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A Bacteriological Study of the Method of Pasteurizing and Homogenizing the Ice Cream Mix

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SUMMARY.

The results reported show that ice cream with a low bacterial count can be produced by the method of pasteurizing and homogenizing the mix. The effect of each step in the process on the bacterial count has been dealt with and the most significant changes found were as follows:

1. The mix had a smaller number of organisms than the cream—the decrease varied from 8 to 75 per cent and averaged 43.6 per cent.

2. The heating of the mix to the pasteurizing temperature effected a destruction of from 91.5 to 99.5 per cent of the bacteria (average, 96.4 per cent) without any holding.

3. The pasteurization of the mix reduced the bacterial content very satisfactorily.

4. The homogenizer may be a source of considerable contamination and every precaution should be taken in its care.

The method of pasteurizing and homogenizing the mix should be considered as satisfactory for the production of ice cream with a low bacterial count. Where the mix is to be held, however, exceptional precautions must be taken during the cooling since the homogenized mix cools slowly unless thoroughly stirred. It also seems to be advisable from the theoretical standpoint to add the gelatine shortly before freezing where the mix is to be held for any length of time.

A Bacteriological Study of the Method of Pasteurizing and Homogenizing the Ice Cream Mix.

[BY B. W. HAMMER AND L. R. SANDERS.]

In continuing the work being carried out at the Iowa Agricultural Experiment Station on the bacteriology of ice cream, [1, 2], a study has been made of the method of pasteurizing and homogenizing the ice cream mix. This method is at present of some commercial importance and apparently its use is increasing. It enables the factory operators to prepare the mixes at their convenience instead of shortly before freezing and thus seems to offer certain advantages insofar as the operation of the plant is concerned. It was the object of the work herein reported to study the method from the standpoint of its value in the production of ice cream of a high sanitary quality.

The most satisfactory of the available methods of arriving at the sanitary quality of a lot of ice cream is to determine the number of bacteria contained. An investigation of the place and method of manufacture and the source and general quality of the ingredients is valuable but it cannot be expected to detect sources of serious contamination that are not detected by bacteriological methods. Where both procedures can be used they supplement each other admirably, but inspection alone cannot be considered to be satisfactory. The ordinary determination of the number of bacteria gives but little information regarding the types of organisms present but the conditions responsible for large numbers of organisms of any type are the conditions that are most apt to permit of the introduction and development of harmful types.

While in most ice cream with a high bacterial content, *Bact. lactis acidi,* a harmless type, predominates, the entrance and rapid multiplication of this organism occurs under conditions that make possible the entrance and multiplication of undesirable and possibly harmful types. The number of bacteria in the ice cream seems to be quite generally accepted as a basis for deciding on the sanitary quality of the output of a factory and the ice cream put out by certain plants has apparently been excluded from given areas on the basis of its bacterial content alone.

[1]Hammer, B. W., Bacteria and Ice Cream. Ia. Agr. Expt. Sta. Bull. 134 Jy. 1912.
[2]Hammer, B. W. & Goss, E. F. Bacteria in Ice Cream II. Ia. Agr. Expt. Sta. Bull. 174 D. 1917.

METHODS USED.

The bacterial counts were made on ice cream manufactured in the ice cream laboratory of the Iowa State College. While the lots of ice cream were ordinarily small, they were made with machinery operated on a commercial basis and under practical conditions. The cans, strainers, and other utensils were thoroughly steamed and the freezer was carefully scalded; the homogenizer was washed with boiling water shortly before use in most of the runs. The frozen ice cream was drawn into steamed containers from which the hardened samples were taken. The different lots of cream used were selected with a varying bacterial content so that the results secured would represent both high and low count cream; the other ingredients used were of the best quality.

All unfrozen samples were collected in sterile tubes that were stoppered and plunged into ice water immediately after receiving the sample. The samples of frozen ice cream were run into sterile Petri dishes from the freezer while the samples of hardened ice cream were secured by means of a sterile butter trier and the plug cut over the edge of the bottom of a sterile Petri dish so that the portion of the plug that has been at the top of the container would fall outside the dish. All samples of ice cream were melted slowly and plated at once on the c.c. basis. The agar recommended at the time the work was done by the A. P. H. A. for the analysis of milk was used and the plates were incubated at 37°C. for 48 hours. The plates were poured in duplicate and the results given represent the average of two plates.

All the ice cream studied was vanilla ice cream and the vanilla was usually added at the time of freezing. This is the preferable practice, because vanilla extract runs very low in bacteria, due to its alcohol content, and there is no advantage and perhaps disadvantages in heating it. The mixes studied were made with different fillers including gelatine. The advisability of adding the gelatine after the homogenizing will be discussed later. It should be noted that the heating of a mix is never uniform since it takes some little time to run the mix through the homogenizer, and during this time the material in the tank remains hot.

