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Production of Cream Cheese from Sesame Milk and Cow Dried Skimmed Milk

إنتاج جبن الكريمي من لبن السمسم و لبن الأبقار منزوع الدسم

A dissertation submitted to Sudan University of Science and Technology in partial Fulfillment for the Degree of B.Sc. in Food Science and Technology

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Dedication

To our Families.

To our Teachers.

To our Friends.

Acknowledgement

Special praise and thanks to Almighty ALLAH who has led us in our educational career, and for innumerable bounties.

We would like to express our gratitude and deep appreciation and recognition to our supervisor **Prof. Dr. Yousif Mohamed Ahmed Idris** who has provided continuous support, guidance and criticism.

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Abstract

This study was carried out to investigate the possibility of producing cream cheese from sesame milk and cow dried skimmed milk, and the evaluation of chemical, microbiological and sensory properties of the produced cheese. Cream cheese was produced with percentage of 0 – 40 – 50 – 60 – 100% sesame milk. Starter culture was added at rate of 1%, $CaCl_2$ was added at rate of 0.25g/L and rennet was added at rate of 0.05g/L and stored at 4ºC. Chemical and microbial (moisture, crude protein, fat, ash, pH, acidity, lactose, total bacterial count and coliform bacteria) analysis and sensory evaluation of cheese was carried out.

Results of chemical analysis of cream cheese showed that increased addition of sesame milk increased moisture, pH, fat and protein content of cream cheese. It caused decrease in lactose, ash and acidity of cream cheese. Total bacterial count increased with the increase of sesame milk, and there was no presence for coliform bacteria.

Sesame milk can be used in producing cream cheese with good quality characteristics.

ملخص الدراسة

أجريت هذه الدراسة لمعرفة إمكانية إنتاج جبنة قابلة للدهن من لبن السمسم ولبن الأبقار منزوع الدسم، ودراسة الخواص الكيميائية، الميكروبيولوجية والحسية للجبنة المنتجة. تم إنتاج الجبنة القابلة للدهن بنسب 0 – 40 – 50 – 60 – 100% لبن سمسم. تمت إضافة البادئ بمعدل 1% ، $CaCl_2$ بمعدل 0.25 جم/لتر وإنزيم الرنين بمعدل 0.05 جم/لتر وتم التخزين في درجة حرارة 4ºC. ثم تم إجراء التحاليل الكيميائية والمايكروبية (الرطوبة، البروتين، الدهن، الرماد، الأس الهيدروجيني ، الحموضة، اللاكتوز، العدد الكلي للباكتريا والباكتريا القولونية) و الحسية للجبنة المنتجة.

أظهرت نتائج التحليل الكيميائي أن الزيادة في إضافة لبن السمسم زادت الرطوبة، الأس الهيدروجيني، الدهن والبروتين للجبنة القابلة للدهن. كذلك سببت انخفاضاً في اللاكتوز، الرماد والحموضة للجبنة القابلة للدهن. زاد العدد الكلي للباكتريا بزيادة لبن السمسم و لم يكن هناك وجود للباكتريا القولونية.

نستنتج انه يمكن استخدام لبن السمسم لإنتاج جبن قابل للدهن بصفات جودة جيدة.

CHAPTER ONE

INTRODUCTION

Sesame (*Sesamum indicum L.*), member of the family Pedaliaceae, is one of the most ancient oilseeds crop known to mankind. According to recent archeological findings, sesame cultivation was derived from wild populations native to South Asia, and its cultivation was established in South Asia from the time of the Harappan civilization and spread west to Mesopotamia before 2000 B.C. Despite other claims, it was first cultivated in Africa and later taken to India at a very early date (Islam *et. al*., 2016).

Sesame plays an important role in human nutrition. Most of it uses is for oil extraction, addition of nutty flavor and as garnish foods. The remain cake after extraction is used for livestock feed. (Akintunde *et. al.*, 2012).

In the recent years much attention has been directed toward increasing uses of sesame seeds due to their high nutritional value, they contain natural antioxidants (Sesamol and Sesaminol) which formed during refining process these substances have cholesterol-lowering effect in humans, prevent high blood pressure and increase vitamin E supplies in animals. (Anilakumar *et. al*., 2010)

The production of sesame-based dairy products can overcome the problems that limit consumption of legumes-based dairy products and other vegetables milk. (Elkier *et. al*., 2008).

Cheese is one of the most ancient dairy products known to mankind, it was first made in northern Europe in the sixth millennium BC. This was known after archeologists analyzed residues in ceramic sieves found in modern-day Poland (Tunick, 2014).

Cream cheese is one type of fresh cheese which is soft, mild, creamy white and slightly acidic tasting product with a di acetyl flavor (Cruz, 2013). It is

used as a spread on sandwiches, as a salad dressing, and as an ingredient for making cheesecake. (Phadungath, 2005)

So in order to benefit of all these properties of sesame and due to our huge production of it without any real use the idea of using sesame milk in production of cream cheese have come to light.

The aim of this research is to produce cream cheese by using sesame milk and cow dried skimmed milk that of similar quality to cream cheese produced by using cow milk only.

Objectives

1. To produce cream cheese from sesame milk and dried skimmed milk.
2. To determine physiochemical characteristics of cream cheese.
3. To evaluate sensory properties of cream cheese.

CHAPTER TWO

LITERATURE REVIEW

2.1. Milk

Milk is an emulsion or colloid of butterfat globules within a water-based fluid. Each fat globule is surrounded by a membrane consisting of phospholipids and proteins; these emulsifiers keep the individual globules from graining and also protect the globules from activity of fat-digesting enzymes found in the fluid portion of the milk (Blume, 2013).

2.1.1. Composition of milk

Milk considered of high nutritional value due to the balance of the nutrients that compose it. The composition varies among animal species and breeds within the same species, and also from one dairy to the other, depending on the period of lactation and diet.

Milk contains different groups of nutrients. The present Organic substances are divided into: elements builders, proteins, energy components, carbohydrates and lipids. It also contains functional elements, such as traces of vitamins, enzymes and dissolved gases (mainly carbon dioxide, nitrogen and oxygen), dissolved salts, especially in the form of phosphates, nitrates and chlorides of calcium, magnesium, potassium and sodium (Mourad *et. al.*, 2014).

Milk is composed of 87.4% water, 3.8% fat, 3.35% crud protein, 2.78% casein, 4.75% lactose and 0.7% ash. The composition of milk varies according to: lactation period, nutritional factors, and different species (Ismail, 2012).

2.1.2. Milk constituents

2.1.2.1. Water

Water is the major component of milk and it used as a solvent for other ingredients. it can be found freely in the product as moisture or as a bond water in dairy products (Spreer, 2005).

The amount of water in milk is depending on the amount of lactose synthesized by the secretory cells of the mammary gland (Mourad *et. al.*, 2014).

2.1.2.2. Milk fat

In milk, fat is the main source of energy, it provides about 9 kcal/g as dietary lipids. it also provides essential vitamins to the body: vitamins A and D.

Milk fat is usually found in form of fat globules surrounded by membrane consisting of complex lipids such as: phospholipids. Each fat globule is composed almost of triacylglycerol's, also di- and mono-acylglycerol's, free cholesterol and cholesterol esters, free fatty acids and phospholipids are present in small amounts (Ismail, 2012).

Triglycerides represent more than 95% of total lipids in milk. Phospholipids comprise 30 - 40 mg/100 ml of cow milk which contains 8 - 10 mg of lipid, cholesterol is from 10 - 20 mg per 100 ml, most of which is in the free form. Homogenization of milk will cause increase in the fat globules numbers due to decrease of the fat globule dimeter which help to prevent fat from rising and promotes digestion.

