**Sudan University of Science and Technology**

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**College of Graduate Studies**

# USING OF SOY MILK FOR ICE CREAM PRODUCTION

استخدام لبن الصويا في إنتاج الآيسكريم

A Dissertation Submitted to Sudan University of Science and Technology in Partial Fulfillment for the Requirements of the Degree of (M.Sc.) in Food Science and Technology

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# الآيـة

**يقول الله تعالى :**

**(وَآيَةٌ لَهُمُ الْأَرْضُ الْمَيْتَةُ أَحْيَيْنَاهَا وَأَخْرَجْنَا مِنْهَا حَبّاً فَمِنْهُ يَأْكُلُونَ(33) وَجَعَلْنَا فِيهَا جَنَّاتٍ مِنْ نَخِيلٍ وَأَعْنَابٍ وَفَجَّرْنَا فِيهَا مِنَ الْعُيُونِ(34))          صدق الله العظيم**

**سورة يّس**

# DEDICATION

*To my beloved family:* father , mother, husband and brothers

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At the start and end I thank Allah for giving me the power and patience to come up with this research.

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**List of Contents**

# List of tables

# ABSTRACT

This study was conducted to examine the capability of using soy milk to produce ice cream. Different ratios of soy milk and cow milk were used (25:75(A), 50:50(B), 75:25(C), 100:0(D) and E (100% cow milk) as control. The results for nutritional value of soy milk were 14.21, 3.92, 2.95 and 0.88% for total solid, protein, fat and ash, respectively. The pH was 6.71. While for soy milk ice cream (A, B, C, D and E) were total sold (45.28, 46.41, 46.47, 46.6 and 43.58%), protein (4.87, 5.03, 5.47, 6.46 and 3.90%), fat (3.75, 3.87, 3.94, 4.87 and 3.64%), Ash (1.17, 1.23, 1.28, 1.34 and 1.12%), pH (4.57, 4.47, 4.41, 4.38 and 4.87%), and lactose (4.18, 3.04, 2.18, 0 and 4.3%) respectively. The physical properties of soy milk ice cream (A, B, C, D and E) were for overrun (70.01, 70.13, 70.32, 70.45 and 69.73%), meltdown (14.93, 14.54, 14.07, 13.65 and 15.17%), and viscosity (4965.16, 5243.12, 5642.32, 5953.1 and 4257.13cp) respectively. The results revealed that by increasing the ratio of soy milk in ice cream samples the total solids, fat, protein, pH, overrun and viscosity of mixture increased while melt down decreased significantly ($P<0.05$) in all treatments. The results of sensory evaluation for the samples ( A, B, C, D, and E) respectively showed that for colour (4.29, 4.29, 3.22, 2.17 and 4.34), taste (4.49, 4.49, 3.20, 2.67 and 4.54), flavor (4.58, 4.51, 3.40, 2.10 and 4.61), texture (4.48, 4.47, 4.54, 2.31 and 3.23) and overall acceptability (4.46, 3.31, 2.26, 4.50 and 4.49) respectively. Finally, the best sample of ice cream was the ratio 25:75 of soy milk to cow milk. From these results it was concluded that, soymilk is suitable for ice cream production.

# الملخص


هدفت هذه الدراسة إلى امكانية استخدام حليب الصويا لإنتاج الآيس كريم. تم استخدام نسب مختلفة من لبن الصويا وحليب البقر (25: 75 (A)، 50:50 (B)، 75:25 (C)، 100: 0 (D)، 0: 100 (E)) على التوالي . و كانت القيمة الغذائية لحليب الصويا كالتالي : إجمالي المواد الصلبة (14.21 % ) و البروتين (3.92% ) و الدهون (2.95 %) و الرماد (0.88 %) والرقم الهيدروجيني (6.71 ) . اما نسب عينات الآيس كريم المختلف (E ,D, C, B , A) كانت إجمالي المواد الصلبة (45.28 ، 46.41 ، 46.47 ، 46.6 ،43.58 %) و البروتين (3.90 ، 4.87 ، 5.03 ، 5.47 ، 6.46%) و الدهون (3.64 ، 3.75 ، 3.87 ، 3.94 ،4.87%) و الرماد (1.12 ، 1.17 ، 1.23 ، 1.28، 1.34%) و الرقم الهيدروجيني (4.87 ، 4.57 ، 4.47 ، 4.41 ، 4.38%) و اللاكتوز (4.3 ، 4.18 ، 3.04 ، 2.18 ، 0%) على التوالي. اما الخواص الفيزيائية لعينات الايس كريم (E ,D, C, B, A) كانت : الرغوة (69.73 ، 70.01 ، 70.13 ، 70.32، 70.45%) و السيحان (15.17 ، 14.93 ، 14.54 ، 14.07 و 13.65%) و اللزوجة (4257.13 ، 4965 ، 5243.12 ، 5642.32 ،5953.1 cp) علي التوالي. كما أظهرت النتائج أنه بزيادة كمية حليب الصويا زاد إجمالي المواد الصلبة والدهون والبروتين والرقم الهيدروجيني والرغوة واللزوجة بينما انخفض السيحان بشكل ملحوظ في جميع العينات . كما أظهرت نتائج التقييم الحسي للعينات (E ,D, C, B, A) أن اللون (4.34 ، 4.29 ، 4.29 ، 3.22 ،2.17)، الطعم (4.54 ، 4.49 ، 4.49 ، 3.20، 2.67)، النكهة (4.61 ، 4.58 ، 4.51 ، 3.40 ،2.10 )، القوام ( 3.23 ، 4.48 ، 4.47 ، 4.54 ،2.31)، القبول العام (4.49 ، 4.46 ، 3.31 ، 2.26 ،4.50) على التوالي . أيضا أوضحت الدراسة أفضل عينات الآيس كريم هي نسبة 75:25 من حليب الصويا إلى حليب البقر. ومن هذه النتائج يمكننا أن نستنتج أن حليب الصويا مناسب لإنتاج الآيس كريم .

# CHAPTER ONE

## INTRODUCTION

Soybean scientifically called *Glycine max L*. It is one of the oldest crops of the Far East and has long been consumed by a significant portion of the world population as one of their most important sources of dietary protein and oil (Gopalan, 2011).

Soybean is a hot weather crop suitable for year-round growth in most parts of the tropics. Temperatures of at least15 degrees C are needed to germinate the seed and mean temperatures of 20-25 C to grow the crop. Soybeans need at least moderate soil moisture in order to germinate and for seedlings to become established, but need dry weather for the production of dry seed .Soybeans suffer if the soil is waterlogged. Established soybean plants can withstand considerable drought (Frankin, 1988). Consumers are interested in foods that may help prevent or reduce the incidence of illness, for this reason, soybean has caught the attention of the world and now it is seen as a crop that could help to combat world hunger and also contribute  health benefit. The concept of functional foods has evolved as the role of food in the maintenance of health and well-being and in the prevention of disease has received scientific and commercial interest (Gopalan, 2011).

Soy foods, especially soymilk, are considered a good substitution for dairy products for individuals who have milk intolerance. Milk intolerance including lactose intolerance is prevalent in the world, especially in children. The important and widely used method used to treat milk intolerance is the exclusion of all forms of animal milk (Gopalan, 2011).

Soymilk is a healthy protein source for those milk intolerant individuals. In addition, cow's milk contains saturated fats that might increase the risk of cardiovascular diseases. Soymilk, which contains much lower amounts of saturated fat than cow's milk, could be a good choice for individuals who are concerned about heart disease. Amino acid pattern is fairly close to cow's milk except a deficient in sulphur containing amino acids (methionine and cysteine). However, adding small amounts of methionine to soy milk gives equivalent nutritional value to cow's milk Ice cream could be made more nutritious and health beneficial by adding soymilk the production of soy milk based high quality ice cream. (Bisla *et al*., 2012).

