

Bacteriological quality of packaged ice cream in Gaza city, Palestine

Emad Abou-El Khair^{1,*}, Abd Al- Raziq Salama², Hamdan Radwan², Abdelrahman Khalafallah³, Hashem Arafa⁴

¹Department of Biology, Faculty of Science, Al-Azhar University- Gaza, Palestine

²Department of Food Science & Technology, Faculty of Agriculture, Al-Azhar University- Gaza, Palestine

³Department of Food & Technology, Faculty of Agriculture, Cairo University, Egypt

⁴Department of Public Health, Ministry of Health, Gaza, Palestine

Email address:

e.khair@alazhar.edu.ps (E. Abou-El Khair), eabouelkhair@gmail.com (E. Abou-El Khair)

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Abstract: Ice cream is absolutely one of the most popular and favorite food product for Palestinian children and adults. However, it is one of the most favorable foods for bacterial growth and potential source of food poisoning. The main objective of this work was to determine the bacteriological quality of packaged ice cream sold in Gaza city. One hundred samples of traditional sealed packaged ice cream were collected randomly from 20 different food stores of Gaza city. The samples represented all types of ice cream products in the local markets; they included chocolate, fruits, nuts and fruits flavor types. Bacteriological quality was assessed through the examination of collected ice cream samples for total aerobic count, coliform and fecal coliform, *Salmonella* spp., *Shigella* spp., *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Enterobacter sakazakii*, *Escherichia coli*, *Listeria ivanovii* and *L. grayi*. Results revealed that many ice cream samples were contaminated with coliform, fecal coliform, *E. coli*, *S. aureus*, *K. pneumoniae*, *E. sakazakii*, *L. grayi* and *L. ivanovii*. Repeated electricity shuts for long periods in addition to poor handling of such perishable products may be the cause of their contamination. It is recommended to launch awareness programs to minimize the contamination of ice cream products.

Keywords: Bacterial Contamination, Gaza City, Packaged Ice Cream

1. Introduction

Ice cream is a nutritionally enriched dairy product which is produced by freezing pasteurized mixture of milk solids. Ice cream is rich in fat, sugar, emulsifier and stabilizer. Flavor enrichment of ice cream is an optional addition of fruits nuts, candies, syrups and other flavoring ingredients (1).

Ice cream should contain extremely low bacterial load, but higher bacterial counts have been reported by many researchers. This could be due to improper pasteurization process or post-process contamination (2).

Bacterial contamination is the main danger posed by old ice cream. Foods spoiled by bacteria which may look, smell and taste just fine can make us sick. Bacteria thrive in protein-rich foods that are also full of water including eggs, meat, fish and milk products. Freezing ice-cream and other frozen dairy products slow bacterial growth but doesn't kill

the bacteria, which begin to grow again as food thaws. The risk of food-borne illness increases after ice cream has been opened and used. Some researchers recommended to discard any ice cream that thaws completely, due to the danger of bacterial growth (3).

There is limited information in Gaza strip about the risk of frequent electricity shutting in Gaza city which leads to several harmful events such as temperature abuse during ice cream packaging; which is considered as the main cause in the activation of pathogenic bacteria. Therefore, eating of ice cream can be a risk factor for tonsillitis and gastrointestinal tract infections such as diarrhea.

The aim of this study was to evaluate the bacteriological quality of sealed packaged ice cream in Gaza city.

2. Materials and Methods

This descriptive study was conducted to determine the

bacteriological quality of packaged ice cream sold in Gaza city. Different tools were used to determine the total aerobic count and to isolate, purify and identify the pathogenic bacteria that may contaminate ice cream.

2.1. Ice Cream Samples Collection

During the study period (June to August 2012), 100 samples, twenty five from each type (chocolate, fruits flavor, fruits and nuts) were collected from different local food stores of Gaza city.

