthy of further consideration.

Of the second class salicylic and boracic acid and their derivatives are the principal ones used. By the use of these chemicals we may greatly increase the time that milk will remain sweet, but at the same time we can hardly add a sufficient amount of the chemicals before it will be noticable in the taste of the milk. In fact one may greatly injure himself by the constant drinking of milk treated with

acids. The bogus and unconscientious chemist has recognized the antiseptic qualities of these chemicals and has put many such on the market. Needless to say that they do not contain the qualities that are extrolled of them. As the use of chemicals is a somewhat dangerous method to prevent the souring of milk and is at the same time expensive and trouble some, there is no need for its use when one knows how to keep milk by the Physical methods.

PHYSICAL METHODS.

In my experiment the seven different methods given below were used:

1st, Samples of milk were left in open and closed vessels, to be taken as standards by which to judge the others.

2nd, Immediate cooling of milk.

3rd, Aeration of milk.

4th, The milk was aerated and then cooled.

5th, Milk run through the Separator.

6th, Milk run through the Separator and then cooled.

7th, The milk was Pasteurized.

Before describing these methods I will give a brief statement as to the surrounding conditions of the milk. During the first half of the experiment the tests were made between 5:00 and 6:30 A.M. The bottles were left in the test room of the Agricultural Laboratory basement. During

the latter part of the experiment the bottles were kept in a refrigarator. The temperature of the milk as it was brought in from the barns was taken, the average being about 90 degrees Far. The water was kept at about 40 degrees F. The temperature of the room in the early morning was from 60 degrees to 80 degrees (Far.) The acidity of the milk was taken each morning, its average being from 10 to 14 cubic centimeter of $\frac{n}{10}$ (the tenth normal) alkaline test. The first lot of the experiments were subjected to the above conditions, while the second lot of test were subjected to somewhat different conditions which are given with each method. The jars used during the entire experiment were the ordinary one quart fruit jars, and frequently there were most thoroughly steamed so as to destroy all the germs that might exist about them. The acidity of the milk as it came from the barn was taken each morning. In the experiment the open and closed jars of each set were placed side by side until the following morning when the acidity of the milk for that day was taken. This process was kept up until the milk curdled.

The first method was very simple and consisted of determining the difference in the rapidity in souring in the open and closed jar. This method was very important as it represented the manner in which milk in the average home is kept, and with this method we compare the other methods of keeping milk. To determine the difference between keeping

milk in a closed and open vessel, all the methods were conducted on this plan.

The second and seventh method consisted of temperature variations. Bacteriologists tell us that germs can be destroyed when they are subjected to very high temperature, while at the same time the quality of the milk is not injured. The variation of temperature will be considered in their respective experiments.

The Second Method: All the conditions given in experiment No. 1. were used in this case, and in addition the samples were placed in ice-water until a temperature of 50 degrees had been reached. The time it remained in the water, the temperature of the milk, before and after treatment, was taken.

METHOD No.3: In this case the milk was thoroughly aerated by passing it from one jar to another, the process being continued for about five minutes. After taking the temperature the milk was then placed in both kind of jars.

METHOD No. 4: Was identical with the above except that the milk was cooled rapidly down to 50 degrees. The time it remained in the water and the temperature of the milk was taken.

METHOD No. 5: In this experiment the milk was run through a separator after which the cream and skimed milk

were remixed. The temperature was taken both before and after being separated.

METHOD No. 6: Was identical with the previous one except that in addition it was rapidly cooled down to 50 degrees. The time it remained in the water and the temperature of the milk was taken.

METHOD NO. 7: The pasteurization of milk is not a method of great complexity as its name seems to indicate. It is the application of a high degree of heat for a short period of time, and is one of the oldest and best known methods of preserving milk, it being first extensively used by Pasteur in 1868. Like most all discoveries it was some years before its merits became known. It has only been during the last decade that the pasteurization has been generally acknowledged as the best means of purifying milk. The great objection to it, is that it imparts to the milk a peculiar and somewhat disagreeable flavor resembling the taste of cooked or boiled milk. The theory of this method is that the high temperature destroys the life of the germs that produce the acidity of the milk. Simply heating the milk does not entirely eliminate all forms of bacteria, but when the milk is subject d to a terperature of 175 degrees it practically destroys all forms of germ life.

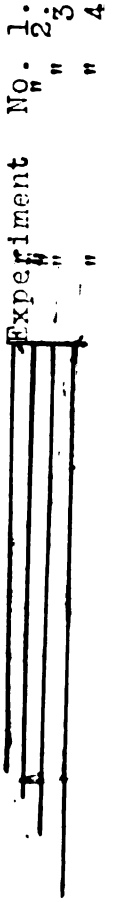
The method used was to put the milk in tin-cans leaving them open during the treatment. These were placed in a pail of water which was heated until the milk reached a temperature

of fully 160 degrees. The milk should be continuously stirred during treatment. It was then taken out, cooled immediately down to a low degree--- one can being cooled down to 65 degrees, the other to 45 degrees or thereabouts. It is not necessary to have the milk cooled down, but experiment have shown the milk when thus treated remains in a better condition longer. During this treatment the temperature should be taken before and after, and the time employed was noted.