Sudan is large country and has rich soil, this should can grow soy bean. An intensive research in developing improved soybean varieties to suitable for irrigated and rainfed farming in Sudan (Ibrahim, 2011).

Soymilk is a nutritional powerhouse capable of solving the protein-energy malnutrition problems in Sudan proving to be cost effective due to less availability of cow milk (Ibrahim, 2011).

## The objectives:

The main objective of this study was examine the capability of using soymilk in ice cream production.

The specific objectives of the study were to:

1-Determine the nutritional value of soybean, soymilk and cow milk.

2- Prepare soy ice cream by different ratios of soy and cow milks.

3- Determine the physicochemical properties of the soy milk ice cream.

4- Evaluate sensory properties of the soy milk ice creams.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Soybean

Soybean scientifically called *Glycine max L*. Is a monocotyledon which belongs to the *Legumenoesae*. The soybean is one of the most important food plants of the world, and seems to be growing in importance. It is an annual crop, fairly easy to grow, that produces more protein and oil per unit of land than almost any other crop. It is a versatile food plant that, used in its various forms, is capable of supplying most nutrients. It can substitute for meat and to some extent for milk. It is a crop capable of reducing protein malnutrition. In addition, soybeans are a source of high value animal feed (Chauhan and Chauhan, 2007).

### 2.1.1Chemical Composition Of Soybean

The soybean seeds contain 13-25% oil, 30-50% protein, and 14-24% carbohydrates. The major fatty acids of soy bean oil are linoleic acid (55%), oleic acid (21%), palmitic acid (9%), stearic acid (6%) and other fatty acids (9%). The ratio of polyunsaturated fatty acid to saturated fatty acid is 82:18(Zimmermann *et al*., 2012). Soy protein based ingredients are usually employed because of their emulsification activity and stability, fat absorption, hydration capacity, colloidal stability, acid and heat gelation, adhesion/cohesion, thickening and foaming abilities . Soy proteins are mainly used in the food industry in form of soy flours (40-50% protein) concentrates , grits (70% protein) and isolates (>90% protein). Soy proteins are classified as globulins, because of their increased solubility in salt solutions. The solubility of soy proteins is a very important property, as it is strongly linked to various processing functionalities, and it can be adversely or favorably affected by processes such as heating, drying, pressure treatments, exposure to polar organic solvents and chemical changes to their environment, such as change in pH and ionic strength. Soy proteins contain two main fractions, Glycinin and conglycinin, accounting for 40% and 30% of total protein, respectively (Zimmermann *et al*., 2012). Soybean oil is low in saturated fat, rich in the essential fatty acids. The amount of saturated fat in soybean is about 15%, while amounts of poly-and mono-unsaturated fats are 61and 24%, respectively. In other word, besides to providing omega-6 fatty acids, soybeans are among the few plant foods that provide omega-3 fat á-linolenic acids and is an excellent source of vitamin E (Savage *at el.*, 2010). Raw soybeans also contain some anti-nutritional factors, including phytic acid, which binds and prevents absorption of some minerals, and growth inhibitory substances, such as soybean trypsin inhibitors, haemagglutinins, saponins and antivitamins. Trypsin inhibitors in raw soybean, soy meal, or soy flour, when fed to animals, have been reported to interfere with the digestion and absorption of proteins and cause pancreatic enlargement (Savage *at el.*, 2010).

### 2.1.2 Production Of Soybean In The World And Sudan

The world production of soybean is about 265.8 million ton, accounting for nearly 57.9% of the total global oilseed production . It provides approximately 60% of vegetable protein and 30% of vegetable oil in the world. The USA, Brazil, Argentina and China are the major soybean-producing countries. The highest soybean average is 2890 kg/ha in the USA and the world average yield is 2430 kg/ha. African countries with the largest area of production were Nigeria, South Africa, Uganda, Malawi, and Zimbabwe. Demand for soybean remains strong and continues to grow because it is used as an ingredient in the formulation of a multitude of food, feed and industrial products (Ibrahim, 2011).

Soybean was first introduced to Sudan in 1910 by the colonial Garden (Shurtleff and Aoyagi, 2009). In 1949 soybean was introduced into South-West Sudan to prevent the severe malnutrition that exists among infants, children, pregnant and lactating women. Research on soybean in Sudan started as early as 1930. Soybean varieties were tested at Gezira Research Station, Wad Medani, central Sudan, between 1973 and 1977 (Salih,1977). An intensive research in developing improved soybean varieties suitable for irrigated and rainfed farming began in 1975 by Agricultural Research Corporation (ARC), in collaboration with International Soybean varietal testing program, USA (Ageeb and Khalifa ,1979). International Soybean Variety Evaluation Experiment trials were conducted at Wad Medani, Abu Naama and Kadugli during 1977-1984. Results of field trials indicated that Sudan has great potential for growing soybeans as irrigated and rain fed crop. Most of the early introduced soybean varieties were sensitive to photo-periods and high temperature resulting in poor vegetative growth, shorter plant height and height to first pod, making mechanical harvesting impossible. In 1982 Sudanese-Egyptian Integration Agricultural Scheme initiated a 2-year commercial soybean production project in Blue Nile State, Damazin (Ibrahim, 2011). In 2012, two soybean varieties, Sudan 1 and Sudan 2 were released for commercial production in irrigated and rainfed farming in Sudan were is late-maturing varieties (120 days) Sudan 1 and Sudan 2 are the first released soybean varieties and are promiscuous soybean varieties introduced from International Institute of Tropical Agriculture. The area planted to soybeans is 2100 ha. and Soya 3 and Soya 4, released in 2017, are early-maturing varieties (100 to 105 days) (Khojely *et al*., 2018).

### 2.1.3 Health Benefit Of Soybean

Soy foods are classified as functional foods because they contain polyphenol components, including isoflavones, glycosides and malonate conjugates, which contribute to their antioxidant activity. Soybeans contain potentially anti-nutritive compounds, such as lectins, phytic acid, protease inhibitors, and phenolic acids. They may adversely affect iron and zinc balances in some individuals who do not eat a well-balanced diet (Xiao, 2008).

#### 2.1.3.1 Coronary Heart Disease

Soy foods contain a high quantity of soy isoflavone components that have effects on reducing the risk for Coronary Heart Disease because of their antioxidant and anti-inflammatory effects (Malik *et al.*, 2004). Soy proteins and soy isoflavones may reduce the blood clot formation and restore damaged blood vessels to protect blood vessels because of their anti-inflammatory effects(Anderson *et al*., 2001).

#### 2.1.3.2 Chronic Kidney Disease

Dietary protein plays a critical role in the prevention and treatment of chronic kidney disease. Compared with meat protein, vegetable protein has a temperate effect on renal glomerular filtration (Kitazato *et al*., 2002).

#### 2.1.3.3 Obesity

Obesity is a disorder of energy balance. Soy protein and their isoflavones have been demonstrated to provide some positive effects in individuals diabetes (Boué *et al*., 2012).

### 2.1.3.4 Anti Carcinogenic

The isoflavones genistein and daidzein may decrease the amount and size of cancer tumors (Budhathoki *et al*., 2011). Soy protein reduction risk of both breast and prostate cancer (Yang *et al.,* 2013) .

### 2.1.3.5 Osteoporosis

Soy foods may help prevent and treat osteoporosis. Soy isoflavones have a similar structure to estrogen receptors, which could enhances calcium transport in intestinal cells, so that soy isoflavones may exert partly estrogen activity in tissues and alter intestinal calcium absorption just like estrogen receptors do (Arjmandi *et al*., 2002). In addition, soybean protein contains a number of asparagine and glutamine, because the free carboxyl group content of the hydrolysates significantly increased by treatment with as paraginase or glutaminase (Bao *et al*., 2007).

