

Microbial Quality of Ice Cream Produced in Khartoum State, Sudan

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Abstract: The microbial quality of commercially produced ice cream in Khartoum State was examined for total bacterial count (TBC), yeast, coliform count and psychotrophic counts in the Laboratory of Dairy Production, Faculty of Animal Production, University of Khartoum. Hundred samples were collected from which 60 were from ice cream machines and 40 were from factory. The TBC, yeast, coliform and psychotrophic counts in machine ice cream were 5.53 ± 0.54 , 6.14 ± 0.53 , 4.99 ± 0.42 and 4.21 ± 0.48 respectively. While the TBC, yeast, coliform and psychotrophic bacteria counts in factory ice cream were 5.12 ± 0.49 , 6.24 ± 0.54 , 5.05 ± 0.52 and 4.39 ± 0.59 respectively. The microbiological examination showed non significant differences ($P>0.05$) results in yeast, coliform and psychotrophic counts in both machines and factory ice cream, however, total bacterial counts revealed significant differences ($p<0.001$). Yeast, coliform and psychotrophic counts were highest in factory samples, while total bacterial count was highest in machines samples. The results indicated highly significant differences ($P<0.01$) in coliform and yeast counts due to type of flavor. But there were non significant differences ($P>0.05$) in total bacterial and psychotrophic counts. The results of machines and factory flavored ice cream showed non significant differences ($P>0.05$) in all microbiological test except total bacterial count.

Key words: Machine ice cream, factory ice cream, microbiological quality, flavor, Khartoum State, Sudan.

INTRODUCTION

Ice cream is popular and nutritionally enriched dairy products produced by freezing pasteurized mixture of milk solids other than fat, sugar, emulsifiers and stabilizer not fat (Joshi *et al.*, 2004). Ice cream is comprised of a mixture of air, water, milk fat, solids (SNF), sweeteners, stabilizers, and flavors, (Marshall *et al.*, 2003). The richness in nutritive constituents of ice cream has been realized by all but the problem lies in the production and handling of this food (Elahi *et al.*, 2002). As the world is faced with a problem of food shortage, these milk products are considered as a partial solution for this problem in developing countries. However these products are vulnerable to spoil by certain microorganism, some of which are beneficial and others are harmful of human beings (Esmail, 1997). Ice cream, a milk based product is good media for microbial growth it has a high nutritive value, almost neutral pH and long storage period (Joshi *et al.* 2004). The richness in nutritive constituents of ice cream has been realized by all; however some hazards may lie between production and handling. So great difficulties with regard to chemical and microbiological quality of ice cream (Bigalke and Chappel, 1984).

Ice milk was produced in Sudan by Belgravia Dairy and vendors early in 20th century. However, modern ice cream factories and machines were in operation during the last thirty years (El Owni and Khater, 2009). Manufacture of ice cream is a relatively complex operation, with a series of steps which, in both compositional and microbiological terms contribute to the overall quality of the ice cream (Robinson,1981). The processing techniques affected the quality of the ice cream, the best score values of texture; flavor, taste and overall acceptability were found in ice cream made by factory, while the lowest values were found in machine(El Owni and Khater, 2010).

In developed countries ice cream receives quality control measures to increase its shelf life as well as to prevent potential threat of public health (Elahi *et al.* 2002). In Sudan the microbiological standards for Food are now in force. The minimum and maximum acceptable microbiological limits for aerobic plate count (APC) and coliforms in ice cream are (10^4 and 10^5) and (10 and 10^2), respectively, *Escherichia coli*, Salmonella in 25 grams, coagulase +ve Staphylococci and *Listeria monocytogenes* should be absent, (SSMO, 2005).

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The present study was conducted to investigate the presence of selected microbial groups in ice cream samples obtained from machine and factory to determine the sanitary quality of commercially produced ice cream in Khartoum State.

MATERIALS AND METHODS

The present study was under taken during the period from September 2003 to March 2004 in the three cities of Khartoum State (Khartoum, Khartoum North and Omdurman). A total of 100 ice cream samples were evaluated, 60 samples were collected from each of Khartoum, Khartoum North and Omdurman. The other 40 samples were factory manufactured. The samples were collected in sterile containers, which kept in iceboxes during transportation to the Department of Dairy Production, Faculty of Animal Production, U of K., within 60 minutes of collection. A representative sample of ice cream (1gm) was diluted 1:10 with sterile distilled water, diluted serially (10^{-1} – 10^{-6}) and one milliliter from each selected dilution after thorough mixing were carefully transferred into Petri dishes using sterile pipettes. The standard methods described for counting the total bacteria by Houghtby *et al.* (1992), yeast and psychotrophic by Frank *et al.* (1992) and coliform bacteria by Christen *et al.* (1992) were used. The media employed for total bacteria and psychotrophic counts, coliform and yeast counts were standard plate count agar (SPC), MacConkey agar (MCA) and yeast extract agar respectively, as described by Singleton (1992).

