Chapter one

Introduction

Nowadays, ice cream has been included in the diet of many people around the world due mainly to their sensory properties. In Mexico, ice pops are frozen sweets on a stick (NOM, 1993).

Ice pops as well as ice creams are classified according to the base used in their formulation which can be water or milk products. Milk based ice pops are those whose main ingredient is milk, cream or its derivatives. They have a nutritional value due to the contribution of protein, carbohydrates, fat and minerals mainly calcium and vitamins such as B2. The main ingredient of the other variety of ice pops is water. In some cases part of this water is substituted with fruit juice which improves the nutritional value.

Concerning milk based ice pops; fat is one of the most important ingredients because it contributes significantly to physicochemical and sensory properties. The fat content in ice cream is provided primarily by the milk fat, either whole cream, natural butter, anhydrous butter or oil butter (Goff, 2006).

Ice cream also contains, in low proportion, vegetable fat, such as coconut oil, palm, palm kernel or vegetable oil blends (hydrogenated and non-hydrogenated) and other ingredients such as chocolate (Goff ,2006&Kirk *etal* ,2005).

For all ice cream types, fats are the nutrients with the most variable content; therefore, these components make the difference in this kind of food (Koxholt, *etal*, 2003).

Ice cream is a frozen dessert usually made from dairy products, such as milk and often combined with other ingredients and flavours. In addition to dairy products, ice cream contains sugar, stabilizers, and emulsifiers, flavouring materials, water and air. The mixture of these ingredients, before air is incorporated and the mixture frozen is known as ice cream mix. The composition of ice cream varies depending upon the ingredients used in the preparation. The percentage composition of good ice cream is: 12% milk fat, 14% milk solid non–fat, 15% sugar, 0.2% stabilizer, 6.2% emulsifier, 55-64% water which comes from the milk or other ingredients and a trace of vanilla. This composition is exclusive of air. That is they are based on the weight of ice cream mix because ice cream is a whipped product and contains a great deal of air to prevent it from being too dense, too hard, and too cold in the mouth. The total solid is about 38.4%, the remainder would be water. Addition of ingredients such as nuts, fruits, chocolate and additional flavour will result in the change of the composition (Umelo *etal*, 2014).

Camel milk is very important source of nutrient for human in several arid and semi arid zones it is complex mixture of fat, protein, lactose, minerals and vitamins and miscellaneous constituents dispersed in water (Ibrahim, 1998). In the traditional pastoral communities, camel milk is consumed fresh or fermented (Farah, 1996).

Frozen yoghurt is a yoghurt product, with or without flavor, t is freeze in ice cream freezers to obtain 50% overrun (Abu Tarboush, 1996). The food value of frozen yoghurt obviously depends upon the food value of ingredients involved, the ingredients which go into the mix contain the same constituents of ice cream and ordinary yoghurt, but in different amounts (Rea, 1983). The manufacture of butter, ghee, cheese and ice cream from camel milk is still not well developed and accepted (Farah, 1996).

Objective:

- The main objective of this study is to determine the effect of using camel milk on the quality of ice cream.

Chapter two

Literature review

2.1. Ice cream

Ice cream or ice-cream (originally iced cream) is a frozen dessert made from dairy products, such as milk and cream, combined with flavorings and sweeteners, such as sugar. This mixture is stirred slowly while cooling to prevent large ice crystals from forming, which results in a smoothly textured ice cream.

Frozen custard, frozen yogurt, sorbet, gelato, and other similar products are sometimes informally called ice cream, but governments generally regulate the commercial use of these terms based on quantities of ingredients American federal labeling standards require ice cream to contain a minimum of 10% milk fat (about 7 grams (g) of fat per 1/2 cup serving) and 20% total milk solids by weight

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Addition of ingredients such as nuts, fruits, chocolate and additional flavour will result in the change of the composition (Mordi, 2003).

Over the years, attempts have been made to find cheaper substitutes for cow milk, due to the rising cost of cow milk and its products irrespective of its high nutritional quality in terms of proteins. The development of tigernut (*Cyperus esculentus)* based milk is a cheap substitute for traditional cow milk.

In Nigeria, cow milk is predominantly used to produce commercial ice cream, while hardly any attention has been given to the use of nuts, milk extract or in combination with milk to produce palatable ice cream (Mordi, 2003). Tigernut is included as one of the underutilized crop and commonly known as "earth almond", "chufa" and "zula" nuts. Tigernut can be eaten raw, roasted, dried, baked or be made into refreshing beverage called "Horchata De Chufas' or tigernut milk. Tigernut is rich in dietary fibre, minerals like potassium, phosphorus and Vitamins E and C.

Ice cream in the United States has a legal definition, which can be found in the Code of Federal Regulations (CFR 2003b), which specifies solids, fat, and air contents. These specifications state that vanilla ice cream must contain a minimum of 10% milk fat by weight, a minimum of 20% milk solids and at least 192g of total food solids per liter of ice cream, with each liter of ice cream weighing a minimum of 540 g. Other ice cream categories exist, such as reduced calorie ice creams, which in the United States must meet the nutrient claims that comply with "reduced fat." (CFR 2003a) These legal requirements often dictate the types and ratios of ingredients used in frozen desserts as well as some of the processing conditions. Because minimum contents (except air content) normally are stated in the federal requirements, commercial ice creams vary considerably in body, flavor, melt, and texture characteristics. Re- cent statistics have shown that 61% of all frozen dessert products manufactured in the United States fall into the ice cream category and 26% into the nonfat and low fat ice cream category. The remaining portions of frozen dessert products consist of frozen yogurt (5%), water ices (4%), sherbets (3%), and other (1%) categories [International Dairy Foods Association (IDFA 2003).