A sample unit consisted of a minimum of 100g ice cream. The samples were collected in 200 ml capacity clean sterile cups and transported to the laboratory in an ice box within 1 hour. The samples were examined as soon as they reached the laboratory or they were frozen at -18°C till analysis.

2.2. Bacteriological Analysis

All the bacteriological media used throughout this study were purchased from Hi media company, India. The procedures followed for the detection of different bacteriological parameters; Total aerobic count, Coliform, Fecal coliform, *Escherichia coli*, *E. coli* O157: H7, *Enterobacter sakazakii*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Salmonella* spp., *Shigella* spp., *Listeria ivanovii* and *L. grayi* were as described in the standard methods for examination of water and waste water (4).

2.2.1. Biochemical Tests

The Analytical Profile Index (API) 20 E and *Staphylococcus* API strips (Bio Merieux, France) were used as the biochemical systems for identification.

Data analysis was performed using SPSS, version 18.0 computer software.

3. Results

3.1. Bacteriological Analysis of Ice Cream Samples

The bacteriological analysis of ice cream showed that most samples do not complied (failed) the Palestinian standards for ice cream. Regarding the total aerobic count, 51 samples (51%) do not complied the Palestinian standard (more than 2.5×10^5). Coliform represented the highest level of contamination (56%) while all samples were free from *salmonella* spp. and *Shigella* spp. (Table 1).

Table 1. Presence of different types of bacteria in ice cream samples.

Type of Bacteria	Positive samples		Negative samples	
	Number	percentage	number	percentage
Total aerobic count	51	51	49	49
<i>Staph. aureus</i>	23	23	77	77
Coliform	56	56	44	44
Fecal coliform	46	46	54	54
<i>E. coli</i>	44	44	56	56

Type of Bacteria	Positive samples		Negative samples	
	Number	percentage	number	percentage
<i>E. coli</i> O 157: H 7	1	1	99	99
<i>K. pneumonia</i>	36	36	64	64
<i>Salmonella</i> spp.	0	0	100	100
<i>Shigella</i> spp.	0	0	100	100
<i>Enterob. sakazakii</i>	8	8	92	92
<i>Listeria ivanovii</i>	6	6	94	94
<i>Listeria grayi</i>	3	3	97	97

3.2. Distribution of *Staphylococcus Aureus* among Different Types of Ice Cream

Table 2 shows that all chocolate and nuts ice cream samples were free from *Staphylococcus aureus* contamination, while fruits flavor ice-cream were highly contaminated (68%).

Table 2. Distribution of *Staphylococcus aureus* among different types of ice cream.

Type of ice cream	Positive %	Negative %	Total	P value
chocolate ice cream	0 (0)	25 (100)	25 (25)	0.000
Fruits flavor ice cream	17 (68)	8 (32)	25 (25)	
Ice cream with fruits	6 (24)	19 (76)	25 (25)	
Ice cream with nuts	0 (0)	25 (100)	25 (25)	
Total	23 (23)	77 (77)	100 (100)	

3.3. Distribution of Coliform among Different Types of Ice Cream

In the term of contamination with coliform, the ice cream with fruits presented 100% contamination with coliform, the chocolate and nuts presented the same level of infection (56%) while ice cream with fruits flavor presented the lowest level of coliform infection (12%) as shown in table 3.

Table 3. Distribution of coliform among Different types of ice cream.

Type of ice cream	Positive%	Negative%	Total	P value
chocolate ice cream	14 (56)	11 (44)	25 (25)	0.000
Fruits flavor ice cream	3 (12)	22 (88)	25 (25)	
Ice cream with fruits	25 (100)	0 (0)	25 (25)	
Ice cream with nuts	14 (56)	11 (44)	25 (25)	
Total	56 (56)	44 (44)	100 (100)	

3.4. Distribution of *E. coli* among Different Types of Ice Cream

Table 4 shows the effect of *E. coli* on different types of ice cream, the study showed that highest levels of *E. coli* infection present on ice cream with fruits 96% while the lowest with nuts 12%.

