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**COLLEGE OF AGRICULTURAL STUDIES**  
**DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY**



**Production of Functional Cheese from Goat Milk**  
**Supplemented With Baobab Fruit Pulp**

انتاج جبنة وظيفية من لبن الماعز مدعمة بلب ثمار التبدي

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## **Dedication**

*To our mothers, fathers and brothers*

*To our extended family*

*To all our teachers and friends with great regard and  
respect.*

## **Acknowledgement**

First all we would like to express our thanks to our great almighty Allah for his help in our success to finish this study. Great thanks due to .

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## **Abstract**

This study was carried out to produce functional cheese from goat milk supplemented with baobab fruit pulp and investigate the effect of Baobab fruit pulp on the physicochemical properties of this cheese. Cheese was made from goat milk with Baobab fruit pulp (0 g/L, 50g/L, 75g/L, 100 and g/L). Coagulant was added and after obtained curd then pressed, packing and salting. Physicochemical (acidity, pH, total solids, solids, ash, protein, fat, lactose, moisture, crude fiber and sensory evaluation), was carried out post processing. Results of physicochemical analysis of goat milk cheese showed that addition of Baobab fruit pulp resulted in an increase in fiber, protein, fat, total solids, ash, acidity of goat milk cheese, and decrease in lactose, pH of product. Baobab fruit pulp can be used in goat milk cheese to improve the quality of goat milk cheese.

## ملخص البحث

أجريت الدراسة لإنتاج جبنة وظيفية من لبن الماعز مدعمة بلب ثمار التبليدي ، ومعرفة أثر لب ثمار التبليدي على التحليل الفيزيوكيميائي للجبنة البيضاء المصنعة من لبن الماعز. تم تصنيع الجبنة من لبن الغنم بإضافة لب ثمار التبليدي (0 جم/ لتر، 50جم/ لتر، 75جم/ لتر، و 100جم/ لتر). تمت بسترة اللبن لدرجة 73°م، ثم تمت إضافة المخثر في درجة حرارة 43م. وتم الحصول على خثرة بعد الضغط والتعليج. أجري تحليل الخصائص الفيزيوكيميائية (الحمضية، الرقم الهيدروجيني، المواد الصلبة الكلية، المواد الصلبة غير الدهون، الرماد، البروتين، الدهون، اللاكتوز، الرطوبة، الألياف الخام، انفصال الشرش). أظهرت نتائج التحليل الفيزيوكيميائي للجبنة المصنعة من لبن الماعز عند إضافة لب ثمار التبليدي زيادة في البروتين، الدهن، المواد الصلبة الكلية، الرماد، الحمضية والإنخفاض في الرقم الهيدروجيني، اللاكتوز. ثم تم إجراء التقييم الحسي للجبنة. يمكن استخدام لب ثمار التبليدي في الجبنة المصنعة من لبن الماعز لتحسين القيمة الغذائية والجودة للجبنة.

# CHAPTER ONE

## INTRODUCTION

Functional foods look like conventional foods consumed as part of the normal diet, have physiological benefits and can reduce the risk of chronic disease beside nutritional functions (Cencic, 2009). There are a number of physiologically active components in animal products have role in optimal health (Anders and Moser, 2010). Dairy products are best sources of calcium, an essential nutrient which can prevent osteoporosis and possibly colon cancer (Kralik *et al* 2012). Cheese is made using cow, goat, sheep, buffalo or a blend of this milk (Ahmed, 2009). Cheese is a concentrated source of many milk nutrients almost all of milk protein, minerals such as calcium, phosphorus and magnesium, fat and soluble vitamins A, D, E and K are retained in the curd during manufacture (Ahmed, 2009). The protein in cheeses is highly quantity casein, it contains all the essential amino acids in amount needed by human, the amino acids are in digestible form. General cheeses are good source of the essential fatty acids linoleic acid and linolenic acid (Castillo, 2001).

Goat milk cheese is the most simple form and made by allowing raw milk to naturally curdle and then draining and pressing (Yassin, 2014). Goat milk has special nutritional properties that make it attractive to some consumers, it is easier to digest than cow's milk and may have certain therapeutic value (AL-Amin, 2016).

Baobab fruit pulp has a slightly tart, refreshing taste and is very nutritious, with high values for carbohydrates, energy, calcium, potassium, thiamine, nicotinic acid and vitamin C (Kabore *et al.*, 2011). It has a high antioxidant capability, this mainly refers to

vitamin C content (Singh *et al.*, 2013). Vitamin C is a powerful antioxidant and important in human nutrition. It has a role to play in the extension of shelf life for food (Kabore *et al.*, 2011). The supplementation of goat milk with baobab fruit pulp to produce cheese will improve the nutritive value and provide health benefits and new properties in cheese.

Manufacturing of the Baobab goat cheese could increase the income of rural people who are involved in the harvest of the fruit and processing of the pulp. In addition, the Baobab goat cheese would diversify the few exotic cheeses currently on the market and may also benefit the consumers nutritionally and pharmacologically as the Baobab pulp is a rich source of micronutrients and phytochemicals (Chipurura, *et al.*, 2014).

**The Aim of the study:**

1. To produce functional cheese from goat milk with added baobab fruit pulp.
2. To determine the physicochemical properties of cheese.
3. To evaluate sensory properties of cheese.

# CHAPTER TWO

## LITRETURE REVIEW

### 2.1 Functional foods

#### 2.1.1 Background of Functional foods

Two thousand years ago, Hippocrates was on the right path when he said "let food be thy medicine and medicine be thy food ". However, now we might change that to " let functional food be thy medicine" since 2006, the functional food center (FFC) has been using the above statement in our functional food related books. Nutrition and medicine as it produces relation that crosses between food and pharmaceuticals particularly, researchers study food content and their beneficial health effects (Anders and Moser,2010).

The term "functional food" was first used in Japan in the 1980s, for food products fortified with special constituents that possess advantageous physiological effects. The concept of functional food was first promoted in 1984 by Japanese scientists who studied the relationships between nutrition, sensory satisfaction, fortification and modulation of physiological systems. In 1991, the Ministry of Health introduced rules for approval of a specific health-related food category called FOSHU (Food for Specified Health Uses) which included the establishment of specific health claims for this type of food. The Japanese interest in functional foods has also brought awareness for the need of such products inplaceslike Europe and the United States (Anders and Moser, 2010).

