WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 7.523
Volume 7, Issue 3, 28-45. Research Article ISSN 2277 – 7105

ASSESSMENT OF THE MICROBIOLOGICAL QUALITY OF ICE CREAM OFFERED FOR PUBLIC CONSUMPTION IN DHAKA CITY, BANGLADESH

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Article Received on
15 December 2017,
Revised on 05 Jan. 2018,
Accepted on 26 Jan. 2018
DOI: 10.20959/wjpr20183-10891

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ABSTRACT

The study was performed to evaluate the microbiological quality of ice cream manufactured by Branded ice cream manufacturing companies (who claimed to maintaind GMP properly) and Non-branded local ice cream manufacturing companies where manufacturing quality and preservation system was not maintained properly. In this study, four brand company samples (namely Igloo, Polar, Kwality & Bellissimo) were collected from retail stores where the preservation system was moderately better, and non brand ice cream samples were collected from eleven different areas of Dhaka City, Bangladesh. The research works was conducted in the Microbiological laboratory of Quality Assurance Department of Igloo ice cream & milk unit. A total of seventy three (73) pcs of ice cream samples were randomly collected for the analysis, among which forty (40) pcs was from retail stores of four brand companies (which are industrially produced, packed, labeled and marketed according to GMP Guideline), the rest thirty three (33) Ice cream samples were collected from street ice cream vendors which are manufactured by non-brand local companies (manufacturing and preservation not maintained according to

GMP) of eleven (11) different areas of Dhaka city. The result was found that the highest extent of microbial contamination and proliferation of viable bacteria occurred in ice cream samples of Kwality Ice Cream Company which is one of the most renowned company among the four selected companies. Besides this, some street vendors ice cream samples were also found with highest viable bacterial count in lab analysis which were collected from few specific areas of Dhaka city, like - Demra, Aminbazar.

KEYWORDS: *Microbiological Quality; Ice Cream Quality; GMP; HACCP.*

INTRODUCTION

The origins of Ice cream's are known to started from the second century B.C., but still no specific date of origin has been found nor inventor has been undeniably awarded with its sole discovery. It's known that the Great Alexander was enjoyed snow and ice flavored with honey and nectar. During the time of Roman Empire, Nero Claudius Caesar (A.D. 54-86) was used-to sent runners into the mountains frequently to bring snow, which was then flavored with fruits and juices. It is also established from Biblical references that King Solomon was affectionate of iced drinks during harvesting.

During warmer seasons snow and ice have been popular because of the cooling properties of these materials. Possibly first snow and ice were mixed with fruit juices and subsequently with milk or yogurt, and this phenomenon resulted in a step-by-step evolution of Ice cream products. Until the nineteenth century, harvesting ice and storing it for use during summer was a labor intensive process and therefore, ice cream was a food for the rich only. With the invention of the hand cranked freezer and a ready availability of ice, ice cream moved down the social ladder, and towards the end of the nineteenth century it was sold on the streets of metropolitan areas (Kilara *et al*., 2007).

Quality of ice cream depends on both extrinsic factors that includes manufacturing procedure and intrinsic factors which include proportion of ingredients used. Ice cream, a milk based product is good media for microbial growth due to high nutrient value, almost neutral pH value and long storage duration. Primary sources of microbial contamination to ice cream include water and raw milk whereas secondary sources include flavoring agents, utensils and handling. Although pasteurization, freezing and hardening steps in production can estimate most of the microbial hazards, but still numerous health hazards are persistent due to various conditions. Many psychrophiles and psychrotolerant microorganisms like *Listeria*

monocytogens, *Staphylococcus aureus*, *Bacillus spp*., *Salmonella spp*., *Shigella spp*., *Streptococus spp*., *Pseudomonas sp*p., *Campylobacter sp*p., *Brucella spp*. and other bacteria are generally present in ice cream (Hankin *et al*., 1984; Joshi *et al*., 2004; Fuhr *et al*., 1986). In all developed countries the establishment of ice cream industry has promoted to build up improvement in health and economic well being of the nation. Unfortunately in Bangladesh keeping in view the coherent consumer's protection policies, there has been made very limited development of ice cream industries like Savoy, Polar, Kwality, Igloo, Bellissimo, Milk vita and street ice cream. Since Bangladesh does not have any organized food control service to ensure safety of food supplies, it is very difficult to ascertain whether the ice cream produced and distributed in our country is hygienically safe and without any public health hazard (Hossain *et al*., 2012).