Milk fat consist of two major groups: simple lipids and complex lipids. Simple lipids composed of triglycerides, sterides and cerebrosides. Where triglycerides represent most of it. While complex lipids are complex with phosphorus and/or nitrogen. Phospholipids works as emulsion stabilizers due to their hydrophilic and lipophilic characteristics which allow them to form bridges between fatty and aqueous phases. There are three main phospholipids: lecithin, Cephalin and Sphingomyelin (Mourad *et. al*., 2014).

The protein membrane act as emulsifier which prevent fat globules from agglomeration and protect the content of the globules from various enzymes present in fluid portion of the milk. The composition of milk fat varies due to: lactation, nutritional factors, and different species (Ismail, 2012).

2.1.2.3. Protein

Proteins are the building blocks of our bodies. Proteins of milk considered of high quality because it contains all the essential amino acids, and it also play a major role in determining the market value of the milk, the more protein content of the milk the higher price it will be sale for, also protein content affects the yield of cheese making in the same manners (Mourad *et. al*., 2014).

Apart from the high-quality and biological value, milk proteins and several bioactive peptides resulting from their enzymatic hydrolysis have shown multiple biological roles that could exert a protective action in human health. These main biological actions include antibacterial, antiviral, antifungal, antioxidant, antihypertensive, antimicrobial, antithrombotic, opioid, and immunomodulatory roles, in addition to improving absorption of other nutrients (Pereira *et. al*., 2014).

Milk is composed of various proteins divided into two main groups: caseins and whey protein (Ismail, 2012).

2.1.2.3.1. Caseins

There are four different types of casein proteins: alpha-1, alpha-2, beta, and kappa casein.

Casein is formed of several similar proteins which form a multi-molecular, granular structure called casein micelle. Casein micelle contain water, salt (mainly calcium and phosphorous) and some enzymes. Casein alone isn’t very soluble in water however Casein micelle is maintained as a colloidal suspension in milk. If this structure is disturbed the casein may separate from the solution forming the gelatinous material of the crud.

The micelle structure of casein plays an important role in milk digestion in the stomach and present the base for many milk products (Ismail, 2012).

k-casein is considered the most important type of caseins because it plays an important role in the stability of the micelle and its role in dairy processing. Caseins form a stable casein micelle in the presence of calcium phosphate. This balance can be adjusted in terms of temperature, pH and the addition of salts. Or by using an enzyme such as Chymosine (Mourad *et. al*., 2014).

2.1.2.3.2. Whey protein

The major whey proteins (represent about 80% of whey proteins) in milk are: beta-lactoglobulin and alpha-lactalbumin. Those proteins are more soluble in water than caseins and don't form larger structure (Ismail, 2012).

The 20% of whey proteins are non-protein fraction composed of proteose, peptone and nitrogen compounds (Mourad *et. al*., 2014).

2.1.2.4. Carbohydrates

Milk contains different carbohydrates include: glucose, galactose, lactose and other oligosaccharides.

Lactose is disaccharide composed of glucose and galactose, it is the main carbohydrate in milk and gives milk it's sweet taste. The lactose content of cow milk is 4.75% (Ismail, 2012).

Lactose plays an important role in milk products in which lactic acid is produced due to conversion of lactose by lactic acid bacteria. Those products include: yoghurt, cheese and fermented milk (Mourad *et. al*., 2014).

2.1.2.5. Vitamins and minerals

Milk contain all essential vitamins in various amounts, the vitamin content of raw milk is mainly affected by the feeding and health of the animal.

Milk contains the fat-soluble vitamins: E and K. as well as the water soluble vitamins: B1, B12, H, Pantothenic acid, Folic acid and Nicotinic acid amide (Spreer, 2005).

Vitamin A has an important role in growth, development, immunity, and eye health. Its content in milk depends mainly on fat amount, but also on factors like animal feed and season. Milk contains about 172 mg/100 g of vitamin A. we find that skimmed milk or free-fat milk have a low content of vitamin A therefore in some countries they fortified them with it.

Milk also rich in its content of vitamin B complex, it provides about 10 - 15% of the recommended daily intake for most people (Pereira *et. al.*, 2014).

Minerals of milk include: Calcium, phosphate, magnesium, sodium, potassium, citrate and chlorine. The major components of milk minerals are: calcium and phosphate and they are mainly associated with casein micelle structure (Ismail, 2012).

Milk considered a source of calcium in its mineral fraction. It contains about 1200 mg/L of calcium distributed between the micellar and aqueous phases. These phases are present in total balance but when this balance is broken due to change of PH or temperature this will lead to the passage of calcium molecules from one phase to another.

Milk also considered a source of phosphorus in it organic and non-organic forms. Organic phosphate is bound to organic molecules like proteins, phospholipids, organic acids, and nucleotides, which are present mainly in the micellar phase; whereas the inorganic form corresponds to the ionized phosphate, which depends on the pH value and is located in the aqueous phase. The average concentration of phosphorus in milk is about 950 mg/L (Pereira *et. al.*, 2014).

2.1.2.6. Milk salts

Salts exist in milk as component of acidic anions and metallic cations. Milk salts contain all milk substance which present in form of ions or can be ionized except hydrogen and hydroxide ions. (Spreer, 2005)

2.1.2.7. Milk enzymes

Enzymes are complex components consisting of protein and functional group. They originated partially in blood and transferred via milk forming cells as natural enzymes. The reaction of the enzymes is very specific and it can be affected by: temperature and the pH value.

The most important milk enzymes are: Peroxidase, Catalase, Phosphatase, Alkaline phosphatase, Acidic phosphatase, Xanthinoxidase, Lipase, Protease, Proteinase, Carbohydrase, Amylase, Diastase and Lactase. (Spreer, 2005)

Each enzyme has its isoelectric point and is susceptible to various denaturing agents such as pH change, temperature, ionic strength, organic solvent (Pereira *et. al.,* 2014).

2.2. Sesame

Sesame (*Sesamum indicum L.*) belong to family Pedaliaceae, is considered one of the early known oilseeds crop to mankind. It is grown worldwide in the zone extending from 35^{o} N to 25^{o} S latitude. The most producing countries of sesame seeds are: India, Sudan, China and Burma. Sudan ranks third in terms of world production and first in terms of world export. The most common varieties grown in Sudan are white and brown seeds (El-Khier *et. al*., 2008).

2.2.1. Plant habitat and characteristics

Sesame, is a yearly shrub with white bell-shaped flowers with a hint of blue, red or yellow with or without branches. It has various of colors, creamy-white to charcoal-black. Sesame is found in tropical, subtropical, and southern temperate areas of the world, particularly in India, China, South America and Africa. The plant grows best in tropical climates, sandy, well-drained soil with hot climate and moderate rainfall. It is spawn by seed disperse in spring and takes about four months for the seeds to ripen fully (Anilakumar *et. al*., 2010).

The stem can grow to (1.5 – 2) meter-tall differs according to the different varieties and growth conditions. Its differs in size, shape, growth habit, color of flowers, seed size, color and composition.

When the plant is mature (usually it takes about 80 to 180 days) the seeds are collected by hanging the stem upside down so that the seeds fall down on the mats (Berhe *et. al*., 2012).

2.2.2. Production of sesame seeds

The average global yield of sesame seeds in 2010 was 3.84 million metric tons grown on an area of 7.8 million hectares. And the largest producer in 2013 was Burma. The world's largest exporter of sesame seeds was India, while Japan was the largest importer.

The major sesame-producing countries in 2007 were India, China, Burma, Sudan, Ethiopia, Uganda, and Nigeria, while in 2001 the largest producers of sesame were China and India followed by Burma (4.2 million tons) and Sudan (3 million tons) (Islam *et. al*., 2016).

Small portion of global sesame harvest enters international trade, while the most parts is expressed locally for oil extraction and used for cooking or the seeds themselves are eaten after been fried.