### **2.1.2 Definition of functional food**

Functional foods look like conventional foods; the former being consumed as part of the normal diet. However, have demonstrated physiological benefits and can reduce the risk of chronic disease beyond basic nutritional functions, including maintenance of gut health. When food is being prepared using "scientific intelligence" with or without knowledge of how or why it is being used, the food is called "functional food". Thus, functional food provides the body with the required amount of vitamins, fats, proteins, carbohydrates, etc..., needed for its healthy survival(Cenic and chingwaru 2010).

Functional foods are foods that in addition to supplying nutrients offer potential health benefits that could the well-being of consumers. They offer the opportunity to reduce the direct and indirect health costs associated with a number of predominant chronic diseases like diabetes, coronary heart disease, and cancer. Functional foods affect beneficially one or more objective functions in the body, beyond nutritional effects to either improve stage of health and well-being and/or reduce the risk of diseases (Cranfield and Shellikeri, 2009).

### **2.1.3 Bioactivity of functional food**

Functional food scientists determine the health effects and intact safe dosages of functional food. Functional foods have bioactive compounds must be consumed in specific effective non-toxic amounts. This fact is paramount to functional food working therapeutically and not toxically. For example, vitamin c is a known bioactive compound that should be consumed at 90 mg. in order to maintain normal health. A food containing more than 200-300 mg. of vitamin C per day may act therapeutically in terms of reducing one's risk of contracting cold,



thereby acting as a functional food. However it becomes toxic, which is at approximately 2000 mg. Brining functional foods to markets, will help billions suffering from chronic illnesses and general health problems (Martirosyan and Singh,2015).

#### **2.1.4 Types of functional foods**

##### **2.1.4.1 Functional foods from plant source**

Functional foods are those which provide specific health benefit beyond their nutritional format. The equilibrium intake of vegetables, fruit, beans, and grains can provide beneficial compounds. New studies have demonstrated that there are multiple effects of vegetables and fruit, they contain many vitamins and minerals that are good for health such as vitamin A, C, E, magnesium, folic acid, phosphorus and zinc. Flavonoids are a group of plant metabolites that pertain to common group of polyphenolics in the human diet (Anders and Moser,2010). The important dietary sources of flavonoids are vegetables, fruits, seeds, some cereals, toghethers with wine, tea and certain spices(Kozłowska and Szostak-wegierek, 2014).

Recent research suggests that, in humans these plant polyphenols provide important health benefit to metabolic syndrome cancer, brain health and immune system. Flavonoids have significant effects on inflammation, cardiovascular diseases and cancer. Epidemiological evidence and clinical attempting data indicates that a plant based diet can reduce the risk of various chronic diseases. In 1992, a review of 200 epidemiological studies demonstrated that risk of cancer was half to people who consumed fruits. Cereals and its ingredients are very good source of dietary fiber, proteins, energy, minerals, vitamins. Wheat, oat, barley, flax

seed, brown rice, and soy products are important cereal based functional food of nutraceuticals (Das R *et.al* ,2016).

#### **2.1.4.2 Functional food from animal source**

Animal products have always played an important role in human nutrition. Animal products such as meats, eggs and milk have great potential for supporting important nutrients such as fatty acids, minerals, antioxidants and bioactive peptides into the diet. Meat is a major source for many bioactive compounds including iron, zinc, conjugated linoleic acid and B vitamins. Meat and eggs are an excellent source of proteins, essential amino acids and fatty acids (Kralik *et.al*, 2012). Milk and dairy products offer thrilling opportunities in the area of functional foods and the functional food components in milk further serve to illustrate the value of dairy products in the human diet. The functional proteins, bioactive peptides, essential fatty acids, calcium, vitamin D and other milk components have health effects on the immune and cardiovascular systems and gastrointestinal tract and intestinal health . The proteins of milk are digested into bioactive peptides by proteolytic enzymes. Some of these peptides exert biological activities such as antihypertensive, anti oxidative antimicrobial(El-Zubeir, and Jabreel, 2008). The functional milk components significantly contribute to the prevention of several diseases like hypertension, coronary vascular diseases, obesity, osteoporosis, cancer, diabetes, and some transmissible diseases (Bhat and Hina,2011). Dairy products rich in proteins, vitamins and minerals, milk has always been considered a healthy animal product. Recently, the market of functional food has been dominated by gut health products, in particular probiotics with 379 products released worldwide in 2005. Probiotic is defined as live microorganisms, as they are consumed in adequate numbers imparts a health benefit on the host. Dairy products are the key

product sector accounted for about 56% of functional foods total global sales in 2004 (Kraliket.al, 2012).

## **2.2 Goat's Milk**

The goat was possibly the first ruminant that was domesticated. Goat originates from Asia and is now deployed almost all over the globe. Goats are very burly animals that prospered in areas where it may be difficult for other animals. Unlike sheep, goats are not drove animals. There are several breeds of goat, but no specialized dairy breed. However, Saanen, Alpine, Toggenburg and chamois breeds have been very successfully selected and bred for boosting and increasing milk products. Because of this, they have been exported all over the world for purpose of being crossed with local breeds. Cashmere and Angora are breeds known for the special wool they produce. Saanen, originally from Switzerland, where they were bred for odor - free milk, are totally white. Like other Swiss breed, they may or may not have horns, they are usually short haired. Saanen goats are used around the world as leading milk producers. Concluded that Damascus goats can thrive with suitable milk production proficiency in Sudan (AL-Amin, 2016).

### **2.2.1 Sudanese Nubian Goat**

The breed was developed along the Nile valley of southern Egypt and northern Sudan. It is dairy type goat characterized by fairly suit body size with small to medium size head humped facial profile and large drooping ears. The back is long and straight. Nubian is the best milk producing goat in Sudan it gives 1½-2 Kg/day (Ahmed, 2007).