Ice cream, a milk-based product, is a good media for microbial growth due to high nutrient value, almost neutral pH value (pH ~6-7) and long storage duration of ice cream (Bell *et al*., 1998). At many points, during production, transportation, storage and preparation milk food for consumption, it may become contaminated with biological agents. The biological agents contaminated with in food are traced to ingredients added post pasteurization and environmental factors such as air, faults in storage tank, cracks in the pant and packaging materials (Bigalke and Chappel., 1984). The potential microbiological hazards found in the final products can still be introduced after pasteurization through adding contaminated ingredients and improper handling procedures. This is especially important in the preparation of soft ice cream as its final stage of the production is carried out at point of sale. Some pathogens that can survive in food even at low temperature include *Salmonella spp*., *Listeria monocytogenes*, *Campylobacter spp*. and *Yersinia spp*. (ICMSF, 1996; Marshall, 1998).

The ice cream industry of Bangladesh is a growing one. With an estimated market size of BDT 220 Cr in 2009, the market can be subdivided broadly into branded and unbranded categories. Boutique format has seen an upsurge from year 2000 with introduction of premium, franchise and imported ice creams. This segment is driven by Dhaka and Chittagong based players. Club Gelato, MövenPick, Andersen's, Gelateria Igloo, Baskin Robbins and Sub Zero are the major players in the segment. Among these, Gelateria Igloo and Sub Zero are run by common format players Igloo and Kwality respectively. Unbranded market basically is constituted with around 20,000 local small producers that do not use any brand leverage and compete in the market based on significant lower price (Abir, 2011).

The Institute of Public Health (IPH) in Dhaka and the World Health Organization (WHO) in their joint study of 1994 on food adulteration tested 52 street vendors and found that, all of the vendors food samples were contaminated with different types of disease breeding microorganisms. Another study of 2003 conducted by the same organizations as above in the capital City. Revealed that among 400 sweetmeats, 250 biscuits, 50 breads and 200 ice creams samples, 96 percent of sweetmeats, 24 percent of biscuits, 54 percent of breads, and 59 percent of ice creams were adulterated (Atahar Ali, 2013).

The aim of this research is to determine the bacteriological quality of ice cream offered for public consumption; to understand the difference in the microbiological qualities between street vendor and industrially produced ice creams in area of Dhaka City, Bangladesh.

MATERIALS AND METHODS

Figure 1: Location of sampling site.

This study was conducted in Microbiological laboratory, Quality Assurance Department, Igloo ice cream & milk unit. A total of 73 pieces of industrially produced ice cream samples (packed, belonging to four different brands) were included in this quality analysis study. Among which forty (40) pieces of ice creams were collected randomly from retail stores and rest thirty three (33) pieces of ice cream samples were collected from street ice cream sellers of eleven (11) different area of Dhaka city. All microbiological procedures were performed according to the methods described in Bacteriological Analytical Manual.

Sample collection

Ice creams samples were collected from four renowned Ice cream Manufacturer Company's of Bangladesh which Ice creams prepared by four manufactures (Igloo, Polar, Kwality & Bellisimo) were collected for this study. A total of twelve ice cream samples of each brand were obtained from the retail stores and four samples of each area of Dhaka city. Ten ice cream samples of each brand were collected from the retail stores and three samples of ice cream collected from eleven (11) area of Dhaka city. Aseptic measure was taken during the collection of ice cream samples. The samples constitute unopened packages or tubes which were delivered intact to the laboratory. All samples were transported in an insulated container packed in ice and brought to the laboratory within two hours for sampling and subsequent studies.

Preparation of Samples

Prior to taking samples, the ice cream was kept in water bath at 45°C as per recommendation of Harrigan and McCance (1976); Rahman (1997). After thawing & when complete liquefaction from the top is so opened that the sterile piptte could be introduced for collection of samples. A quantity of about 10 ml of liquid ice cream was pipetted out from different depths and transferred into a sterile glass bottle fitted with a screw capped stopper. Ice creams of each brand were handled as above and the samples were taken in the labeled bottles. In this way a total quantity of 100 ml of the ice cream sample was collected from each brand and 40 ml of the ice cream sample was collected from isolated area of Dhaka city. The collected ice cream was considered as a single representative sample. From this thoroughly mixed sample, an exact quantity of 1 ml of ice cream was pipetted out aseptically and transferred into a sterile empty test tube and plugged with cotton. To this ice cream 9 ml of diluents was added to give a 1:10 dilution v/v. The choice of dilution for the preparation of samples was sterile 0.1% peptone water at pH 6.8-7.0. Further decimal dilutions as required were prepared according to standard method given by APHA.