### 2.1.3.6 Cognitive Function

Soy isoflavones in the prevention of Alzheimer's and enhanced cognitive function(Duffy *et al*., 2003). The soy isoflavones may exert potentially biological activities in the brain (Lee, 2006).

### 2.1.4 Soy Side Effects

Soy may be possibly unsafe when used during pregnancy in medicinal amounts. Very high levels of phytoestrogens can be toxic. Large amounts of a group of chemicals called oxalates causes to kidney stones. Some of the interactions and side effects are seen. When there is consumption of soy it leads to risk of clotting. As well there is an interaction with the antioxidants and Tamoxifen ( Komata *et al*.,2009 ).

### 2.1.4.1 Soy Foods Allergy

Approximately 0.4% of children are allergic to soy based products, making soy allergy about half as common as peanut allergy (Savage *et al*., 2010). The major allergens in soybean could be classified into three categories, Gly m Bd 30K, Gly m Bd 28K and Gly m Bd 60K .Gly m Bd 30K, it a common allergenic protein in soybean (Ogawa, 2006). There are several methods that could reduce or remove these three major allergens. It is molecular breeding, genetic modification, physicochemical reduction, enzymatic digestion, chemical modification, extrusion cooking and transgenic suppression( Komata *et al*., 2009).

### 2.1.4.2 Soy Foods Intolerance

After consumption of soy foods, some sensitive individuals may generate undesirable microbial fermentation in the intestines, leading to digestive distress. Some sensitive individuals cannot fully digest α-galactosides. So in their large intestine, non-digestible oligosaccharides are digested by microorganisms, liberating huge amounts of gas These nondigestible oligosaccharides, including the stachyose and raffinose families of oligosaccharides (RFOs), cannot be eliminated by usual processing (Bilyeu *et al*.,2009).

### 2.1.4.3 Beany Flavor

Normal mature soybeans contain three lipoxygenase (LOX) isozymes, LOX-1, LOX-2, and LOX-3. in oxidation reactions, LOX isozymes require substrates containing polyunsaturated fatty acids, including linoleic acid and linolenic acid. It is contribute to beany or grassy flavor in soy foods. that the differences in LOX may lead to different results in sensory studies of soymilk (King *et al*., 2001).

### 2.1.5 Soybean Products

#### 2.1.5.1 Shelled Green Seeds

The fully developed pods while still green are harvested for their green seeds. These are removed by hand and then boiled until tender. The cooked beans can be eaten as they are, or combined in many dishes. Their flavor is unique but very good (Frankin,1988).

#### 2.1.5.2 Preliminary Boiling Of Dry Seeds

Normal boiling of soybeans as done with most kinds of dried beans results in an off flavor (enzyme-substrate reaction) that many people do not like. The following technique avoids this reaction by destroying the enzyme by heat and is a basic technique for several other foods. Bring to boiling two parts of water. Add one part of soybeans and boil five minutes. Remove the seeds from the first water, rinse them, and boil them in the second water for five minutes more. Discard water and rinse again. Note that this product will be called preboiled soybeans (Gandhi, 2008).

#### 2.1.5.3 Boiled Soybeans Pulp, Nuts And Sauce

Boil parboiled soybeans until as soft as desired. This product can be used as soft, cooked beans, soup, or as a mashed paste (Gandhi, 2008).

#### 2.1.5.4 Cheese (Tofu)

Soak beans (not parboiled beans) overnight in water. Discard water and rinse. Grind as fine as possible. Mix three parts water to one part ground soybean. Filter through a cheesecloth. Heat to Soybean boiling stirring to avoid scorching. While the milk is still boiling, add one part of a precipitating solution as follows: 1% solution of MgSO4 (Epsom salts) -- One part solution to 8 parts milk, or vinegar -- One part solution to 66 parts milk. Curd formation occurs immediately. After 15 minutes filter through cheesecloth, discarding the solution. Wash curd twice. Press to shape and to remove water. Use this as a cheese substitute in cooked dishes (Gandhi, 2008).

### 2.1.5.5 Defatted Soy Flour

It is made entirely from defatted soy meal and is currently used worldwide by commercial processors. Soy flour is also a common ingredient in blended food aid products and can also be fortified with various micronutrients (Gandhi, 2008).

### 2.1.5.6 Soy Protein Isolates

It is made wholly from defatted soy meal and is used as an ingredient in high protein foods including dairy foods, nutritional supplements, meat systems, infant formulas, nutritional beverages, cream soups, sauces and snacks. It is also a good source of protein in milk replacers (Gandhi, 2008).

### 2.1.5.7 Soybean Milk

Soy milk is a water extract from whole soy beans. It is an emulsion containing water soluble proteins, carbohydrate and oil droplets. Where the soy beans were soaked, grinded, filtered and cooked. Grind parboiled soybeans as fine as possible. This can be done with a home blender, a hand mill, or an electric mill. Mix one part ground, parboiled beans to two parts water. Filter with cloth . The liquid is left to stand one hour and is then filtered. The manufacturers of plant milks typically label their products the equivalent of "soy beverage soy drink" (Bisla *et al.*, 2012).

#### 2.1.5.7.1 Nutritional Value Of Soymilk

Soy milk composition varies depending on processing conditions and bean variety and in general contains about (10-14.6)% total solids (3.6-6.6)% protein, (2.0-3.96)% fat ( 2.9-3.9)% carbohydrates and (0.5-2.09)% ash (Bisla *et al.,* 2012).

#### 2.1.5.7.2 Manufacturing Process Of Soy Milk

Soybeans are first cleaned to remove dirt, stone and foreign material. It is then soaked in water for about 4 hours. After this water is removed and soaked beans are fed to grinding machine where hot water is added during grinding. This process is done at about 80 degree centigrade and in absence of air so that formation of beany odor is prevented in the final product. Soymilk is collected from outlet and filtered to remove solid material called okra. One kg of soybean produces 6.5 liters of milk containing about 3% protein and 2% fat. It is then formulated with flavor, sugar and other additives. Glass bottles of 200 ml are filled with the formulated milk; crown cork is fitted and sterilized at 118 degree centigrade for 15 minutes. This process gives the shelf-life of 6 months (Frankin,1988).

## 2.2 Ice Cream

Ice cream is a frozen dairy product made by freezing a mix with agitation to incorporate air and ensure uniformity of consistency (Arbuckle ,1986). The composition of ice cream varies depending upon the ingredients used in its preparation (Manay *et al.*,1987 ).

### 2.2.1 History Of Ice Cream

The history of ice cream, in various forms, goes back at least as far the ancient Greeks and Romans, who cooled their wine with mountain snow and ice. Most of the ice cream during that period was made through a method of beating cream in a pewter pot that was shaken in a larger pot of salt and ice (Mariani, 1994). Ice cream became a national favorite during the early 1900 after Soda fountains introduced Sodas, Sundaes and other new ways of serving it About 1926 the first successful commercially continuous process freezer was perfected. The term, “ice cream”, is found in an advertisement which appeared in the New York Gazette (Mariani, 1999).

### 2.2.2 Ingredients

Ice cream comes in many flavors and types. All ice cream has a general formula, which can be added to or slightly modified to create the desired product. The major 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).

#### 2.2.2.1 Fats

Fats increase the richness of the ice cream flavour, produce a smooth texture, give ‘body’ to the ice cream and produce good melting properties when the ice cream is eaten. Although dairy fats are most commonly used to make ice cream, a number of vegetable fats (including hydrogenated palm oil, coconut oil soybean oil and margarine) may be cheaper and are used to reduce the cost of ice cream. The number of double bonds in fatty acids influences melting behavior and oxidative stability (off flavors) whereas distribution of the fatty acids in the triglyceride structure influences crystallization behavior, melting behavior and nutritional aspects (Kaylegian and Lindsay, 1995).