As has been previously stated I divided the experiment into two divisions. Under the first division I tried the first four methods, and in the second division all the methods were used. Below I give a tabulated result of the first four experiments. I will briefly describe the table:

The different experiments are numbered 1., 2., 3. and4. By reference to sheet No. 4. You will find that in Ex. No. 1. the milk was left as it was brought in. Ex. No. 2. the milk was immediately cooled. 3. the milk was aerated. 4th, the milk was aerated and then cooled.

	Temperature of room	Temperature of Milk.	Acciddity of Milk. C	EXPERIMENT NO. 1. Open vessel	EXPERIMENT NO. 1. Closed vessel	EXPERIMENT NO. 2. Open vessel	EXPERIMENT NO. 2. Closed vessel	EXPERIMENT NO. 3. Open vessel	EXPERIMENT NO. 3. Closed vessel	EXPERIMENT NO. 4. Open vessel	EXPERIMENT NO. 4. Closed vessel
Wed. May 27	64°	88°	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4
Thurs." 28	68°	90°	10.8	13.6	14.2	13.3	14.5	13.2	14.3	15.3	15.6
Fri. " 29	61°	89°	12.4	19.1	20.3	15.6	17.4	15.6	19.1	17.6	21.6
Sat. " 30	64°	90°	12.5	23.	25.8	21.	24.5	20.4	23.5	25.2	26.3
Sun. " 31	63°	90°	11.7	35	34.	30.	32.	25.7	30.1	31.8	30.3
Mon. June 1	58°	93°	14.	C.	41.	39.	41.	31.8	35.7	37.4	37.
Tues. " 2	64°	90°	13.1	13.1	C.	C.	C.	39.6	40.6	44.	41.
Wed. " 3	60°	94°	11.4	15.2	11.4	11.4	11.4	43.	C.	C.	C.
Thurs." 4	63°	91°	13.2	19.3	13.3	13.2	15.2	C.	13.2	13.2	13.2
Fri. " 5	60°	90°	10.8	23.8	16.1	18.6	18.9	10.8	15.6	14.3	14.7
Sat. " 6	70°	96°	12.6	29.7	19.9	25.4	26.4	14.2	19.7	16.8	16.5
Sun. " 7	65°	93°	11.8	35	26.4	31.1	33.6	17.6	23.	20.1	19.8
Mon. " 8	70°	96°	11.9	C.	33.8	35.2	40.3	21.4	29.8	25.4	27.4
Tues. " 9	67°	93°	12.		40.1	40.2	45.	27.8	31.9	30.8	31.4
Wed. " 10	61°	90°	10.7		C.	43.	C.	31.4	39.4	36.9	39.6
Thurs." 11	63°	91°	11.8			C.		38.9	41.8	40.8	40.
Fri. " 12	61°	90°	12.5					43.8	C.	43.	44.5
Sat. " 13	64°	90°	12.5					C.		C.	C



In the first column is the date, it extending from May 27th, to June 13th, inclusive. The temperature of the room is given in the second column. The temperature was taken about 5:30 A.M.

The acidity of the milk was taken during the entire time whether I began a new experiment or not. This column plainly shows how fluctuating the condition of milk is from day to day. The last four columns are given over to the four experiments. Starting from the top we trace downward the acidity of the milk from day to day until it curdles, at which time no test is made. The milk usually curdles when about 42 cubic centimeters of tenth normal alkaline solution is required to neutralize it. The letter C. in the column indie ates that the milk has cirdled and that the particular test ha come to a close and a new one has began.

The above explaination pretains to the other three columns.

As to the preserving of milk by different methods it can plainly be seen that Experiment No. 4. gives best results, No. 3. comes next; this is followed by No. 2., and lastly comes No.1., which shows that when milk is not treated by any method it sours the quickest. By averaging the acidity of both tests in each experiment I have in the last columngiven a graphic comparison of the different merits of the several experiments. Experiment No. 4. has the longest time because

the milk in this experiment was in good condition the longest time, whereas, experiment No. 1. has the shortest time because the milk in that experiment was the first to sour.

Taking the average for these I find the temperature of the milk was 91.896x degrees Far., of the room for the same time was 63.205x degrees. The average acidity of the milk was 12.435x degrees.

The second division of the experiment was practically a repitition of the previous experiment with three other additional methods. The form of the chart is the same as the previous and hence the description of the chart will be unnecessary as it has been previously stated what the first four experiments are and I will not repeat them, but will simply tell what the last three were.