Media for Bacteriological Analysis

For the isolation of pathogenic bacterial strains different types of medium were used such as Plate Count Agar (PCA), Violet Red Bile Agar (VRBA), Eosin Methylene Blue Agar (EMB), Mannitol Salt Agar (MSA), MacConkey broth (MCB), Xylose Lysine Deoxycholate (XLD), Selenite F broth (SFB) and different biochemical media.

Microscopic Examinations

The size, shape, arrangement, presence of spore, and staining properties of isolated bacterial strains were examined by the bright field microscope, wet preparation, and Gram staining of the direct specimen was examined to visualize the microorganisms and presumptive characterization groups of the isolates.

Media used for Detection of Biochemical Properties

According to 'Microbiological Laboratory Manual' by G Cappuccino, several biochemical tests were performed to identify the bacteria of interest. To detect the biochemical properties optimization of the selected isolated strains, the following tests were used:

Microbiological Methods

The microbiological analysis of fresh produce sample include-

Total viable bacterial colony count (TVC):

For the determination of total bacterial count, 1 ml of each ten-fold dilution was transferred and pour into plate count agar and swirl clock wise and anti clock wise. The plates were then kept in an incubator at 37°C for 24-48 hours. Following incubation, plates exhibiting 30-300 colonies were counted. The average number of colonies in a particular dilution was multiplied by the dilution factor to obtain the total viable count. The results of the total bacterial count were ex-pressed as the number of organism or colony forming units per gram (CFU/gm) of ice cream sample.

Enumeration of Total Coliform Count (TCC):

For the determination of total coliform count 1 ml of each tenfold dilution was transferred to Violet Red Bile Agar (VRBA). For each dilution five test plates containing Violet Red Bile Salt agar (VRBA) were used. All the agar plates were incubated at 37°C temperature for 48 hours. The results of the total coliform count were expressed as the number of organism or colony forming units per gram (CFU/ml) of ice cream sample.

Enumeration of Total Staphylococcal Count (TSC):

For the determination of total *staphylococcal* count 1 ml of each tenfold dilution was transferred to mannitol salt agar. For each dilution five test plate containing Mannitol salt agar were used. All the agar plates were incubated at 37°C temperature for 48 hours. The results of the total *staphylococcal* count were expressed as the number of organism or colony

forming units per gram (CFU/gm) of ice cream sample. Typical yellow colonies on MSA were identified as *Staphylococcus aureus* by gram staining, catalase, oxidase, oxidative fermentative (O-F) and coagulase test.

Detection of *Escherichia coli*:

Detection of *E.coli* was done by MacConkey broth with Durham's tube after 37°C overnight incubation if gas produced, one loopful of the samples were also inoculated onto Eosin Methylene Blue (EMB) agar to examine them for production of metallic sheen to confirm *E. coli* growth. Xylose Lysine Deoxycholate (XLD) agar media were also used to observe the growth pattern of *E. coli* on this medium. A pure colony of each isolates was picked and Gram staining was performed. Then the shape, arrangement and gram reaction of the isolates were observed in a microscopic field (Pelczar *et al*., 1993). According to 'Biochemical Test for Identification of Medical Bacteria' by Zean F. Macfabdin (1980) and 'Microbiological Laboratory Manual' by G.Cappuccino and Ntalie Fhernan (1996), following by biochemical tests were performed to identify the bacteria.

Detection of *Salmonella* spp.:

Detection of *Salmonella* spp. was done by enrichment in Selenite F broth followed by streaking on Xylose Lysine Deoxycholate (XLD) agar. Typical pink colonies with black centre were identified as *Salmonella* spp. by gram staining and various biochemical tests as described by Benson (1994).

Statistical Analysis

Results were analyzed by calculating the Mean value and Standard deviation using Microsoft Excel, 2010.

