International Journal of
Dairy Science

ISSN 1811-9743

Academic
Journals Inc.

www.academicjournals.com

International Journal of Dairy Science 10 (6): 297-305, 2015
ISSN 1811-9743 / DOI: 10.3923/ijds.2015.297.305

Processing Properties and Chemical Composition of Low Fat Ice Cream Made from Camel Milk Using Natural Additives

A.S.M. Ahmed and I.E.M. El Zubeir
Department of Dairy Production, Faculty of Animal Production, University of Khartoum, P.O. Box 321, Khartoum, Sudan

Corresponding Author: I.E.M. El Zubeir, Department of Dairy Production, Faculty of Animal Production, University of Khartoum, P.O. Box 321, Khartoum, Sudan Fax: +249187321246

ABSTRACT

This study is a trial to process ice cream from camel milk using natural additives (honey and gum arabic) and flavored with vanilla, coconut and their combination. The processed ice cream was packed into plastic cups and stored at -18°C for eight weeks, the chemical evaluation was carried out every week. The results showed significantly higher total solids and fat content in the combination of vanilla and coconut ice cream samples, while the high ash content was found in vanilla ice cream samples. The present study concluded that ice cream could be produced from camel milk.

Key words: Camel milk, ice cream, processing, gum arabic, vanilla, coconut, composition

INTRODUCTION

Camel milk has important nutritional and functional properties as it provides particular health benefits due to the presence of bioactive substances (Al Alawi and Laleye, 2008). Based on a definition of functional food by which ingredients with an additional health value have been added to foods (Hilliam, 2000), camel milk can be a functional food because it has important nutritional and functional values and it could provide particular health benefits. In Sudan, most of camel milk production is consumed locally by families and their animals and does not reach the urban markets because most of the camel herds are located in the arid and desert areas which are far from the consumers (Musa *et al*., 2006; El Zubeir and Nour, 2006; Suliman and El Zubeir, 2014).

Ice cream is a quality nutritious frozen dairy dessert with high calories food value (Del Giovine and Bocca, 2003; Khillari *et al.,* 2007; Temiz and Yesilsu, 2010). Moreover, ice cream may also contain other food products such as fruit, which enhances its nutritive value and consequently, ice cream influence the mind because of its organoleptic characteristics and its importance as thermoregulatory food in the fight against heat (Del Giovine and Bocca, 2003). Ice cream contains a variety of ingredients in addition to milk, such as cream and sugar, it is a popular dairy product throughout the world, 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 desert (M-E-Elahi *et al*., 2002). Ice cream is a complex system consisting of air cells, ice crystals, fat globules partially concealed or aggregated, surrounded by sugar, protein, salts and water matrix. Each one of the ingredients in formulation influences ice cream properties (Goff, 2002; Soukoulis *et al*., 2008).

The demand for low-fat ice cream is increasing, while regular and non-fat ice creams are decreasing (Anonymous, 2005). The development of new varieties of ice cream is based on either milk, cream and whey concentrates and flavored with fruit and vegetable extract (Olenev, 1989).

Ice cream was reported to be produced successfully from camel milk using a mixture of 12% fat, 11% Milk Solids Not Fat (MSNF) and 37% total solids (Abu-Lehia *et al*., 1989). The present study was designed with the objective of processing of ice cream from camel milk using some natural flavors and natural additives (vanilla and coconut), gum arabic and honey to improve taste and aroma of camel milk ice cream to strengthen its contribution as a functional food. The chemical content was also evaluated during 8 weeks of storage.

MATERIALS AND METHODS

Source of milk and ice cream ingredients: Fresh raw camel milk (15 L) was obtained from a local farm in Khartoum North. The experimental procedures were done in the small processing unit located in Khartoum North during the period of June 2012 to August 2012.

Honey and flavors were obtained from Jeddah-Saudi Arabia, while gum arabic, sugar and skim milk powder were obtained from the local market of Khartoum North-Sudan.