In 2001 approximately 6,116,560,000 liters of frozen desserts were made in the United States, with an annual per capita consumption of 21.5 liters, reflecting both the size of the industry and the popularity of the final products. The most popular frozen dessert flavor sold in U.S. supermarkets in 2001 was vanilla; thus, vanilla ice cream will be used as the model product throughout this chapter (IDFA 2003).

Ice cream processing is basically a two-step process the mix making and the mix freezing. Mix is the liquid product consisting of milk ingredients fat and milk solids-not-fat sugar, flavor (perhaps), and water. Optional mix ingredients such as corn syrup solids, whey, whey protein powders, caseinates, colors, egg solids, and stabilizers and emulsifiers may be used, depending upon the desired end product. In most countries, the mix must be pasteurized to assure a pathogen-free product; owever, the minimum times and temperatures may vary with the country and process choice. Mixes may be homogenized, but all are cooled prior to the freezing process. Additional steps after pasteurization and cooling may include aging, flavoring, and coloring. The second major process step is freezing and hardening of the final product. During this step, mix is frozen in equipment referred to as a "freezer," cooled during the hardening stage, and subsequently distributed to markets. Many other frozen desserts, such as sherbet and sorbets, are made using a process similar to that for ice cream, but formulations differ, as do some of the ingredient choices and final product requirements. The U.S. Code of Federal Regulations provides guidance in formulating and manufacturing other frozen dessert products that meet legal specifications (IDFA 2003).

Table1. Typical Ingredients, Usage Levels, and Sources for Vanilla Ice Cream Mixes.

Ingredient Category	**Usage Level**	**Sources**	**Function**
Colors Emulsifiers	0.001–? 0.05–0.25%	Caramel Monoacylglycerides, diacylglycerides,spans, tweens	Characteristic color for flavor Mix emulsification, mix Deemulsification
Flavors Milk fat	0.001–? 10% minimum	Vanilla extract, vanillin Butter/butteroil, condensedmilks,creams, milks, plastic cream	Air incorporation, foam stabilization, flavor mouth feel, texture
Milk solids, nonfat		Butter,condensedmilks, creams, milks, nonfat dry milk, plastic cream	Emulsification, flavor, melt quality, solids content, texture, water binding properties
Stabilizers	0.1–0.5%	Guar gum, locust bean gum, microcrystalline cellulose, xanthan gum	Air incorporation, body and texture, melt quality, viscosity increase, water binding
Sweeteners	12–16%	Corn syrup, corn syrup solids, dextrose, sucrose	Body and texture, depress freezing point, enhance flavor, sweetness, viscosity

Sources: Adapted from the Code of Federal Regulations and Marshall and Arbuckle 1996.

2.2. Chemical composition of ice cream:

Fat gives adequate texture properties to ice cream, provides a slight scent and acts synergistically with added flavorings, although it produces some decrease in shaking rate. This ingredient also plays an important role in flavor and in the solid structure formation during freezing, establishes the consistency, appearance and resistance to ice cream melting (Goff, 2006). During ice cream manufacturing, milk fat can be replaced by vegetable fat, reducing production costs but this affects their final composition and becomes a source of Tran's fatty acids (TFA) (Alonso, 2002).

Fat contributes to the melting resistance of ice cream, promote softness and body and have the property of absorbing and retaining flavors (Marshall, 2000). The types of fat commonly used in ice cream formulations are hydrogenated fats. More recently fat-free formulations have been used as a result of a trend towards increased consumption of reduced fat products and one area where this potential exists is the production of fat reduced ice cream (Marshall, 2000).

Davidson et al (2000) and Akalin and Erişir (2008) who respectively found pH ranging from 5.60 and 5.47 for fermented probiotic ice cream. It is important to emphasize that the use of powdered milk can act as a product standardization factor to minimize the expected variations in milk composition due to the breed, diet, lactation stage, health and physiology of the animal.

The main role of the fat substitute is to efficiently replace the hydrogenated vegetable fat. Nevertheless, usually it has high solid, carbohydrate and protein contents, a fact which explains the higher solids, total reducing sugar and protein content (Rechsteiner, 2009).

Ice cream is a milk product, which contain a variety of ingredients in addition to milk, cream, and sugar (Elhai *et al.* ,2002). Frozen desserts are among the most popular desserts eaten in or out the home. These include ice cream, sherbets, and mousses. Locally made type ice milk in Sudan is called *Dandorma,* is well known in urban areas, distributed by ice cream vendors in push carts (El Owni and Khater, 2009). Recently, in1978 factory Ice Cream was manufactured by the Modern Ice Cream and Sweets Factory in Khartoum State. This was followed by El gaith Dairy Products Company in 2006. By the beginning of the 21st century bulk Ice Cream sales were common in confectionary and sweets shops.