RESULTS

Bacteriological Analysis of Ice Cream Samples

The Total Viable Bacterial Counts

Total bacterial counts helps to determine the concentration of the aerobic or mesophilic microorganisms present in the samples. The bacterial loads found were not uniform and varied quite considerably. The occurrence and identity of the various bacterial isolates are shown in Table 1(Industrially produced ice cream). The range is between cfu/ml of Igloo, Polar, Kwality & Bellisimo were 21 x 10^2 to 55 x 10^2, 52 x 10^2 to 110 x 10^2, 178 x 10^2 to 200 x 10^2, 20 x 10^2 to 80 x 10^2 respectively.

The occurrence and identity of the various bacterial isolates are shown in Table 2 (street-vendor ice cream samples). The range between cfu/ml of area of Dhaka city such as Dhanmondi, Tejgaon, Khilgaon, Keraniganj, Shyampur, Mirpur, Uttara, Tongi, Savar, Demra, Aminbazar were 90 x 10^2 to 180 x 10^2, 90 x 10^2 to 130 x 10^2, 80 x 10^2 to 220 x 10^2, 200 x 10^2 to 250 x 10^2, 98 x 10^2 to 210 x 10^2, 90 x 10^2 to 110 x 10^2, 120 x 10^2 to 180 x 10^2, 216 x 10^2 to 330 x 10^2, 41 x 10^2 to 400 x 10^3, 180 x 10^2 to 430 x 10^3, 380 x 10^3 to 428 x 10^3 respectively.

The Total Coliform Counts

The highest percentages of these organisms were isolated from open ice cream samples. The occurrence and identity of the various bacterial isolates are shown in Table 1 & 2. In general, most of the isolates were total Coliform 72.5% found positive in industrially produced branded company ice cream samples and 100% found positive in street-vendor ice cream samples. Coliform were detected 20% in branded company manufactured ice cream samples, which was exceeded the limit of BSTI standard and 90.90% found in street vendor samples that also exceeded standard range. Coliform counts were found in highest density in Kwality and lowest in Igloo ice cream samples.

Table 1: Bacteriological quality of Branded Company produced ice cream samples (n = 40).

Sample No.	Brand of Ice Cream	TVC (cfu/ml)	Total Coliform (cfu/ml)	S.aureus (cfu/ml)	E.coli (Absent/g)	Salmonella spp. (Absent/25g)
01	Igloo	26 x 10^2	-	-	-	-
02	Igloo	21 x 10^2	1	2	-	-
03	Igloo	28 x 10^2	-	-	-	-
04	Igloo	55 x 10^2	4	4	-	-
05	Igloo-Mi-amore	40 x 10^2	6	-	-	-
06	Igloo-Mi-amore	23 x 10^2	-	-	-	-
07	Igloo-Mi-amore	22 x 10^2	1	-	-	-
08	Igloo-Mi-amore	24 x 10^2	-	-	-	-
09	Igloo-Mi-amore	26 x 10^2	-	-	-	-
10	Igloo-Mi-amore	22 x 10^2	-	-	-	-
11	Polar	55 x 10^2	-	-	-	-
12	Polar	65 x 10^2	8	-	-	-
13	Polar	52 x 10^2	10	-	-	-
14	Polar	50 x 10^2	4	1	-	-
15	Polar	54 x 10^2	10	-	-	-
16	Polar	62 x 10^2	8	-	-	-
17	Polar	90 x 10^2	5	2	-	-
18	Polar	110 x 10^2	6	4	-	-

19	Polar	98×10^2	-	4	-	-
20	Polar	90×10^2	8	-	-	-
21	Kwality	190×10^2	14	2	-	-
22	Kwality	198×10^2	22	3	Present	-
23	Kwality	188×10^2	18	6	-	-
24	Kwality	200×10^2	12	-	-	-
25	Kwality	180×10^2	40	-	Present	-
26	Kwality	180×10^2	9	-	-	-
27	Kwality	182×10^2	16	-	-	-
28	Kwality	200×10^2	16	2	-	-
29	Kwality	188×10^2	10	2	-	-
30	Kwality	178×10^2	8	6	-	-
31	Bellissimo	28×10^2	8	-	-	-
32	Bellissimo	26×10^2	-	5	-	-
33	Bellissimo	22×10^2	-	-	-	-
34	Bellissimo	22×10^2	1	-	-	-
35	Bellissimo	45×10^2	4	-	-	-
36	Bellissimo	80×10^2	9	-	-	-
37	Bellissimo	20×10^2	-	1	-	-
38	Bellissimo	24×10^2	10	-	-	-
39	Bellissimo	28×10^2	10	-	-	-
40	Bellissimo	32×10^{2s}	16	-	-	-

Table 2: Bacteriological quality of Non-Brand Company produced street-vendor ice cream samples (n = 33).