Chemical analysis of honey: The chemical composition of honey was analyzed using proximate analysis according to the AOAC (2003).

Chemical analysis of camel milk: The chemical composition of camel milk was analyzed using the Lactoscan, the milk samples were analyzed for fat, protein, solids not fat and lactose content. The concentration of milk constituents were measured twice by Lactoscan milk analyzer (Milkotronic LTD, Europe) according to the manufacturer's instructions. The measurement is based on the principle of fourier transform infrared spectroscopy that combines the recording of infrared spectra and data processing with high precision and stability.

Pilot processing of camel milk ice cream: Before the processing of ice cream, there were some pilot trials of manufacturing ice cream from camel milk by several percentages of gum arabic and skim milk powder. The percentage of gum arabic used for camel milk ice cream were A (0.3%), B (0.5%) and C (0.7%) for 1 L of camel milk. The ice cream in sample C showed good viscosity than sample A and B. However, after the hardening there was a coarse icy body like (milk ice), therefore skim milk powdered was used. The percentage of low fat cream powder, which was added to 1 L of camel milk was 1 (11%), 2 (12%) and 3 (13%) with 0.7% gum arabic for each sample. The ice cream made from camel milk in 1 has good texture and body than 2 and 3. After this pilot trial, the ice cream was processed.

Ice cream samples were made from camel milk using three different flavors (vanilla, coconut and mixture of vanilla and coconut) using gum arabic, honey, sugar and low fat cream powder of 0.7, 9, 6 and 11%, respectively.

Manufacturing of ice cream: The mix was done by incorporation of 105 g of gum arabic (0.7%), 1350 g of honey (9%), 900 g of sugar (6%) and 1650 g low fat powder cream (11%) with 10.995 kg camel milk for the manufacturing of ice cream. Also 2 pods (4 g) of vanilla and grated coconut (80 g) were used.