RESULTS AND DISCUSSION

The result given in Table (1) shows the average total bacterial count, yeast count, coliform count and psychotrophic bacterial counts in ice cream produced in Khartoum State. The highest significant average numbers of the standard plate count ($P < 0.001$) were obtained from ice cream made by machines ($\log 5.53 \pm 0.54$), while the average of the factory ice cream was $\log 5.12 \pm 0.49$. These results are higher than the acceptable limits of SSMO, (2005), and those reported by (Elahi *et al.*, 2002).

Table 1: Microbial quality of ice cream samples from machines and factory in Khartoum State, Sudan.

Microbial content	Machines	Factory	Sig. level
Total bacterial counts (\log_{10} cfu/ gm)	5.53±0.54 ^a	5.12±0.49 ^a	***
Yeast count (\log_{10} cfu/ gm)	6.14±0.53 ^a	6.24±0.54 ^a	NS
Coliform (\log_{10} cfu/ gm)	4.99±0.42 ^a	5.05±0.52 ^a	NS
Psychotrophic count (\log_{10} cfu/ gm)	4.21±0.48 ^a	4.39±0.59 ^a	NS

In this and the following tables the means within each row bearing the similar superscripts are not significantly different ($P > 0.05$).

NS: No significant: at ($P > 0.05$).

***: Very highly significant: at ($P < 0.001$).

The mean yeast, coliforms and psychotrophic bacterial counts were $\log 6.24 \pm 0.54$, 5.05 ± 0.52 and 4.39 ± 0.59 respectively, in factory ice cream, compared to machines ice cream which have an average log counts of 6.14 ± 0.53 , 4.99 ± 0.42 and 4.21 ± 0.48 . The coliform revealed no-significant variation in log counts in factory ice cream and the machine, They were higher than the acceptable limits of SSMO, (2005) and those recorded previously (Joshi *et al.*, 2004 and Elahi *et al.*, 2002). Although, the ice cream made in the machines had higher counts than the factory ice cream. It was clear that the average total bacterial count of ice cream made in the machines had high count than the other samples made by factory. This might be due to the processing methods, tools and selling methods which lacked aspects of public hygiene. The present results are also in agreement with the findings of Rossi (1990) who reported that the ice cream might be contaminated due to improperly cleaned servers and debris falling into uncovered tubes at point of selling. Similarly the results were in agreement with the report of Robinson (1981) who mentioned that ice cream produced on a small scale often has a poor bacteriological quality than the output of a large scale factory, for often these small factories have no system of quality control at all. Another reason for this high average bacterial numbers was that the containers were continuously opened and re-closed for purpose of selling and this will allow more contamination by dust and hands to occur. The highest maximum average numbers of the yeast, coliform and psychotrophic bacterial count of ice cream made by factory may be due to the use of milk and raw materials from different sources or the heat treatment were not efficient to destroy organisms contaminating them. Raw milk was found previously to have high bacteriological load in Sudan (Said Ahmed *et al.*, 2008).

Table (2) shows the average total bacteria count, yeast, coliform and psychotrophic counts in ice cream made using (chocolate, vanilla, coconut, strawberry and mango flavors). Chocolate and strawberry flavored ice

cream showed a mean total bacteria count (log 5.64±0.59) and psychotropic count (log 4.44±0.54) respectively, while vanilla (log 5.10±0.47) and mango (log 4.13±0.59) revealed minimum counts, respectively. However, the maximum numbers of coliform (log 5.24±0.49) and yeast count (log 6.45±0.53) were obtained from ice cream made with vanilla and chocolate (P< 0.05) respectively, while the minimum average scores for coliform and yeast were obtained for ice cream made from coconut (log 4.84±0.32), strawberry (log 4.84±0.40) and mango (log 6.00±0.62). Significant results (P< 0.01). However non significant results were observed in TBC and psychrotrophic bacteria counts. The results were generally, in agreement with the findings of Eckles and Macy (1951) who found that the numbers of bacteria which are present in ice cream will depend very largely upon the numbers and types of raw materials, especially milk, cream and condensed or dried milk. Tables (3) shows the microbial content of ice cream made by machine and factory producers. The maximum total bacterial counts (P< 0.05) obtained from chocolate produced by machines (log 5.97±0.37) and coconut ice cream produced by factory (log 5.33±0.46). The maximum average total bacterial count, yeast and coliform were obtained in chocolate ice cream made by machine (log 5.97±0.37, 6.50±0.51 and 5.22±0.46), while the maximum psychrotrophic count was recorded for ice cream manufactured from coconut (4.35±0.55). However the maximum average of these counts for total count, yeast, coliform and psychrotrophic counts were reported in coconut, coconut, vanilla and strawberry (log 5.33±0.46, 6.64±0.44, 5.37±0.57 and 4.71±0.43, respectively, in ice cream produced by factory. The present findings disagree with the results of Marino (1954) and Keller *et al.*, (1987) who suggested that fresh ice cream contained not more than 100,000 cfu/ ml of total bacteria counts.