### **2.2.2 Health benefits of goat's milk**

Goat milk can be tolerated by most of those who are lactose intolerant. Lactose does not remain for long periods of time in intestine, where it can ferment or cause an osmotic imbalance, followed by digestive contractility. Goat milk does not contain the complex of proteins that are stimulants of allergic reactions to cow dairy products. Therefore, it does not stress the immune system. Goat milk is easier to digest than cow milk, it has smaller protein molecules than cow milk, and the fat molecules in goat milk have thinner, more brittle membranes. And are half the sizes of those in cow milk (Wani, 2011). Goat milk will digest in a baby's stomach in 20 minutes, whereas pasteurized cow milk takes 8 hours. Anecdotal evidence suggests that goat milk is easier to digest due to the softer curd formed in the stomach as a result of the much lower content of a particular type of casein,  $\alpha$ s-1 casein. The implication is that the different casein composition of goat milk allows the digestive products (including lactose) to pass through the large intestine more quickly and helps prevent the symptoms of lactose intolerance. Other properties of goat milk such as its potential to stimulate the growth of probiotic bacteria also help to improve its lactose digestive properties (Holvik, 2013).

### **2.2.3 Goat milk products**

The use of goat milk becomes a prospect to vitiating the dairy market since it allows us to develop added value to dairy products and fermented milk products with certain properties compared to cow milk. The fat of goat milk is more digestible and it may be regarded as an excellent source of energy, for use in different metabolic diseases. The source of goat milk from various breeds is of greater importance considering the genetic polymorphism and the manufacture and functionality of goat-based

product. Goat milk cheese is simple form made by naturally curdle and then draining and pressing .The curdle and there techniques use an acid such a vinger or lemion juice or rennet for coagulate the milk (Yassin,2014).

#### **2.2.4 Nutritive value of goat's milk**

Goat milk frequently improves the diet of many rural families. It is traditionally valued for the elderly, the sick , babies and children who allergic to cow, Goat milk is a nutrient rich food with unparalleled feature among its nutritional and therapeutic properties, goat milk contains high quality proteins and a great content of minerals and vitamins. In addition to better digestibility of lipid fraction, and lower allergenicity of protein fraction, when compared to cow milk (AL-Amin, 2016).

##### **2.2.4.1 Fat**

Goat's milk derives many of its most distinctive properties from its lipid fraction. The average total fat content in the milk is similar to that found in other ruminant species, despite reports that the percentage of fat in goat's milk exceeds that of the cow. Such a controversy most likely derived from the fact that the average percentage of milk fat, as with cow's milk fat, is a variable component, often ranging between 3.0 and 6.0 percent. There are also distinct breed differences in fat composition. It should be remembered, however, the quality and quantity of feeds, genetics season, stage of lactation, etc all influence the average percentage of goat milk fat (Getaneh *et al.*,2016).

#### **2.2.4.2 Proteins**

The milk protein casein of goat milk is sufficiently different from that found cow's milk to be easily different tilted distribution of amino acids in the casein of the milks of goat and cow are similar (Yassin,2014).

##### **2.2.4.2.1 Whey protein**

The value 0.433 g/100 g in the concentration range from 0.346 to 0.524 g/100g .Goat have a unique whey protein composition compared to bovine whey, in which  $\beta$ -Lg represents approximately 50% and  $\alpha$ -La 25%. Goat milk is highly digestible and has higher biological value than cow milk proteins the proteins of goat milk are similar to the major cow milk proteins in their classifications of  $\alpha$ -,  $\beta$ -, $\kappa$ -caseins,  $\beta$ -lactoglobulin,  $\alpha$ -lactalbumin. But they differ in genatic polymorphisms and their indecisions in goat population, the difference in genetic types are due to amino acid substitutions in the protein chains which it turn responsible for the differences in digestibility (Hejtm`ankova`,*et.al* ,2013).

##### **2.2.4.3 Lactose**

Lactose constitutes the main carbohydrate in goat milk (4.1%, 4.7%) but cannot be regarded as a dietary solution to people suffering from lactose intolerance (Al-Amin, 2016).

##### **2.2.4.4 Vitamins and minerals**

The vitamin content of goat milk is similar to that of cow and human milk. The concentration of B<sub>6</sub> and B<sub>12</sub> are equal or excesses than those concentration found in human milk (Yassin, 2014).A natural minerals nutrition program that includes goat milk can bring excellent health benefits. The milk contains major and trace minerals including Ca, Na, Mg, P, K and Zn, Mn, Se, Co, Cu, Fe respectively. For instance, the milk

is a good source of calcium, containing approximately 13% more calcium per serving than cow's milk, and making it one of the predominant natural minerals in milk and containing about 134% more K element (Getaneh *et al.*,2016).

## **2.3 Cheese**

### **2.3.1 Definition of cheese**

Cheese is the fresh or ripened product obtained after coagulation and whey separation of milk, cream or partly skimmed milk, butter milk or mixture of these products of selective concentration of milk (Blume, 2013).

### **2.3.2 Classification of Cheese**

Divides of cheese with the help of chemical compositional data more recently, classification has been typed using casein, peptide and amino acid data produced using electrophoretic and chromatographic methods. The moisture content of cheese serves as the first term to characterize varieties. The fat content is the second term, and treating properties representing a third term. Also found many ways or methods to classify cheese. They can be defined by microbial properties, appearance and mode of packaging. Also the most common methods of classifying cheese are by processing method and milk source (cow, sheep, goat, etc). cheese classified according to moisture content are prescribes as fresh , soft , semi - hard , hard and very hard or classify cheese by including the milk - producing species, moisture to protein ratio and method of coagulation (Ali, 2010 ).

### **2.3.3 Cheese in Sudan**

There are two main types of cheeses in Sudan namely Sudanese white cheese (Gibnabayda) and braided semi hard cheese (Mudaffara). Sudanese white cheese is usually made from cow's , ewe's and goat's milk or their mixtures (El Zubeir and Hashim,2013).

### **2.3.4 Sudanese white soft cheese**

The most popular type of cheese manufacture in Sudan is Jibnabeyda, which may be consumed fresh but more commonly after maturation in salt brine or salted whey. Sudanese white cheese falls into the family of soft and semi soft pickled cheeses of East European countries, the East Mediterranean region, North Africa, the Balkans and Near East. It is produced in four areas in South and West Darfur States (Abbas,2013).