### 2.2.2.2 Milk Solids Not Fat

Milk solids-not-fat is included as skimmed milk powder or full-fat milk powder. They improve the body and texture of ice cream, allow a higher overrun (below), and produce a thicker, less icy product. Higher levels of milk solids nonfat permit higher overruns without textural breakdown (Potter, 1978). Water binding is a property of whey protein concentrate that can be utilized in frozen desserts to delay development of coarseness (Morr, 1989). The water binding capacity of whey protein concentrate (WPC) is influenced by protein concentration, mineral content and the extent of heating during manufacture (Sienkiewicz and Riedel, 1990). Protein interacts at the oil water interface during homogenization to stabilize the fat emulsion and during freezing, proteins function to control destabilization of fat ( Mangino, 1992). 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).

### 2.2.2.3 Sugars

Sweeteners improve the flavour, texture and palatability of ice cream. They contribute to a lower freezing point, so that the ice cream has some unfrozen water. Without this the ice cream would be too hard to eat. They also reduce the 'fattiness' of ice cream and help to produce a smooth texture.The major sugar used is sucrose (cane or beet sugar), because of its solubility and its high sweetening power, but other sugars, notably glucose syrups produced from corn flour by hydrolysis of the starch, are used (Goff *et al.,* 1989).

### 2.2.2.4 Stabilizers

The function of stabilizers in ice cream is attributed to their water binding capacity by forming a three dimensional network of hydrated molecules throughout the system. In this way they retard ice crystal formation, growth, improve mix viscosity, air incorporation, body texture and melting properties(Morr, 1989). The first substance used was gelatin, which, on hydration, produces a gel network during a period of about four a hours at 5°C (aging). But now the most widely used commercial stabilizer is carboxymethyl cellulose (CMC), which may have small amounts of vegetable gums (such as guar gum or locust bean gum), or seaweed extract (available as sodium alginate) mixed with it to improve its stabilizing action. The amounts of stabilizer used should follow the manufacturer's recommendations (Clark, 2000).

### 2.2.2.5 Emulsifiers

An emulsifier is a substance which produces an emulsion of two liquids that do not naturally mix. An emulsifying agent is really a surface active agent, which acts by reducing the energy required to maintain the integrity of the fat globules. It will also materially assist in obtaining larger numbers of smaller, more uniform air cells, which in turn, help to produce a smooth ice cream (Robinson, 1981).The traditional emulsifier used in ice cream was egg yolk(the active ingredient being lecithin), but now mono- and di-glycerides and Polysorbate 80 are used in most ice cream formulations(Clark, 2000).

### 2.2.2.6 Flavorings And Coloring's

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. interactions among volatile aroma substances and nonvolatile compounds depend on the physicochemical properties of the compounds and on the binding that may occur among them. Moreover butter fat is one of the chief factors affecting the flavor of ice cream(Danisco, 2010). Foods may acquire their color from any of several sources (Potter, 1978). One major source is the natural plant and animal pigment. A second source of color comes from the action of heat on sugars. Thirdly, dark colors result from certain chemical interactions between sugars and protein referred to as the browning reaction or the Maillard reaction (Potter, 1978). There also are the complex color changes when a wide variety of organic chemicals present in foods come in contact with air(Clark, 2000).

#### 2.2.2.7 Air

The amount of air dispersed in the ice cream influences quality and affects profits. More air lowers the total cost of ingredients, increasing profits. Too much air can decrease the quality. Air affects the smoothness, texture, price and weight Legally no more than 50% of the ice cream can be air and the ice cream weigh more than 4.5 pounds per gallon (Clark, 2000).

### 2.2.3 Processing Steps

The vast majority of frozen desserts are made using the same methods .the process for ice cream will be described here. The general steps in the process

#### 2.2.3.1 Blending

The first step in producing frozen desserts is the production of a pasteurized “mix.” In producing a mix, the liquid and dry ingredients must be brought together in such a way that all ingredients are dispersed completely prior to heat treatment. There are several problems that must be overcome in this process. Each ingredient will have different density. The tendency will be for these ingredients to float or sink depending on their density(Marshall *et al*., 2003). Ingredients that float to the top or sink to the bottom may not be in corporate into the final mix. This will cause in consistency in the final product. Some ingredients are so hydroscopic that they have a tendency to clump. In extreme cases, such as with some hydrocolloids and proteins the material will form insoluble clumps that are difficult or impossible to break up. If this happens, these ingredients may not be able to pass through filters or screens and will not be incorporated into the mix, causing quality and consistency issues (Marshall *et al*., 2003).

#### 2.2.3.2 Pasteurization And Homogenization

The primary purpose of pasteurization is to destroy all pathogenic microorganisms that might be present in the mix Heating results in a reduction of the total numbers of bacteria, thorough mixing of the ingredients, dispersion of stabilizers and in physicochemical effects on the milk solids that are related to whipping ability and to body texture of ice cream(Robinson, 1981). Pasteurization is either the low temperature holding procedure (LTH) at 68.3°C for 30 minutes, the high temperature short time method (HTST) at 79.5C°for 25 seconds or the ultra-high temperature method (UHT) at 138°C or higher**(**Marshall *et al*., 2003). Ice cream mixture most not be kept for more than one a hour at any temperature which exceeds 7.2°C (45°F), before being pasteurized. Sterilization temperature not less than 148.8°C (300°F) for at least 2 seconds(Marshall *et al*., 2003). Homemade ice cream is made from pasteurized products. The mixture does not required pasteurization, although heating in double boiler for 15-20 minutes at a temperature of 63°C (145°F). blends ingredients thoroughly and may be an extra precaution from a health stand point(Marshall *et al*., 2003). The object of the homogenization is to reduce the fat globule size, so that globules do not rise to the surface (Robinson, 1981). The pressure used for homogenization depends upon several factors: desired viscosity, composition of the mix, stability of the mix, temperature used and construction of the homogenizing machine. He also added that a pressure of 2000-2500 Ib/inch$^2$ with single stage homogenizer or 250-300 lb/inch$^2$ on the first stage and 500 lb/inch$^2$ on the second stage homogenizers will usually give good results for an average mix (Danisco, 2010).

#### 2.2.3.3 Aging

The mix is aged for at least four hours and usually overnight. The overnight aging usually gives the best results (Danisco, 2010). Also he added that the protein and the emulsifiers interact and cause the reduction in stabilization of the fat globules. This process improves the whipping quality of the mix, improves the body and the texture of the ice cream. The aging process is performed in insulated and refrigerated storage tanks. The mix temperature is then maintained at as low temperature (5°C) as possible without freezing. There is little change in total count unless additional contaminants are introduced from the vats used for aging. Moreover 16-24 hours at 4.4°C (40°F) has a little effect on the total bacterial count of ice cream mix (Dogan and Kayacier, 2007).

#### 2.2.3.4 Flavoring

In ice cream manufacture there are three points at which the flavor of the product is altered. The first point is during formulation and blending. Chocolate ice cream is added at blending and pasteurized. Any flavor that does not contain particulates could be made this way but due to the heat treatment, flavors are altered chemically and combine with the other components, which leads to the loss of volatiles. Any pathogenic bacteria on the flavoring material will be killed. The second point where flavor (and color) can be altered is just prior to freezing This operation is most often done in a flavor vat. It is important that flavorings and colorings be pasteurized or assured to be free of pathogens. This is especially true of raw agricultural products like strawberry juice. The third place where flavors may be added is just prior to packaging. At this point the flavorings added are most often either large particulate flavors like nuts, fruits and candy or thick syrups like chocolate syrup. Some fruit jams can be added into the products (Drewett and Hartel, 2007).