Sesame is a smallholder crop and much of the harvest is consumed locally, without record of the internal trade and domestic processing (Akintunde *et. al*., 2012).

There is some prediction on the decrease of sesame seeds production in the future because the land used worldwide for sesame production has generally remained constant over the years, and in some countries the crop has become marginalized due to higher remuneration from other crops and labor shortages pushing sesame to less fertile areas (Islam *et. al.*, 2016).

2.2.3. Nutritional profile of sesame seeds

Sesame oil is highly stable and rarely turns rancid in hot climates. It is rich in unsaturated fatty acids where the fatty acids composition is 14% saturated, 39% mono-unsaturated, and 46% poly-unsaturated fatty acids. Carbohydrates in sesame seed are composed of 3.2% glucose, 2.6% fructose and 0.2% sucrose while the remaining quantity is dietary fibers. Also, they have desirable physiological effects including antioxidant activity, blood pressure and serum lipid lowering potential as proven in experimental animals and humans.

The major protein fraction (globulin) in sesame contains about 95% of 13S globulin and seems to be a simple, salt soluble, very susceptible to heat denaturation and similar in subunit structure to soybean 11S globulin with more hydrophobic properties. Sesame is rich in sulfur containing amino acids and limited in lysine and contains significant amounts of oxalic (2.5%) and phytic (5%) acids (Anilakumar *et. al*., 2010).

Sesame oil has a yellow color and it used in salad, margarine and similar food products. The oil content of the seeds differs according to the different varieties and range between 40 - 60%, and it provides the body with energy about 884 kcal.

Sesame seeds rich in calcium oxalate and fatty acids. The oil is high in Vitamin A, Vitamin B, Vitamin E, calcium, magnesium and phosphorous; but, low in total free fatty acid content. Both of these substances and have been shown to possess cholesterol-lowering effect in humans and to prevent high blood pressure and increase vitamin E supplies in animals (Berhe *et. al*., 2012).

2.2.4. Chemical composition of corticated and decorticated sesame seeds

Sesame seeds contain about 42-54 % oil, 22-25 % protein, 20-25 % carbohydrates and 4-6% ash. The hull contains large quantities of oxalic acid, crude fiber, calcium and other minerals. (Akintunde *et. al*., 2012)

Decorticated sesame seeds contain about 45-63% oil, 19-31% (averaging about 25%) proteins, about 14% carbohydrates and about 3% ash. (Anilakumar *et. al*., 2010)

2.2.6. Sesame milk

Recently, much attention has been directed toward increasing use of oilseeds in general and sesame seed in special basic on their functional properties. Decorticated sesame seed supply us with nutritious functional and healthy meals with low cost. (Abd-allwahab *et al*., 2017)

The production of sesame-based dairy products can overcome the problems that limit consumption of legumes based dairy products and other vegetable milk such as presence of anti-nutritional factors, Beany flavor, low solids yield, Low dispersion stability and flatulence factors. (Quasem *et. al*., 2009)

2.2.6.1. Preparation of sesame milk

Decorticated sesame seed and tap water were weighed to give the desired sesame seed percentage. Sesame seed was transferred to the blender vessel and a small portion of the weighed water was added to facilitate the progress of mixing/grinding process. The blender was operated at highest speed for 10 min. After finishing the grinding process, the remaining quantity of water was added and mixed thoroughly. The resulted sesame dispersion was homogenized (in portions of 300 g) for 5 min using lab homogenizer. The temperature reached due to homogenization was 52 ±2°C. The homogenized sesame milk base was squeezed through cheesecloth to separate coarse particles. The resulted milky solution was weighed, readjusted to its original weight (before filtration) by adding tap water, mixed thoroughly, filled in a beaker and heated in boiling water bath with manual stirring. The heat-treated milk was filled in 50 mL pre-sterilized glass tubes (50 mL of sesame milk per tube), cooled (by immersing the tubes in ice bath for 5 min) and then stored refrigerated (at 4°C). (Abd-allwahab *et. al*., 2017)

2.3. Cheese

Cheese is one of the most ancient dairy products known to mankind, it is ripened or un ripened, soft or semi-soft, hard or very hard product.

The quality of produced cheese is depending on the composition, quality and activity of the leaven of the milk used in cheese production. (Tunick, 2014)

2.3.1. Basic steps of cheese manufacture

Generally, production of all verities of cheese has a similar protocol involve of different steps, those steps are:

1. Selection, standardization and pasteurization of the milk.
2. Acidification.
3. Coagulation of the milk by acidification.
4. Dehydration of the coagulum.
5. Forming the curds into characteristic shapes.
6. Salting.
7. Ripening. (Guinee *et. al*., 2017)

2.3.1.1. Selection and standardization

The composition of cheese is directly affected by the composition of the milk used in production, the constituent of milk is influenced by several factors including species, breed, individuality, nutritional status, health and stage of lactation of the producing animal. Due to the major compositional abnormalities cow's milk from the beginning and ending of lactation period should be excluded. The milk should be free of chemical taints and free fatty acids, which cause off-flavors in the cheese, and antibiotics which inhibit bacterial cultures. The milk should be of good microbiological quality, as contaminating bacteria will be concentrated in the cheese curd and may cause defects or public health problems. (Guinee *et. al*., 2017)

Milk must immediately cool after collection, the raw milk then transferred to an insulate tanker truck and delivered to the cheese plant unpasteurized, then

the fat and protein level maybe adjusted to gain the highest level of yield (Tunick, 2014), the level of fat plus protein, is determined mainly by the manufacturing protocol, the fat-protein ratio is determined mainly by the fat-casein ratio in the cheese milk.

Depending on the ratio required, it can be modified by:

removing some fat by natural creaming, or centrifugation, addition of skim milk, cream, micellar casein (prepared by ultrafiltration), or milk powder. Such additions also increase the total solids content of the milk and hence cheese yield. (Guinee *et. al.*, 2017)

2.3.1.2. Pasteurization of milk

The pasteurization of cheese milk became widespread about 1940, primarily for public health reasons, but also to provide a milk supply of more uniform bacteriological quality and to improve its keeping quality. Although a considerable amount of cheese is still produced from raw milk, on both an artisanal and factory scale, especially in southern Europe. The flavor of cheese made from raw milk is different from and more intense than that from pasteurized because beneficial indigenous LAB, which may contribute positively to cheese flavor, are killed by pasteurization, to counteract the loss of such LAB, it is becoming increasingly common to add a culture of selected LAB (lactobacilli) to cheese milk in addition to the main acid-producing culture. (Guinee *et. al*., 2017)

After standardization of milk then it's pasteurized by heating to 161 degrees for 15 sec or 145 degrees for 30 min, these time-temperature combinations will inactivate all milk-borne pathogens and naturally occurring enzymes. Pasteurization is performed by heat exchanger when milk is ready it's pumped into temperature controlled stainless steel vat, the vat usually double-walled. (Tunick, 2014)

2.3.1.3. Acidification

Acidification is achieved due to formation of lactic acid by lactic acid bacteria which ferment sugar, lactose, to lactic acid during it growth, the indigenous microflora of milk was relied upon to produce acid but due to it variability the rate and extent of acidification is variable. therefore, cultures of lactic acid bacteria for cheese making were introduced. (Guinee *et. al*., 2017)

Addition of starter culture to milk allow faster coagulation of casein when we add rennet, cause protein matrix to force out more whey, make it harder for other varieties of bacteria to survive and affect formation of flavor and texture during ripening. (Tunick, 2014)

Direct acidification using acid may be used as an alternative to biological acidification and is used commercially to a significant extent in the manufacture of Cottage, Quarg, Feta and Mozzarella. Direct acidification is controllable than biological acidification and there is no risk of phage infection but because starter bacteria serve an important role in ripening and flavor of cheese, direct acidification is used mainly for cheese varieties for which texture is more important than flavor.