### **2.3.5 Packing of Sudanese white cheese**

The increase in cheese production in Sudan sealed by soldering. However, soldering of cheese metal packages was prohibited and accordingly the packaging of cheese was change to metal and plastic press lid containers. Osman *et al.* (2009) investigated the effect of vaccum packaging on chemical composition and sensory properties are gradually improved. However, vaccum packaging is currently not feasible in rural areas of Sudan where the majority of cheese is produced (Idris and Alhassan, 2010).

### **2.3.6 Nutritional and health benefits of white cheese**

Cheese is a concentrated product or riches in nutrients like protein , minerals such as calcium, phosphorous and magnesium , fat and soluble vitamins A, D, E and K cheese is a good source of health factors because contain is high content of nutrients such as calcium. Calcium has



prevented bone against osteoporosis increasing dietary calcium; increases bone mass and lower total LDL (low density lipids) cholesterol. The protein in cheese is highly quantity casein; it contains all the essential amino acids needed by human bodies (ElOwni and Hamid, 2009). Cheese content amount of fat is necessary in the human diet, also content is low fat and fat free and fat soluble vitamins. Cheese is a good source of essential fatty acids such as linoleic and linolenic acids, conjugated linolenic acid (CLA) is concentrated in cheese has been against cancer, enhance immune system and decrease inflammation (Yassin, 2014)

### **2.3.7 Cheese manufacture steps**

Cheese manufacturing is the best way for keeping of milk (Elfdial, 2015). The first step in the cheese making process involves the coagulation of milk. For the principal of cheese (75% of the total cheese), this is achieved by adding a small amount of rennet .When rennet is added to milk, nothing seems to happen initially. However after a lag period, the milk rather suddenly begins to coagulate to form coagulum. Actually, a process is set in motion that continues through the aging of the cheese product (Mohamed, 2011).

#### **2.3.7.1 Pasteurization and standardization**

Cheese milk must first be clarified detaching and standardized. The milk may then be exposed to a sub pasteurization treatment to 63-65 c for 15 to 16 seconds. The thermilization treatment results in a reduction of high prima bacteria counts before storage. It must followed right pasteurization whilst HTST pasteurization (72C for 16 sec is often used, a variant heat treatment of 60c for 16 sec may also used. This less shrill heat treatment is thinks to result in a better final flavor of cheese by preserving some of the natural cheese must be stored for 60 days before the sale.

Homogenization is not usually done for most cheese milk . It disable the fat globules and increase the fat surface area where casein molecules adsorb. This results in a soft, poorly curd at renneting and increased hydrolytic rancidity (Blume,2013). Milk standarization means adjusting the fat content in milk to the exact percentage required. Different products require different percentages (Tessema and Tibbo, 2009).

### **2.3.7.2 Inoculation and milk ripening**

The basis of cheese making relies on the fermentation of lactose by lactic acid bacteria (LAB) produce lactic acid which lowers the PH and in turn coagulation, promotes syneresis helps inhibits spoilage and pathogenic bacteria from growing , contribute to cheese texture, flavor and keeping quality. LAB also produce growth factor which hearten the growth of non-starter organisms and supply lipases and proteases necessary for flavor development during curing (Blume ,2013).After inoculation with the starter culture the milk is musk for 45 to 60 minutes at 25 to 30c to ensure the bacteria are active. Growing and have developed acidity. This step is ripening the milk and is act prior to renting (Shrivastava and Swarup, 2014).

### **2.3.7.5 Coagulation**

In this step add the rennet, rennet is enzyme found in stomach calf (natural rennet), rennet is added to form solid curd which can take 30 minutes to 24 hours. Rennet can be diluted in some cool bottle water before to cranking it into the milk, but do not stir for more than 2 minutes (Yassin ,2014).The amount of rennet addend for cow milk decrease by 20% compared to goat milk, the temperature should be regulated and constant during the renneting process. some cheese and coagulated without adding rennent, in this case the coagulation process is produced

by lactic acid bacteria transforming lactose into lactic acid, occur two types of coagulation are enzymatic coagulation and acid coagulation (Ali, 2010 ).

#### **2.3.7.5.1 Enzymatic coagulation (rennet)**

Caseins idealize 80% from ratio protein in milk. Find in the form of large, multi molecular musters called micelles. Casein micelles are globular a musters of the four kinds of casein, alpha  $s_2$ -, beta and kappa- casein (Elfdial,2015).The coagulation takes place in two phases: first a negatively is charged part of the k-casein (1.3 of the k-casein molecule) in split off by hydrolysis (catalyzed by the rennet enzyme) of one peptide bond in k-casein. The casein micelles there by lose a part of the negative charge which otherwise prevent the micelles from coagulating the casein (para casein) is now insoluble in the present of calcium. In the second phase of renneting the para casein micelles aggregate by hydrophobic attraction between hydrophobic amino acid residues in the caseins (Shrivastava and Swarup, 2014).

#### **2.3.7.5.2 Acid coagulation**

In this process, the PH of the milk decrease to 4.6, this changeable the reaction of the calcium phosphate molecules with micelles, and start to form balls, the micelles unstable and start to react with each other forming agel array. The source of acid can be exteriorly (direct acid addition to the milk, such as vinegar or citric acid) or interiorly (from the lactic acid produced by bacteria) (Elfdial,2015).

### **2.3.7.6 Cutting and Draining**

The curds cut in to cubes, in order to promote the curd separate from whey. The cut curds determine the final texture of the cheese (Yassin, 2014).

### **2.3.7.8 Pressing**

The pressing of cheese help to separate more whey, to shape the cheese and to form texture; through pressing process the curds are dressed to short period of time at specific pressure (ElOwni and Hamid, 2009).

### **2.3.7.9 Salting**

Salt is the important for conservation of cheese and for a balanced, pleasant taste and for consistency, for many cheeses salting plays a role in reduction of the moisture content. The lactic acid bacteria are sensitive to salt and will be severely inhibited if the cheese is salted before acidification has finished (Ali, 2010).