#### 2.2.3.5 Freezing

Freezing of ice cream mixture is accomplished by circulating cold brine or by allowing ammonia to expand directly around the walls of the cylinder surrounding the mix (Eckies and Macy, 1982). There are two general types of ice cream coolers, namely the “batch” and the “continuous” freezers. The batch freezer is the more commonly used, while the continuous type is adaptable for use in factories producing relatively large volumes of ice cream (Eckies and Macy, 1982). The amount of water frozen as ice in the freezer varies between 30% and 60%, depending on drawing temperature and composition of the mix (Marshall *et al*., 2003). Freezing must be quick to prevent the growth of large ice crystals that would coarsen texture and air cells must be small and evenly distributed to give as table frozen foam (Potter, 1978). The outer container of an ice cream freezer is usually made of a poor conductor of heat, such as wood. The container that holds the ice cream mixture inside the wooden outer container is made of metal, which permits the rapid absorption of heat from the ice cream mixture (Drewett and Hartel, 2007).

### 2.2.3.6 Packaging

The ice cream will normally be packaged, either in bulk, in smaller sized ‛family packs of one liter or less, or in individual’ retail packs . Some ice cream is sold directly from a dispensing freezer as ‛Soft serve’ ice cream, either on cones or in various types made up sweets in cafes and restaurants or from vehicles complete with their own electricity generation equipment (Robinson,1981). The volume of ice cream packaged in the various carton sizes depends upon the type of market outlet and local consumer buying practices. Packaging protects food during storage, transportation and distribution against deterioration, which may be physical or biological(Clark *et al*.,2009).

### 2.2.3.7 Hardening

After packaging, half of the water in the product is not frozen. In this state the product is semisolid and vulnerable to damage. Hardening is the process of continuing freezing without agitation until the temperature is −18 $^{O}$C or preferably lower. This process should be done as quickly as possible to avoid the growth of large ice crystals in the product (Marshall *et al*., 2003). During hardening ice will form on all the ice crystals available. At any point in time, there is a tendency for the larger ice crystals to grow at the expense of the smaller ones. (Everett, 1988).

#### 2.2.3.8 Storage And Shelf Life

The ice cream must stay frozen solid for quality assurance. When the ice cream leaves the factory, it must be stored at a constant, uninterrupted, freezing cycle at low temperatures to avoid problems (Goff, 1998). Problems at retail level can arise from overfilling of the display cabinet, heat from the display lamps or hot air from incorrectly positioned circulation fans or displaying ice cream together with the semi frozen goods (Goff, 1998). The shelf life of any food commodity should combine the two considerations of safety and organoleptic property of the product. Moreover they reported that it is more economical to ship the products of which ice cream is made to a point from which the finished ice cream can be easily distributed (Marshall *et al*., 2003).

### 2.2.4 Defects Of Ice Cream

#### 2.2.4.1 Body And Texture Defects

Body and texture defects include coarse icy texture, which is due to the presence of ice crystals of such a size that is noticeable when the ice cream is eaten (Flores and Goff, 1999). The term body, used in relation to ice cream refers to the consistency or richness of the product. The body defects are commonly described as crumbly, soggy and weak, while the common texture defects are coarse, icy fluffy, sandy and buttery. The crumbly body or a flaky, snowy characteristic in ice cream is caused by low stabilizer or emulsifier, low total solids or coarse air cells (Marshall *et al.,* 2003). To achieve small initial ice crystals, the ice cream mix must be rapidly sub cooled to the point of the maximal nucleation rate (Hartel, 1996). A fluffy texture is a spongy characteristic that is caused by incorporation of large amounts of air as large air cells, low total solids or low stabilizer content. A gummy body defect is opposite of crumbly in that it imparts a pasty or putty like body (Goff, 1998). Ice cream texture is dependent upon the number, size, shape and arrangement of ice crystals and other particles. A sandy texture is due entirely to fairly large lactose crystals which are slow to dissolve. This defect may be controlled by reducing the milk solids not fat content of the mix, acid standardization, replacing part of the cane sugar content with the dextrose and maintaining uniformly low storage temperature (Arbuckle, 1986).

#### 2.2.4.2 Flavor Defects

Flavor defects can be classified in five different ways. This includes the flavoring system, which is that it lacks flavor or the flavor is too high or that the flavor is the unnatural . The dairy ingredient flavor defects include acid, salty, old ingredient, oxidized/metallic, rancid or whey flavor (Smith *et al*., 1999). The most commonly used system in flavor assessment for ice cream is the dairy ingredient flavor defect system claimed off flavors in butterfat can be carried to second products, such as ice cream and affect consumer acceptance. However, milk fat with a high mono unsaturated fatty acid content compared with a high polyunsaturated fatty acid content did not exhibit oxidation problems (Lin *et al*., 1996).

#### 2.2.4.3 Shrinkage Defects

A very trouble defect in ice cream processing is shrinkage . It appears to be that there is no single cause or mixture (Goff, 1998). This defect shows up in hardened ice cream and manifests itself in reduced volumes of ice cream, usually by pulling away from the top and/or sides of the container (Flores and Goff, 1999). They also added that structurally, it is caused by a loss of spherical air bubbles and formation of continuous air channels. Freezing and hardening, both low and high storage temperatures appear to contribute, ultra smooth ice cream as can be produced in continuous freezer, type of container, partial destabilized protein, season of the year as more shrinkage occurs in winter months and methods of handling in grocery store cabinets( Goff ,1998).

### 2.2.4.4 Color Defects

Ice cream should possess a pleasing color, if its color is too high or if it lacks color, too pale nor too intense . Uniform, natural color is desirable ice cream. An uneven color results if the color is not properly added and also it care is not exercised when changing flavor. Excessive color is the result of adding too much artificial color to the mix. An unnatural color describes defects due to insufficient (pale) color, excess (intense) color and colors that are not characteristics (true in shade) of the flavor (Arbuckle, 1986).

### 2.2.5 Major Diseases Transmitted Through Ice Cream:

The same dangers of illness caused by drinking raw milk are inherent in ice cream either made from raw milk and cream or handled under unsanitary conditions. With few exceptions, outbreaks occurred in recent years have been caused by ice cream made not in commercial establishments but rather at homes where a combination of faulty practices occurred such as use of raw milk, cream and eggs, inadequate heat treatment and contamination (Marshall *et al.,* 2003).

# CHAPTER THREE

# MATERIAL AND METHODS

## 3.1 Materials

Fresh cow milk was obtained from the herds of (Faculty of Agriculture University of Khartoum). Soy bean (Sudan1) was obtained from(industrial Research and consultancy center). Butter was supplied by cream (97%) fat. sweeteners was sugar used (kenana sugar). Solid nonfat was supplied by Skimmed milk and milk powder wear obtained from( local market Khartoum north). flavour commercial vanilla was used from (kamena international company) the stabilizers was gum arabic (the gum arabic company).

## 3.2 Methodology

### 3.2.1 Preparation Of Soy Milk

The soy milk was prepared by soy milk maker (G3 soy milk maker, Soya Joy, Dandridge, TN). (Pilot plant for soymilk provided by SPX in Japan to industrial Research and consultancy center in Sudan).

Five kg of soybeans were cleaned, washed and soaked in water for 18 h at room temperature. The soaked beans and distilled water were charged into the grinder/cooker hopper with the ratio of 1:4 (w/v). The grinder motor was started and the steam injected. The temperature in the grinder/cooker was raised 100°C for 5 min to pasteurize these ingredients. Soymilk was removed from the soy milk maker, filtered twice with a 7-inch stainless steel strainer and transferred into a clean container. Then was opened the discharge valve the grinder/cooker slowly so that the slurry flows into the filter bag. The grinder motor was shuttled off, allow all the slurry to be discharged, and close the valve. The screw was countered clockwise to expel all the extracted milk.