EXPERIMENT No.5. The milk was run through a separator, but not cooled.

EXPERIMENT No.6. The milk was cooled down to 50 degrees besides being run through the separator.

EXPERIMENT No.7. Was the process commonly known as pasteurization of the milk. In this experiment the milk was cooled to about 60 degrees. Whereas, in (a) it was cooled down to 50 degrees.

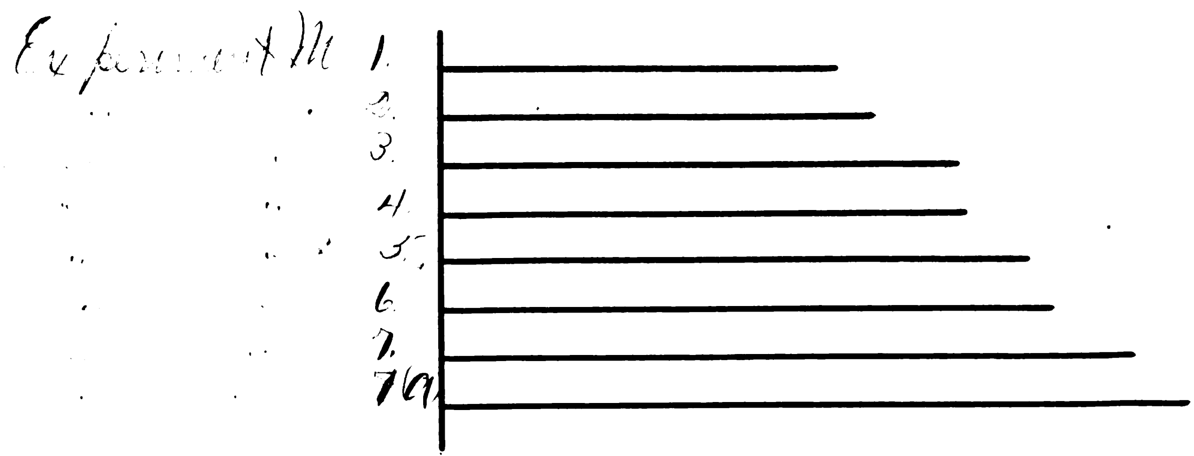
In conclusion it can plainly be seen that Pasteurization process is by far the best method. The qualities and merits of the different methods can best be represented by a graphic comparison as in the last column, on sheet No.

This was taken by averaging the time from the beginning of the test until the milk soured. The long line represents the bes method. The shortest line represents the milk when nothing was done to it, and this can be used as standard of comparison. After June 25th, I did not take a daily record of the temperature of the room, of the milk and of the acidity of the milk, except on days that I began new experiments. It can thus be seen that pasteurization of the milk is the best method to prevent rapid souring.

	Temperature of room.	Temperature of milk.	Acidity of milk.	Experiment No. 1.	Experiment No. 2.	Experiment No. 3.	Experiment No. 4.	Experiment No. 5.	Experiment No. 6.	Experiment No. 7.	Experiment No. 7 (a)
Fri. June 5	60°	90°	10.8								
Sat. " 6	70°	96°	12.6	11.2	11.3	11.2	11.	11.2	11.1		
Sun. " 7	65°	93°	11.8	13.3	11.8	15.2	12.1	15.8	12.		
Mon. " 8	70°	95°	11.9	23.6	13.1	22.7	19.1	28.5	15.8		
Tue. " 9	67°	93°	12.	35.1	18.7	33.5	31.1	32.	22.7		
Wed. " 10	61°	90°	10.7	C.	C.	C.	C.	C.	C.		
Thurs. " 11	63°	91°	11.8	12.4	13.	12.1	12.2	12.4	12.4		
Fri. " 12	61°	90°	12.5	15.5	12.8	15.2	12.2	17.5	15.3		
Sat. " 13	64°	90°	12.5	30.2	18.5	25.9	20.3	28.2	26.4		
Sun. " 14	66°	92°	11.8	40.6	26.6	39.6	27.6	43.4	37.		
Mon. " 15	60°	94°	12.3	C.	38.9	C.	39.7	C.	C.	11.7	11.4
Tues. " 16	62°	90°	10.9		C.		C.			11.6	11.8
Wed. " 17	63°	89°	12.5	11.8	11.8	11.2	12.	11.5	11.3	13.2	13.
Thurs " 18	64°	88°	12.7	13.9	12.8	11.9	11.9	16.3	12.7	15.8	14.9
Fri. " 19	69°	90°	11.8	22.2	12.8	19.5	17.3	33.7	18.7	19.6	20.1
Sat. " 20	66°	93	12.3	34.1	25.5	32.2	25.4	42.	32.1	25.4	28.
Sun. " 21	70°	91	11.8	46.1	35.	41.8	37.3	43.1	40.3	37.8	39.4
Mon. " 22	70°	94	13.3	C.	C.	C.	C.	C.	C.	C.	C.
Tue. " 23	64°	89	14.	10.8	11.2	11.1	11.3	11.3	10.9	11.4	10.8
Wed " 24	66°	90	12.2	11.	11.3	11.3	11.2	12.7	11.7	11.5	12.1
Thurs. " 25	63°	88	13.4	12.5	12.8	11.4	12.1	13.6	12.3	11.3	12.4