Table 2: Average microbial quality of flavor ice cream in Khartoum State, Sudan.

Microbial content	Chocolate	Vanilla	Coconut	Strawberry	Mango	Sig. level
Total bacteria count (log ₁₀ cfu/ gm)	5.64±0.59 ^a	5.10±0.47 ^a	5.36±0.51 ^a	5.34±0.58 ^a	5.38±0.56 ^a	NS
Yeast count (log ₁₀ cfu/ gm)	6.45±0.53 ^a	6.01±0.42 ^{bc}	6.33±0.53 ^{ab}	6.12±0.44 ^{ab}	6.00±0.62 ^{bc}	**
Coliform count (log ₁₀ cfu/ gm)	5.16±0.49 ^{bc}	5.24±0.49 ^a	4.84±0.32 ^{bc}	4.84±0.40 ^{bc}	5.00±0.48 ^{ab}	**
Psychrotrophic count (log ₁₀ cfu/ gm)	4.21±0.52 ^a	4.26±0.47 ^a	4.38±0.53 ^a	4.44±0.54 ^a	4.13±0.59 ^a	NS

Table 3: Average microbial quality of flavored machines and factory ice cream in Khartoum State.

Microbial content	Machine					Factory					Sig. level
	Chocolate	Vanilla	Coconut	Strawberry	Mango	Chocolate	Vanilla	Coconut	Strawberry	Mango	
Total bacteria count (log ₁₀ cfu/ gm)	5.97±0.37 ^a	5.13±0.33 ^{ab}	5.38±0.56 ^{bc}	5.61±0.54 ^{ab}	5.55±0.56 ^{bc}	5.15±0.51 ^{ab}	5.06±0.65 ^{bc}	5.33±0.46 ^a	4.92±0.36 ^{ab}	5.12±0.47 ^{ab}	NS
Yeast count (log ₁₀ cfu/ gm)	6.50±0.51 ^a	6.03±0.44 ^a	6.12±0.50 ^a	6.16±0.48 ^a	5.91±0.61 ^a	6.38±0.59 ^a	6.00±0.43 ^a	6.64±0.44 ^a	6.06±0.40 ^a	6.12±0.66 ^a	NS
Coliform count (log ₁₀ cfu/ gm)	5.22±0.46 ^a	5.15±0.43 ^a	4.90±0.37 ^a	4.78±0.25 ^a	4.90±0.47 ^a	5.07±0.55 ^a	5.37±0.57 ^a	4.75±0.24 ^a	4.94±0.55 ^a	5.12±0.50 ^a	NS
Psychrotrophic count (log ₁₀ cfu/ gm)	4.22±0.44 ^a	4.14±0.34 ^a	4.35±0.55 ^a	4.26±0.55 ^a	4.09±0.54 ^a	4.19±0.65 ^a	4.44±0.61 ^a	4.42±0.54 ^a	4.71±0.43 ^a	4.19±0.69 ^a	NS

From the above findings, it was found that all ice cream samples were higher than the acceptable limit of public health safety because the samples did exceed the total viable count (100,000 cfu/ ml) which were in disagreement with that of Marino (1954) and Hankin and Hanna (1984). It is clear from the overall results that ice cream samples were of moderate quality, because the counts of total bacteria were higher than the recommended microbiological standard of Food and Drug Administration (USPS, 1965). The results of the samples are consistent with that reported by Tampieri and Dosseena (1967). His report showed that the ice cream contained >10 coliform per ml. The coliform standards for ice cream should not exceed 10/ ml (James and Jay, 1978). The present study recommended careful selection and testing of the raw materials, the use of correct processing conditions, equipment should be properly cleaned and adequately sanitized and finally satisfactory handling of the product at the sales point should be monitored. Legal standards and application of the HACCP system should be introduced into the ice cream industry to improve the quality of such product in Sudan.

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