The rate of acidification varies according to type of cheese and duration, the range for cheddar and cottage from 5 to 6 h while Dutch and Swiss types range from 10–12 h. the ultimate pH of the curd for hard cheese varieties is in the range 5.0–5.3 but it is 4.6 for the soft, acid-coagulated varieties, e.g., Cottage, Quarg and Cream, and some rennet-coagulated varieties, e.g., Camembert and Brie. (Guinee *et. al*., 2017)

2.3.1.4. Coagulation

Milk is slightly acidic with PH around 6.6, once the PH has decreased by (0.2 – 0.3) unit rennet is added to coagulate milk to crud, the initial crud is called coagulum. (Tunick, 2014)

Most of cheese varieties and around 70% of total production are produced by rennet coagulation, but also acid coagulated varieties such as: cottage and cream, are of great importance. (Guinee *et. al*., 2017)

Rennet consist of number of enzymes include: rennin, proteolytic enzyme breakdown protein and form crud, pepsin and lipase. usually rennet is isolated from calf stomachs but there are other sources for it include: some fungi, such as: *Crypbonectria parasitica, Rhizomucor meibei.,* microorganisms, such as: *Kluyveromyces lactis,* come safe varieties of *E. coli.,* some plants, such as: cardoon.

Rennet attack casein and make it in form of micelles made up of submicelles by destroying a bond between tow particular amino acids in kappa caseins which cause the micelles to destabilize and various interactions then allow the caseins to aggregate into a three dimensional coagulum. (Tunick, 2014)

2.3.1.5. Dehydration and forming of the crud

Once the coagulum has formed the process of separating whey is started, there are variable methods for separating whey include: transferring the crud into perforated template which allow the crud to settle and whey to dry out, scooping the curds from the vat using heavy cloths and placing them in molds or draining the whey form the curds using perforated screens. (Guinee *et. al*., 2017)

Some soft cheese varieties such as: Camembert the crud is gently laded into boxes and allowed to drained overnight by action of gravity while harder cheeses require cutting of the crud by cheese knives. (Tunick, 2014)

many cheeses are formed into different shapes include: small flat cylinders, taller cylinders, large low cylinders, spheres. The size of cheese plays an important role in ripening process of many cheese varieties.

Curds for high-moisture cheeses form a congealed mass under their own weight but the curds for medium- and especially for low-moisture cheese must be pressed to form a well-matted body. (Guinee *et. al*., 2017)

2.3.1.6. Salting

NACL is usually used for salting process to enhance flavor and control microbial and enzymatic activity. The production of acid by starter culture bacteria and growth of spoilage bacteria are inhibited by NACL which dehydrate bacterial cells. Also there are some types of cheeses dried by salt such as: blue cheeses. The NACL content of cheese varies, but is usually under %2.5 (Tunick, 2014).

Salting is not a satisfactory method for controlling the moisture content of cheese curd which is best achieved by ensuring that the degree of acidification, heating and stirring in the cheese vat are appropriate to the particular variety.

Excessive intake of salt is not desirable, although cheese contain a little amount of NACL there is a commercial incentive to reduce the level of salt in cheese. (Guinee *et. al*., 2017)

2.3.1.7. Ripening

When the cheese is made it must be stored for a period of time known as aging or ripening. The time required for ripening varies according to the different type of cheese. Different varieties necessitate different temperatures, relative humidity levels and storage time, which affect growth of microorganisms and thus the rate and extent of flavor and texture development. (Tunick, 2014)

Fresh cheese represents a major proportion of the cheese consumed in some countries. Most of these cheeses are produced by acid coagulation while most rennet coagulated cheese varieties are ripened for a period ranging from 3 weeks to 2 years. The duration of ripening differs according to the moisture content of the cheese. During ripening the unique characteristics of the individual cheeses are developed as a result of a complex set of biochemical reactions which hence the flavor, aroma and texture of the mature cheese. The biochemical changes that occur during ripening are caused by one or more of those agents: coagulant, indigenous milk enzymes, especially proteinase and

lipase, which are particularly important in cheese made from raw milk, starter bacteria and their enzymes, secondary microorganisms and their enzymes or non-starter lactic acid bacteria. (Guinee *et. al.*, 2017)

2.4. Cream Cheese

Cream cheese is one type of fresh cheese which is soft, mild, creamy white and slightly acidic tasting product with a di acetyl flavor. It is manufacture is usually done by the coagulation of cream or mixture of milk and cream by acidification with starter culture and it can be consumed immediately after manufacturing process is complete.

It is one of the most popular soft cheese products in North America. It is used as a spread on sandwiches, as a salad dressing, and as an ingredient for making cheesecake (Cruz, 2013).

2.4.1. Cream cheese varieties

Cream cheese products are often categorized into two main types based on the different fat content in the initial mix and the final composition. These are double-cream cheese with at least 9- 11% fat content in the initial mix, and single-cream cheese with 4.5-5% fat content in the initial mix. There are also other similar kinds of cream cheeses based on different fat and dry matter contents. In the United States, the Food and Drug Administration (FDA) regulations state that cream cheese has to have at least 33% fat and not more than 55% moisture content. The Canadian standard for cream cheese requires at least 30% fat content in the product, and in France, the cream type cheese such as 'Triple creme' has to have at least 75% fat in dry matter content. Neufchatel is also similar to cream cheese but has a different fat content in the initial mix as well as the final product composition. (Phadungath, 2005)

2.4.2. Ingredients of cream cheese

1. Skimmed milk.
2. Starter culture.

3. Rennet.
4. Cream.
5. Sodium chloride and calcium chloride.

2.4.3. Cream cheese manufacture

Commercial skimmed milk was heated up to 37 ◦C, then calcium chloride (0.25 g/L) and starter cultures (1% Lactococcus lactis subsp. lactis and L. lactis subsp. cremoris) were added. After homogenization, commercial rennet (0.05 g/L) was incorporated. Upon the formation of a firm curd (pH 5.6 to 5.8), it was gently diced, separated from the whey and left to stand for 15 min to allow remained whey to drain off. The cheese curd was then transferred to sterilized cotton bags and kept for 14 hours at refrigeration temperature (5 ◦C) until all the residual whey had drained off. Next, the curd was homogenized with 29.6% pasteurized cream (20% of fat), 0.5% xanthan, and 1.5% sodium chloride, using a kitchen mixer. After homogenization, the products were packaged in polypropylene pack (600 g) with lids and stored under refrigeration (5 ◦C) (Santini *et. al.*, 2012).

2.4.4. Shelf life, qualities and defects of cream cheese

A cold pack cream cheese has shelf life of about 2-3 weeks while The shelf life of the hot pack product is around 3 months at 4 - 8ºC.

According to USDA (1994), cream cheese and related products should have a uniform white to light cream color with a slightly lactic acid and cultured di-acetyl flavor and aroma; off-flavors such as bitter, sulfide, yeasty, and unnatural flavor should not be present. The texture of the products should be smooth without lumps or grittiness, and the products should not show any indication of cracking, or wheying off. The cheese products should be spreadable at room temperature (68ºF or 20ºC) or when cold (45ºF or 7.2ºC) if labeled as 'soft', and the product should be of medium firmness when refrigerated (< 45ºF or 7.2ºC).

Defects in cream cheese can occur depending on the final pH of the cheese. The texture of the cheese will be soft, and the cheese will lack flavor, if the pH of the cheese is too high (> 4.7). If the pH of the cheese is too low (< 4.6), the texture may be too grainy, and the flavor will be too acidic. In addition, cream cheese defects include whey separation from the product during storage and a grainy, sandy, or chalky texture, especially in the lower-fat types (Phadungath, 2005).

