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# Assessment of Bacteriological Quality of Ice-cream During Manufacturing Processes*

**P. E. Pawar[1] and S. H. Vyas**

Dairy Sci. College, Gujarat Agricultural University, Anand Campus, Anand

**ABSTRACT**

**To determine the sources of contamination during ice-cream manufacture, fifteen batches of ice-cream were examined bacteriologically. It was observed that total bacterial count varied from 0 to 1,98000/ml and coliform count 0 to 3000/ml containing in different ingredients of ice-cream mix and at the different processed stages. Equipment coming in contact with the product as well as ingredients like colour and essence added after pasteurization of ice-cream mix were found to be the sources of contamination. No pathogenic organisms were detected.** *(Received on Oct. 26, 197*

## INTRODUCTION

ICE-CREAM has earned its popularity as dessert and has been judged as finest food nutritionally. Ice-cream provides high caloric value. It has a superior quality of milk proteins which are rich in amino acids and a rich source of calcium and phosphorous along with lactose which favours the assimilation of calcium.

According to Fabian (1945) manufacture of frozen dessert is more complicated than the manufacture of butter and cheese. It is reasonably easy to maintain the chemical composition of ice-cream practically the same throughout the year but difficult to maintain the bacteriological clean conditions of its manufacture and of the equipment involved in manufacturing process. Study on the bacteriological quality of ice-cream mix and ice-cream during different stages of manufacture in the USSR revealed a heavy contamination with enterococci which did not decrease even after three months storage at — 20°C (Mann 1967).

Laxminarayana (1961) stated that high grade ice-cream of acceptable quality can never be produced from raw materials which are initially of poor hygienic quality, irrespective of subsequent methods of treatments and of handling. Similarly the equipment with which the ice-cream mix usually comes in contact at various stages of manufacturing are also important lest they may act as serious sources of contamination for lack of thorough cleaning and sterilization.

Pagaria and Sarswat (1969) observed that pathogenic bacteria can easily gain access to ice-cream mix from fresh or inadequately heat treated milk products

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1 Maharastra State Vet. Officer — Akola.

or other ingredients and surviva in the frozen and hardened finished product unless the mix is properly pasteurized.

Bacterial count of ice-cream is perhaps a better index to judge the conditions prevalent during the production. The present investigation was aimed at collecting the information regarding the bacteriological quality of ice-cream manufactured at the Students' Training Dairy (by a private concern) and to locate the sources of contamination during its manufacture and storage.

## MATERIALS AND METHODS

A total number of 15 batches of ice-cream mix and finished ice-cream were examined for the bacterial quality. The bacteriological tests like standard plate count, coliform count, presumptive coliform test were conducted on raw materials such as milk, cream, whole milk powder, sugar, emulsifier, stabilizer, essence and colour when received on the dairy plant as per procedure outlined by Standard methods for examination of Dairy products (1967) except where otherwise stated.

Similarly these ingredients were mixed in proper proportion as per requisite standard and the composite samples of the mixed ingredients were taken at various stages of its manufacture. Such as raw mix (all ingredients mixed), after pasteurization, after aging and freezing and during hardening process also. Along with the standard plate count, coliform count, presumptive coliform test, phosphatase and stormy fermentation tests were also carried out to detect the sources of contamination. The bacteriological cleanliness of various equipments involved in manufacture of ice-cream like pasteurization vat, mix supply trough: freezing chamber, packaging materials were tested as per ISI, 1963 specifications.

Packaging materials like paper cartons (packages) paper cups were tested with Swab and Rinse method according to ISI specifications.

Necessary precautions were taken while examining the finished ice-cream by first wiping the cup's outer surface with cotton wool dipped in alcohol before making a transfer in the previously sterilized container. The container with ice-cream was then placed in waterbath at 45°C (113°F) for 16 minutes and was thoroughly agitated to ensure proper mixing. The portions were then removed for necessary tests.

### Detection of Salmonella Spp.

Various media have been suggested for the preparation of differentiation of closely related organisms. The procedure followed for the detection of pathogens (Salmonella) was as suggested by Difco manual (1966) and Davis (1963).

Similarly the bottom of the petri dishes with sterile media (S.P.C.A. and MacConkey's Agar) were exposed for the specific period of time i.e. 3, 5 and 7 minutes at different locations in the processing room during ice-cream manufacture to detect bacteriological quality of air as stated by Hedrick and Heldman (1969) circulating in processing room.