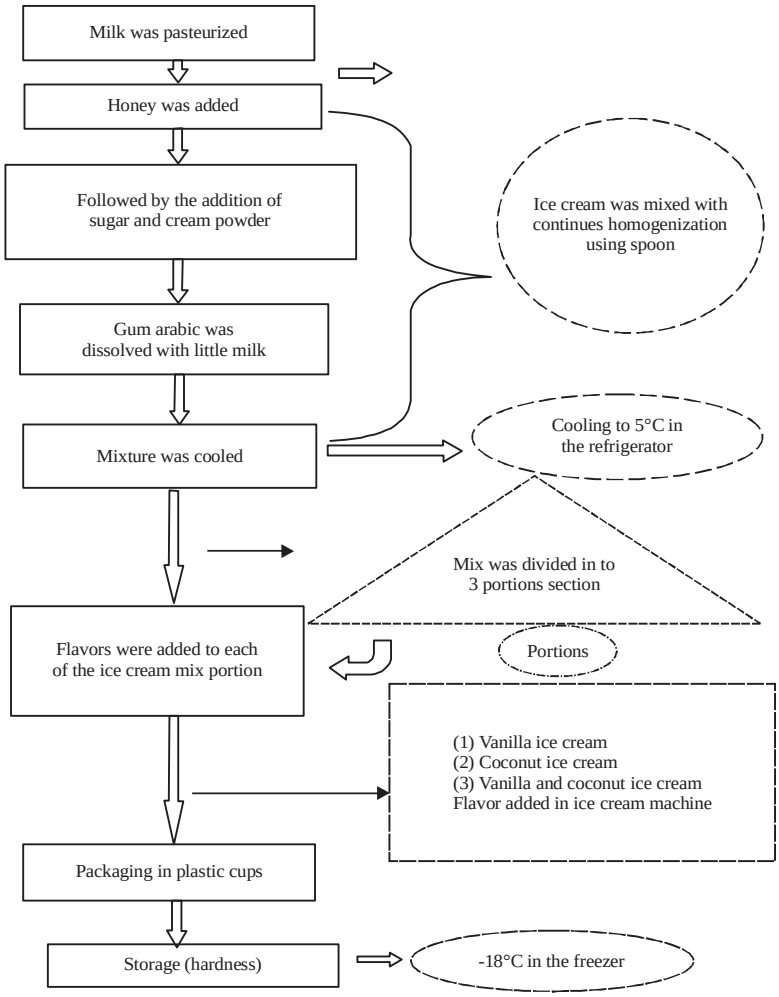

Fig. 1: General steps for manufacturing of ice cream

The steps done for manufacturing of ice cream were illustrated in Fig. 1. Milk was first pasteurized at 72°C for 15 sec, then honey, sugar, gum arabic and skim milk powder were added and homogenized for the mix. After cooling the mix in the refrigerator for 5°C, it was divided into 3 portions and the flavors were added. Then the mixes were derived into ice cream machine and the ice cream was made using 3 different flavors (vanilla, coconut and combination of vanilla and coconut) and packed into plastic cups (80 g) and stored at -18°C.

Chemical analysis of ice cream: The chemical composition evaluation was carried out weekly for 8 weeks in duplicate. The fat content of ice cream was determined using Gerber method (Bradley *et al*., 1992) and the protein content was determined using Kjeldahl method (AOAC., 2003). The total solids content were determined using forced draft oven method and the ash content was determined using gravimetric method (AOAC., 2003).

Statistical analysis: The data was analyzed using Statistix 8 (2003). Analysis of variance was run according to the following statistical model:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where:
Y_{ij} = Observation
μ = Overall mean
T_i = Fixed effect of treat (1, 2, 3,…, 6)
e_{ij} = Random error term

The significant differences between means were separated by LSD and determined at $p \leq 0.05$.

RESULTS

Chemical composition of camel milk and honey: The chemical composition of camel milk samples analyzed by Lactoscan were 8.9, 0.57, 1.5 and 2.5% for solids non fat, ash, protein and fat content, respectively. The chemical composition of honey sample revealed 80, 2.3, 20 and 60% for total solids, ash, moisture and sugar, respectively.

Processing of camel milk ice cream: Successful processing of ice cream from camel milk was obtained using 0.7% gum arabic after incorporation of 11% cream using 9 and 6% honey and sugar, respectively. The produced ice cream was flavored using either vanilla, coconut or a mixture of vanilla and coconut.

Chemical composition of ice cream from camel milk: The mean of chemical composition in all flavored ice cream revealed significant ($p<0.05$) differences for total solids, ash and fat during the storage period (Table 1). The means of total solids and fat were higher in the combination of vanilla and coconut ice cream samples compared with vanilla ice cream and coconut ice cream samples. The mean of ash was higher in vanilla ice cream compared with other flavored ice cream samples.

Total solids: The total solids revealed significant ($p<0.05$) differences between vanilla, coconut and vanilla and coconut ice cream samples (Table 2). The highest average of total solids were found in ice cream samples flavored with both vanilla and coconut (24.65±0.43, 24.15±0.19, 24.65±0.29,

Table 1: Chemical composition of ice cream made from camel milk

Measurements	Vanilla ice cream	Coconut ice cream	Vanilla and coconut ice cream
Total solids (%)			
Mean±SD	21.79±0.23^{c}	22.86±0.23^{b}	24.57±0.23^{a}
Maximum	22.00	23.25	25.095
Minimum	21.55	22.45	24.15
Protein (%)			
Mean±SD	2.19±0.12^{a}	2.28±0.12^{a}	2.36±0.12^{a}
Maximum	2.32	2.415	2.68
Minimum	2.14	2.14	2.23
Fat (%)			
Mean±SD	3.09±0.21^{b}	3.21±0.21^{b}	3.91±0.21^{a}
Maximum	3.6	3.4	4.3
Minimum	2.75	2.7	3.4
Ash (%)			
Mean±SD	3.72±0.15^{a}	3.13±0.15^{c}	3.45±0.15^{b}
Maximum	4.00	3.39	3.6
Minimum	3.42	2.98	3.235