Ice cream has a general formula, which can be added to or slightly modified to create the desired product. The major constituents in the ice cream formula back bone are milk fat, milk solids not fat, sweetener, stabilizer and/or emulsifiers, water and air (Varnam and Sutherland, 1994). Flavor is a sensation which is derived from odor. Ice cream owes its variety and popular appeal to many pleasing flavoring materials which can be used in its manufacture. The flavors are added directly into the mix when powders or purees are used (Desrosier, 1977). The fact that ice cream comes in many flavors and types leads a person to believe that ice cream is a complex and confusing product (Varnam and Sutherland, 1994). Flavorings are added to ice cream in the form of extract, fruit, nuts, spices, chocolate, or coffee and only in amounts that will impart a mild, pleasant flavor (Peckham, 1974). Thanh *et al*. (1992) reported that interactions among volatile aroma substances and non volatile compounds depend on the physicochemical properties of the compound and on the binding that may occur among them. Moreover butter fat is one of the chief factors affecting the flavor of ice cream (Bennion, 1975). Non significant differences ($p>0.05$) in all chemical components due to flavor except total solids between machine and factory ice cream in Khartoum State, Sudan El Owni and Khater, (2009).

Table 2: Proximate composition of two most acceptable ice creams.

Nutrient composition	S	D
Moisture (g/100g)	89.16	80.10
Protein (g/100g)	3.83	11.12
Fat (g/100g)	5.83	7.26
Ash (g/100g)	1.4	2.30
Iron (mg/100g)	1.27	1.56
Vitamin C (mg/100g)	0	89.92

Source: Gita *et al* (2012).

S- Standard cows milk ice cream

D- 50% Soy milk and 50% watermelon seed milk ice cream with guava pulp.

[c] Mean value of a three triplicate samples ± Standard deviation.

2.3. Sensory characteristics of ice cream:

Sensory quality is most closely linked to the choice of food products. This evaluation technique can be applied from designing a new food product to the standardization and evaluation of the reference of product quality. When it comes to sensory analyses, ice cream has its own particularities like the ideal temperature of degustation ranging from 10 until 12oC and a maximum of six samples for capture and absorption of sensory interactions by judges.

In addition to that, during consumption it undergoes phase changes from solid to liquid (Frost *et al*, 2005). All these facts make ice cream a complex food system to be sensory evaluated.Over the past 10 years, ice cream consumption in the U.S. has remained stable, averaging approximately 15 lb of ice cream per capita (USDA 2006).However, higher priced, higher milk-fat premium and super premium ice cream sales have risen (Putnam and Allshouse, 2003). A main competitor of super premium ice cream is gelato, which has been popular in Italy and is increasing in popularity in the U.S.A. (Ryan, 2005).

Many studies have measured sensory properties of ice cream to examine the relationship among various ingredients and sensory characteristics such as flavor and texture. Hyvönen *et al.* (2003) found that the nature of strawberry flavoring affects flavor perception and that modifying fat distribution influences flavor release in ice cream; dairy fat retards flavor release at the highest level (~18%). Replacement of milk fat with tapioca dextrin or potato malt dextrin also significantly affects textural properties: increasing coarseness and wateriness and decreasing creaminess of ice cream (Specter and Sester, 1994).

Stampanoni-Koeferli *et al.* (1996) showed that the addition of fat increased the buttery and creamy notes in ice cream as well as its mouth-coating, while increase in sugar levels increased sweetness, caramel and vanillin attributes, and decreased milkiness. Guinard *et al.* (1996) demonstrated that sugar and to a lesser extent – fat were key determinants of ice cream acceptability and that too little or too much sugar or fat was detrimental to ice cream quality.

Other studies also determined that higher fat content positively affected overall sensory quality of ice cream (Roland *et al.* 1999).

Nowadays, consumers have directed their interest towards reduced or low-fat products as they associate them with a reduced risk of obesity and coronary heart diseases (Akalin *etal*., 2008). Typically, ice cream contains 10– 16% fat that is the main component affecting flavour and textural properties of the product.

Milk fat interacts with other ingredients to develop the texture, mouth feel, creaminess, and overall sensation of lubricity. In recent years, the dairy industry has developed a variety of low-fat and fat-free ice cream products (Adapa *et al*., 2000).

The challenge in working with low fat ice cream is related to the fact that the fat globule network would either be disrupted or absent and this could seriously impact flavour and texture of the product (Aime *et al.*, 2001). Devereux *et al.*(2003) reported that texture was more important than flavour in determining overall acceptability of the low-fat foods. Removal of fat causes such body and textural problems as coarseness and iciness, crumbly body, shrinkage and flavour defects (Marshal and Arbuckel, 1996).Ice cream manufacturers have made a practice to use milk fat replacers to form products that meet the demands of health conscious consumers. Accepted fat substitutes for ice cream are made up of carbohydrates and proteins, instead of being based on lipid, which may form lipophilic particles (Schirle- Keller *et al*., 1992). It has been reported that the use of carbohydrate based fat replacers increased ice cream mix viscosity (Akalin *et al.*, 2008)**.**

Protein based fat replacers have also been used in ice cream formulation (Adapa *et al*., 2000). Alvarez *et al*. (2005) reported that the use of Milk Protein Concentrate (MPC 65 and 85%) in ice cream composition improved viscosity and melting properties, compared with the control. Also the use of MPC in ice cream was studied and product quality compared with the samples containing malt dextrin, polydextrose and lactose-reduced freeze concentrated skim milk (Roland *et al*., 1999).

Other factors contributing to ice cream texture include stabilizers and emulsifiers.Stabilizers are of high water binding capacity and therefore their type and content can affect rheological properties of ice cream mix. It was reported that increasing the stabilizer content in ice cream formulation leads to increasing viscosity that has an important effect on melting behaviour of the product (Moeenfard and Mazaheri, 2008). In work with full fat ice cream, it has been demonstrated that stabilizers promote viscosity development in the aqueous phase and control ice crystal growth (Aime *et al.*, 2001).