## RESULTS AND DISCUSSION

The problem of safeguarding ice-cream mix and finished ice-cream against microbial contamination is considerably more difficult than any other dairy products, because the mix ingredients and finished ice-cream have to pass through various stages of preparation while coming in contact with various types of equipment. Frandsen (1938) and Fabian (1942) have listed three agencies which may cause increased microbial count to frozen products. They are (i) ingredients (ii) equipments (iii) workers.

The results obtained from the bacteriological analysis of 15 batches of the mix ingredients have been averaged and are presented in Table 1.

*Milk and Cream:*

For formulating the ice-cream mix, pasteurized milk and cream were purchased. Standard plate count showed bacterial count from 10, 250 per ml to 1,11000 per ml in milk and 17,500 bacteria per ml to 1,65000 per ml in cream (Table 1). About 40% of the total milk samples studied from 15 batches of the ice-cream and about 53·3% of cream showed higher bacterial count than the standard of pasteurized milk and cream. This can be reasonably attributed to improper care during transportation as well as unsatisfactory conditions of containers used.

*Whole Milk Powder:*

The bacteriological characteristics of whole milk powder used as one of the ingredients in manufacture of ice-crea can be seen in Table 1. The standar plate count varied from 3200 to 28,50 count/ml while surprisingly no sampl was found to contain coli. The count less than the one suggested by ISI (1963 as 50,000 SPC/ml and 90 coli/ml for th whole milk powder. Herbert *et el* (1967 recorded that 85 per cent of the sample from different dryers were below 30,00 per g. and only 0·9% samples exceede the 90 coli per g.

*Sugar:*

The maximum and minimum star dard plate count in sugar recorded 29,50 and 2000 bacteria per ml respectivel against the standard of 200 bacteria/n recommended by Foster *et al* (1958 (Table 1). Except for one sample whic showed presence of coli less than 10/ the rest of the samples were all negati for coli. Foster *et al* (1958) stated that the sugar is well protected there are le chances of the microbial contaminatio

*Emulsifiers and Stabilizers:*

No bacterial standard have bee laid down for the emulsifiers howeve these can be judged on the line of stab lizers. Total bacterial count in emulsifi has been recorded from 150 to 37,450/n (Table 1) and coli were present only three samples out of 15, counting 3 50 and 100 coli per ml.

Sixty-six per cent of total (stabilizers samples examined showed SPC coun below 10,000/ml while the rest showe higher, some of this upto 28,000/m Except one sample rest of the sampl

*TABLE 1*

**Maximum and minimum bacterial counts in mix ingredients.**

| *Sr. No.* | *Ingredients* | *No. of samples* | *SPC* | | *Coli.* | | *Below standard* | | | | *Above standard* | | | | *Standard recommended count* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | *Max.* | *Min.* | *Max.* | *Min.* | *SPC* | | *Coli.* | | *SPC* | | *Coli.* | | |
| | | | | | | | *No. of SAM.* | % | *No. of SAM* | % | *No. of SAM* | % | *No. of SAM* | % | |
| 1. | Milk | 15 | 111000 | 10250 | 3000 | 20 | 6 | 40 | 0 | Nil | 9 | 60 | 15 | 100 | 30,000; 10 |
| 2. | Cream | 15 | 165000 | 17500 | 3000 | 20 | 8 | 53·3 | 0 | | 7 | 46·6 | 15 | 100 | 60,000; SPC 10 coli. |
| 3. | W.M.P. | 15 | 28500 | 2300 | 0 | 0 | 15 | 100 | 15 | 100 | Nil | 0 | Nil | 0 | 50,000 SPC 90 coli. |
| 4. | Sugar | 15 | 29500 | 2000 | 10 | 0 | Nil | 0 | — | — | 15 | 100 | — | — | 200 SPC no report coli. |
| 5. | Emulsifier | 15 | 37450 | 150 | 100 | 30 | 8 | 53·3 | | | 7 | 46·6 | | | no St. (SPC 10,000 SPC) Coli. |
| 6. | Stabilizer | 15 | 28000 | 0 | 90 | 0 | 10 | 66·6 | | | 5 | 33·3 | | | 10,000 or less no report coli. |
| 7. | Essence | 15 | 21050 | 100 | 0 | 0 | 1 | 6·6 | | | 14 | 93·4 | | | 100 SPC |
| 8. | Colour | 15 | 165000 | 3250 | 2670 | 0 | 6 | 40 | | | 9 | 60 | | | 10,000 SPC |

showed absence of coli (Table 1). The quality of the stabilizer used can be said to be of satisfactory standard.

