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Chemical Composition of Ice Cream Produced in Khartoum State, Sudan

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Abstract: The objective of this study was to examine the effect of chemical composition on the quality of ice cream. The study was conducted during the period from September, 2003 to March, 2004, in the Laboratory of Dairy Production, Faculty of Animal Production University of Khartoum. Hundred samples were examined from ice cream machines and a modern factory. The results revealed a highly significant differences ($p < 0.001$) in all chemical components except protein and Sucrose. The results showed non significant differences ($p > 0.05$) in all chemical components due to flavor except total solids. There was non significant differences ($p > 0.05$) between machines and factory ice cream with respect to type of flavor in all chemical components except total solids.

Key words: Ice cream, chemical composition, flavor, Khartoum State

Introduction

Ice cream is a popular dairy product throughout the world. As a result, its production and consumption are rapidly increasing and the substantial part of milk produced in many countries is being utilized for the manufacture of frozen dessert (Elahi *et al*., 2002). Ice milk was produced in Sudan by Belgravia Dairy and vendors early in the 20th century. However, modern ice cream factories and machines were in operation during the last thirty years. The nutritive value of ice cream varies with its composition; however, all the constituents of milk are present in a concentrated (Eckles and Macy, 1951). The major constituents (ingredients) in the ice cream formula backbone are milk fat, milk solids not fat, sweetener, stabilizer and/or emulsifiers, water and air (Varnam and Sutherland, 1994). Protein interacts at the oil water interface during homogenization to stabilize the fat emulsion and during freezing, proteins function to control destabilization of fat (Goff, 1997 and Goff *et al*., 1989). Increased amount of whey protein at the oil water interface lowers surface tension and slightly increases mix viscosity that produces a drier ice cream and enhances partial coalescence in the freezer (Goff *et al*., 1989). Goff (1997) found that properly controlling the physical properties of an ice cream mix by further processing can favorably alter the texture and physical appearance of ice cream. The 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 UK Food Standard (ice cream) regulation cream must contain not less than 5% fat, and not less than 7.5% milk solids-not-fat (SNF), Rothwell (1983).

During this study the effect of chemical composition and type of flavor of machine and factory ice cream were evaluated.

Materials and Methods

A total of 100 samples were evaluated, 60 samples were collected from each of Khartoum, Khartoum North and Omdurman. The other 40 Samples were factory manufactured. The percentage of the ingredients varied from locality to another according to price and availability. The chemical tests were carried out in duplicate at the Laboratory of Department of Dairy Production, Faculty of Animal Production, University of Khartoum. Fat content was determined by Gerber method described by Bradley *et al*. (1992), total solids and ash contents were assessed according to the modified method of AOAC (1990), the protein content by Kjeldahl method according to AOAC (1990) and total sugars by Lane and Eynon micrometric method of AOAC (1994).

Statistical analyses were performed using the Statistical Package for Social Science (SPSS-10.5). General Linear Models (GLM) were analyzed to test their effect on the chemical composition (fat, protein, total Solid, ash and sucrose) of ice cream. Means were separated using Duncan' Multiple Range test ($P = 0.05$).

Results and Discussion

Results in Table 1 show the chemical composition of ice cream made by different producers. The fat ($P < 0.001$), protein ($P > 0.05$), total solids ($P < 0.01$), ash ($P < 0.001$) and sucrose ($P > 0.05$) were highest in factory samples (9.28±1.37, 2.69±1.03, 33.40±2.87, 0.64±0.19 and 9.14±1.17, respectively) compared to machines (4.25±1.65, 2.49±0.87, 31.82±2.48, 0.39±0.21 and 8.98±1.34, respectively). The present results were consistent with the finding of Roland *et al*. (1999) who reported that the fat content was the highest in control manufactured ice cream. Our results also were in agreement with the findings of Petersen (1950) who reported that the fat of ice cream varies from 8% to more

Table 1: Average chemical composition of ice cream samples from machines and factory

Composition	Machines	Factory	Sig. level
Fat (%)	4.25±1.65[b]	9.28±1.37[a]	***
Protein (%)	2.49±0.87[a]	2.69±1.03[a]	NS
Total solids (%)	31.82±2.48[b]	33.40±2.87[a]	**
Ash (%)	0.39±0.21[b]	0.64±0.19[a]	***
Sucrose (%)	8.98±1.34[a]	9.14±1.17[a]	NS

Means within the each row bearing similar superscripts are not significantly different (P> 0.05). NS: No significant: at (P > 0.05). **Highly significant: at (P < 0.01). ***Very highly significant: at (P < 0.001).

than 20% in special product. The results were not far from UK Standard (ice cream) regulation which refers to the ice cream must contain not less than 5% fat. This may be due to using low milk fat content with the machines samples. Similarly Zheng *et al.* (1997) indicated that the addition of cream increased significantly the fat content of ice cream. This is important, as increases in fat content have be shown to reduce ice crystal size (Keeney and Kroger, 1974) and affect sensory evaluation by causing a lubricating sensation in the mouth (Keeney, 1979; Arbuckle, 1986). The highest total solids content in ice cream made by factory may be due to increase skim milk powder in milk based ice cream or added stabilizers and sugar in the mix. Ice cream mix with low total solids (high water content) has proportionately more water to freeze than a higher total solids mix (low water content) hardened to the same storage temperature. The total solid of the ice cream mix is directly related to ice crystal size distribution (Flores and Goff, 1999) and lower total solids ice cream contains lager ice crystals (Donhowe *et al.*, 1991). Variations in solids content of just a few percent greatly influences ice crystal growth (Keeney, 1979).