2.4. Camel milk:-

Camels are considered to be a good source of milk and meat, and are used for other purposes such as transportation and sport racing. Camel milk has an important role in human nutrition in the hot regions and arid countries. This milk contains all the essential nutrients found in bovine milk (El-Agamy *et al.,* 1998; Karue, 1998). Camel milk is popular in Saudi Arabia and consumed as fresh and soured milk (Abu-Taraboush *et al*., 1998). Fresh and fermented camel milks have been used in different regions in the world including India, Russia and Sudan as a treatment for a series of diseases such as dropsy, jaundice, tuberculosis, asthma and leishmaniasis or kala-azar (Abdelgadir, Ahmed, & Dirar, 1998).

Recently, camel milk was also reported to have other potential therapeutic properties, such as anti-carcinogenic (Magjeed, 2005), anti-diabetic (Agrawal *et al*., 2007a), and anti-hypertensive (Quan, Tsuda, & Miyamoto, 2008), and has been recommended to be consumed by children who are allergic to bovine milk (El-Agamy *et al.,* 2009). Moreover, camel urine was also reported to be used as a treatment for diarrhoea (Al-Attas, 2008).

Camel milk has not been given as much attention in research compared with bovine milk. Most of the research conducted on camels in the past was mainly focused on their anatomical and physiological features (Farah & Farah-Riesen, 1985). However, the recent studies have mainly concentrated on the compositional, Characteristics and functionality of camel milk. Several reviews have been published on camel milk (Farah, 1993, 1996). This review covers the available information from 1997 to 2009 with emphasis on Dromedary camel milk composition. Most 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 commercial markets. Recently, a new camel milk product called Camelicious_ has been launched in the United Arab Emirates market (AME Info, 2006). This product is now available in different flavours and was developed by Central Veterinary Research Laboratory in Dubai. Nowadays, other dairy products (cheese and ice cream) and chocolates produced from camel milk are also available in the markets of Gulf countries due to the increasing demand in recent years. In conclusion, fresh camel milk and their products have unique flavour and good nutritional values, therefore can compete in the market if made available on supermarket shelves and packed in an attractive packaging. It is also important that final products should have acceptable sensory attributes such as taste, aroma, colour and texture during their shelf life. Furthermore, consumers should be provided with the nutritional value of camel milk (Haddadin, *et al.,* 2008).

Chapter three

Material and methods

3.1. Study area:

This study was conducted at the Laboratory of Dairy Science and Technology, Sudan University of Science and Technology, College of Animal Production Science and Technology, Department of Dairy Science and Technology, during the period 14 -15 August 2015.

3.2. Materials:

Camel milk, Cream, Powder milk, Gum Arabic, Sugar, Vanilla, Strawparry and Water

Equipment

Ice cream machine, Thermometer, Spoon, Water bath, Balance, Electric mixer And Ice cream cups

3.3. Experimental design:

In this study three treatments were conducted. The first treatment is the control in which the ice cream formula consists mainly of 800 ml cow's milk, 465 (g) creams, 200(g) powder milk, 6(g) Gum Arabic, 267(g) sugar, 0.4 (g) vanilla and 0.4 strawberries. The second treatment the ice cream formula consists of 800 ml camel milk, 465 (g) cream, 200 (g) powder milk, 6(g) Gum Arabic, 267(g) sugar, 0.4 (g) vanilla and 0.4 (g) strawberry and the third treatment of the ice cream consists of 400 ml camel milk and 400 ml cows milk, 460 (g) cream, 200(g), powder milk, 6(g) Gum Arabic, 267(g) sugar, 0.4 (g) vanilla and 0.4 (g) strawberry.

3.4. Methods:

In all treatments the milk was warmed at 40 °C then the other ingriedients were mixed thoroughly with the milk the pasteurized at 79 °C/15 min. the the mixture was cooled gradually and left at thr refrigerator at 7 °C four 24 hous then the next day the flavours and the colour were mixed with mixter then the mixture was poured into the ice cream machine at -19 °C and left for 30 minutes until ice cream was formed, the ice cream from all treatments were packed into plastic containers, Chemical and sensory evaluation were done for the ice samples.

3.4.1. Ice cream preparation

The components of the ice cream in this study are as follows; 12% SNF, 12% fat, 15% sucrose, stabilizer- (0.5%) and 0.1% vanillin. (Chagani and Meshkat, 2006).

3.4.2. Physicochemical analysis:

3.4.2.1. PH Determination

The pH was measured directly using a pH meter (Jenway model-England). This was turned on and allowed to become stable; 20 ml of the buffer solution was poured into a clean 50ml polypropylene beaker. The electrode was immersed into the buffer solution. After this, the temperature was adjusted to buffer solution temperature using the temperature control knob. The buffer solution was removed and the electrode rinsed with distilled water. About 20ml of sample was put in a 50ml polypropylene beaker. The electrode of the pH meter was put inside the sample while gently agitated. Finally the pH was read directly from the screen of the meter when the point was steady.

3.4.2.2.Determination of total solids

The gravimetric method described by AOAC (1990) was used. A measured weight of the sample was weighed into a previously weighed moisture can. It was first evaporated to dryness over a steam-bath and was dried in a Gallemkamp (made in England) moisture extractor oven at 105O for 3h. It was cooled in a desiccator and weighed. The weighed sample was returned to the oven for final drying. Thereafter, it was cooled and weighed at an hourly interval until no further difference in the weight was observed (This is, constant weight is observed). The moisture content was calculated as a percentage ratio of the weight of moisture content, to that of the weight of sample analysed. The formula below was used.