	Temperature of room Average previous experiment.	Temperature of milk. Average previous experiment.	Acidity of milk Average previous experiment.	Experiment no 1.	" " 2.	" " 3.	" " 4.	" " 5.	" " 6.	" " 7.	" " 7 (a)
Fri. June 26	63.205	91.896	12.485	20.1	13.1	17.	22.5	20.6	13.7	14.2	13.2
Sat " 27	"	"	"	27.7	16.5	23.3	37.6	27.1	22.5	17.4	15.3
Sun. " 28	"	"	"	24.4	21.8	31.3	48.1	33.1	33.8	21.9	19.8
Mon. " 29	"	"	"	41.9	35.4	43.3	C.	40.3	43.1	33.4	34.8
Tue. " 30	"	"	10.8	C.	C.	C.		C.	C.	43.6	41.8
Wed. July 1	"	"	11.1	13.1	12.6	11.8	10.8	12.5	12.2	C.	C.
Thurs. " 2	"	"	"	18.3	13.1	12.6	13.4	13.2	12.3	11.6	11.4
Fri. " 3	"	"	"	22.7	15.4	14.8	17.5	14.9	15.6	12.1	12.4
Sat. " 4	"	"	"	34.1	18.4	23.7	23.6	20.6	23.7	15.1	13.3
Sun. " 5	"	"	"	43.1	29.1	38.1	38.6	30.8	37.2	17.2	15.4
Mon. " 6	"	"	11.9	C.	37.6	C.	C.	41.7	C.	24.4	19.2
Tue. " 7	"	"	"		C.			C.		30.6	28.4
Wed. " 8	"	"	"	13.	14.2	12.9	13.3	12.	14.9	43.6	37.8
Thurs " 9	"	"	11.2	15.6	16.1	13.	15.4	13.1	16.8	C.	C.
Fri. " 10	"	"	"	21.5	19.5	18.1	11.8	18.3	19.2	12.5	11.3
Sat. " 11	"	"	"	26.5	18.2	26.4	26.8	33.8	23.4	13.6	13.4
Sun. " 12	"	"	"	37.4	30.1	39.6	39.5	41.8	28.8	14.8	15.4
Mon. " 13	"	"	"	C.	C.	C.	C.	C.	39.6	16.8	19.8
Tue. " 14	"	"	10.5						C.	21.3	20.7
Wed. " 15	"	"	"	12.1	11.4	11.6	12.8	10.6	13.	36.4	35.6
Thurs. " 16	"	"	11.8	13.8	13.2	13.4	16.9	15.4	14.1	C.	C.

	Average temperature of room.	Average temperature of milk.	Average acidity of milk.	Experiment No 1.	" " 2.	" " 3.	" " 4.	" " 5.	" " 6.	" " 7.	" " 7. (a)	Experiment No 1.
Fri. July 17	"	"	"	23.8	20.2	21.7	20.1	20.4	14.8	12.2	12.	
Sat. " 18	"	"	"	36.7	30.6	29.8	25.2	33.2	27.9	12.7	13.5	
Sun. " 19	"	"	"	C.	43.8	46.7	39.2	43.9	39.8	14.1	14.6	
Mon. " 20	"	"	"		C.	C.	42.7	C.	43.8	17.2	16.1	
Tue. " 21	"	"	"				C.		C.	30.8	27.8	
Wed. " 22	"	"	"							38.4	36.2	
Thurs. " 23	"	"	"							44.	41.7	
Fri. " 24	"	"	"							C.	C.	



As a conclusion of the thesis I will give a brief composition of the facts concerning the pasteurization of milk.

As the sme object of pasteurization is to kill the bacteria it is absolutely necessary that the temperature of the milk should be of such a degree as to exceed the thermal death point of all vegetable bacteria and yet not high enough to injure the physical qualities of the milk. The temperature at which I kept the milk was 160 degrees Far. it was then cooled down to 48 degrees. It has been found that germs can be killed when exposed to low heat for a long duration of time as they can by a short exposure to a high temperature.

Lastly as to the apparatus used for pasteurization. To pasteurize the milk does not require any additional expense as any milk pail will do. The can of milk is placed in a pail of water this is placed on the stove. When the milk has reached a temperature of about 160 degrees, it can then be taken off and cooled it will then be ready for use.