Values with the same superscripts letters are not significantly different ($p>0.05$)

Table 2: Comparison of total solids content of vanilla and coconut ice cream samples made from camel milk during storage

	Types of ice cream		
Storage period (weeks)	Vanilla	Coconut	Vanilla and coconut
1	21.60±0.43^{c}	22.45±0.43^{b}	24.65±0.43^{a}
2	21.70±0.19^{c}	22.70±0.19^{b}	24.15±0.19^{a}
3	21.55±0.29^{c}	22.85±0.29^{b}	24.65±0.29^{a}
4	21.88±0.18^{c}	22.77±0.18^{b}	24.40±0.18^{a}
5	21.75±0.27^{c}	23.25±0.27^{b}	25.10±0.27^{a}
6	21.90±0.10^{c}	22.95±0.10^{b}	24.25±0.10^{a}
7	22.00±0.22^{c}	22.95±0.22^{b}	24.70±0.22^{a}
8	21.95±0.15^{c}	22.95±0.15^{b}	24.70±0.15^{a}

Values with the same superscript letters are not significantly different (p>0.05)

Table 3: Comparison of proteins of camel milk ice cream made using vanilla and coconut during storage

	Types of ice cream		
Storage period (weeks)	Vanilla	Coconut	Vanilla and coconut
1	2.32±0.10^{ab}	2.23±0.10^{b}	2.60±0.10^{a}
2	2.23±0.11^{b}	2.42±0.11^{ab}	2.68±0.11^{a}
3	2.14±0.17^{a}	2.23±0.17^{a}	2.33±0.17^{a}
4	2.14±0.10^{a}	2.23±0.10^{a}	2.23±0.10^{a}
5	2.23±0.19^{a}	2.33±0.19^{a}	2.23±0.19^{a}
6	2.14±0.07^{a}	2.14±0.07^{a}	2.23±0.07^{a}
7	2.14±0.17^{a}	2.23±0.17^{a}	2.33±0.17^{a}
8	2.14±0.11^{a}	2.42±0.12^{a}	2.23±0.12^{a}

Values with same superscript letters are not significantly different (p>0.05)

Table 4: Variations of fat content of vanilla and coconut ice cream made from camel milk during storage

	Types of ice cream		
Storage period (weeks)	Vanilla	Coconut	Vanilla and coconut
1	2.90±0.18^{b}	3.40±0.18^{ab}	3.70±0.18^{a}
2	2.70±0.34^{b}	2.75±0.34^{b}	3.90±0.34^{a}
3	3.25±0.24^{a}	3.35±0.24^{a}	3.95±0.24^{a}
4	3.60±0.27^{ab}	3.25±0.27^{b}	4.30±0.27^{a}
5	3.20±0.09^{b}	3.20±0.09^{b}	3.95±0.09^{a}
6	3.35±0.25^{ab}	3.25±0.25^{b}	4.10±0.25^{a}
7	2.85±0.06^{c}	3.20±0.06^{b}	3.95±0.06^{a}
8	2.85±0.25^{a}	3.25±0.25^{a}	3.40±0.25^{a}

Values with same superscript letters are not significantly different (p>0.05)

24.40±0.18, 25.10±0.27, 24.250±0.10, 24.70±0.22 and 24.70±0.15%) during week 8 compared to vanilla ice cream and coconut ice cream samples. The lowest means for total solids content were found in ice cream flavored with vanilla (21.60±0.43, 21.70±0.19, 21.55±0.29, 21.88±0.18, 21.75±0.27, 21.90±0.10, 22.00±0.22 and 21.95±0.15%). However, all types of ice cream revealed non-significant variations during the storage period for total solids (Table 2).