% M C = 100 x W2 –W3

Where

MC =Moisture content

W1 = Weight of empty moisture can

W2 = Weight of moisture can + sample before drying

W3 = Weight of moisture can + sample after drying to constant weight.

% dry matter (Total solid) = 100 -% MC

3.4.2.3. Determination of solid non-fat

This was estimated by difference as the solid non-fat (SNF). It was calculated as shown below according to AOAC (1990):

% Solid non-fat = % Ts -% fat

3.4.2.4 Moisture Content Determination:

Moisture content was determined according to **AOAC (1990**). The samples were first weighed (Initial weight) then dried in an electric oven at 105°C for 3 hours to obtain a constant weight. The moisture content was calculated as follows:-

Moisture content (%) = $\dfrac{W1\times 100}{W2}$

Where:

W1 = initial weight

W2 = final weight

3.4.2.5. Crude Protein Determination:

The protein contents of Ice cream was determined according to AOAC (1990) using kjeldahl method. For the determination three empty and dried porcelain dishes were weighed. Three grams of Ice cream samples were weighed separately then transferred to kjeldahl flasks. Twenty five ml of concentrated sulfuric acid free nitrogen which had 1.86 density, were added to Ice cream samples followed by two kjeldahl tablets then they were digested on a heater until clean solutions were obtained. The flasks were removed and left to cool. Each digested sample was poured in a 100 ml volumetric flask, diluted to 100 ml with distilled water and allowed to cool. Five ml of each diluted sample was transferred to a distillator followed by 10 ml of 40% NaOH. The distillate of each of the samples received in a conical flask of 100 ml capacity containing 25 ml of 2% boric acid and three drops of bromo-cresol green plus methyl red indicator then the distillaion continued until the volume in the flak reached 75 ml. The flasks were removed then titrated against 0.1 N HCl until the end points were reached (red colour). The protein contents were then calculated as follows:

$$N\% = \frac{T X\ 0.1 X 0.014 X 20 X 100}{\text{Wt of sample}}$$

$$\text{Protein }\% = N\% \text{ X } 6.38$$

Where:

T = Titration figure

0.1 N = Normality of HCl

0.014 = The atomic weight of nitrogen/1000

20 = Dilution factor

3.4.2.6. Crude Fat Determination:

Five grams of each ice cream sample were placed in a test tube adding 3.75 mL of a chloroform-methanol mixture (1:2 v/v). This mixture was shaken in a vortex mixer for one minute followed by the addition of 1.25 mL of chloroform, and then it was shaken again for another minute until total lipid sample separation was achieved. All tubes were centrifuged at 4000 rpm for 5 minutes. The aqueous phase was discarded and 5 mL of chloroform-methanol mixture were added. The tubes were shaken in a vortex for one minute. The lipid extract was transferred into clean test tubes. Fat percentage was then calculated as follows:

$$\textbf{Fat \%} = \frac{\text{Extracted fat weight}}{\text{Sample weight}} \times 100$$

3.4.2.7. Ash Content Determination:

Ash was determined according to AOAC (1990) by heating 10 gm at 55^0C in muffle furnace until a constant weight was obtained. Ash content percentage was given by the following formula:

$$\textbf{Ash \%} = \frac{\text{Ash weight}}{\text{Sample weight}} \times 100$$

3.5. Sensory Evaluation

The sensory analysis was performed with 30 untrained panelists using a structured 9-point hedonic scale ranging from 1 (disliked it very much) to 9 (liked it very much). Ice cream was evaluated for colour, flavour, taste, texture. Approximately 20g of each sample was placed in a 50ml disposable container which was coded with three-digit numbers, sealed and kept in a thermal box to maintain the samples' temperature (approx. 4 C°) O' Mahoney, (1985).

3.6. Statistical analysis:

Statistical analysis was performed using Statistical Analysis program (SPSS, 16). And the Analysis of variance one way (ANOVA) and least significant difference (LSD), were used to determine differences between treatments means at significance rate of ($P < 0.05$).

Chapter four

Result

The chemical composition of ice cream from three treatments was presented in table (3). The results showed that there were no significant differences (P>0.05) in the chemical composition of the ice cream samples except in the crude protein and pH Moisture of the studied ice cream in the three samples was found to be 69.75±2.96, 70.50±0.71 and 70.25±0.96 respectively. Also in case of protein in three samples of ice cream was found to be 9.77±0.14, 8.86±0.29 and 8.95±0.69 respectively. Fat content in this study was found to be 17.00±o.82, 16.50±1.29 and 17.50±1.29 respectively. The present study revealed that Ash content was found to be 0.63±0.25, 0.75±0.29 and 0.98±0.62b respectively.

Data in Table (4) showed the sensory scores of ice cream made from different milks. The color of the ice cream samples showed no significant (p>0.05) variations with the highest colour scores (5.93±1.14) was in ice cream made from camel milk compared with those of the cow's and mix milk ice cream (5.33±1.63, 5.93±1.14 respectively). The highest flavor scores (P<0.05) was secured by an ice cream from the mix milk (6.20±2.01) while the lowest one (6.00±2.08) was for the ice cream from camel milk. The results indicated that highest taste score (5.53±1.57) was recorded for ice cream from camel milk and the lower score was for mix milk ice cream (4.67±1.58).The results revealed that significant differences (P<0.05) were found in the texture of the ice cream made from different treatments. The highest texture scores (6.67±1.97) was for the ice cream from cows milk, however the lower value (5.53±2.03) was for the ice cream from camel milk.