Table 2 shows the chemical composition of ice cream made using different types of flavors. Although there was no significant (P > 0.05) difference between ice cream made using different type of flavors (chocolate, vanilla, coconut, strawberry and mango) in all chemical components expect total solids was significant (P < 0.01) difference. Fat, protein and ash (P > 0.05) were highest in strawberry flavor ice cream (6.47±3.40, 2.81±1.07 and 0.53±0.27, respectively), while total solids (P < 0.01) was highest in ice cream made with chocolate flavor (33.88±3.89). The sucrose (P > 0.05) was highest in ice cream made with mango flavor (9.20±1.03).

Tables 3 and 4 show the chemical composition of different flavors. There was non significant (P > 0.05) difference between machines and factory in chemical composition, while total solids was significantly (P > 0.05) different. In samples produced by machines mango, vanilla and chocolate ice cream showed highest

Table 2: Effect of type of flavor on chemical composition of ice cream

Composition	Chocolate	Vanilla	Coconut	Strawberry	Mango	Sig.level
Fat (%)	6.32±3.31[a]	6.06±2.85[a]	6.09±2.60[a]	6.47±3.40[a]	6.39±3.01[a]	NS
Protein (%)	2.36±0.68[a]	2.76±1.13[a]	2.23±0.63[a]	2.81±1.07[a]	2.71±0.99[a]	NS
Total solids (%)	33.88±3.89[a]	31.62±2.23[bc]	32.25±1.93[ab]	31.75±2.47[bc]	32.77±2.38[ab]	**
Ash (%)	0.50±0.21[a]	0.49±0.22[a]	0.48±0.23[a]	0.53±0.27[a]	0.47±0.25[a]	NS
Sucrose (%)	8.96±1.48[a]	9.15±1.20[a]	8.89±1.50[a]	9.04±1.17[a]	9.20±1.03[a]	NS

Means within the each row bearing similar superscripts are not significantly different (P > 0.05). NS: Non significant: at (P > 0.05). **Highly Significant: at (P < 0.01).

Table 3: Chemical composition of flavored ice cream from machines producers

	Machines					
Composition	Chocolate	Vanilla	Coconut	Strawberry	Mango	Sig. level
Fat (%)	3.90±1.29[a]	4.07±1.58[a]	4.26±1.40[a]	4.33±1.74[a]	4.70±2.26[a]	NS
Protein (%)	2.51±0.69[a]	2.84±1.10[a]	2.25±0.72[a]	2.54±1.06[a]	2.32±0.68[a]	NS
Total solids (%)	31.98±2.74[bc]	31.52±1.77[bc]	31.78±2.17[bc]	31.17±2.63[bc]	32.64±3.06[a]	*
Ash (%)	0.43±0.19[a]	0.45±0.25[a]	0.33±0.11[a]	0.44±0.29[a]	0.32±0.13[a]	NS
Sucrose (%)	9.21±1.40[a]	9.03±1.31[a]	8.84±1.71[a]	8.93±1.28[a]	8.90±1.14[a]	NS

Means within the each row bearing similar superscripts are not significantly different (P > 0.05). NS: No significant: at (P > 0.05). *Significant: at (P < 0.05).

Table 4: Chemical composition of flavored ice cream from factory

	Factory					
Composition	Chocolate	Vanilla	Coconut	Strawberry	Mango	Sig. level
Fat (%)	9.94±1.45[a]	9.04±1.05[a]	8.84±0.93[a]	9.68±0.83[a]	8.91±2.11[a]	NS
Protein (%)	2.13±0.63[a]	2.63±1.23[a]	2.20±0.53[a]	3.21±1.02[a]	3.30±1.12[a]	NS
Tot[a]l solids (%)	36.71±3.74[a]	31.73±2.92[bc]	32.96±1.31[ab]	32.61±2.06[ab]	32.95±0.77[ab]	*
ash (%)	0.61±0.19[a]	0.54±0.16[a]	0.71±0.16[a]	0.65±0.21[a]	0.70±0.20[a]	NS
Sucrose (%)	8.58±1.62[a]	9.34±1.08[a]	8.96±1.23[a]	9.19±1.04[a]	9.64±0.68[a]	NS

Means within the each row bearing the similar superscripts are not significantly different (P > 0.05). NS: No significant: at (P > 0.05). *Significant: at (P < 0.05).

values for fat, protein, ash and sucrose (4.70±2.26, 2.84±1.10, 0.45±0.25 and 9.21±1.40, respectively). However, factory ice cream revealed highest fat, protein, ash and sucrose for chocolate, mango, coconut and mango (9.94±1.45, 3.30±1.12, 0.71±0.16 and 9.64±0.68, respectively). The total solid ($P < 0.05$) was highest in machines ice cream with mango flavor (32.64±3.06) and factory made with chocolate flavor (36.71±3.74).

The results indicated obvious differences among samples. Fat, total sold and ash contents showed a highly significant difference in ice cream made by machines and factory. Flavor of ice cream showed non significant difference in fat, protein, ash and Sucrose. The present study recommended further investigation on some nutritional characteristics of ice cream made from different raw materials and Sudan is a large country in the production of gum Arabic; this should an encourage ice cream producer to use as the main stabilizing to avoid the hazards of the animal gelatin stabilizer.

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