RESULTS SECURED.

The results secured on nine lots of ice cream are given in Tables I-IX. While it would have been advisable to have continued the work, the uniformity in the results makes this more or less unnecessary. The data secured is published at this time because certain manufacturers are having difficulty in meeting the bacteriological requirements set where large bodies of troops are quartered.

CREAM.

The cream used varied in bacterial content from 81,500 to 24,700,000 per c.c. with five of the nine samples, or 56 per cent, running over 1,000,000; as has already been stated the cream was selected with a varying bacterial count so that the results secured would represent cream of different qualities. The cream used undoubtedly represents fairly well the cream used by many manufacturers today; such cream should of course be pasteurized at some stage of its manufacture into ice cream.

MIX.

In all the eight cases where counts were made on the mix, the mix showed a lower bacterial content than the cream; the extent of these decreases, which varied from 8 to 75 per cent and averaged 43.6 per cent, are shown in Table X.

The cause of the lower bacterial content in the mix than in the cream may be due in part to the volume change but this alone could never account for the larger decreases and it seems that the plasmolyzing influence of the sugar added must be largely responsible.

MIX HEATED BUT NOT HELD.

There was, in each of the six cases for which figures were secured, a very great decrease in the bacterial content when the mix was heated, usually to 145° F., but not held. These decreases, which varied from 91.5 per cent to 99.5 per cent and averaged 96.4 per cent, are shown in detail in Table XI.

The decrease secured in the bacterial content of the mix when heated to the pasteurizing temperature but not held is about the same as the decrease secured with sweet cream or milk during the entire pasteurization exposure. It is probable that the efficient destruction of the organisms is due to the large amount of material (sugar particularly) present in solution which exerts a much greater plasmolyzing action than does the material present in solution in cream or milk.

MIX TAKEN FROM THE TANK AFTER PASTEURIZATION.

The bacterial content of the mix taken from the tank after pasteurization was quite low in all cases and exceptionally low in most of them. In only two of the nine cases was it over 10,000 and in only one case over 50,000 per c.c. The figures on the bacterial content of the mix before and after pasteurization are retabulated in Table XII (columns 1 and 2). The data show that the bacterial content of the mix can be reduced very satisfactorily by pasteurization at the exposures used (142-150° F., usually 145° F., for about 20 minutes).

PASTEURIZED MIX AFTER RUNNING THROUGH THE HOMOGENIZER WITHOUT PRESSURE.

The bacterial content of the pasteurized mix after it had run through the homogenizer without pressure was determined in order to see whether or not the machine was a source of contamination. Table XII (columns 2 and 3) shows the counts before and after running through the machine. In all cases the count was higher after running through the machine and often the increase was considerable on a percentage basis. This indicates that the homogenizer may be a source of contamination of some little significance. The figures for the material run through the homogenizer without pressure were obtained on the first material run through the machine which is presumably the most heavily contaminated and it is probable that later on in a run the contamination from the machine amounted to much less. The homogenizer was given what was considered to be satisfactory care since it was thoroughly washed after use and then in most of the runs flushed with boiling water just before use.

PASTEURIZED MIX AFTER RUNNING THROUGH THE HOMOGENIZER WITH PRESSURE.

When the bacterial content of the mix run through the homogenizer without pressure is compared with that of the mix run with pressure (Table XII, columns 3 and 4), it will be seen that the former was the greater in six cases and the latter in three. At least two factors are operating to change the bacterial content when the pressure is thrown on; first, the machine has been in operation longer and the contamination from it is becoming less; second, the agitation in the machine tends to break up any clumps that may be present and thus apparently increase the count.

It is probable that the varying importance of these two factors accounts for the variation in the results obtained. In some cases (runs 3, 4 and 9) the much smaller count in column 4 than in column 3 shows clearly a heavy contamination from the machine. In one case (run 9) the count on the mix after passing through the homogenizer with pressure was less than the count immediately after pasteurization. This is presumably due to the longer exposure to heat with the former material (as explained under methods) in addition to practically no increase due to contamination or breaking up of the clumps.

PASTEURIZED MIX AFTER RUNNING THROUGH HOMOGENIZER WITH PRESSURE AND THEN OVER THE COOLER.

In the four trials for which data are available, running the mix over the cooler increased somewhat the bacterial content as shown in Table XII (columns 4 and 5). The results obtained here agree in general with the results obtained when pasteurized sour cream was run over a cooler[3].

FROZEN AND HARDENED ICE CREAMS.

The influence of freezing and hardening on the bacterial content of the ice cream will not be considered because this has already been rather extensively dealt with by the Iowa Agricultural Experiment Station[4] and the figures presented here cannot be expected to agree exactly with those already published because the breaking up of the clumps of bacteria in the homogenizer makes the agitation in the freezer, which usually is responsible for an increase during the freezing process, of much less significance.