CHAPTER THREE

MATERIALS AND METHODS

3.1. Materials

Sesame was obtained from Bahri market: the seeds were soaked, mixed and squeezed through cheese cloth to produce sesame milk. Skimmed milk was obtained from Bahri market. Samples of sesame milk and skimmed milk were taken in clean plastic containers to Food Research Center laboratory for approximate analysis. Cream cheese was taken to Industrial Research and Consultancy Center for physicochemical analysis and Food Research Center laboratory for microbiological analysis.

3.2. Methods

3.2.1. Chemical analysis of sesame milk

3.2.1.1 Moisture determination

Moisture content was determined according to the association of official's analytical chemists AOAC (2008) as follows: A sample of 5 g was weighed into a pre-dried and tarred dish. Then, the sample was placed into an oven (Kat-NR.2851, Elektrohelios, Sweden) and left to dry at 105 ºC until a constant weight was obtained. After drying, the covered sample was transferred into a desiccator and cooled to room temperature before reweighing. Triplicate results were obtained for each sample and the mean value was reported to two decimal points according to the following formula:

Calculation:

Moisture content %

$$\text{Moisture content \%} = \frac{(W1-W2)}{W1} \times 100$$

Where:

W_1= Original weight of sample.

W_2= Weight of sample after drying.

3.2.1.2 Crude protein determination

Crud protein was determined according to the association of official's analytical chemists AOAC (2008) as follows: A 0.5g sample was accurately weighed and transferred together with 2-3 pills of kjeldahl catalyst and 20 ml of concentrated sulphuric acid was added into kjeldahl digestion flask. After that, the flask was placed into a kjeldahl digestion unit (Tecator, Sweden) for about 3hours, until a colorless digest was obtained. Then, the flask was left to cool to room temperature. The distillation of ammonia was carried out in 30 ml of boric acid (2%) by using 40 ml distilled water and 60 ml sodium hydroxide solution (33 %). Finally,

the distillate was titrated with standard solution of 0.1N HCl in the presence of 2-3 drops of indicator (Bromocreasol green and methyl red) until a brown reddish color was observed. The total nitrogen and protein were calculated using the following formula:

$$N\% = \frac{\text{volum of HCl} \times N \times 14}{\text{weight of sample} \times 1000} X100$$

P%= N% X 6.38 (factor)

Where:

N% = crude nitrogen.

P% = crude protein.

N = normality of HCl.

14 = equivalent weight of nitrogen

3.2.1.3 Fat determination

The fat content was determined by Gerber method according to AOAC (2008). Ten ml sulfuric acid (density 1.815gm/ml at 20°C) was poured into a clean Gerber tube, followed by the addition of 10 ml of sample. Then 1ml of amyl alcohol and distilled water at 20°C were added. The tubes were thoroughly mixed till no white particles were seen. The tubes were centrifuged at 1100 revolution per minute (rpm) for 5 minutes. The tubes

were then transferred to water bath at 65°C for 3 minutes. The fat content was immediately read.

3.2.1.4 Ash determination

Ash content was determined according to the association of official's analytical chemists AOAC (2008) as follows: A sample of 2g was weighed into a pre- heated, cooled weighed in porcelain crucible and placed into a muffle furnace (Carbolite, Sheffeild, England) at 550 ºC. After ashing completed, the crucibles with ash were transferred directly to a desiccator, cooled, weighed and the ash content was calculated as percent of the original weight of sample:

$$\text{Ash content \%} = \frac{(W_1 - W_2)}{W} \times 100$$

Where:

W_1 = Weight of crucible with ash.

W_2 = Weight of empty crucible.

W = Sample weight in g.

3.2.1.5. Determination of Lactose content

The lactose content was determined by Anthrone Method (Richard, 2003). One gram of samples was weighed and poured into a 500 ml volumetric flask and diluted to 500 ml with distilled water. The sample was mixed well then, 0.5 ml was transferred in a boiling test tube (in duplicate) the samples were placed in an ice bath, and shacked while adding 10 ml of ice cold Anthrone reagent. The tubes contents were mixed and then placed in a boiling water bath for 6 min, then transferred back to the ice bath for 30 minutes. The optical density of the colored solution was then read at 625nm. A blank consisting of distilled water 0.5 ml, Anthrone reagent and standard containing 100mg/ml of lactose and Anthrone reagent were included in each batch of analysis. The percentage of lactose was then calculated using the following formula:

$$\text{Lactose content} = \frac{\text{O.D of sample} \quad \text{O.D of blank}}{\text{O.D of standarad} - \text{O.D of blank}} \times 4.75 = \text{g/1000ml}$$

Where:

OD: Optical density

3.2.1.6 Total solids determination

Total solids were determined according to the association of official's analytical chemists AOAC (2008) as follows: A clean dried aluminum dishes were dried at 105°C for 3 hrs. Five grams of each sample were weighed in dry clean flat bottomed aluminum dish and heated on stream bath for 15 minutes. The dishes were placed into a forced draft oven at 100°C for three hrs. Then cool in a disccator and weighed quickly. Weighing was repeated until the different between the two readings was < 0.1 mg. The total solids (TS) content was calculated as follows:

$$\text{Total solid (\%)} = \frac{w1}{w0} \times 100$$

Where:

W_1 = weight of sample after drying

W_0= weight of sample before drying

3.2.1.7 pH-value

The pH was determined according to the association of official's analytical chemists AOAC (2008) as follows: Ten grams of the sample were diluted in 90 ml distilled water, the solution was mixed thoroughly, filtered through filter paper (Whatman No.1). The pH meter was calibrated using two standard buffers (6.8 and 4.0). pH values of the mixture were measured using a recalibrated pH meter model (HI 8521 microprocessor bench pH / MV / ˚C meter).

3.2.3.1.8 Titratable acidity

The acidity was determined according to the association of official's analytical chemists AOAC (2008) as follows: Ten grams of the sample were diluted in 90 ml distilled water, the solution was mixed thoroughly. Then the

acidity was determined by titrating 10 ml of the filtrate against 0.1 N (NaOH) using phenolphthalein as an indicator. The Titratable acidity was Calculated as follows:

$$TA\% = T.F / 10$$

Where:

T.F: Titration figure

3.2.2. Chemical analysis of skimmed milk

3.2.2.1. Moisture determination

Moisture content was determined according to the association of official's analytical chemists AOAC (2008) as follows: A sample of 5 g was weighed into a pre-dried and tarred dish. Then, the sample was placed into an oven (Kat-NR.2851, Elektrohelios, Sweden) and left to dry at 105 ºC until a constant weight was obtained. After drying, the covered sample was transferred into a desiccator and cooled to room temperature before reweighing. Triplicate results were obtained for each sample and the mean value was reported to two decimal points according to the following formula:

Calculation:

Moisture content %

$$\text{Moisture content \%} = \frac{(W1-W2)}{W1} \times 100$$

Where:

W_1= Original weight of sample.

W_2= Weight of sample after drying.

3.2.2.2. Crude protein determination

Crud protein was determined according to the association of official's analytical chemists AOAC (2008) as follows: A 0.5g sample was accurately weighed and transferred together with 2-3 pills of kjeldahl catalyst and 20 ml of concentrated sulphuric acid was added into kjeldahl digestion flask. After that, the flask was placed into a kjeldahl digestion unit (Tecator, Sweden) for

about 3hours, until a colorless digest was obtained. Then, the flask was left to cool to room temperature. The distillation of ammonia was carried out in 30 ml of boric acid (2%) by using 40 ml distilled water and 60 ml sodium hydroxide solution (33 %). Finally,

the distillate was titrated with standard solution of 0.1N HCl in the presence of 2-3 drops of indicator (Bromocreasol green and methyl red) until a brown reddish color was observed. The total nitrogen and protein were calculated using the following formula:

$$N\% = \frac{\text{volum of HCl} \times N \times 14}{\text{weight of sample} \times 1000} \times 100$$

$$P\% = N\% \text{ X } 6.38 \text{ (factor)}$$

Where:

N% = crude nitrogen.