Foster *et al* (1958), Gayer *et al* (1966) both have suggested that stabilizers should not exceed the count more than 10,000/ml.

*Colours:*

It can be seen from Table 1 that the average standard plate count for colour varied from 3,250 to 1,65,000 count/ml and coliforms from 0 to 2,670 count/ml; 60 per cent of the samples are above the standard plate count of 10,000/ml and 73 per cent of the samples showed more than 10 coliforms/ml indicating improper preparation, preservation and handling.

*Flavouring Materials:*

The results obtained in Table 1 showed 100/ml to 21,050/ml bacterial count of which 93·4% samples failed t attain the standard of 100 bacteria per ml However, all the samples were free fro coli count.

*Raw Mix (all ingredients mixed).*

All the ingredients were mixed t gether in pasteurizing vat and the bacte ial count was taken which varied fro 20,000 to 1,65000 bacteria/ml and co forms were 70 to 3000/ml. Shitsko (1954) recorded 1,25,0000 to 180,00 count per ml from the samples obtain from two different factories for the ra ice-cream mix.

*Pasteurization Process:*

The mix was pasteurized at 72° for 20 mts. Table 2 depicts the bacteri count of the pasteurized mix. T efficiency of the pasteurization proce was 98% indicating reasonably low bacterial count in pasteurized mix. T

*TABLE 2*

**Total bacterial counts at various stages.**

| Sr. No. | Raw mix | | Pasteurized mix | | Aging | | Freezing | | Hardening | |
|---|---|---|---|---|---|---|---|---|---|---|
| | SPC | Coli. | SPC | Coli. | SPC | Coli. | SPC | Coli. | SPC | Coli. |
| 1. | 1,10,000 | 180 | 8,000 | 0 | 65,000 | 120 | 80,000 | 200 | 1,65,000 | 460 |
| 2. | 1,65,000 | 720 | 3,000 | 0 | 45,000 | 20 | 72,000 | 30 | 48,750 | 150 |
| 3. | 75,000 | 70 | 1,500 | 0 | 25,550 | 20 | 36,000 | 300 | 1,62,500 | 500 |
| 4. | 54,850 | 70 | 1,600 | 0 | 33,000 | 50 | 42,000 | 90 | 64,050 | 350 |
| 5. | 42,550 | 80 | 1,400 | 0 | 28,150 | 30 | 37,000 | 70 | 64,500 | 680 |
| 6. | 20,200 | 780 | 800 | 0 | 39,500 | 210 | 24,000 | 190 | 57,250 | 260 |
| 7. | 1,55,000 | 1250 | 1,700 | 0 | 45,450 | 990 | 57,350 | 480 | 52,300 | 320 |
| 8. | 56,450 | 200 | 1,000 | 0 | 32,600 | 120 | 29,900 | 170 | 92,550 | 3000 |
| 9. | 1,29,500 | 900 | 1,850 | 0 | 17,000 | 0 | 26,500 | 100 | 1,58,550 | 520 |
| 10. | 1,40,000 | 3000 | 1,800 | 10 | 58,500 | 2000 | 24,600 | 3000 | 21,000 | 230 |
| 11. | 35,500 | 610 | 700 | 0 | 48,000 | 120 | 50,050 | 80 | 50,100 | 180 |
| 12. | 76,700 | 110 | 900 | 0 | 38,850 | 90 | 60,250 | 30 | 67,200 | 1110 |
| 13. | 58,500 | 270 | 950 | 0 | 86,500 | 1110 | 77,500 | 650 | 2,07,500 | 2300 |
| 14. | 50,200 | 150 | 1,830 | 0 | 58,000 | 140 | 75,000 | 230 | 1,21,000 | 1600 |
| 15. | 72,750 | 2000 | 2,350 | 0 | 1,78,500 | 110 | 1,98,500 | 500 | 1,69,600 | 1800 |

coliforms were absent in all the pasteurized samples. To reduce the protective effect of sugar and stabilizer higher temperature are usually recommended.

Foster *et al* (1958) reported that ice-cream mix if pasteurized properly, will give total count of 10,000 or less bacteria per g.

*Aging and Freezing:*

It can be seen from Table 2 that during the aging period there was an increase in bacterial count as well as coli count.

The increase in bacterial count during the process of aging and freezing can be attributed to improper handling of mix by the workers involved in manufacturing of ice-cream. It can be due to prolonged storage and exposing the pasteurized mix to atmospheric temp. by often opening and closing the aging vat.