Sample No.	Name of Sampling Site	TVC(cfu/ml)	Total Coliform (cfu/ml)	S.aureus (cfu/ml)	E.coli (Absent/g)	Salmonella spp. (Absent/25g)
01	Dhanmondi	90×10^2	11	10	-	-
02	Dhanmondi	120×10^2	19	31	-	-
03	Dhanmondi	180×10^2	23	11	-	-
04	Tejgaon	100×10^2	41	9	-	-
05	Tejgaon	90×10^2	16	-	Present	-
06	Tejgaon	130×10^2	10	10	-	-
07	Khilgaon	220×10^2	11	8	-	-
08	Khilgaon	80×10^2	10	8	Present	-
09	Khilgaon	93×10^2	14	11		-
10	Keraniganj	200×10^2	44	12	Present	Present
11	Keraniganj	224×10^2	41	18	Present	Present
12	Keraniganj	250×10^2	33	20	-	-
13	Shyampur	120×10^2	32	21	-	-
14	Shyampur	98×10^2	30	1	-	-
15	Shyampur	210×10^2	13	4	-	-
16	Mirpur	90×10^2	11	8	Present	-
17	Mirpur	98×10^2	12	-	Present	-
18	Mirpur	110×10^2	10	4	-	-
19	Uttara	124×10^2	11	4	-	-
20	Uttara	120×10^2	13	7	Present	-

21	Uttara	180×10^2	11	-	-	-
22	Tongi	220×10^2	18	18	-	-
23	Tongi	216×10^2	44	-	-	-
24	Tongi	330×10^2	51	6	-	-
25	Savar	400×10^3	56	-	-	-
26	Savar	41×10^2	34	11	-	-
27	Savar	398×10^2	22	15	-	-
28	Demra	430×10^3	112	13	Present	Present
29	Demra	228×10^2	44	21	Present	-
30	Demra	180×10^2	48	11	-	Present
31	Aminbazar	380×10^3	122	13	Present	Present
32	Aminbazar	428×10^3	66	13	Present	-
33	Aminbazar	418×10^3	61	10	-	-

The *Enterobacteriaceae* Isolates

The pathogenic bacteria *E.coli* and *Salmonella* spp both was found in street vendor ice cream samples respectively 33.33% and 15.15%. Among the industrially produced ice cream samples, approximately 5% sample was found positive in *E.coli*.

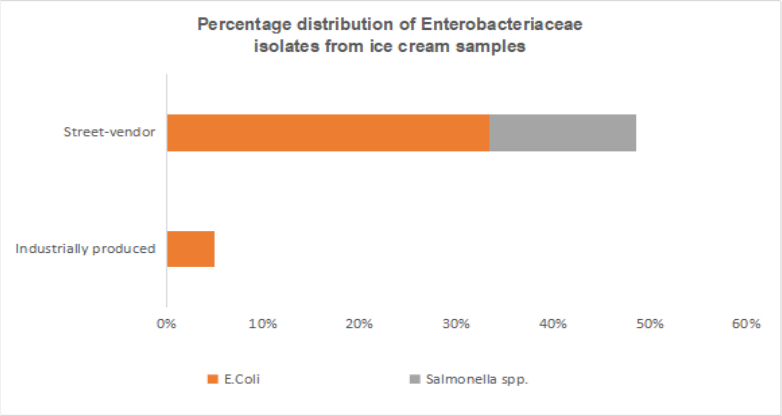

Figure 2: Percentage distribution of *Enterobacteriaceae* isolates from ice cream samples.

The Gram Positive Bacteria Isolates

Gram positive isolates were distributed as shown in Figure 2 & 3. Results of *Staphylococcal* count also suggest the need to improve handling measures of finished products. According to FSSA, *Staphylococcus aureus* should be less than 10 cfu/gram of the sample. In this study, we have noticed that 10% of Polar, and 15% of Kwality ice cream samples found positive which were industrially produce, packed and marketed ice cream samples and 84.84% of the samples showed a positive count which are from street vendor ice cream samples.