P% = crude protein.

N = normality of HCl.

14 = equivalent weight of nitrogen

3.2.2.3. Fat determination

The fat content was determined by Gerber method according to AOAC (2008). Ten ml sulfuric acid (density 1.815gm/ml at 20°C) was poured into a clean Gerber tube, followed by the addition of 10 ml of sample. Then 1ml of amyl alcohol and distilled water at 20°C were added. The tubes were thoroughly mixed till no white particles were seen. The tubes were centrifuged at 1100 revolution per minute (rpm) for 5 minutes. The tubes were then transferred to water bath at 65°C for 3 minutes. The fat content was immediately read.

3.2.2.4. Ash determination

Ash content was determined according to the association of official's analytical chemists AOAC (2008) as follows: A sample of 2g was weighed into a pre- heated, cooled weighed in porcelain crucible and placed into a

muffle furnace (Carbolite, Sheffeild, England) at 550 ºC. After ashing completed, the crucibles with ash were transferred directly to a desiccator, cooled, weighed and the ash content was calculated as percent of the original weight of sample:

$$\text{Ash content \%} = \frac{(W1 - W2)}{W} \times 100$$

Where:

W_1 = Weight of crucible with ash.

W_2 = Weight of empty crucible.

W = Sample weight in g.

3.2.2.5. Determination of Lactose content

The lactose content was determined by Anthrone Method (Richard, 2003). One gram of samples was weighed and poured into a 500 ml volumetric flask and diluted to 500 ml with distilled water. The sample was mixed well then, 0.5 ml was transferred in a boiling test tube (in duplicate) the samples were placed in an ice bath, and shacked while adding 10 ml of ice cold Anthrone reagent. The tubes contents were mixed and then placed in a boiling water bath for 6 min, then transferred back to the ice bath for 30 minutes. The optical density of the colored solution was then read at 625nm. A blank consisting of distilled water 0.5 ml, Anthrone reagent and standard containing 100mg/ml of lactose and Anthrone reagent were included in each batch of analysis. The percentage of lactose was then calculated using the following formula:

$$\text{Lactose content} = \frac{\text{O.D of sample} - \text{O.D of blank}}{\text{O.D of standarad} - \text{O.D of blank}} \times 4.75 = \text{g/1000ml}$$

Where:

OD: Optical density

3.2.2.6. Total solids determination

Total solids were determined according to the association of official's analytical chemists AOAC (2008) as follows: A clean dried aluminum dishes were dried at 105°C for 3 hrs. Five grams of each sample were weighed in dry clean flat bottomed aluminum dish and heated on stream bath for 15 minutes. The dishes were placed into a forced draft oven at 100°C for three hrs. Then cool in a disccator and weighed quickly. Weighing was repeated until the different between the two readings was < 0.1 mg. The total solids (TS) content was calculated as follows:

$$\text{Total solid (\%)} = \frac{w1}{w0} \times 100$$

Where:

W_1 = weight of sample after drying

W_0= weight of sample before drying

3.2.2.7. pH-value

The pH was determined according to the association of official's analytical chemists AOAC (2008) as follows: Ten grams of the sample were diluted in 90 ml distilled water, the solution was mixed thoroughly, filtered through filter paper (Whatman No.1). The pH meter was calibrated using two standard buffers (6.8 and 4.0). pH values of the mixture were measured using a recalibrated pH meter model (HI 8521 microprocessor bench pH / MV / ˚C meter).

3.2.2.8. Titratable acidity

The acidity was determined according to the association of official's analytical chemists AOAC (2008) as follows: Ten grams of the sample were diluted in 90 ml distilled water, the solution was mixed thoroughly. Then the acidity was determined by titrating 10 ml of the filtrate against 0.1 N (NaOH) using phenolphthalein as an indicator. The Titratable acidity was Calculated as follows:

$$TA\% = T.F / 10$$

Where:

T.F: Titration figure

3.2.3. Chemical analysis of cream cheese

3.2.3.1. Production of cream cheese

1.6 liters of sesame milk and 1.6 liter of cow skimmed milk divided into five treatments (A: 60% sesame milk + 40% cow milk, B: 50% sesame milk + 50% cow milk, C: 40% sesame milk + 60% cow milk, D: 100% sesame milk, E: 100% cow milk).

3.2.3.1.1. Preparation method

Sesame milk was prepared by soaking the weighted amount of sesame in water for six hours then Sesame seed was transferred to the blender vessel and a small portion of the weighed water was added to facilitate the progress of mixing. The blender was operated at highest speed for 10 min. After finishing the mixing process, the remaining quantity of water was added and mixed thoroughly. The resulted sesame dispersion was homogenized for 5 min using magnetic stirrer at 52°C. The homogenized sesame milk base was squeezed through cheesecloth to separate coarse particles. The resulted milky solution was weighed, readjusted to its original weight (before filtration) by adding tap water, mixed thoroughly, filled in a beaker and heated in boiling water bath at 85°C for 5 min with manual stirring (Quasem, 2011).

3.2.3.1.2. Treatment

The pasteurized sesame milk and skimmed milk was cooled to 36°C and then the desired treatments where prepared and the starter culture of (*Streptococcus thermophiles)* at the rate of 1% and $CaCl_2$ (0.25g/L) were added and blended thoroughly, measured and mixed with sample size of 600 ml. the samples were incubated for 10 min at 37°C until PH reached 5.4 then rennet (0.05g/L) were added to each treatment and incubated for 3 hours at 45°C. the resulted coagulum was separated from whey by using clean cheese

cloth and left to stand for four hours to allow remained whey to drain off. Next, the curd was homogenized with 20% pasteurized oil and 0.7% sodium chloride, using a kitchen mixer. After homogenization, the products were packaged in packs of 50g and stored under refrigeration 4°C. cream cheese samples physiochemical components were analyzed and sensory evaluation done and replicated for each treatment.

3.2.3.2. Moisture determination

Moisture content was determined according to the association of official's analytical chemists AOAC (1990) as follows: tow grams of each sample were weighted in clean dry and pre-weighted crucible and then placed in oven at 105°C and left over night. The crucible was transferred to desiccators and allowed to cool and then weighted. Further placed in the oven was carried out until constant weight was obtained. Moisture content was calculated using the following formula:

$$MC\% = \frac{(W2-W1) - (W3-W1)}{(W2 - W1)} \times 100$$

Where:

MC : moisture content.

W1 : weight of empty crucible.

W2 : weight of crucible with sample.

W3 : weight after drying.

3.2.3.3. Ash content

Ash content was determined according to the association of official's analytical chemists AOAC (1990) as follows: tow grams of each sample were weighted in clean dry and pre-weighted crucible and then the crucible with its content ignited in a muffle furnace at about 550°C for three hours or more until light gray ash was obtained. The crucible was removed from the furnace to a desiccator to cool and then weighted. The crucible was reignited in the

furnace and allowed to cool until a constant weight was obtained. Ash content was calculated using the following equation:

$$AC\% = \frac{W2 - W1}{W3} \times 100$$

Where:

AC : ash content.

W1 : weight of empty crucible .

W2 : weight of crucible with ash.

W3 : weight of sample.

3.2.3.4. Crud protein

Crud protein of the sample was determined by using the micro-kjeldahl method according to AOAC (1990) as follows:

Digestion

0.2 gram of the sample was weighted and placed in small digestion flask (50 ml). about 0.4 gram catalyst mixture (96% anhydrous sodium sulfate and 3.5% copper sulfate) was added. 3.5 ml of approximately 98% H_2SO_4 was added. The content of the flask was then heated on an electrical heater for two hours till the color changed to blue – green. The tubes were then removed from digester and allowed to cool.