Table (3): Physicochemical composition of ice cream samples from cows milk, camel milk and mix cows and camel milk.

Treatment / Parameters	A M±SD	B M±SD	C M±SD	Sig
Moisture	70.25±0.96	70.50±0.71	69.72±2.96	**NS**
Total solids	29.63±0.75	29.50±0.71	29.550±1.58	**NS**
Crude protein	8.95±0.69	8.86±0.29	9.77±0.14	*****
Fat	17.50±1.29	16.50±1.29	17.00±0.82	**NS**
Ash	0.98±0.62	0.75±0.29	0.63±0.25	**NS**
NFS	12.13±1.31	13.50±1.47	12.50±2.27	**NS**
Acidity	0.22±0.01	0.22±0.02	0.21±0.02	**NS**
PH	4.00±0.0	4.50±0.12	4.45±0.06	******

Means bearing different superscripts are significantly different (P0.05).

A- Cow milk ice cream.

B- Camel milk ice-cream.

C-.50% cow’s milk &50% camel milk ice cream

Table 4: Sensory characteristics of the ice cream from camel and cows milk

Treatment	Color M±SD	Flavor M±SD	Taste M±SD	Texture M±SD
A	5.90±1.72	6.2±2.01	5.47 ± 1.87^{b}	6.67 ± 1.97^{a}
B	5.93±1.14	6.00±2.08	5.53 ± 1.57^{a}	5.53 ± 2.03^{ab}
C	5.33±1.67	6.13±2.08	4.67 ± 1.58^{b}	5.93 ± 1.95^{a}
Sig	**NS**	**NS**	*	*

Means bearing different superscripts are significantly different (P0.05).

A- Cow milk ice cream.

B- Camel milk ice-cream.

C-.50% cow's milk &50% camel milk ice cream

Chapter five

Discussion

The composition of the ice cream samples statistically differed ($p<0.05$) for crude protein, and pH. The pH values were lower when compared to Akalin and Erisir (2008)**,** who respectively found pH ranging from 5.60 and 5.47 for fermented probiotic ice cream. (Table 3).

The result obtained from this study showed that no significant different ($p<0.05$) in moisture content, total solids, fat,, Ash, NFS, and acidity between the three samples of ice cream this result is in agreement with El Owni and Khater, (2009) who reported that there is no significant differences ($p>0.05$) in all chemical components due to flavor except total solids between machine and factory ice cream in Khartoum State, Sudan.

The moisture content values were lower when compared to Gita (2012)**,** who respectively found moisture ranging from 89.16 and 80.

The fat content values were higher when compared to Gita (2012) who found fat ranging from 5.83 – 7.26. However the main role of the fat substitute is to efficiently replace the hydrogenated vegetable fat. Nevertheless, usually it has high solid, carbohydrate and protein contents, a fact which explains the higher solids, total reducing sugar and protein content (Rechsteiner, 2009).

The Ash content values were lower when compared to Gita (2012) who found ash ranging from 1.4 – 2.30%.

The present results were in agreement with the findings of Roland *et al*. (1999) who concluded that the sensory response to the ice cream samples was affected by the variation in fat content. The present data (Table 4) were also in agreement with the findings of Zheng (1997) who reported that fat is important in food for sensory qualities such as flavor, color, texture and mouth feel. The present results were, in agreement with the findings of Noakes *et al*, (1996) who observed slightly color differences in dairy products (milk, butter, cheese and ice cream) with a higher unsaturated fatty acid content.

The result of this study showed significant different (P<0.05) between the three ice cream samples in taste and texture this result is in agreement with Akalin *etal*., (2008),who reported that typically, ice cream contains 10– 16% fat that is the main component affecting flavor and textural properties of the product.

Many studies have measured sensory properties of ice cream to examine the relationship among various ingredients and sensory characteristics such as flavor and texture. Hyvönen *et al.* (2003) found that the nature of strawberry flavoring affects flavor perception and that modifying fat distribution influences flavor release in ice cream; dairy fat retards flavor release at the highest level (18%). Replacement of milk fat with tapioca dextrin or potato malt dextrin also significantly affects textural properties: increasing coarseness and wateriness and decreasing creaminess of ice cream (Specter and Sester 1994).

Chapter six

Conclusion and recommendation

6.1. Conclusion:

The study concluded that processing techniques and type of milk 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 camel milk and cow milk while the lowest values were found in mix samples. The lowest score values of color were found in mix milk samples. Color, flavor, and overall acceptability were not significantly affected. Hence, these results indicate that taste and texture of ice cream samples were significantly affected. Also the study concluded that there are no significant differences in the chemical composition parameters of ice cream samples except in crude protein and pH.

6.2. Recommendation:.

- Further work is needed to study microbiology of ice cream from different formulations.
- Further studies for evaluation of vitamins and mineral contents of ice cream from different mix.

References

Abdelgadir,W. S., Ahmed, T. K., and Dirar, H. A. (1998). The traditional fermented milk products of the Sudan. International Journal of Food Microbiology, 44, 1e13.

Abu-Taraboush, H. M. (1996). Comparison of associative growth and proteolytic activity of yoghurt starters in whole milk from camels and cows . Journal of Dairy Science, 79, 366e371.