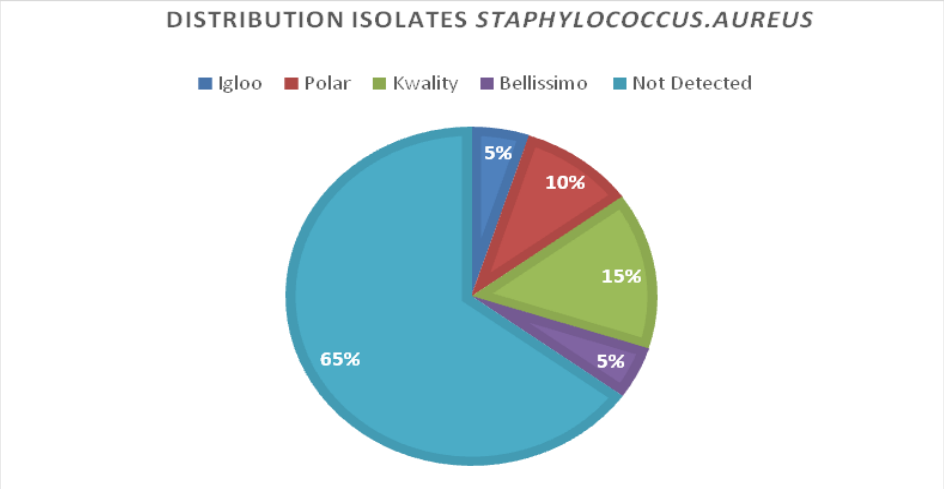

Figure 3: Distribution isolates *Staphylococcus. aureus* in Branded Company produced ice cream samples.

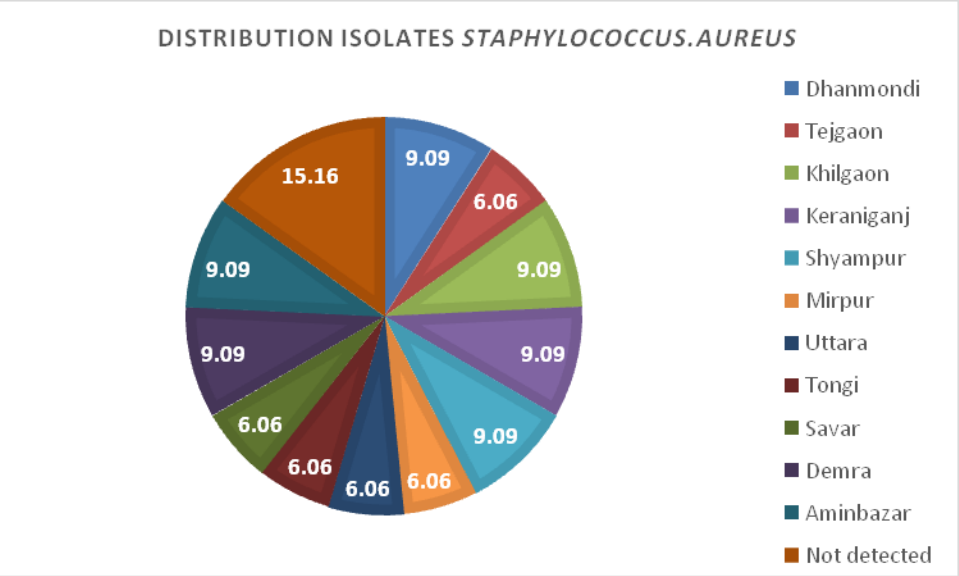

Figure 4: Distribution isolates *Staphylococcus.aureus* in Non-Brand Company produced street-vendor ice cream samples.

In general, most of the microbial isolates were total Coliform (72.5%) found from industrially produced ice cream samples of four branded ice cream manufacturers and 100% found positive in non-branded manufacturers produced street-vendor ice cream samples. Coliform were detected 20% in industrially produce ice cream samples, which was exceeded the limit of BSTI standard and 90.90% found in local manufactured non brand street vendor ice cream samples which was also exceeded the standard limit. Coliform counts were found in highest density in the ice creams samples of Kwality and lowest in Igloo ice cream samples. The pathogenic bacteria *E.coli* and *Salmonella spp* both was found in street vendor ice cream samples

respectively 33.33% and 15.15%. Industrially produced ice cream samples were found 5% positive in *E.coli*. *Staphylococcal* count were noticed 10% and 15% in industrially produce ice cream samples respectively in Polar and Kwality, while the street vendor ice cream samples showed 84.84% positive count. Results showed that ice creams produced in Dhaka city in Bangladesh had poor microbiological quality in street vendor ice cream. Application of the HACCP system for ice cream production should become legally mandatory to improve the product quality.