The bacterial content of the frozen ice cream made with the mix at once after homogenization was in general very low, being over 10,000 per c.c. but twice, and over 50,000 per c.c. but once, while in the other

[3]Hammer, B. W., Pasteurization of Cream for Buttermaking, Part II, Bacteriological Studies. Bull. Ia. Agr. Expt. Sta. 156. D. 1914.

[4]See reference 2.

case the hardened ice cream had a count of 1,330 per c. c. The lowest count secured in the eight trials for which data were obtained was 360 and the highest, 84,000 per c.c. The results indicate that ice cream can be made by the method of pasteurizing and homogenizing the mix with a highly satisfactory bacterial count.

When the mix was held for 24 or 48 hours before freezing there was a higher count than when the mix was frozen at once. This was in all probability due to growth of the organisms during the holding. The mix usually came from the cooler at about 60° F., and then, in most cases, was put into a brine tank running at a low temperature. The viscosity of the mix was such, however, that cooling did not take place rapidly and presumably the temperature stayed high enough for growth to take place for some time. In one trial (No. 4) the mix was frequently stirred during the cooling and in each lot of ice cream made from the mix after holding a low bacterial count was secured. The results indicate that where the mix is held over it should be rapidly cooled to a temperature low enough to prevent growth (at least 40° F. and preferably lower) and that this cooling cannot be accomplished by standing the cans in brine or in a cooler without resorting to frequent stirring.

The question of growth during the holding of the mix is one that demands some consideration where gelatine is added before pasteurization and homogenization. If the gelatine contains many organisms, as is frequently the case, large numbers of them are practically certain to survive the heating and since they are in general types that attack protein the possibility of them producing toxic products must be kept in mind. It seems that from a theoretical standpoint it would be safer, where the mix is to be held, to add the gelatine shortly before freezing. The heating to which the gelatine is subjected in getting it into solution in all probability destroys almost as many organisms as such heating plus the pasteurization before the homogenization.

ADVANTAGES FROM SANITARY STANDPOINT OF METHOD OF PASTEURIZING MIX.

The results reported show that by the method of pasteurizing and homogenizing the mix, ice cream can be made with a very low bacterial count, but this can also be accomplished by pasteurizing the cream and then paying considerable attention to the cleanliness of the utensils and the quality of the ingredients as has been shown in a former publication of this Station[5]. From the sanitary standpoint the method of pasteurizing and homogenizing the mix has certain advantages, as follows:

1. The ingredients other than the cream with the possible exceptions of vanilla and gelatine are subjected to pasteurizing temperatures. While such ingredients may be very free from bacteria, their heating should be considered an advantage.

2. There is much less handling after pasteurization. This is of a great deal of importance when it is considered that the utensils are often an important source of contamination and also that the persons employed in the plant may be disease carriers.

[5]See reference 1.

TABLE I.

Material Plated	Bacteria per c. c.
Cream (pasteurized and held two days at about 50° F.)	81,500
Mix	56,000
Mix taken from tank after pasteurization	170
Pasteurized mix after running through homogenizer without pressure	7,400
Pasteurized mix after running through homogenizer at 150 K.	9,450
Ice cream, made at once, immediately after freezing	8,000
Ice Cream, made with mix held 24 hours, immediately after freezing	9,600

TABLE II.

Material Plated	Bacteria per c. c.
Cream (pasteurized and held 1 day at about 50° F.)	720,000
Mix heated to 142° F. but not held	156,500
Mix taken from tank after pasteurization (142° F.-20 min.)	1,545
Pasteurized mix after running through homogenizer without pressure	2,025
Pasteurized mix after running through homogenizer at 170 K.	4,250
Pasteurized mix after running through homogenizer at 170 K. and then over cooler	6,050
Ice cream, made at once, immediately after freezing	5,900
Ice cream, made at once, after hardening	2,250
Ice cream, made with mix held 24 hours, immediately after freezing	35,550
Ice cream, made with mix held 24 hours, after hardening	22,600

TABLE III.

Material Plated	Bacteria per c. c.
Cream (pasteurized and held 4 days at from 34-50° F.)	205,000
Mix	189,500
Mix taken from tank after heating to 150° F-10 min.	1,030
Mix taken from tank after pasteurization (150° F.-20 min.)	370
Pasteurized mix after running through homogenizer without pressure	2,020
Pasteurized mix after running through homogenizer at 150 K.	850
Pasteurized mix after running through homogenizer at 150 K. and then over cooler	1,285
Ice cream, made at once, immediately after freezing	1,490
Ice cream, made at once, after hardening	1,660
Ice cream, made with mix held 24 hrs., immediately after freezing	13,050
Ice cream, made with mix held 24 hrs., after hardening	7,700

TABLE IV.