Table 4. Distribution of *E. coli* among Different types of ice cream.

Type of ice cream	Positive%	Negative%	Total	P value
chocolate ice cream	10 (40)	15 (60)	25 (25)	0.000
Fruits flavor ice cream	7 (28)	18 (72)	25 (25)	
Ice cream with fruits	24 (96)	1 (4)	25 (25)	
Ice cream with nuts	3 (12)	22 (88)	25 (25)	
Total	44 (44)	56 (45)	100 (100)	

3.5. Distribution of *E. Coli* O157: H7 among Different Types of Ice Cream

Regarding to *E. coli* O157: H7, table 5 shows that 3 types of ice creams were free (chocolate, fruits and nuts), while fruits flavor presented 4%.

Table 5. Distribution of *E. coli* O157: H7 among Different types of ice cream.

Type of ice cream	Positive %	Negative %	Total	P value
chocolate ice cream	0 (0)	25 (100)	25 (25)	0.38
Fruits flavor ice cream	1 (4)	24 (96)	25 (25)	
Ice cream with fruits	0 (0)	25 (100)	25 (25)	
Ice cream with nuts	0 (0)	25 (100)	25 (25)	
Total	1 (1)	99 (99)	100 (100)	

3.6. Distribution of *K. pneumoniae* among Different Types of Ice-Cream

In the term of presence of *K. pneumonia* among different types of ice cream, it is observed that fruits type had the maximum level of contamination 68%, while fruits favor and nuts had the lower value 16% (Table 6).

Table 6. Distribution of *K. pneumoniae* among Different types of ice cream.

Type of ice-cream	Positive%	Negative%	Total	P value
chocolate ice cream	11 (44)	14 (56)	25 (25)	0.000
Fruits flavor ice cream	4 (16)	21 (84)	25 (25)	
Ice cream with fruits	17 (68)	8 (32)	25 (25)	
Ice cream with nuts	4 (16)	21 (84)	25 (25)	
Total	36 (36)	64 (64)	100 (100)	

3.7. Distribution of *Enterobacter Sakazakii* among Different Types of Ice Cream

The contamination of *Enterobacter sakazakii* was observed in all types of ice cream, 16% in fruits flavor as maximum percentage of infection and 4% for chocolate and fruits types as the minimum infection level. Meanwhile in ice cream with nuts analysis, only two samples were contaminated with *Enterobacter sakazakii* (Table 7).

Table 7. Distribution of *Enterobacter sakazakii* among Different types of ice cream.

Type of ice cream	Positive%	Negative%	Total	P value
chocolate ice cream	1 (4)	24 (96)	25 (25)	0.35
Fruits flavor ice cream	4 (16)	21 (84)	25 (25)	
Ice cream with fruits	1 (4)	24 (96)	25 (25)	
Ice cream with nuts	2 (8)	23 (92)	25 (25)	
Total	8 (8)	92 (92)	100 (100)	

3.8. Distribution of Fecal Coliform among Different Types of Ice Cream

Contamination with fecal coliform appeared clearly in fruits type of ice cream (88%), 44% in fruits flavor, and 36% in chocolate ice cream, while the lowest level of contamination (16%) presented in ice cream with nuts (Table 8).

Table 8. Distribution of fecal coliform among Different types of ice cream.

Type of ice cream	Positive %	Negative %	Total	P value
chocolate ice cream	9 (36)	16 (64)	25 (25)	0.000
Fruits flavor ice cream	11 (44)	14 (56)	25 (25)	
Ice cream with fruits	22 (88)	3 (12)	25 (25)	
Ice cream with nuts	4 (16)	21 (84)	25 (25)	
Total	46 (46)	54 (54)	100 (100)	

3.9. Distribution of *Listeria Ivanovii* among Different Types of Ice Cream

Regarding to *Listeria ivanovii*, table 9 shows that ice cream with fruits flavor type were free of contamination, while other types presented light level of contamination 12% for chocolate, 8% for fruits and 4% for ice cream with nuts.