DISCUSSION

The quality of food depends on the total number of viable organisms as revealed by the total bacterial count. However, the microbial load of food products is influenced by a number of factors such as the general environment from which the raw materials were obtained, the environment in which it was processed, the sanitary conditions under which the food was handled and processed, and the adequacy of processing procedures targeted at reducing contaminants during the packaging, handling and storage of the product. (Osamwonyi, 2005). The microbial content of frozen dairy Products that include ice cream largely reflects the quality of the ingredients used for their manufacture, handling during and after manufacturing and sanitation of equipment used. Due to the fact that ice cream mix has to undergo pasteurization the microbial counts are expected to be low, less than 100 bacterial cells per ml (Mathews *et al*. 2013; Tomislav *et al*. 2012). The only organisms that might be present after pasteurization are the spore-formers such as *Bacillus* species and other thermoduric bacteria that might have been part of some the ingredients. The microbiological quality of street vendor ice cream samples and industrially produced ice cream samples in terms of mesophilic, psychrotrophic, *E.coli*, *S.aureus*, *Salmonella spp*. and yeasts counts were different (Tables 1, 2 and 3).

The result presented in Table 1 & 2 showed the total viable bacterial load of 40 industrially produced ice cream samples of four different brands and 33 street ice cream samples were collected randomly from 11 different area of Dhaka city. In the present study, The TVC loads found were not uniform and varied quite considerably. The average counts/ml of Igloo, Polar, Kwality & Bellissimo were 21 x 10^2 to 55 x 10^2, 52 x 10^2 to 110 x 10^2, 178 x 10^2 to 200 x 10^2, 20 x 10^2 to 80 x 10^2. The TVC was within the prescribed limit of BSTI for all the industrial ice cream brands. However, the street vendor samples which were manufactured and

preserved locally without maintaining GMP guideline found to exceeded the regular standards of BSTI in the area of Amin bazar, Demra and Savar.

Hossain *et al*., 2012 reported that, the average counts/ml of Milk vita, Igloo, Polar, Savoy and Kwality brand were 3,267 CFU/ml (log 3.5), 3,500 CFU/ml (log 3.5), 13,833 CFU/ml (log 4.1), 16,500 CFU/ml (log 4.2), and 20,916 CFU/ml (log 4.3) correspondingly. Although the samples we analyzed were having lesser counts, they were not in the safe limits.

Better microbiological quality of branded ice cream samples may be attributed to pasteurization of the ice cream mix, clear industry guidance on microbiological standards and prompt adherence to cold chain Contamination of the mix, temperature abuse of the mix and inadequate cleaning of the equipment and premises of sale can lead to TVC counts in excess of 10^6 cells (Harrigan, 1998). TVC of the frozen dairy products are generally considered as incidence of plant sanitation and handling conditions.

As per BSTI standard, the Coliform count in ice cream should not be more than 10/gram. In the present, in this study, 75.5 % of the samples contained Coliforms positive in industrially produced ice cream and 100% Coiliform positive in street vendor ice cream. However, 20% in industrially produce ice cream, which was exceed limit of BSTI standard and 90.90% street vendor also exceed BSTI standard. Though TVC was within the prescribed range, Coliform count exceeded the limits in kwality and lowest in Igloo branded ice creams. Hossain *et al* also reported, the average count/ml was observed in samples belongs to kwality. Satisfactory TVC with high Coliform count clearly indicates inadequate handling practices at the selling point. Plant hygiene and personnel hygiene should be suspected when Coliform count of the product is high (Ambily *et al*., 2012). The present investigation however showed significant Coliform counts in under control belongs to Igloo, Polar and Bellissimo ice cream samples. The scoop water can get contaminated by the unhygienic conditions during the sale. Kanbakan *et al.* (1999) reported that inadequate cleaning of the hands, same person selling ice cream and collecting money, open cones and unclean cloth for cleaning the scoops can contribute to high Coliform count.