Protein content: Results in Table 3 showed the protein content of different flavored camel milk ice cream during the storage period. The protein content revealed non-significant (p>0.05) differences between the different types of ice cream during the storage period expect for vanilla ice cream during the second week of storage and coconut ice cream during the first week of storage. The highest mean value of protein was found in vanilla and coconut ice cream samples (2.68±0.11%) during the second week, while the lowest mean was found in vanilla ice cream samples and coconut ice cream samples (2.23±0.11 and 2.23±0.10%, respectively) during the first week of storage.

Fat content: Results in Table 4 showed the fat content of the flavored ice cream during the storage. The fat content was significantly (p<0.05) different during the storage period expect during

Table 5: Variation of ash content of camel milk during storage of ice cream using different flavors

	Types of ice cream		
Storage period (weeks)	Vanilla	Coconut	Vanilla and coconut
1	3.72±0.14[a]	3.26±0.14[b]	3.42±0.14[ab]
2	3.42±0.22[a]	3.10±0.22[b]	3.53±0.22[a]
3	3.57±0.04[a]	2.98±0.04[c]	3.24±0.04[b]
4	4.00±0.28[a]	3.18±0.28[c]	3.58±0.28[a]
5	3.46±0.09[a]	3.39±0.09[b]	3.39±0.09[a]
6	3.95±0.06[a]	3.16±0.06[c]	3.41±0.06[b]
7	3.68±0.21[a]	3.00±0.21[b]	3.60±0.21[a]
8	3.95±0.15[a]	3.00±0.15[b]	3.45±0.15[b]

Values with the same superscript letters are not significantly different (p>0.05)

the third and eighth weeks of storage. The highest mean value of fat was reported for vanilla and coconut ice cream samples (4.30±0.28%) during the fourth week, while the lowest mean value was found in vanilla ice cream samples (2.70±0.34%) during the second week of storage.

Ash content: Results in Table 5 showed the ash of flavored ice cream from camel milk during the storage period. The ash content of ice cream revealed significant ($p<0.05$) differences between vanilla, coconut and vanilla and coconut ice cream samples. The highest means of ash were found in vanilla ice cream samples (3.72±0.14, 3.42±0.22, 3.57±0.04, 4.00±0.28, 3.46±0.09, 3.95±0.06, 3.68±0.21 and 3.95±0.15%, respectively) during the last week of storage.

DISCUSSION

The composition of camel milk obtained during this study was in accordance with those reported by Al Haj and Al Kanhal (2010).

The successful processing of ice cream from camel milk might indicate the possibility of using camel milk to produce special ice cream such as low fat ice cream. This supported Abu-Lehia *et al*. (1989), who reported that the overrun of camel milk ice cream was found to significantly depend on the fat and MSNF levels in the mixture.

The produced ice cream showed good compositional content that kept over a period of 8 weeks during storage at a temperature of -18°C. Ice cream from camel milk combined the benefit of ice cream and benefit of camel milk to fulfill the requirements of the functional food. Elagamy (2000) reported that camel milk contains good qualities of antibacterial and antiviral protective proteins, which made it more superior over cow milk in terms of nutrients. The pilot trials indicated that addition of 0.7% gum arabic to one liter of camel milk showed good viscosity compared to those made after addition of 0.3 and 0.5% gum arabic. Although, Marshall and Arbuckle (1996) stated that the stabilizer for ice cream should be in the rate of 0.2-0.4%. The higher rate of gum arabic needed to stabilize ice cream from camel milk might be due mainly to the special properties of camel milk. In the present study, the gum arabic was added as stabilizer, emulsifier because of availability in Sudan. Gum arabic is dietary fiber that is derived from dried exudates of *Acacia senegal* (Nasir *et al*., 2010). The use of gum arabic; although small proportion was used; might also add some nutrition value to ice cream in addition to its health benefit (Gamal El-Din *et al*., 2003; Elkhidir *et al*., 2010). El-Owni and Khater (2009) recommend the processing of ice cream made from different raw materials available in Sudan and to encourage ice cream producers to use gum arabic as the main stabilizing to avoid the hazards of the animal gelatin stabilizer.