Table 9. Distribution of *Listeria ivanovii* among Different types of ice cream.

Type of ice-cream	Positive %	Negative %	Total	P value
chocolate ice cream	3 (12)	22 (88)	25 (25)	0.31
Fruits flavor ice cream	0 (0)	25 (100)	25 (25)	
Ice cream with fruits	2 (8)	23 (92)	25 (25)	
Ice cream with nuts	1 (4)	24 (96)	25 (25)	
Total	6 (6)	94 (94)	100 (100)	

3.10. Distribution of *Listeria grayi* among Different Types of Ice Cream

Other type of *Listeria* was tested *L. grayi*, the results showed that two ice cream types were free of contamination, fruits flavor and fruits, while nuts presented 8% and chocolate was the lowest one 4% (Table 10).

Table 10. Distribution of *Listeria grayi* among Different types of ice cream.

Type of ice cream	Positive %	Negative %	Total	P value
chocolate ice cream	1 (4)	24 (96)	25 (25)	0.28
Fruits flavor ice cream	0 (0)	25 (100)	25 (25)	
Ice cream with fruits	0 (0)	25 (100)	25 (25)	
Ice cream with nuts	2 (8)	23 (92)	25 (25)	
Total	3 (3)	97 (97)	100(100)	

3.11. Distribution of all Types of Bacteria among Different Types of Ice-Cream

From above mention, we observed that all ice cream types presented contamination with one or more type of bacteria, the following table presents the distribution of all types of bacteria among different types of ice cream, which appear that ice cream with fruits presented the maximum chance of contamination 80% then the chocolate ice cream 60% while fruits with flavor 52% and the low chance of contamination presented in ice cream with nuts.

Table 11. Distribution of All Types of Bacteria among Different types of ice cream.

Type of ice-cream	Positive %	Negative %	Total	P value
chocolate ice cream	15 (60)	10 (40)	25 (25)	0.000
Fruits flavor ice cream	13 (52)	12 (48)	25 (25)	
Ice cream with fruits	20 (80)	5 (20)	25 (25)	
Ice cream with nuts	3 (12)	22 (88)	25 (25)	
Total	51 (51)	49 (49)	100 (100)	

3.12. Results of *Salmonella* and *Shigella* Species

It is important to mention that all types of ice cream were free from *salmonella* spp. and *Shigella* spp..

4. Discussion

Frequent electricity shuts in Gaza city leads to temperature abuse during storage of ice cream, therefore, the main objective of this work was to determine the bacterial quality of ice cream sold in Gaza city.

In this study, the cross sectional method has been selected. Such method would be useful for the purpose of descriptive analysis being the most convenient and representative.

Most of the studies select approximately the same types of bacteria which can affect the ice cream, such as our types selected (1,5,6). All ice cream samples contained one or more microorganism contamination, at the same times all samples were free from *salmonella* & *Shigella* spp. The absence of *Salmonella* might be due to substituting a pasteurized egg product, egg substitute, or pasteurized shell eggs for the raw eggs in the favorite recipe. Egg products are eggs that have been removed from their shells and pasteurized, or another possibility that the ice cream made without using egg (7).

The possible source(s) of these bacteria in ice-cream

could be from nose where it is commonly found; hands, skin, and clothing of handlers (8). Coughing, talking and sneezing produce droplets which could settle on ice cream during transportation, storage and retailing (9).

The status of microbial quality of ice cream being sold in the northwest region of Iran was investigated, results showed that all analyzed traditional cacao ice cream samples (n=30) showed positive growth (7.52 ± 0.25 log cfu/g) on plate count agar indicating the presence of aerobic microorganisms (1). Our results are more or less in agreement with these results.