### **2.3.7.10 Cheese ripening**

The curd is ripened or matured at different temperature time even the change characteristic flavor development achieved during ripening worsening of lactose and fat are brone out by ripening agents the ripening agents (bacteria and enzymes of the milk, lactic culture, rennet, lipases, added moulds in cheese, environmental contaminants (Blume, 2013)

### **2.3.7.11 Packing**

Some type of cheese such as mould cheeses, soft cheeses, and ripened sour - milk cheeses usually are packed in aluminum foil. Feta- type cheeses and Halloumi, kept in brine in containers, are sold directly from the container or packed in plastic bags with brine (Shrivastava and

Swarup, 2014).The cheese must be packed and considerate good carriage and protect against outside impacts, non occurrence reaction between the packing material and product. The pack must contain suitably labeling (Mostafa, 2008).

## 2.4 Baobab fruit pulp

### 2.4.1 Botanical description tree

Baobab a tree plant belong to the Malvaceae family, is proliferates in hot and drier areas of tropical Africa. The size of this tree is big and the trunk is bulged strong, and cylindrical shaped. Branches are distributed evenly and sizable (Dabora, 2016). The Baobab tree is found in the countries of Southern Africa, such as Botswana, Mozambique, Namibia, South Africa and Zimbabwe. The Baobab tree has been exported around the world, so much so that the Baobab tree is also common in America, India, Sri Lanka, Malaysia, China, Jamaica and Holland (Singh *et al.*, 2013).

**Table 2.1:** The taxonomic classification of the Baobab tree

<b>Kingdom</b>	<b>Planate</b>
Division	Magnoliophyta
Class	Magnoliopsida
Order	Malvales
Family	Bomba
Genus	Adansonia

**Source:** (Phyto Trade Africa, 2006).

#### **2.4.2 The uses of baobab fruit**

The fruit pulp is probably the most important foodstuff. It is dry and mealy and it is used in cool and hot drinks. Pulp can be dissolved in water or milk and the liquid is used as a drink, as a sauce for food, as a fermenting agent in local brewing or as a substitute for cream of tartar in baking (Adedayo *et al.*, 2011).

#### **2.4.3 Ecology and Distribution**

The eight species of baobab find in the single genus ,Adansonia Madagascar is their centre of variety , these species include A.grandidier , A.madagascariensis , A. perrier, A. rubrostipa, A. suarezensis, A. za, A. digitata, A. gregorii, A. digitata is distributed from north as the sahal to little grades south of the Capricorn tropic in the south of the continent (Dabora, 2016). A. gregorii finds in the north western part of Australia in the Kimberley ranges. In Sudan the baobab is occur on sandy soils and by seasonal streams in short grass savannas. it forms waist bands in central Sudan, in Kordofan, Darfur, Blue Nile, Viper Nile, and Bahr Elghazal. It is occur linked with the tamarind. The baobab trees can survives an age of several years under suitable conditions. Baobab tree is discriminated by an inclusive root system, high water holding capacity and resists fire. This adaptation allows it to grow in areas with 100-1000 mm annual rainfall, but tree are growth stopped in the lower rainfall areas (Singh *et al.*, 2013). It is insensitive to soil pH and endures jejune lateritic soils. Such an extensive jejune root system is the best adaptation to utilizing the low annual rainfall. In Sudan reported that the Baobab tree spends four months of the year in leave and this is probably because some photosynthesis occurs in the trunk and branches during the month leafless period (Dabora, 2016).

#### **2.4.4 Chemical composition**

The fruit is a big, oval shaped capsule, covered with yellowish brown filaments. The fruit consists of a solid, woody outer cowry with a dry, powdery substance entered that covers the solid, black kidney-shaped seeds. The Baobab fruit is comprised of outer cowry (45%), fruit pulp (15%) and seeds (40%). The woody cowry contains the internal fruit pulp which is fissure in small floury, dried and powdery slides that attach multiple seeds and filaments, the red fibers that apportioned the pulp in segment (Singh *et al.*, 2013). Pectin is found in most fruits, some in big amounts, the fruit pulp contains high amount of carbohydrate low protein, and low fat (Dabora, 2016). The baobab fruit looks like a coconut, but has six times the vitamin C of an orange, ten times the antioxidant level of oranges, six times more antioxidants than Cranberries, Blueberries, and Blackberries, six times more Potassium than a banana, more Iron than red meat, more Magnesium than Spinach, twice the calcium level of milk, valuable aid in the prevention and treatment of gastric disorder. Baobab pulp extract also contains anti inflammatory, antibacterial, antifungal, antipyretic and analgesic properties (Adedayo *et al.*, 2011).

##### **2.4.4.1 Fruit pulp**

The dry Baobab fruit pulp has a slightly tart, refreshing taste and nutritious, with particularly high values for carbohydrates, energy, potassium, thiamine, nicotinic, acid and vitamin C added that vitamin B<sub>1</sub>, B<sub>2</sub>(Dabora, 2016). The Baobab fruit pulp is dry, acidulous and mealy, and rich in pectin, tartarate and tartaric acids. The presence of the tartarate rise to the name (cream of tartar tree) pulp sweetness is provided by saccharose and glucose contents, fruit pulp is also acidic and this is due to presence of organic acids including citric, tartaric, malic, succinic

as ascorbic acid (Singh *et al.*, 2013). The baobab fruit pulp contains levels of vitamin c ranging from 74 - 163 mg/100g and pectin 23.4-33.9 mg/100g depending on categories and geographical location. It is also a good source of calcium and a source of iron (Dabora, 2016).

#### **2.4.4.2 Vitamin C**

Vitamin C is a powerful antioxidant and extremely important in human nutrition. has been shown to be related to low blood pressure, enhanced immunity against many tropical diseases, lower incidence of cataract development and coronary disease. The daily recommended intake for healthy adults is 65 mg (Singh *et al.*, 2013). Vitamin C content of baobab fruit (2800 mg/kg dry weight), the recommendations can be converted into amounts of baobab powder. The daily recommended dose of vitamin C can be obtained from 23 g of baobab powder (Kabore *et al.*, 2011).

#### **2.4.4.3 Fiber**

Baobab fruit pulp supplies both soluble and insoluble fibers up to about 45 grams per 100 grams of product. Baobab fruit pulp supplies a quantity of soluble (22.54% dry weight) and insoluble (22.04% dry weight) fibers (Abdullahi *et al.*,2014) .