Some natural additives were used to produce camel milk ice cream, in order to promote camel milk for production of the functional food. Agrawal *et al*. (2007) reported the effect of utilization of

camel milk in the reduction of diabetes among the Indian consumers. Also, the honey was used in the present study as for partial substitution of sucrose because in addition to its availability in Sudan, it can serve as a natural food preservative due to its antimicrobial properties (Chen *et al*., 2000; Young, 2005). Moreover, it can be used as sucrose replacer and/or supplemented in ice cream formulation (Khaliduzzaman *et al*., 2012). Similarly, Al-Jabri (2005) recommended that honey when used with milk may offer even faster killing rate of bacteria than either used alone to fight infection and to reduce the wide spread use of antibiotics. Thus combination of gum arabic and honey in the present study may give a chance to diabetic persons to utilize and use this ice cream. This because as was stated by Del Giovine and Bocca (2003) that ice cream plays an important role of actual food which, besides its digestive, metabolic and nutritive qualities, its influence the mind because of its organoleptic characteristics and its importance as thermoregulatory food.

The present study also used vanilla and coconut in camel ice cream. Gassenmeier *et al*. (2008) reported that vanilla bean is a tropical aromatic orchid widely used in aroma industries for its flavor, mainly due to phenolic compounds. Moreover, Goodenough (1982) reported that the pods (beans) of vanilla are the source of the popular flavoring substance called vanillin. Vanillin is mainly used in flavoring cakes, ice creams, sweets, chocolate and beverages. Also as a functional food, coconut has fatty acids that provide both energy (nutrients) and raw material for antimicrobial fatty acids and monoglycerides (functional components) when it is eaten (Enig, 1999). On the other hand, the ice cream diet is useful for children therefore; taking into consideration the selected natural additives as was presented in this study for children food will promote the health benefit of such ice cream. This fact match with Del Giovine and Bocca (2003), who reported that ice cream plays a fundamental role in children's diets, who consume great amounts of it. However, the presence of additives particularly of dyes might create health risk to consumers.

Significantly ($p<0.05$) higher means values were obtained for the total solids (Table 1 and 2), protein (Table 1 and 3) and fat (Table 1 and 4) in the ice cream samples flavored with vanilla and coconut compared with vanilla ice cream and coconut ice cream samples. Similarly, Ahmed and El Zubeir (2015) concluded that combination of vanilla and coconut showed higher acceptability for the taste of camel milk ice cream. Temiz and Yesilsu (2010) reported that ice cream contains high levels of milk fat, i.e. 10-16%, it is a source of high quality protein and energy. The higher levels of protein compared to milk supported Arbuckle (1966), who reported that the protein content of ice cream also rates high both in amount and in quality. This is nutritionally important, especially for babies, children and sportsmen, as well as in situations demanding urgent energy supply (Sengul *et al*., 2005). The proteins are mostly derived from milk as small amount from stabilizers. Ice cream provides these valuable proteins in a very palatable form and in fact, ice cream is to many individuals, is the most palatable source of milk proteins (Arbuckle, 1966). Beside its nutritional value, camel milk is also containing bioactive component that reported to have a medical value (Agrawal *et al*., 2007).

The result indicated significant ($p<0.05$) difference in ash content of flavored ice cream made from camel milk. The mean of ash was higher in vanilla ice cream compared with other flavored ice cream samples (Table 1 and 5). However lower values for ash content were reported for the ice cream made using cow milk (El-Owni and Khater, 2009). This might be due to the addition of honey (2.3% ash) and the natural flavoring material used on camel milk ice cream as pods of vanilla were used. The present results of ash content on honey were in accord with Khaliduzzaman *et al*. (2012), who reported that the ash content was 2.3% in honey. The significant ($p<0.05$) variation reported in total solids content of camel milk ice cream due to the different flavors used might be due to the

difference found in protein, fat and the ash content (Table 1-4). Similarly, El-Owni and Khater (2009) found that total solids content of ice cream made from cow's milk was significantly affected by the different flavor used. However, the present results disagreed with El-Owni and Khater (2009), who reported non significant differences in ice cream made using different flavor in the content of fat, protein and ash.