Distillation

The digested sample was transferred to the distillation unit and 20 ml of NaOH (40%) were added. The ammonia was received in 100 ml conical flask containing 10 ml of 2 % boric acid plus 3 – 4 drops of methyl red indicator. The distillation was continued until the volume reached 50 ml.

Titration

The content of the flask was titrated against 0.02 N HCl. The titration reading was recorded. The crud protein was calculated using the following equation:

$$CP\% = \frac{(T - B) \times N \times 14 \times 100 \times 6.25}{Ws \times 1000}$$

Where:

CP = crud protein.

T = titration reading.

B = blank titration reading.

N = normality of HCl.

W_S = sample weight.

1000 = to convert to mg.

3.2.3.5. Fat content

Fat was determined according to the method of AOAC (1990) using soxhlet apparatus follows:

An empty clean and dry exhaustion flask was weighted. About 2 gram of sample was weighted and placed in clean extraction thimble and covered with cotton wool. The thimble was placed in an extractor. Extraction was carried out for 8 hours with petroleum ether. The heat was regulated to obtain at least 15 siphoning/hour. The residual ether was dried by evaporation. The flask was placed in an oven at 105°C till it dried completely and then cooled in a desiccator and weighted. The fat content was calculated using the following equation:

$$FC\% = \frac{W2 - W1}{W3} \text{ x } 100$$

Where:

FC : fat content.

W1 : weight of extraction flask.

W2 : weight of extraction flask with fat.

W3 : weight of sample.

3.2.3.6. Determination of Lactose content

The lactose content was determined by Anthrone Method (Richard, 2003). One gram of samples was weighed and poured into a 500 ml volumetric flask and diluted to 500 ml with distilled water. The sample was mixed well then, 0.5 ml was transferred in a boiling test tube (in duplicate) the samples were placed in an ice bath, and shacked while adding 10 ml of ice cold Anthrone reagent. The tubes contents were mixed and then placed in a boiling water bath for 6 min, then transferred back to the ice bath for 30 minutes. The optical density of the colored solution was then read at 625nm. A blank consisting of distilled water 0.5 ml, Anthrone reagent and standard containing 100mg/ml of lactose and Anthrone reagent were included in each batch of analysis. The percentage of lactose was then calculated using the following formula:

$$\text{Lactose content} = \frac{O.D\ of\ sample - O.D\ of\ blank}{O.D\ of\ standarad - O.D\ of\ blank} \times 4.75 = \text{g/1000ml}$$

Where:

OD: Optical density

3.2.3.7 pH-value

Ten grams of the sample were diluted in 90 ml distilled water, the solution was mixed thoroughly, filtered through filter paper (Whatman No.1). The pH meter was calibrated using two standard buffers (6.8 and 4.0). pH values of the mixture were measured using a recalibrated pH meter model (HI 8521 microprocessor bench pH / MV / ˚C meter).

3.2.3.8 Titratable acidity

Ten grams of the sample were diluted in 90 ml distilled water, the solution was mixed thoroughly. Then the acidity was determined by titrating 10 ml of the filtrate against 0.1 N (NaOH) using phenolphthalein as an indicator. The Titratable acidity was

Calculated as follows:

$$TA\% = T.F / 10$$

Where:

T.F: Titration figure.

3.2.4. Microbiological analysis of cream cheese.

3.2.4.1. Total viable bacterial counts (TVBC).

Total viable bacterial counts (TVBCs) were done using the pour plate technique as described by Harrigan (1998). Ten ml from the water sample was taken by sterile pipette and transferred to the first tube containing 90 ml sterile diluent (distilled water) to give a10-1dilution; with a sterile pipette 1 ml from this first dilution tube was transferred to a second tube of sterile diluent to give a 10-2 dilution, then further dilutions were made. One ml from each suitable dilution was aseptically transferred, in duplicate, into sterile Petri-dishes. Ten mL of molten Plate Count Agar (Biomark, India) (45-46^{o}C) were poured into each dish. The dishes were then thoroughly mixed to facilitate distribution of the sample throughout the medium. The medium was allowed to solidify and the plates were incubated aerobically in an incubator (Griffin, England)at 37 ^{o}C for 48 hours. A colony counter (Labtech digital colony counter, India) and a hand-tally were used to count the viable bacterial colonies. The count was expressed as colony-forming units (CFU) per mL.

The Most Probable Number (MPN) technique was used for the enumeration of coliforms, faecal coliforms of all samples according to APHA (2000).

3.2.4.2. Most probable number (MPN) technique.

The 3-tube most probable number test was used for the enumeration of total coliforms (TC) and faecal coliforms (FC). MacConkey Broth (Himidia, India) was used for the presumptive test for coliform bacteria and results were confirmed by culturing positive tubes into Brilliant Green Bile Broth (Oxoid, England) tubes. Both media were incubated at 35 ^{o}C for 48 hours. EC Broth (Merck, Germany) was used for the enumeration of faecal coliforms after incubation in a water-bath at 44.5 ^{o}C for 24 hours. Further confirmation of faecal coliforms was done by isolation on EMB agar (Difco, USA).

3.2.5. Statistical analysis.

One way ANOVA was preformed to examine significant difference between samples of replicated measurements. Probability level of less than 0.05 was considered significant ($p < 0.05$). all data were analyzed using MINITAB version 17 statistical software.

CHAPTER FOUR

RESULTS AND DISCUSSTION

4.1. Chemical composition of raw materials.

Sesame milk contains 90.66% moisture. This result was higher than Abd-allwahab *et. al*. (2017) who found 86%. The protein content was 2.92%, this result was lower than Abd-allwahab *et. al*. (2017) who reported 3.5% and higher than Quasem *et. al*. (2009) who found 2.52%. the fat content was 4.80% this result was higher than Abd-allwahab *et. al.* (2017) who reported 3.64%. the ash content was 0.58%, this result was lower than Abd-allwahab *et. al*. (2017) who found 3.53%. the lactose content was 0.00%. this result agreed with Abd-allwahab *et. al*. (2017) The pH was 6.21. this result was lower than Abd-allwahab *et. al*. (2017) who reported 6.50. the acidity was 0.20%. this result was lower than Abd-allwahab *et. al*. (2017)) who found 1.36%. the total solids of sesame milk were 9.34%. this result was lower than Quasem *et. al*. (2009) who reported 9.90%. this difference may be due to sesame cultivar, preparation conditions and analytical method.

Table 4. 1. Chemical composition of raw materials (sesame milk and skimmed milk).

Parameter	Sesame milk	Skimmed milk
Moisture %	90.66	85.23
Ash %	0.58	1.20
Fat %	4.80	0.22
Protein %	2.92	4.80
PH	6.21	6.62
Acidity %	0.20	0.16
Lactose %	0.00	7.95
T.S	9.34	14.77

4.2. Chemical composition of cream cheese with different concentrations of sesame milk.

Table (4.2) shows that moisture content significantly increased ($p < 0.05$) with the increase of sesame milk. The highest moisture content was 71.45%. on the other hand, the lowest moisture content was 67.68%, these results were higher than the control 67.23% and those obtained by Santini *et. al*. (2012) 64.80% and Phadungath (2005) 70%.

The ash content ranged between (2.20 - 3.51%). The ash content decreased significantly ($p < 0.05$) with the increase of sesame milk, these agreed with the results obtained by Santini *et. al*. (2012) who reported 3.13%.

The fat content increased significantly ($p < 0.05$) with addition of sesame milk, and ranged between (13.66 – 14.37%). These results were higher than Santini *et. al*. (2012) who reported 9.36% and the control 13.10% but agreed with Phadungath (2005) who reported 14%.

The protein ranged between (11.37 – 12.40%), there was no significant difference ($p > 0.05$) with the addition of sesame milk. These results were higher than Santini *et. al*. (2012) who reported 11.61% and the control 11.65% but agreed with Phadungath (2005) who reported 12%.