Material Plated	Bacteria per c. c.
Cream (a mixture of old pasteurized lots)	5,000,000
Mix	4,400,000
Mix heated to 145° F. but not held	25,500
Mix taken from tank after pasteurization (145° F.-20 min.)	230
Pasteurized mix after running through homogenizer without pressure	605
Pasteurized mix after running through homogenizer at 150 K.	235
Ice cream, made at once, immediately after freezing	360
Ice cream, made at once, after hardening	420
Ice cream made with mix held 24 hrs., immediately after freezing	440
Ice cream, made with mix held 24 hrs., after hardening	175
A second lot, made with mix held 24 hrs., immediately after freezing	540
A second lot, made with mix held 24 hrs., after hardening	160

TABLE. V.

Material Plated	Bacteria per c. c
Cream (pasteurized and held 3 days at 50° F.)	2,595,000
Mix	1,050,000
Mix heated to 145° F. but not held	89,500
Mix taken from tank after pasturization (145° F.-20 min.)	66,000
Pasteurized mix after running through homogenizer without pressure	78,000
Pasteurized mix after running through homogenizer with pressure	72,000
Pasteurized mix after running through homogenizer with pressure and then over cooler	84,000
Ice cream, made at once, immediately after freezing	84,000
Ice cream, made with mix held 48 hrs., immediately after freezing	275,000

TABLE VI.

Material Plated	Bacteria per c. c.
Cream (a mixture of old pasteurized lots)	5,600,000
Mix	2,600,000
Mix heated to 145° F. but not held	175,000
Mix taken from tank after pasteurization (145° F.-20 min.)	6,150
Pasteurized mix after running through homogenizer without pressure	12,650
Pasteurized mix after running through homogenizer with presure	6,150
Pasteurized mix after running through homogenizer with pressure and then over cooler	6.600
Ice cream, made at once, immediately after freezing	6,700
Ice cream, made at once, after hardening	8,700
Ice cream, made with mix held 24 hrs., immediately after freezing	150,000

TABLE VII.

Material Plated	Bacteria per c. c.
Cream (old pasteurized)	5,200,000
Mix	1,300,000
Mix heated to 145° F. but not held	40,000
Mix taken from tank after pasteurization (145° F.-20 min.)	170
Pasteurized mix after running through homogenizer without pressure	490
Pasteurized mix after running through homogenizer at 100 K.	375
Ice cream, made at once, immediately after freezing	7,950
Ice cream, made at once, after hardening	12,350
Ice cream, made with mix held 24 hrs., immediately after freezing	18,850

TABLE VIII.

Material Plated	Bacteria per c. c.
Cream	520,000
Mix	150,000
Mix heated to 145° F. but not held	700
Mix taken from tank after pasteurization (145° F.-20 min.)	225
Pasteurized mix after running through homogenizer without pressure	430
Pasteurized mix after running through homogenizer at 100 K.	670
Ice cream, made at once, after hardening	1,330

TABLE IX.

Material Plated	Bacteria per c. c.
Cream	24,700,000
Mix	15,300,000
Mix heated to 145° F. but not held	299,000
Mix taken from tank after pasteurization (145° F.-20 min.)	10,500
Pasteurized mix after running through homogenizer without pressure	20,600
Pasteurized mix after running through homogenizer with pressure	8,900
Ice cream, made at once, immediately after freezing	10,300
Ice cream, made with mix held 24 hrs., immediately after freezing	17,600

TABLE X.—PER CENT DECREASE IN BACTERIAL CONTENT FROM CREAM TO MIX.

Run	Decrease in per cent
1	31
3	8
4	12
5	60
6	54
7	75
8	71
9	38
Average	43.6

TABLE XI.—PER CENT DECREASE WHEN MIX WAS HEATED TO PASTEURIZING TEMPERATURE BUT NOT HELD.

Run	Decrease in per cent
4	99.4
5	91.5
6	93.3
7	96.9
8	99.5
9	98.0
Average	96.4

TABLE X.—PER CENT DECREASE IN BACTERIAL CONTENT FROM CHANGES IN NUMBERS.

Run	Mix before past.	Mix after pasteurization	Past. Mix thru homogenizer without pressure	Past. Mix thru homogenizer with pressure	Past. Mix thru homogenizer with pressure and then over cooler
1	56,000	170	7,400	9,450	———
2	720,000*	1,545	2,025	4,250	6,050
3	189,500	370	2,020	850	1,285
4	4,400,000	230	605	235	———
5	1,050,000	66,000	78,000	72,000	84,000
6	2,600,000	6,150	12,650	6,150	6,600
7	1,300,000	170	490	375	———
8	150,000	225	430	670	———
9	15,300,000	10,500	20,600	8,900	———

*Cream. Unheated mix not counted.

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