CONCLUSION

The present study concluded that the total solids and ash content of camel milk ice cream were found to be significantly ($p<0.05$) affected by the different flavors used. Hence, it is recommended that the ice cream could be processed from camel milk, moreover gum arabic and honey as ice cream stabilizer and sweetener, respectively, could be used in camel milk ice cream to strengthen the health benefit of camel milk. Further studies should be carried out on making ice cream from camel milk by adding fruits to enrich nutritional and health benefit and provide pleasant flavors to consumers.

REFERENCES

AOAC., 2003. Official Methods of Analysis of AOAC International. 17th Edn., AOAC International, Gaithersburg, MD., USA., pp: 553-558.

Abu-Lehia, I.H., I.S. Al-Mohizea and M. El-Behry, 1989. Studies on the production of ice cream from camel milk products. Aust. J. Dairy Technol., 44: 31-34.

Agrawal, R.P., S. Budania, P. Sharma, R. Gupta, D.K. Kochar, R.B. Panwar and M.S. Sahani, 2007. Zero prevalence of diabetes in camel milk consuming Raica community of north-west Rajasthan, India. Diabet. Res. Clin. Pract., 76: 290-296.

Ahmed, A.S.M. and I.E.M. El Zubeir, 2015. Microbiological and sensory properties of low fat ice cream from camel milk using natural additives. Ann. Food Sci. Technol., 16: 236-244.

Al Alawi, A.A. and L.C. Laleye, 2008. Characterization of camel milk protein isolates as nutraceutical and functional ingredients. Sultan Qaboos University and United Arab Emirates University, Collaborative Research Project, SQU\UAEU, Oman, USA.

Al Haj, O.A. and H.A. Al Kanhal, 2010. Compositional, technological and nutritional aspects of dromedary camel milk. Int. Dairy J., 20: 811-821.

Al-Jabri, A.A., 2005. Honey, milk and antibiotics. Afr. J. Biotechnol., 4: 1580-1587.

Anonymous, 2005. The U.S. Market for Ice Cream and Related Frozen Desserts: Ice Cream, Frozen Yogurt, Sherbet, Sorbet and Frozen Novelties. 4th Edn., Packaged Facts, New York, USA., Pages: 386.

Arbuckle, W.S., 1966. Ice Cream. 1st Edn., The AVI Publishing Company, Westport, CT., USA.

Bradley, R.L., E. Arnold, D.M. Barbano, R.G. Semerad, D.E. Smith, B.K. Vines and R.A. Case, 1992. Chemical and Physical Methods. In: Standard Methods for the Examination of Dairy Products, Marshall, R.T. (Ed.). 16th Edn., Port City Press, Baltimore, Washington, ISBN-10: 0-87553-208X.

Chen, L., A. Mehta, M. Berenbaum, A.R. Zangerl and N.J. Engeseth, 2000. Honeys from different floral sources as inhibitors of enzymatic browning in fruit and vegetable homogenates. J. Agric. Food Chem., 48: 4997-5000.

Del Giovine, L. and A.P. Bocca, 2003. Determination of synthetic dyes in ice-cream by capillary electrophoresis. Food Control, 14: 131-135.

El Zubeir, I.E.M. and E.M. Nour, 2006. Studies on some camel management practices and constraints in pre-urban areas of khartoum state, Sudan. Int. J. Dairy. Sci., 1: 104-112.

El-Owni, O.A.O. and Z.K.O. Khater, 2009. Chemical composition of ice cream produced in Khartoum state, Sudan. Pak. J. Nutr., 8: 158-160.