### 3.2.2 Preparation Of Ice Cream

The calculated milk amount was added to the dry blend (standard ice cream and their composition is shown in table no 3.1). All the solid ingredients were mixed together and added into milk till it dissolve it was blended rapidly to incorporate air and to avoid the crumply then followed by adding 3drops of liquid vanilla flavor into the mixtures. Then mixed in a high speed mixer for 1 min. The mixtures were heated at 85°C for 15 min. Then the mixes were cooled to room temperature, and stored at 4°C overnight for ageing. The ice creams were packed in 500 mL plastic containers with lids and stored at -18°C for hardening (Marshall *et al.*,2003).

Five variant of ice creams were prepared by incorporating soy milk and cow milk (100%cow milk ice-cream, 100%Soy milk ice-cream, 50% Soy milk 50% cow milk ice-cream,75 Soy milk 25 cow milk ice-cream, 25% Soy milk75% cow milk ice-cream).

**Table 3.1: The Ingredients Of Ice-cream Samples.**

| Ingredient | A | B | C | D | E |
|---|---|---|---|---|---|
| Cow milk (ml) | 750 | 500 | 250 | - | 1000 |
| Soya milk (ml) | 250 | 500 | 750 | 1000 | - |
| Sugar (g) | 200 | 200 | 200 | 200 | 200 |
| Cream (g) | 750 | 750 | 750 | 750 | 750 |
| Skimmed milk (g) | 25 | 25 | 25 | 25 | 25 |
| Powder milk (g) | 25 | 25 | 25 | 25 | 25 |
| Vanilla(drops) | 2-3 | 2-3 | 2-3 | 2-3 | 2-3 |
| Gum Arabic(g) | 3 | 3 | 3 | 3 | 3 |

Sample (A) 25% Soy milk 75% cow milk ice-cream

Sample (B) 50% Soy milk 50% cow milk ice- cream.

Sample (C) 75% Soy milk 25% cow milk ice-cream.

Sample (D) 100% Soy milk ice-cream.

Sample (E) 100% cow milk ice-cream (Control).

### 3.2.3 Chemical Analysis Methods

The chemical tests of samples soybean , soymilk , cow milk , and ice cream samples were carried out in duplicate at the Laboratory of Department of Dairy Production, Faculty of Animal Production, University of Khartoum and they included the following way:

#### 3.2.3.1 Determination Of Protein Content:

The protein content was determined by Kjeldahl method according to AOAC (2005).

In a Kjeldahl flask,10gm sample was placed followed by addition of Kjeldahl tablets (each tablet contained 1gm $Na_2SO_4$ and the equivalent of 0.1mg Hg). Twenty five milliliters of concentrated sulfuric acid (density 1.86gm/ ml at 20°C) were added to the flask and the mixture was then digested on a digestion heater until a clear solution was obtained (3 hours), the flasks were then removed and left to cool. The digested samples were poured in volumetric flasks (100 ml) and diluted to 100 with distilled water. Five milliliters were taken and neutralized using 10 ml of 40% NaOH. The distillate was received in a conical flask containing 25 ml of 2% boric acid and 3 drops of indicator (bromocresol green + methyl red). The distillation was continued until the volume in the flask was 75 ml. The flasks were then removed from the distillator and the distillates were titrated against 0.1N HCl until the end point was obtained (red colour).

Protein content was calculated as follows:

Nitrogen (%) = $(T \times 0.1 \times 20 \times 0.014 \times 100)$/ Weight of sample

Protein (%) = Nitrogen (%) × 6.38

Where: T: Titration figure.

0.1: Normality of HCl. , 0.014: Atomic weight of nitrogen/ 100 20: Dilution factor.

**3.2.3.2 Determination Of Fat Content**:

Soy milk, cow milk and ice cream samples fat content wear determined by Gerber method described by
Bradley *et al*. (1992).

Ten ml of sulfuric acid (density 1.815 gm/ ml at 20ºC) were poured into clean dry Gerber tubes, then , 5 gm sample was added, followed by the addition of 1 ml amyl alcohol and 5 ml distilled water at 20ºC. The contents of the tube were thoroughly mixed till no white particles were seen. The tubes were then centrifuged at 1100 revolutions per minutes (rpm) for 5 minutes. The tubes were transferred to a water bath at 65ºC for 3 minutes, after which the fat content was immediately read.

**3.2.3.2.1 Soy Bean Fat Content**

The crude fat in the product was determined according to the standard method of AOAC (2005).

The methods determines the substance which are soluble in Hexane (40-60°C) and extractable under specific of Soxhlte Extraction method. The dried Hexane extract is weighted as percentage of dry mater as crude fat. Soybean of 5g+1mg was weighted into an extraction thimbles (30-100 mm)and covered with cotton that previously extracted with hexane. Then ,the sample and a pre-dried and weighted Erelenmeyer flask containing about 150 ml hexane (No1622,BDH,England) were attached to the extraction unit (Electrothermal ,England) and the temperature was adjusted to produce about 150 to 200 drops of the condensed solvent per minute for 16 hours .At the end of the distillation period, the flask with was disconnected from the unit and the solvent was redistilled .Later ,the flask with the remaining crude hexane was put in an oven at 105°Cfor 3 hours ,cooled to room temperature in a desiccators ,reweighed and the dried extract was register as crude fat (% DM) according to the following formula:

$$\text{Fat content (\%)} = \frac{(w_1 - w_2)}{W_3} \times 100$$

Where:

$W_1$= weight of flask and ether extract

$W_2$ = weight of empty flask $W_3$= initial weight of sample

### 3.2.3.3 Determination Of Total Solids Content :

Total solids content of soy milk, cow milk and ice cream samples were determined according to the modified method of AOAC (2005).

Two grams of sample was placed in a clean dried flat bottomed aluminum dish. The dishes were heated on a steam bath for 10-15 minutes and then the dishes were transferred to an air oven for 12 hours at 50°C. The dishes were placed into desiccator to cool and then weighed. Heating, cooling and weighting were repeated several times until the difference between two successive weightings was less than 0.5 mg. the total solids content was calculated as follows:

Total solids (%) = $(W_1/W_0)$* 100

Where:

$W_1$: Weight of sample after drying.

$W_0$: Weight of sample before drying

### 3.2.3.4 Moisture Content

The moisture content of soy bean was determined according to standard methods of association of official analytical chemists (AOAC, 2005).

The moisture content is a weighed sample removed by heating the sample in an oven under atmospheric pressure at 105 ±1°C. Then the difference in weight before and after drying is calculated as a percentage from the initial weight. A soy bean of 5g ±1mg was weighed into a pre-dried and tarred dish .Then the sample was placed into an oven (NO.03-822, fn400, turkey) at 105±1°C until a constant weight was obtained .After that the cover sample was transferred to desiccators and cool to room temperature before reweighing. Triplicate results were obtained for each sample and the mean value was reported.

$$Moisture\ content\ \% = \frac{(\mathrm{M2} - \mathrm{M3})}{(M2 - M1)} x100$$

Where:

M1= weight dish+ cover

M2= weight of dish + cover +sample before drying

M3= weight of dish + cover+ sample after drying

The dry matter (DM) percentage was calculated by subtracting the percentage of moisture from 100%.

### 3.2.3.5 Determination Of Ash Content

The ash content was determined according to AOAC (2005). Two grams of sample was weighted into a suitable clean dry crucible and evaporated to dryness on a steam bath. The crucibles were placed in a muffle furnace at 550°C for 1.5-2 hours, cooled in a desiccator and weighted. The ash content was calculated as follows:

Ash% =( $W_1/W_0$)*100

Where:

$W_1$ = Weight of ash.

$W_0$ = Weight of sample.