FSSA stipulates that *E. coli* should be absent in one gram of ice cream. In the present trial, *E. coli* indicative of feacal contamination were isolated 33.33% were positive in street vendor ice cream and 5% were industrially produced ice cream. This finding highlights the importance of personnel hygiene at the selling point. In many cases, the final stages of

packing and marketing is likely to be frequently contaminated by human carriers. Equipment hygiene at the food service establishment is also very important to assure safe products for consumers.

Handler's hygiene is to be suspected in case of increased *Staphylococcal* count. Results of *Staphylococcal* count also suggest the need to improve handling measures of finished products. According to FSSA *Staphylococcus aureus* should be less than 10/gram of the sample. In this study, noticed that 45.45 % of the samples showed a higher count in the street vendor ice cream. Although, in industrially produce ice cream positive 35% but not exceed FSSA standard. In certain situation *staphylococci* organisms particularly *S. aureus* may be a pathogen, a source of enterotoxin and indicator of un-sanitary practice. In man, the main reservoir of *S. aureus* is the nasal cavity and skin. From these sources *staphylococci* find their way into air and dust, into clothings and in other place from which foods get contaminated. Since *staphylococcal* food poisoning is an intoxication and depends on the ability of food concerned to support the growth of the *staphylococci* which produce the toxin. It is therefore important to consider that the processing and handling of the food products should be so designed to minimize contamination and to make unfavorable medium for the growth of these organisms. When susceptible foods are produced with low numbers of *staphylococci*, they will remain free of enterotoxin if kept either below 4°C until consumed. The factors that contribute mostly to *staphylococcal* food-borne outbreaks may be due to inadequate refrigeration, preparing food far in advance of planned service, infected persons practicing poor personal hygiene, inadequate heat processing and holding food in warming devices at bacterial growth temperature. Hossain *et al.* (2012) stated that *staphylococci* may come into milk and milk product from food handlers who may have acute infections or from healthy carriers who harbor the organisms in their nose or throats and also it is due to improperly stored and refrigerated milk and milk product that make excellent culture media for growth of these organisms.

Salmonella was isolated from five sample (15.15%) sold by a street vendor which incidentally had high coliform count also. As per the standards, *Salmonella* should be absent in 25 gram of the sample. In the present work, *Salmonella* was isolated from representative sample of one gram itself. The result is suggestive of the alarming situation that the product poses to public health. Raw material quality, processing quality and hygiene at all levels till consumption are crucial to assure product safety. Consumption of contaminated ice cream

has been the cause of several food poisoning outbreaks (Mathews *et al*. 2013; Hennessy, 1996). A recent report on gastrointestinal infections in children due to consumption of contaminated ice creams from the make-shift stall outside the temple premises in Kinanur-Karindalam village near Neeleswaram, North Kerala also supports the view that there is an urgent requirement to implement food safety guidelines to ensure the safety and quality of ice creams all over Kerala (Anonymus, 2012).

In this study, we found a correlation between the Coliform count and the *Staphylococcal* count. Samples with high Coliform count had a high *Staphylococcal* count also. *Escherichia coli* count was also found to be related to this. We could isolate *E. coli* from the samples sold by street vendors which were high in Coliforms and *Staphylococcus aureus*. The bacteriological analysis of the ice cream from the street vendor reflected the unhygienic vendor handling practices.

CONCLUSION

Ice cream is one of most popular and favorite food products all over the world. It is an ideal media for microbial growth due to high nutritive value and long storage duration. Once the ice cream becomes contaminated, freezing temperature could not make the product safer later. Several steps in their production can cause bacteriological hazards. Though pasteurization of milk can destroy most of the pathogens posing risk to public health, yet, the potential bacteriological hazards can still be found in the final products after pasteurization through the addition of contaminated ingredients or improper handling. At retail shops, improper storage temperature and prolonged storage time affects the microbiological quality of ice cream. The same reasons would have contributed to poor quality of branded ice cream also. To improve quality of ice cream, Good manufacturing practice (GMP) is mandatory especially at all post pasteurization steps. The use of good quality raw materials and automatic machines to minimize handling will be effective in assuring quality. Adoption of good sanitation practices and application of the HACCP principles in the system along with education of workers on personal hygiene will definitely improve the quality of ice cream.

ACKNOWLEDGEMENTS

We thank Abdul Monem Ltd., Igloo Ice Cream & Milk Unit and State University Bangladesh for the technical support and laboratory facilities.

DISCLOSER OF CONFLICTS OF INTEREST

Authors have no conflicts of interest associated with this study.

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