The results show that each chocolate ice cream and with nuts are free from *S. aureus* contamination, while ice cream with fruits flavor present the highest level of infection 68%. This result is more or less similar to other studies which showed heavy contamination of notable bacteria (*E. coli*, *Klebsiella*, *Proteus*, *Salmonella* and *Staphylococcus*) which may indicate fecal contamination (9,10,11).

Contamination with coliform bacteria was detected, the ice cream with fruits presents 100% contamination with coliform, while, the chocolate and nuts present the same level of contamination 56% while ice cream with fruits flavor showed the lowest level of coliform infection 12%. Also in a study in Cameron reported that 71.3% of 300 ice cream samples were infected with fecal bacteria (12). Another study by Bialasiewicz and Rzedzinska in Lahestan, 12.3% of 195 samples were infected with fecal coliforms were observed (13). Also coliforms were found in 47 of the 49 (95.9%) samples from Guadalajara and in 10 of the 49 (20.4%) samples from Houston (14). In studies in Libya, India and Dakar respectively, coliforms in percentages of 6, 19 and 10.6 in ice cream samples were reported (15).

Regarding to the effect of *E. coli* on different types of ice-cream, the study showed that the highest levels of *E. coli* present on ice cream with fruits (96%) while the lowest with nuts (12%). Many studies showed a compatible results and reported that more than 40% of the ice cream samples (n=50), were contaminated with *E. coli* (10,16, 17).

Regarding *E. coli* O157: H7, the present study showed that 3 types of ice creams are free (chocolate, fruits and nuts), while fruits flavor present just 4%. While, in one study showed that there are certain parallels that exist between the potential sources of contamination between these Gram-negative pathogens and the control measures that could be taken to prevent or reduce the risk of contamination (1).

Contamination with fecal coliform appear clearly in fruits type of ice-cream 88%, 44% in fruits flavor, and 36% in chocolate ice cream, while the lowest level of contamination present in ice cream with nuts 16%. This finding support the results of many researchers (1,13), showed that more than 75% of fruits ice creams produce in Teheran's confectionaries and 94.7% produced in workshops were contaminated. Fecal coliforms were detected in 64 (80%) samples, and *E. coli* was detected in 60 (75%). It is recommended to use and implement immediate regulatory measures like good manufacturing

practices as well as distribution and retail storage practices for ensuring microbiological safety of ice cream (18).

Regarding to the presence of *K. pneumoniae* among different types of ice cream, we observed that fruits type have the maximum level of *K. pneumoniae* (68%), while fruits flavor and nuts have the lower value (16%). *K. pneumoniae* was not present in ice cream and kulfi samples whereas 60 and 70% samples of color ice bar and mango shake were positive for this organism, respectively (11).

The contamination with *Enterobacter sakazakii* was observed by the researcher in all types of ice cream, 16% in fruits flavor as maximum percentage of contamination and 4% for chocolate and fruits types as the minimum infection level.

In the present study, the results showed that ice cream with fruits flavor type is free of contamination with *Listeria ivanovii*, while other types present light level of contamination 12% for chocolate, 8% for fruits and 4% for ice cream with nuts. Out of a total of 316 food samples analyzed, 103 (32.6%) were positive for *Listeria* (20 from 43 in case of ice cream samples number(19).

Our results demonstrated that all types of ice cream are free from *salmonella* & *Shigella*. In spite of using of Hazard Analysis Critical Control Points (HACCP) implementation to increase the microbiological quality of ice cream, the presence of *salmonella* still positive (20).

5. Conclusion

- Since ice cream harbors many potent pathogens, its microbial quality has always been crucially important to public health. Our results show that most of the ice cream samples failed to conform to the Palestinian standards.

6. Recommendations

- More interest in ice cream research is recommended to be practiced in food technology and health services.
- packaged ice cream must store at proper temperature, defrosted products must discarded and any melted ice cream must not re-freeze for sale.
- Hygienic practices during all preparation and handling processes should increase.

For consumers we can advise to purchase packaged ice cream products from freezer and to observe the hygienic conditions of the food stores.

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