Abu-Taraboush, H. M., Al-Dagal, M. M., & Al-Royli, M. A. (1998). Growth, viability,and proteolytic activity of Bifidobacteria in whole camel milk. Journal of Dairy Science, 81, 354e361.

Adapa, S., Dingeldein, H., Schmidt, K. A. and Herald, T. J. (2000). Rheological Properties of Ice Cream Mixes and Frozen Ice Creams Containing Fat and Fat Replacers. *J. Dairy Sci.,* 83: 2224-2229.

Agrawal, R. P., Budania, S., Sharma, P., Gupta, R., and Kochar, D. K. (2007a). Zero Compounds with Microparticulated Proteins. *J. Food Sci.,* 57:1448–1451.

Aime, D. B., Arntfield, S. D., Malcolmson, L. J. and Ryland, D. (2001). Textural Analysis of Fat Reduced Vanilla Ice Cream Products.*Food Res. Int.,* 34: 237-246.

Akalin AS, Erişir D.(2008). Effects of inulin and oligofructose on the rheological characteristics and probiotic culture survival in low-fat probiotic ice cream. J. Food Sci.; 73(1): 184-8.

Akalin, A. S., Karagözlü, C. and Ünal, G. (2008). Rheological Properties of Reduced-fat and Low-fat Ice Cream Containing Whey Protein Isolate and Inulin. *Eur. Food Res.Technol.*, 227:889-895.

Al-Attas, A. S. (2008). Determination of essential elements in milk and urine of camel and in Nigella sativa seeds. *Arabian Journal of Chemistry, 1*, 123e129.

Alonso L, Fraga MJ, Juárez M and Carmona P.(2002). Fatty acid composition of Spanish shortenings with special emphasis on trans unsaturation content as determined by Fourier Transform Infrared Spectroscopy and Gas Chromatography. *J Am Oil Chem Soc*; 79: 1-6.

Alvarez, V. B., Wolters, C. L., Vodovotz, Y. and Ji, T.(2005). Physical Properties of Ice Cream Containing Milk Protein Concentrates. *J. Dairy Sci.,* 88 (3): 862-871.

AME Info. (2006). Emirates industry for camel milk and products launches CameliciousinUAE.Retrievedfrom. www.ameinfo.com/95152.html

AOAC (1990). Official Methods of Analysis (11th ed.) Association of Official Analytical chemists. Washington D.C USA.

Bennion, M., (1975). Introductory foods, 6th ed. Macmillan Publishing Co. Inc., ew York and Collier Macmillan Publishers London.

Davidson RH, Duncan SE, Hackney CR, Eigel WN, Boling JW.(2000). Probiotic cultures survival and implications in fermented frozen yogurt characteristics. *J Dairy Sci*.; 83(4): 666-73.

Desrosier, N.W., (1977). Elements of Food Technology. AVI Publishing Co., West Port,. Connecticut, USA.

El Owni, O.A.O. and Khater ,Z.K.O., (2009). Chemical composition of ice cream produced in Khartoum State, Sudan. *Pakistan Journal of Nutrition*, 8(2): 158-160.

El-Agamy, E. I., Abou-Shloue, Z. I., and Abdel-Kader, Y. I. (1998). Gel electrophoresis of proteins, physicochemical characterization and vitamin C content of milk of different species. *Alexandria Journal of Agricultural Research*, 43, 57e70.

El-Agamy, E. I., Nawar, M., Shamsia, S. M., Awad, S., and Haenlein, G. F. W. (2009). Are camel milk proteins convenient to the nutrition of cow milk allergic children. *Small Ruminant Research*, 82, 1e6.

Elahi, A.T.M.M.E., S. Habab, M.M. Rahman, G.I. Rahman and M.J.U. Bhuiyan, (2002). Sanitary quality of commercially produced ice cream sold in the retrial tores. *Pak. J. of Nutr*., 1(2): 93-94.

Farah, Z. (1993). Composition and characteristics of camel milk. Journal of Dairy prevalence of diabetes in camel milk consuming Raica community of northwest Rajasthan, India. Diabetes Research and Clinical Practice, 76, 290e296.

Farah, Z. (1996) Camel milk properties and products. St. Gallen, Switzerland: SKAT,Swiss Centre for Developments Cooperation in Technology and Management.

Farah, Z., (1996). Camel milk properties and products. Published by SKAT, Swiss center for Development Cooperation in Tech. and management, Vadianstrasse 42, CH. 900 St. Gallen. Switzerland.1st edition.

Farah, Z., and Farah-Riesen, M. (1985). Separation and characterization of major components of camel milk casein. *Milchwissenschaft*, 40, 669 - 671.

Frost M, Heymann H, Bredie W, Dijksterhuis G, Martens M (2005).Sensory measurement of dynamic flavour intensity in ice cream with different fat levels and flavourings. *Food Qual Prefer*; 16(4): 305-14.

Goff HD. Fox, PF, McSweeney, PLH eds (2006). Advanced Dairy Chemistry. Volume 2. Lipids, Springer, USA, p. 441-50.

Guinard, J.X., Zoumas-morse, C., mori, l., Panyam, D. and Kilara, A. (1996). Effect of sugar and fat on the acceptability of vanilla ice cream. *J. Dairy Sci. 79*, 1922–1927.

Haddadin, M. S. Y., Gammoh, S. I., & Robinson, R. K. (2008). Seasonal variations in the chemical composition of camel milk in Jordan. *Journal of Dairy Research*, 75, 8e12.