#### **2.4.4.4 Pectin**

*A. digitata* L. has been reported to have high gummy substance called pectin, which is found naturally and has high gelling ability. Pectin is found in most fruits, some in large varying amounts. Some fruits provide enough pectin for jam making, whilst others need to have pectin added from another source . A fruit, which has high pectin content, can be added and blended with a fruit that have low pectin content to give an adequate amount required for jam making. The gelling potential of baobab powder



is unfamiliar to both small and large scale food processors due to limited information on its characteristics .The baobab fruit pulp contains a high level of pectin, and has been found to contain up to 56% water soluble pectin by weight (Ndabikunze *et.al* , 2011).

# **CHAPTER THREE**

## **MATERIALS AND METHODS**

### **3.1 Materials**

#### **3.1.1 Food materials**

Fresh goat milk samples were obtained from Department of Animal Production, Sudan University of Science and Technology, College of Agricultural Studies, and transferred immediately in ice container to Animal Products Department. Coagulant was purchased from a local pharmacy and stored at room temperature around (25°C). Boabab fruit pulp is obtained from market at Bhari city.

#### **3.1.2 Other materials**

Face mask, gloves, aluminum foil and packing materials were purchased from local market at Bhari city.

#### **3.1.3 Chemical materials**

Chemicals and reagents used were obtained from the National Food Research Center (NFRC), Ministry of the Higher Education, Sudan. All the chemical and reagents were of analytical grades.

### **3.2 Methods**

#### **3.2.1 Raw materials preparation**

##### **3.2.1.1 Raw milk**

Raw goat milk was analyzed for protein, fat, moisture, ash content and in addition pH and acidity were determined.

### 3.2.1.2 Baobab fruit pulp powder preparation

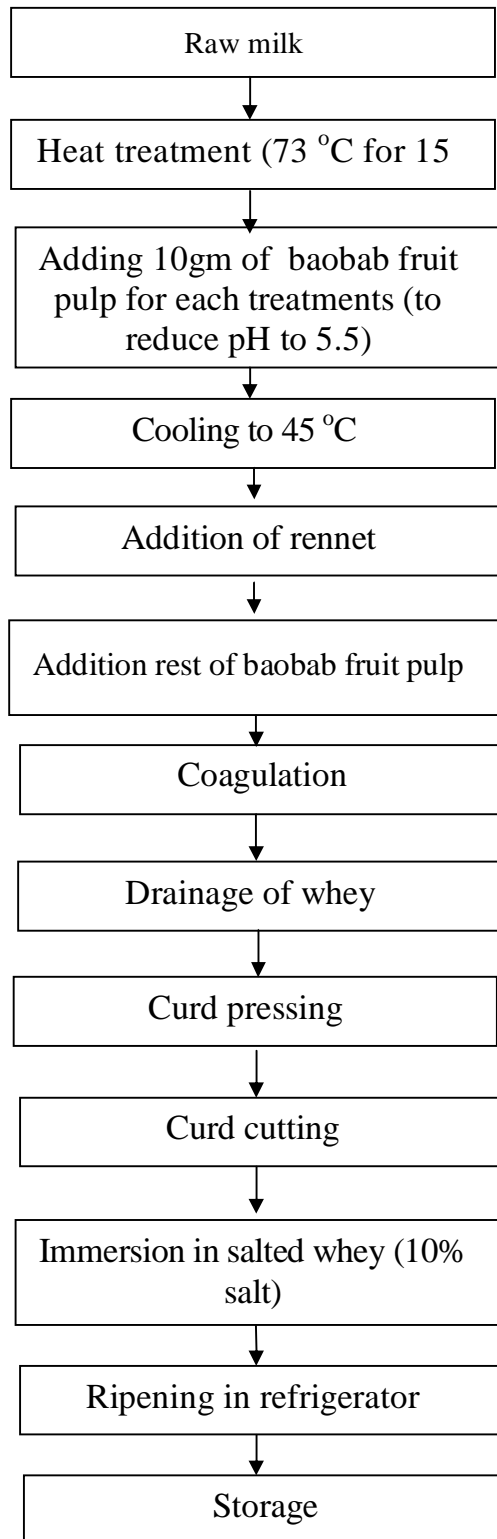
The pulp was separated from the seeds, mixed and passed through a British Standard sieve No ( 250 MIC) and analyzed for moisture, protein, fat, fiber, ash, CHO.

### 3.2.2 Cheese preparation

The experiment was designed to produce goat cheese with the following specifications shown in Table 1. Cheese preparation protocol is shown on Fig 2.

**Table 3.1:** Product formula of goat cheese enriched with baobab fruit pulp powder

<b>Ingredients</b>	<b>Amount (g)</b>
Raw goat milk	Liter
Rennet	2ml
Baobab fruit pulp powder	0, 50, 75 and100 gm
Salt (Sodium chloride)	10 gm



**Figure 1. Goat milk cheese processing steps**

### 3.3 Analytical methods

The Analytical methods were the standard method of the Association of Official Analytical Chemists (AOAC, 2005).

#### 3.3.1 Moisture content

Principle:

The moisture content in a weighed sample is removed by heating the sample in an oven (under atmospheric pressure) at  $105 \pm 1\text{C}^\circ$ . Then, the difference in weight before and after drying is calculated as a percentage from the initial weight.

Procedure:

A sample of  $2 \text{ gm} \pm 1 \text{ mg}$  for baobab powder and  $5 \text{ gm}$  for cheese was weighed into a pre-dried and tarred dish. Then, the sample was placed into an oven (Kat-NR.2851, Elektroheliol, Sweden) and left to dry at  $105 \pm 1\text{C}^\circ$  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 %**

$$\text{Moisture content \%} = \frac{W_1 - W_2}{W_1}$$

Where:

$W_1$  = Original weight of sample.  $W_2$  = Weight of sample after drying.