Similarly there was an increase in bacterial count after freezing the mix. Ellikar (1949), Foster *et al* (1958) noted the increase after freezing on account of breaking up of clumps of bacteria and contamination from the freezer.

But Llyod (1969) observed reduction after freezing and concluded that the effect of freezing on various types of bacteria results in physical destruction of the cells by agitation in the presence of ice-crystal. Alexander and Rothwell (1970) reported that the reduction of bacterial count on freezing is mainly at the temperature of maximum ice-crystal formation.

Results recorded in Table 3 indicate that the freezing chamber, mix supply trough and environmental air are reasonably responsible for the increase in the total bacterial count after the freezing process.

The ingredients, colour and essence do not receive any heat treatment and are directly added to the pasteurized mix at the time of freezing which might act as the source of contamination resulting in increased load of bacterial count after the freezing process.

*Bacterial count after hardening period in cold storage:*

The increase in total bacterial count during storage reveal that due to uncontrolled practice of handling. On and often entry in the hardening room, or unmindfully keeping the doors open result into the fluctuation of the temperature which encourages the increased bacterial count.

The final product of ice-cream taken out from the storage after 48 hours proved to be positive to presumptive coliform test in all samples. Patel and Vyas (1969) reported 90% of the cases positive to presumptive coliform test conducted on the ice-cream sold in Anand market (Gujarat). However, according to Delay (1947) the presence of coliforms in the samples cannot be correlated to the presence of pathogens in the samples examined.

Patel and Vyas (1969) reported a very small incidence of Salmonella organisms in the icecream sold in Anand market (Guj.).

*TABLE* 3

**Microbial condition of the equipments, air and packges used in manufacturing of ice-cream.**

| *Sr.* | *Pasteurization Vat.* | | *Mix supply trough* | | *Freezing chamber* | | *Air* | | *Packages* | | | *S.P.C.* | | *Coli.* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *No.* | *SPC* | *Coli.* | *SPC* | *Coli.* | *SPC* | *Coli.* | *SPC* | *Coli.* | *SPC* | *Coli.* | | *Max.* | *Min.* | *Max.* | *Min.* |
| 1. | 9000 | 0 | 25000 | 0 | 18500 | 0 | 128·28 | 0·37 | 13600 | 0 | Past. vat. | 25500 | 4250 | 250 | 0 |
| 2. | 5500 | 0 | 10750 | 0 | 6250 | 0 | 30·68 | 38·68 | 16000 | 0 | | | | | |
| 3. | 18750 | 0 | 30750 | 0 | 15000 | 0 | 18·18 | 0 | 18200 | 400 | Mix | 46500 | 5000 | 1000 | 0 |
| 4. | 19000 | 0 | 27500 | 500 | 20000 | 0 | 6·23 | 0 | 2400 | 200 | sup. | | | | |
| 5. | 5500 | 0 | 14250 | 0 | 30000 | 250 | 31·97 | 0 | 14800 | 800 | through | | | | |
| 6. | 11000 | 0 | 46500 | 0 | 3000 | 0 | 5·51 | 0·29 | 9400 | 800 | Freezing | 75000 | 3000 | 1000 | 0 |
| 7. | 25000 | 0 | 14500 | 0 | 22250 | 0 | 67·81 | 0 | 5200 | 0 | chamber | | | | |
| 8. | 4250 | 0 | 6000 | 0 | 9000 | 0 | 53·53 | 1·78 | 3600 | 0 | Air | 128·28 | 5·51 | 38·68 | 0 |
| 9. | 11000 | 0 | 19500 | 1000 | 11500 | 0 | 20·55 | 0·95 | 6400 | 0 | | | | | |
| 10. | 5500 | 0 | 37500 | 0 | 7500 | 1000 | 13·48 | 0·83 | 9400 | 0 | Packages | 45000 | 2400 | 1800 | 0 |
| 11. | 19750 | 0 | 34000 | 0 | 23500 | 0 | 68·80 | 1·49 | 7400 | 200 | | | | | |
| 12. | 13500 | 0 | 22250 | 0 | 11500 | 0 | 30·72 | 0·83 | 5400 | 0 | | | | | |
| 13. | 17500 | 0 | 8000 | 0 | 2000 | 0 | 24·14 | 0 | 6400 | 0 | | | | | |
| 14. | 17500 | 250 | 5000 | 0 | 8250 | 0 | 33·56 | 1·25 | 35400 | 1800 | | | | | |
| 15. | 11250 | 0 | 10500 | 0 | 3750 | 0 | 34·96 | ·59 | 45000 | | | | | | |

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