Hyvönen, L., Linna, M. and Dijksterhuis, G. (2003). Perception of melting and flavor release of ice cream containing different types and contents of fat. *J. Dairy Sci*. *86*, 1130–1138.

Ibrahim, A.E., (1998).Potential of milk production from Sudanese She Camels. The *Sudan J. Vet. Res*., 15:57-59.

International Dairy Foods Association (IDFA). (2003).Dairy Facts. Washington, D.C.U.S. Department of Agriculture (USDA). October 2002. *Nutritive Value of Foods*, 22–23.

James, E.G. (1995). Analytical chemistry of roots, Chapman and Hall, New york.pg 28-30.

Karue, C. N. (1998). The dairy characteristics of the Kenyan camel. In P. Bonnet (Ed.), Actes du colloque, Dromadaires et chameaux, animaux laitiers/Dromedaries and camels, milking animals (pp. 55e60). Nouakchott, Mauritania: CIRAD Publishing.

Kirk RS, Sawyer R, Egan H (2005). Composición y Análisis de Alimentos de Pearson. CECSA, México.

Koxholt MMR, Eisenmann B, Hinrichs J (2001). Effect of the fat globule sizes on the meltdown of ice cream, *J Dairy Sci*; 84: 31–7.

Magjeed, N. A. (2005). Corrective effect of milk camel on some cancer biomarkers in blood of rats intoxicated with a flatoxin B1. Journal of the Saudi Chemical Society,9, 253e263.

Marshal, R. T. and Arbukle, W. S. (1996).Formulas and Industry Standards. In: "*Ice Cream*", (Ed.): Arbukle. W. S. 5th Edition, Chapman and Hall, New York, PP. 314-327.

Marshall RT, Arbuckle WS (2000). Ice Cream. 5th ed.:International Thomson Publishing. New York.

Moeenfard M. and Mazaheri Tehrani M. (2008). Effect of Some Stabilizers on Physicochemical and Sensory Properties of Ice Cream Type Frozen Yoghurt. *American-Eurasian J. Agric. Environ. Sci.,* 4(5): 584- 589.

Mordi, J.I. (2003). Development and Production of tigernut based dairy Analogues, Federal Institute of Industrial Research (FIIRO), In-house seminar paper, Oshodi, Lagos state.

Norma Oficial Mexicana NOM-036-SSA1-(1993). Bienes y servicios. Helados de crema, de leche o grasa vegetal, sorbetes y bases o mezclas para helados. Especificaciones sanitarias. Secretaría de Salud. Diario Oficial de la Federación. México, DF.

O' Mahoney, M. (1985). Sensory Evaluation of Food (Statistical methods and procedures). Pub. Marcel Dekker, Inc. New York and Basel. Pg.

Olsen DW, White CH, Watson CE (2003). Properties of frozen dairy desserts processed by microfluidization of their mixes. *J Dairy Sci*; 86: p. 1157–62.

Putnam, J. and Allshouse, J. (2003). Trends in U.S. per capita consumption. Economic Research Service USDA. Amber Waves *1*(3), 12–13.

Rea, H.O., (1983). Studies on The Manufacture of Frozen Yoghurt. M.Sc.thesis, Ein Shams University. Egypt.

Rechsteiner MS (2009). Desenvolvimento de amidos fosfatados de batata doce e mandioca e aplicacao como substitutos de gordura em sorvetes [tese de doutorado]. Botucatu(SP): Universidade Estadual Paulista “Julio de Mesquita Filho”;.Research, 60, 603e626.

Roland, A.M., Phillips, L.G. and Boor, K.J.(1999). Effects of fat content on the sensory properties, melting, color, and hardness of ice cream. *J. Dairy Sci. 82*, 32–38.

Ryan, C. (2005). An old favorite gets new attention. Fresh cup magazine. http://www.freshcuproadshow.com/back-issues/2005/2005_jul/gelato. htm (accessed June 15, 2006).

Schwartz, H.J. and M. Dioli, (1992). The one Humped Camel In Eastern Africa: A Pictorial Guide to Disease, Health Care and Management. verla Josef Magraf. Scientific Books.

Schwartz, H.J., (1992). Introduction: The Camel (*C.dromedarius*) In East Africa in: The one Humped Camel in Eastern Africa: A Pictorial Guide to diseases, health care and Management.

Specter, S.E. and Sester, C.S. (1994). Sensory and physical properties of a reduced-calorie frozen dessert system made with milk fat and sucrose substitutes. *J. Dairy Sci. 77*, 708–717.

Stampanoni-Koeferli, C.R., Piccinali, P. and Sigrist, S. (1996). The influence of fat, sugar and non-fat milk solids on selected taste, flavor and texture parameters of a vanilla ice-cream. Food Qual. Pref. *7*(2), 69–79.

Thanh, M.L., L.A. Thibeaudeau, M.A. Thibaut and A. Voilley, (1992). Interactions between volatile and non volatile compounds in the presence of water. Food hem., 43: 129.

Umelo M.C, Uzoukwu A.E, Odimegwu E.N, Agunwah, I.M, Njoku, N.E & Alagbaoso, S.O. (2014). Proximate, physicochemical and sensory evaluation of ice cream from blends of cow milk and tigernut (*cyperus esculentus*) milk. *International Journal of Scientific Research and Innovative Technology*; Vol. 1 No. 4;36-39.

USDA. (2006). Table 39 – per capita consumption of major food commodities.

Varnam, A.H. and J.P. Sutherland, (1994). Milk and Milk products: Technology, chemistry and microbiology. Chapman and Hall. London, U.K.