### **3.3.2 Determination of total solids**

Total solids (TS) content was determined according AOAC (2003). Clean aluminum moisture dishes were dried at 105 °C for 3 hrs. Five grams of the sample were weighed in dry clean flat bottomed aluminum dish and heated on a steam bath for 15 minutes. The dishes were placed into a forced draft oven at 100C° for 3 hrs. The dishes were transferred to desiccators cool and weighted. Heating, cooling and weighting were repeated several times until the difference between successive weighting was less than 0.1mg .the total solids (T.S) content were calculated as follows:

$$\text{T.S}\% = \frac{W_1}{W_2} \times 100$$

Where:

$W_1$ = Weight of sample after drying

$W_2$ =Weight of sample before drying

### **3.3.3 Crude protein determination**

The crude protein content was determined in all samples by micro-Kjeldahl method using a copper sulphate or sodium sulphate catalyst according to the Official Method of the AOAC, (2005).

Principle:

The principle of the method consists of sample oxidation and conversion of nitrogen to ammonia, which reacts with the excess amount of sulphuric acid forming ammonium sulphate. The solution is made alkaline and the ammonia is distilled into a standard solution of boric acid (2%) to form the ammonia-boric acid complex, which is titrated

against a standard solution of HCL (0.1N). Accordingly, the crude protein content is calculated by multiplying the total N % by 6.25 as a conversion factor for protein.

Procedure:

0.5gm  $\pm$  1mg sample was accurately weighed and transferred together with 2-3 glass pellets, kjeldahl catalyst (No 33064, BDH, England) and 20ml concentrated sulphuric acid (No 18474420, Mark AG, Germany) 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. Following, the flask was left to cool to room temperature. The distillation of ammonia was carried out in 30 ml 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:

$$N\% = \frac{\text{Volum of HCL} \times N \times 14}{\text{Weight of sample}} \times 100$$

P% = N%  $\times$  6.38 (factor) and 6.25 for baobab powder

Where:

N% = crude nitrogen. P% = crude protein.

N = normality of HCL.

Equivalent weight of nitrogen.

### **3.3.4 Determination of fat content**

#### **3.3.4.1 Fat content of baobab fruit pulp powder**

Procedure:

A sample of  $5\text{g} \pm 1\text{ mg}$  was weighed into an extraction thimble and covered with cotton that previously extracted with hexane (No.9-16-24/25-29-51, LOBA Cheme, India). Then, the sample and a pre-dried and weighed extraction flask containing about 100 ml hexane were attached to the extraction unit (Electrothermal, England) and the extraction process was conducted for 6 hrs. At the end of the extraction period, the flask was disconnected from the unit and the solvent was re-distilled. Later, the flask with the remaining crude extract was put in an oven at  $105\text{ }^{\circ}\text{C}$  for 3 hrs, cooled to room temperature in a desiccator, reweighed and the dried extract was registered as fat content according to the following formula;

**Calculation:**

$$\text{Fat content (\%)} = \frac{(W_2 - W_1)}{W_3} \times 100\%$$

Where:

$W_2$  =Weight of the flask and ether extract

$W_1$  =Weight of the empty flask

$W_3$ =initial weight of the sample

#### **3.3.4.2 Fat content of cheese**

Fat content was determined by Gerber method as described by AOAC (2003). Ten milliter of Sulphuric acid (specific gravity 1.820 at  $155^{\circ}\text{C}$ ) were measured into Gerber butyrometers, and mixed well, 10.94 mL of



sample was slowly added into butyrometers tube. One milliter of amyl alcohol was added and lock stopper was inserted securely with the stoppers end up. Gerber tube was grasped and shacked with precaution until the sample was completed digested, the Gerber tube were centrifuged at 1100 rpm for 4minutes. Butyrometer was then placed in a water bath at 65°C for at least 3 minutes. The fat percent was finally read out directly from the Colum.

### **3.3.5 Determination of Ash**

The ash content was determined by gravimetric method AOAC (2005). Five grams of the samples (baobab and cheese sample) were weighed in crucibles, and then placed in a muffle furnace at 550-600 C° for 3 hours until ashes were carbon free. The crucibles were then cooled in desiccators and weighed. The ash content was calculated using the following equation:

$$\text{Ash \%} = \frac{W_2}{W_1} \times 100$$

Where:

W<sub>1</sub>= Weight of ash

W<sub>2</sub>=Weight of sample before ashing

### **3.3.6 Lactose content**

Preparation of solution:

The standard solution was prepared by dissolving 5mg lactose in to 95ml of distilled water to give 5% (w/v) solution of monohydrate. One ml of this solution was diluted with 500ml volumetric flask to give 75mg Lactose /ml standard solution. The Anthrone reagent was prepared by dissolving 150mg of Anthrone into 100 ml of 70% (w/v) sulfuric acid.

The solution was then cooled and stored overnight.

Procedure:

One ml of milk and cheese was pipetted into a 500ml flask with distilled water. The solution was then mixed thoroughly and 0.5ml was transferred to boiling tube (sample) standard stock solution (0.5ml) was transferred to a second boiling( blank).To each tube 10ml ice cooled Anthrone reagent was added. The tube were then transferred to boiling water bath for 6 min then transferred to an ice bath and held for 30 min.

The optical density (O.D) was read at 625nm Lactose content (in mg/100 ml) was calculated as follows:

$$\text{Lactose g/100ml} = \frac{\text{O.D of sample} - \text{O.D of blank}}{\text{O.D of standard} - \text{O.D of blank}} \times 4.75$$

Where:

O.D =Optical density

### **3.3.7 Determination of pH**

Ten grams of cheese were weighed and placed in a conical flask and distillate water at 40°C was added until the volume in the flask was 105 ml. The sample was then vigorously agitated and filtered. Then pH of the filtrate was measured by using a recalibrated pH meter model (HI 8521 microprocessor bench pH / MV / °C meter). This has been calibrated with two standard buffers pH 4 and 7, the pH meter was placed into the sample, then it was directly read.

### **3.3.8 Titrable acidity**

Ten grams of cheese were weighed and placed in a conical flask and distillate water at 40 °C was added until the volume in the flask was 105 ml. The sample was then vigorously agitated and filtered. 25 ml of the filtrate were pipetted into porcelain dish and 3-4 drops of phenolphthalein indicator were added. The sample was titrated against 0.1N NaOH until a faint pink color. The acidity calculated from

the following equation:

$$\text{Acidity \%} = T \times 4 / W$$

Where:

T= Titration figure. W=Weight of sample.