The lactose content decreased significantly ($p < 0.05$) with the addition of sesame milk, and ranged between (0.00 – 3.39%). The highest lactose obtained was 3.39%, which is lower than the control 3.96% and Phadungath (2005) who reported 3.50%. The pH of the cheese increased significantly ($p < 0.05$) with the addition of sesame milk. The highest pH obtained was 5.52 in sample (100% sesame milk), while the lowest pH obtained was 4.64 in the control. Also the acidity decreased significantly with the addition of sesame milk and ranged between (0.414 – 0.449%). These results were lower than the control 0.450%. This may be because sesame milk doesn’t contain lactose.

Table 4. 2. Chemical composition of cream cheese with different concentrations of sesame milk.

Treatment (sesame milk level)	**A (100% sesame milk)**	**B (60% sesame milk)**	**C (50% sesame milk)**	**D (40% sesame milk)**	**E (0% sesame milk)**
Lactose	0.00 ± 0.00^{B}	2.97 ± 0.02^{A}	3.37 ± 0.08^{A}	3.39 ± 0.02^{A}	3.96 ± 1.301^{A}
Acidity	0.418 ± 0.006^{C}	$0.441\pm0.01^{B\,C}$	0.414 ± 0.00^{C}	0.42 ± 0.006^{A}	$0.450\pm0.00^{A\,B}$
pH	5.52 ± 0.13^{A}	4.84 ± 0.007^{B}	4.81 ± 0.00^{B}	4.76 ± 0.04^{B}	4.64 ± 0.01^{B}
Protein	11.37 ± 0.24^{A}	12.005 ± 0.07^{A}	12.40 ± 0.42^{A}	11.67 ± 0.09^{A}	11.65 ± 0.07^{A}
Fat	14.37 ± 0.10^{A}	$13.75\pm0.02^{A\,B}$	$13.72\pm0.48^{A\,B}$	$13.66\pm0.13^{A\,B}$	13.10 ± 0.07^{B}
Ash	2.20 ± 0.13^{C}	2.44 ± 0.04^{C}	2.42 ± 0.007^{C}	3.51 ± 0.007^{A}	3.05 ± 0.03^{B}
Moisture	71.45 ± 0.354^{A}	69.005 ± 0.007^{B}	68.11 ± 0.028^{B}	67.68 ± 0.014^{B}	67.23 ± 1.01^{B}

Means that do not share a letter in the same column are significantly different ($P < 0.05$).

4.3. Microbiological analysis of cream cheese with different concentrations of sesame milk.

Table (4.3) shows that the total bacterial count ranged between ($4x10^3$ – $6x10^3$) with no significant difference between the different samples and the control. Also there was no presence for Coliform bacteria.

Table 4. 3. Microbiological analysis of cream cheese with different concentrations of sesame milk.

Test	Result				
Samples preparation	**A (100% sesame milk)**	**B (60% sesame milk)**	**C (50% sesame milk)**	**D (40% sesame milk)**	**E (100% cow milk)**
Total bacterial count	$5x10^3 \pm 14^A$	$6x10^3 \pm 14^A$	$4x10^3 \pm 28^A$	$4x10^3 \pm 28^A$	$5x10^3 \pm 0^A$
Coliform (*E.coil*)	Negative	Negative	Negative	Negative	Negative

4.4. Sensory characteristics of cream cheese with different concentrations of sesame milk.

The Sensory characteristics of cream cheese with (0%, 40%, 50%, 60% and 100%) sesame milk are shown in Table (4.4). they are ranked according to color, flavor, texture, taste and overall acceptability.

The color decreased significantly ($p < 0.05$) with the increase in sesame milk. The control sample (0% sesame milk) had the highest score 4.42 while (100% sesame milk) had the lowest score 1.85.

The flavor and texture decreased significantly ($p < 0.05$) with the increase in sesame milk. The control sample (0% sesame milk) had the highest score 4.00 in flavor and 3.85 in taste, while (100% sesame milk) had the lowest score 1.75 and 1.64 in taste.

The panelists detected that the increase addition of sesame milk decrease significantly ($p < 0.05$) the texture of cream cheese. The control sample (0% sesame milk) had the highest score 4.28 in texture among all other treatments.

Within each treatment the overall acceptability decreased significantly ($p < 0.05$) with the increase in sesame milk from 4.35 to 1.57.

Table 4. 4. Sensory characteristics of cream cheese with different concentrations of sesame milk.

Parameter / Treatment	Color	Flavor	Texture	Taste	Overall acceptability
A (100% sesame milk)	1.85 ± 1.09^{C}	1.78 ± 0.89^{C}	1.42 ± 0.85^{C}	1.64 ± 0.84^{B}	1.57 ± 0.85^{C}
B (60% sesame milk)	3.21 ± 0.97^{B}	3.07 ± 0.61^{B}	2.50 ± 1.01^{B}	3.07 ± 1.20^{A}	3.07 ± 1.07^{B}
C (50% sesame milk)	$3.78\pm0.69^{A\ B}$	$3.42\pm1.01^{A\ B}$	$3.35\pm1.00^{A\ B}$	3.21 ± 1.18^{A}	$3.57\pm1.08^{A\ B}$
D (40% sesame milk)	$4.00\pm0.67^{A\ B}$	$3.42\pm0.85^{A\ B}$	3.92 ± 1.00^{A}	3.57 ± 0.93^{A}	$3.64\pm1.00^{A\ B}$
E (100% cow milk)	4.42 ± 0.85^{A}	4.00 ± 0.67^{A}	4.28 ± 1.13^{A}	3.85 ± 0.66^{A}	4.35 ± 0.84^{A}

Means that do not share a letter in the same column are significantly different ($p < 0.05$).

Where:

5 = Excellent. 4 = Very good. 3 = Good. 2 = Acceptable.

1 = Unacceptable.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Based on the results obtained in this study, we conclude that:

- It’s possible to produce cream cheese from sesame milk with good quality characteristics.
- Cream cheese with 40% sesame milk was the closest in texture to the control.
- Cream cheese with 100% sesame milk was found to have the highest fat content with lower score for all sensory characteristics.

5.2. Recommendations

We recommend that:

- Production of cream cheese from sesame milk as it has a high nutritive value.
- Further research is needed to make cream cheese from sesame milk more acceptable to consumer.
- More research need to be done on the utilization of sesame milk in producing other dairy products.

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APPENDICES

Figure 1. *Sesamum indicum* L.

Figure 2. Sesame seeds

Figure 3. Sesame milk

Figure 4. Mixer

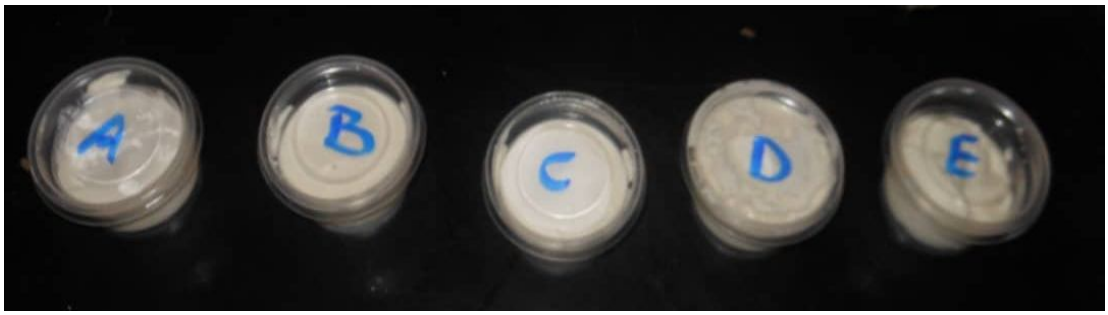

Figure 5. Cream cheese