Elagamy, E.I., 2000. Effect of heat treatment on camel milk proteins with respect to antimicrobial factors: A comparison with cows and buffalo milk proteins. Food Chem., 68: 227-232.

Elkhidir, E.E., A.Z.B. Baharum Shah and T.S. Yew, 2010. Estimation of technical efficiency for share contract of producing gum Arabic: Kordofan gum Arabic Belt, Sudan. Res. J. Forestry, 4: 185-193.

Enig, M.G., 1999. The health benefits of coconuts and coconut oil. Asian Pacific Coconut Community (APCC), Federated States of Micronesia, Micronesia, USA.

Gamal El-Din, A.M., A.M. Mostafa, O.A. Al-Shabanah, A.M. Al-Bekairi and M.N. Nagi, 2003. Protective effect of arabic gum against acetaminophen-induced hepatotoxicity in mice. Pharmacol. Res., 48: 631-635.

Gassenmeier, K., B. Riesen and B. Magyar, 2008. Commercial quality and analytical parameters of cured vanilla beans (*Vanilla planifolia*) from different origins from the 2006-2007 crop. Flavour Fragrance J., 23: 194-201.

Goff, H.D., 2002. Formation and stabilisation of structure in ice-cream and related products. Curr. Opin. Colloid Interface Sci., 7: 432-437.

Goodenough, D.R., 1982. Vanilla, vanillin and vanillin derivatives. Bakers Dig., 56: 8-10.

Hilliam, M., 2000. Functional food. World Food Ingredients, 12: 50-52.

Khaliduzzaman, A.A.S., M. Islam, M. Easdani and H.R. Bhuiyan, 2012. Effect of honey on freezing point and acceptability of ice cream. Bangladesh Res. Publ. J., 7: 355-360.

Khillari, S.A., P.N. Zanjad, K.S. Rathod and M. Raziuddin, 2007. Quality of ice cream made with incorporation of whey protein concentrate. J. Food Sci. Technol., 44: 391-393.

M-E-Elahi, A.T.M., S. Habib, M.M. Rahman, G.I. Rahman and M.J.U. Bhuiyan, 2002. Sanitary quality of commercially produced ice cream sold in the retail stores. Pak. J. Nutr., 1: 93-94.

Marshall, R.T. and W.S. Arbuckle, 1996. Ice Cream. 15th Edn., International Thomson Publ., New York, USA.

Musa, H.H., E.S. Shuiep, I.E.M. El Zubeir and G.E. Chen, 2006. Some reproductive and productive traits of camel (*Camelus dromedarius*) in Western Sudan. J. Anim. Vet. Adv., 5: 590-592.

Nasir, O., K. Wang, M. Foller, M. Bhandaru and D. Sandulache *et al*., 2010. Downregulation of angiogenin transcript levels and inhibition of colonic carcinoma by Gum Arabic (*Acacia senegal*). Nutr. Cancer, 62: 802-810.

Olenev, Y.U.A., 1989. The use of vegetable materials in ice cream manufacture. Dairy Sci. Abstract, 5: 39-40.

Sengul, M., M.F. Ertugay and M. Sengul, 2005. Rheological, physical and chemical characteristics of mulberry pekmez. Food Control, 16: 73-76.

Soukoulis, C., I. Chandrinos and C. Tzia, 2008. Study of the functionality of selected hydrocolloids and their blends with κ-carrageenan on storage quality of vanilla ice cream. LWT-Food Sci. Technol., 41: 1816-1827.

Suliman, E.S.K. and I.E.M. El Zubeir, 2014. A survey of the processing and chemical composition of gariss produced by nomadic camel women herders in AlGaderif state, Sudan. Jordan J. Biol. Sci., 7: 95-100.

Temiz, H. and A.F. Yesilsu, 2010. Effect of pekmez addition on the physical, chemical and sensory properties of ice cream. Czech J. Food Sci., 28: 538-546.

Young, T., 2005. Honey: Rediscovering an ancient healer. Pract. Nurs., 16: 542 -547.