### 3.2.3.6 Determination Of Lactose Content

Fehling method was used for determination the lactose content according to (AOAC, 2005).

The procedure :

Two grams of sample was dissolved with about 130 ml of distilled water in a beaker(300 ml),and 15ml of 1 N HCL was added, then the mixture was boiled for 2 minutes and the mixture was neutralize with 10% NaOH ,and then it was transferred into a volumetric flask (500 ml) and diluted to the mark and mixed ,the solution was titrated with 10 ml of Fehling's solution till the blue colour was disappeared.

Lactose% =( factor of lactose /titration ml )*100

lactose factor = 64.9

### 3.2.4 Physical Analysis

#### 3.2.4.1 Determination Of PH Value

The pH value of samples was determined with a pH meter (S20 Seven Easy TM pH, Metter Toledo, Columbus, OH) accordance with (AOAC, 2005).

Soymilk and cow milk samples were placed in room temperature . Soy ice cream mixes were stored in -4°C overnight, and measured at room temperature.

#### 3.2.4.2 Viscosity Value

The measurement of ice cream samples which filled in 180 ml containers (6 cm diameter × 9 cm height), were taken after a period of aging (for 8 hour at temperature of 4 °C) with spindle number 4 , at 42 rpm , at temperature of 14±1ºC and at the time of 45 seconds in three replications with a Brookfield viscometer and viscosity was reported based on Cent i- Poise (cp) (model DV-II+Pro, USA) (Akesowan, 2009).

#### 3.2.4.3 Overrun

The overrun value was determined according to the method described by (Whelan *et al*., 2008).

An overrun measurement was taken per sample by comparing the weight of ice cream mix and ice cream in a 100 mL beaker. Overrun (%) was calculated as follows:

Overrun (%) = (weight of mix – weight of ice cream) / weight of ice cream .

#### 3.2.4.4 Meltdown

A sample of ice cream was cut from the quarter gallon container, and weighed 120 g. The sample of ice cream (initially at -18°C) was placed on a wire screen (around 8 holes per cm) on top of a funnel that was attached to a 50 mL beaker. The ice cream was placed in a room temperature environment at 25°C. Every 5 min, for up to 90 min, the dripped weight was recorded was recorded (Muse and Hartel, 2004).

## 3.3 Sensory Evaluation

Sensory evaluation was done as described according to Clarke (2004). Using the hedonic scoring test method. In this method 25 trained panelist from the industrial Research and consultancy center. Panelists were asked to evaluate the products with regard of their Taste, colour ,flavor, texture and overall acceptability color, using the following hedonic scale:
5= excellent, 4= very good, 3= good, 2= acceptable, 1= unacceptable.

## 3.4 Statistical Analysis

The data was analyzed by Analysis of Variance (ANOVA) to determine significant parameters factors for the physical and chemical properties and sensory evaluation (color, texture, flavor, taste and overall acceptability) Statistical analyses were performed using the Statistical Analysis System SPSS (10.5). General Linear. Means were separated using Multiple comparisons applying LSD Test ($P \leq 0.05$).

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.1 Nutritional Value Of Soybean, Soymilk And Cow Milk

Table (4-1) shows the nutritional value of soybean, soy milk and cow milk. The major difference between soymilk and cow milk is that one is derived from a plant and the other from an animal.

The moisture contents results of cow milk, soy milk and soy seeds were 88.1, 84.79 and 14.2% respectively. They was significant difference (P>0.05). Soy milk is a water extract from whole soy beans. So that moisture contents of soy milk higher than soy seed (Bisla *et al*, 2012).

The results reveals that the protein content of soy milk was found 3.92g/100g which was higher than the cow milk which contains 3.46g/100g protein content. There was no significant difference in protein content of soy milk in comparison to cow milk. Since soybean seeds contain 35.2% protein higher than the soy milk due to extraction ratio of seeds to water. These results of this study are in agreement with that reported by Pourahmad and Ahanian (2015).

Fat content the results show that fat content of soymilk was 2.95g/100g which was higher than the cow milk that contain 2.6g/100g fat. Since soybean seed contain 15.7% oil and its protein and oil content are not only high in quantity but also rated as best in quality (O'kennedy *et al*., 1979).

Ash content results of soymilk and soybean were 0.88g/100g and 04.2g/100g, respectively found to be higher in comparison to cow milk which contains 0.73g/100g ash. This is because soybean is a good source of iron, potassium, calcium, magnesium and phosphorus with water soluble and B complex vitamins (Gupta, 1982).

The result reported that total solids found in soy milk is 14.21g/100g which higher in comparison to cow milk that contain 11.9 g/100g. The studies indicated that the total solids in milk increased significantly when the extraction ratio of seeds to water was increased( Razavi *et al*.,2001).

This study showed that lactose in cow milk was (4.37%) , soy milk doesn't contain any lactose. Soy milk contain soluble and non-soluble sugars (including dietary fiber). Also the sugars in soy milk, are mainly types of raffinose, stachyose and insoluble sugars (Fenselav and Schrezemeir, 2000).

**Table 4.1: Chemical Composition Of Cow Milk , Soy Milk And Raw Soybean**

| Composition | cow milk | Soymilk | Raw soybean |
|---|---|---|---|
| Moisture | $88.1^{a}$ | $85.79^{b}$ | $14.2^{c}$ |
| Protein % | $3.46^{ab}$ | $3.92^{a}$ | $35.2^{c}$ |
| Fat % | $2.6^{b}$ | $2.95^{a}$ | $15.7^{c}$ |
| Ash % | $0.73^{ab}$ | $0.88^{a}$ | $4.2^{c}$ |
| Total solids % | $11.9^{b}$ | $14.21^{a}$ | ND |
| Lactose | $4.37^{a}$ | ND | ND |

Means with the different superscript letters in the same row are significantly different ($p \leq 0.05$).

## 4.2 Chemical Composition Of Soy Ice Cream Samples

Table( 4-2) shows the chemical properties of soy ice cream samples.

Total solids contents of soy ice cream were ranged from (43.58-45.28%) as adding soy milk increased the total solids contents significantly ($P<0.05$) due to total solids soy milk higher than total solids cow milk. The sample (D) had the highest content of total solids while the lowest content of total solids was recorded in the sample (E). These results are in agreement of those reported by Razavi *et al*.(2001) and Pourahmad and Ahanian (2015).

The protein content was ranged from (4.87- 6.46)% of soy ice cream samples. The protein content of sample (E) (3.90%) was lower than samples (A),(B),(C) and (D) were (4.87 ,5.03 , 5.47, 6.46) % respectively. Adding soy milk increased the protein contents significantly ($P<0.05$). High protein content in sample (D) is due to high protein content found in soy milk. These results of this study as similarly reported by (Bisla *et al.*, 2012).

The fat content of sample (E) was (3.64%) and samples (A),(B),(C) and (D) were (3.75, 3.87, 3.94, 4.87)% respectively, sample ( D) higher than all samples. The fat content in soy ice cream increased significantly ($P<0.05$) with increasing amounts of soy milk. These results are in agreement with Razavi et al.(2001) and Pourahmad and Ahanian (2015).

The lactose content of samples (A),(B),(C) and (E) were (4.18, 3.04, 2.18 and 4.3)% respectively, sample (D) is not contain lactose. The increasing of soy milk level may had no effect on the lactose content duo to soy milk is not contain lactose. These results are in agreement with Pourahmad and Ahanian (2015).

Ash content of ice cream samples (A),(B) and (C) were (1.17, 1.23 , 1.28)%., respectively. The highest ash content was recorded in

Sample(D) was (1.34%). While the lowest of ash content was found in Sample (E) was (1.12%). The ash content increased in treatments containing high amounts of soy milk. These results are in agreement with Abdullh et al. (2003).

**Table 4.2: Chemical Composition Of Ice Cream Samples.**

| Parameters | A | B | C | D | E |
|---|---|---|---|---|---|
| Total solids% | $45.28^{b}$ | $46.41^{b}$ | $46.47^{b}$ | $46.6^{a}$ | $43.58^{c}$ |
| Protein% | $4.87^{b}$ | $5.03^{a}$ | $5.47^{a}$ | $6.46^{a}$ | $3.90^{c}$ |
| Fat% | $3.75^{d}$ | $3.87^{c}$ | $3.94^{b}$ | $4.87^{a}$ | $3.64^{d}$ |
| Lactose% | $4.18^{b}$ | $3.04^{a}$ | $2.18^{b}$ | ND | $4.3^{a}$ |
| Ash% | $1.17^{c}$ | $1.23^{bc}$ | $1.28^{b}$ | $1.34^{a}$ | $1.12^{a}$ |

Sample (A) 25% Soy milk 75% cow milk ice-cream

Sample (B) 50% Soy milk 50% cow milk ice- cream.

Sample (C) 75% Soy milk 25% cow milk ice-cream.

Sample (D) 100% Soy milk ice-cream.

Sample (E) 100% cow milk ice-cream (control)

Means with the same letter in the same row are not significantly different ($p>0.05$).

## 4.3 Physical Properties Of Soy Ice Cream Samples

Table (4-3) shows the Physical properties of ice cream samples. The viscosity of the ice cream samples was determined and Results indicated that sample (D) had the highest viscosity(5953.1mcp). While sample (E) had the lowest viscosity (4257.13mcp). The viscosity of soy ice cream containing soy milk increased due to higher content of soy protein and capacity of soy protein for interaction and binding with water. (Onuorah *et al.*, 2007) shown that soy proteins have higher water holding capacity this ability is one of the most important functional properties of soy based ingredients.

The overrun of ice cream samples (A),(B),(C) and (E) were (70.01, 70.13, 70.32, 69.73)mcp respectively, sample (D) was (70.45). The obtained results that mixtures of soy milk at different levels with cow milk had a significant effect (P<0.05) on ice cream samples. Increasing ratios of soy milk , the overrun content increased in soy ice cream than the sample (E) 100 cow milk. Abdullah *et al*.(2003) showed that with increasing total solid, overrun increased. Also, the overrun increased when soy protein content increased which increase the viscosity of soy ice cream. that soy proteins have higher water holding capacity this ability is one of the most important functional properties of soy milk to overrun values increased These results are similar to obtained results by (Gracas *et al*., 2011).

Melt down show the resistance of the ice cream samples to melt under outer conditions. this property of the ice cream will define the quality which has a relation with incorporated air in the ice cream. the highest melt down value was recorded in sample (E) was (15.17%). While the lowest melt down value was observed in sample (D) was (13.56%). The results indicated that increasing levels of soy milk decreased the melt down value of prepared ice cream. These results are similar to results obtained by Gracas *et al*.(2011).

The pH value was samples(A),(B) and (c) ice cream were (4.41, 4.47, 4.57) respectively. The lowest pH value was (4.38) from sample (D) and the highest pH value was (4.87) from sample (E) however, no significant differences ($P<0.05$) on pH of ice cream samples. As increasing ratios of soy milk pH increases. These study shown that with substituting cow milk with soy milk extract, pH of ice cream mixture increases. These results are similar to results published by Gracas *et al*.(2011).

**Table 4.3: Physical Properties Of Ice Cream Samples**

| Properties | A | B | C | D | E |
|---|---|---|---|---|---|
| Viscosity (cp) | 4965.16[d] | 5243.12[c] | 5642.32[b] | 5953.1[a] | 4257.13e |
| Overrun% | 70.01[c] | 70.13[b] | 70.32[a] | 70.45[ab] | 69.73[c] |
| Meltdown% | 14.93[ab] | 14.54[b] | 14.07[c] | 13.65[d] | 15.17[a] |
| PH | 4.41[a] | 4.47[a] | 4.57[a] | 4.87[b] | 4.38[a] |

Sample (A) 25% Soy milk 75% cow milk ice-cream.

Sample (B) 50% Soy milk 50% cow milk ice- cream.

Sample (C) 75% Soy milk 25% cow milk ice-cream.

Sample (D) 100% Soy milk ice-cream.

Sample (E) 100% cow milk ice-cream stander**.**

Means with the same letter in the same raw are not significantly different ($p>0.05$).

## 4.3: Sensory Analysis Of Ice-cream

Table (4-4) shows the effect of incorporating different levels of soy milk on sensory characteristics of ice cream. Results showed that different ratios of soy milk with cow milk have a significant effect ($P<0.05$) on colour taste, Flavor, texture, and overall acceptability of the treatments. There is no significant deference among samples (A) ,(B) and (E) in taste, odor, texture, color and overall acceptability. Substituting more than 50% of soy milk exhibited a significant difference in organoleptic properties between samples (C) and (D), soy milk with the highest amount of cow milk improves taste and flavour of ice cream because increasing cow milk reduces astringent taste of soy milk. Also, the sample (B) 25:75% of soy milk and cow milk creates the highest consistency in soy ice cream, this indicates that soy milk and cow milk together have a synergistic effect and cause created more tightly and stronger texture, soy milk has beany flavour with increasing levels of soy milk the score of taste decreased. Ahanian *et al*.(2014) found that volatile and non-volatile components of soybean have considerable effect, the volatile components are responsible for the gassy and beany flavors while the non-volatile compounds originate astringent flavour and bitter flavor. Addition of soy milk increased desirability and decreasing color score, also increase amine compounds, which react with aldehydes via Maillard reaction to form dark pigments (melanoidins), for this reasons treatments containing high percentage of soy milk are darker than others as presented previously.

**Table 4.4 : Sensory Characteristics Of Soy Ice Cream Samples**

| Parameters | A | B | C | D | E |
|---|---|---|---|---|---|
| Colour | 4.29[a] | 4.29[a] | 3.22[b] | 2.17[c] | 4.34[a] |
| Taste | 4.49[a] | 4.49[a] | 3.20[c] | 3.67[b] | 4.54[a] |
| Flavor | 4.58[a] | 4.51[b] | 3.40[b] | 2.10[c] | 4.61[a] |
| Texture | 3.23[b] | 4.48[a] | 4.47[a] | 4.54[a] | 2.31[c] |
| Overall acceptability | 4.49[a] | 4.46[a] | 3.31[b] | 2.26[c] | 4.50[a] |

Sample (A) 25% Soy milk 75% cow milk ice-cream

Sample (B) 50% Soy milk 50% cow milk ice- cream.

Sample (C) 75% Soy milk 25% cow milk ice-cream.

Sample (D) 100% Soy milk ice-cream.

Sample (E) 100% cow milk ice-cream stander

[a, b, c, d]: Means with the same letter in the same raw are not significantly different ($p>0.05$).

The using scale was: 5= excellent, 4= very good, 3= good, 2= acceptable, 1= unacceptable.

# CHAPTEER FIVE

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Conclusions

Soymilk was successfully used to prepare ice cream . The results indicated that increasing levels of soy milk in ice cream samples increased the nutritional value of soy milk ice cream. Moreover soymilk has significantly ($P<0.05$) affected the total solids, fat, protein, ash, pH, overrun, viscosity and melt down values of ice cream. The results showed that, different levels from soy milk had significant ($P<0.05$) effects on taste, flavour, texture, color and overall acceptability of samples. Finally the treatment contains 25% soy milk and 75% cow milk was selected as the most desirable treatment in terms of sensory evaluations.

## 5.2 Recommendations

1- Addition of soy milk for production of Ice cream made it more nutritious and with high health benefits . But more studies are needed to reduce and remove the beany flavor and the dark color that related to soy milk .

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