### **3.3.9 Crude fiber content**

About 2g ± 1 mg of a defatted sample was placed into a conical flask containing 200 ml of H<sub>2</sub>SO<sub>4</sub> (0.26 N). The flask was then, fitted to a condenser and allowed to boil for 30 minutes. At the end of the digestion period, the flask was removed and the digest was filtered (under vacuum) through a porcelain filter crucible (No.3). After that, the precipitate was repeatedly rinsed with distilled boiled water followed by boiling in 200 ml NaOH (0.23 N) solution for 30 minutes under reflux condenser and the precipitate was filtered, rinsed with hot distilled water, 20ml ethyl alcohol (96%) and 20 ml diethyl ether.

Finally, the crucible was dried at 105 °C (over night) to a constant weight, cooled, weighed, a shed in a Muffle furnace (No.20. 301870, Carbolite, England) at 550-600 °C until a constant weight was obtained and the difference in weight was considered as crude fiber.

#### **Calculation:**

$$\text{Crude fiber (\%)} = \frac{(W_1 - W_2)}{\text{Sample weight (g)}} \times 100\%$$

Where:

W<sub>1</sub> = weight of sample before ignition (g).

W<sub>2</sub> = weight of sample after ignition (g).

### **3.4 Sensory evaluation**

The panels consisted of 12 researchers (4 male and 8 female) Age range (35-45 years) from the National Food Research Center (NFRC), Ministry of Higher Education, Sudan, semi-trained according to the procedure of Cross *et al.*, (1978). The panel evaluated the prepared cheese samples for color, taste, flavor, texture, over all acceptability, using a hedonic scale of 7 points (7 extremely like, 1 extremely dislike). The sample used for sensory evaluation were randomly selected, separately and kept warm for evaluation. Every treatment was given a code number. From each treatment a sample of about 13 samples were placed in a dish having a code number of each sample under natural light. Water at room temperature was made available for the panel to be used between sample testing.

### **3.5 Statistical analysis**

The data collected from the different treatments were subjected to analysis of variance and whenever appropriate the mean separation procedure of Duncan was employed (Steel and Torrie, 1980). The SAS program (SAS, 2010), was used to perform the general linear model (GLM) analysis.

## CHAPTER FOUR

### RESULTS AND DISCUSSION

#### 4.1 Chemical composition of raw materials (Raw milk and Baobab fruit pulp powder)

Raw goat milk had contain 4.1 % protein, 2.93% fat, 0.88% ash, 3.98% lactose, 88.08 % moisture, 11.92 % total solids, 6.96 pH and 0.19% acidity. These results agreement with that obtained by Abdarhman (2011). Generally, the milk composition is affected by water availability, stage of lactation and availability of the green fodder as well as the differences in management system under which the herds are kept (Eissa, 2008). Generally, the above results accordance with SSMO(2010), who stated that cheese milk physical and chemical composition of the milk must be normal, protein content (especially casein) must be high, microorganism count of raw milk must below, raw milk should not contain inhibitors. For baobab powder the results indicated that the powder contains 5.56% protein, 0.64% fat, 6.95% moisture content, 5.01%, CHO 73.54% and fiber content 8.29%. Fat content in Baobab fruit powder in this study was higher than Oyeleke *et.al* (2012) who reported 0.4%, Therefore, the observed variations may result from the analytical methods used, but also from the different Baobab ecotypes and species studied (Ibrahim *et.al* 2013). The fiber result was not far from that reported Oyeleke *et.al* (2012), who found fiber content was 5.7%, These differences may be the species, maturity of the fruits, and environmental soil and climate (Murray *et al.* 2001).

**Table 4.1: Chemical composition of raw materials (Raw goat milk and baobab fruit pulp powder)**

<b>Parameters</b>	<b>Raw goat milk</b>	<b>Baobab fruit pulp powder</b>
Moisture %	88.08	6.951
Protein %	4.1	5.563
Fat %	2.93	0.643
Ash %	0.88	5.013
Total solids %	11.92	93.046
Fiber %	-	8.286
CHO	-	73.541
pH	6.96	-
Acidity %	0.19	-

## **4.2 Effect of baobab fruit pulp powder supplemented on goat milk white cheese**

### **4.2.1 Chemical composition**

Table (4) showed that the moisture content of goat white cheese was significantly decreased ( $p \leq 0.05$ ) with the increase of baobab powder. The highest moisture content was 51.14%. On the other hand, the lowest moisture content was 47.25%, these agree with that obtained by (Dabora, 2016).

Immediately after processing, the different treatments had protein content ranged between 24.04% and 25.46% (Table4 ). Apparently, the protein content of goat cheese increased ( $P < 0.05$ ) with the increase of baobab powder. However the current results are in line with that

reported by Dabora (2016). Protein of goat cheese in this study was 3.06% which is lower than 3.46% that reported by Shazali (2015).

For fat content the result revealed that fat content of cheese increase as baobab powder increase. The lowest value recorded at untreated sample these result consists with Dabora (2016). Fat content of goat cheese was lower than that recorded by Shazali (2015). Table (4) shows that the ash and fiber content significantly increased ( $p \leq 0.05$ ) with the increase of baobab powder from 20.36% to 22.15% and 0% to 4.03% respectively. These results supported with that mentioned by Adedayo, *et al*(2011), who mentioned that baobab fruit pulp very nutritious, with particularly high values for calcium, potassium (very high), thiamine, nicotinic acid and vitamin C, B<sub>1</sub> and B<sub>2</sub> in addition high content of fiber.

Total solids of goat cheese increase with increase baobab powder these may be due to the present of nutrient in baobab powder the lowest value was recorded at control sample, the obtained result on line with Dabora (2016). These results disagreement with that result obtained by Shazali (2015). These variations could be due to several factors including analytical measurement procedures, water availability and stage of lactation (Ahmed *et al.*, 2014).

Lactose content of goat cheese was found in small value it ranged between 0.15% to 0.5% , these may be due to the conversion of lactose sugar to lactic acid. pH of goat cheese decrease as baobab powder increase. The highest value 5.32 recorded at 0% baobab powder, while the lowest one 4.18 recorded at 10% baobab powder, these attributed to presence of organic acids in baobab powder including citric, tartaric, malic, succinic as well as ascorbic acid as mentioned by (Ahmed *et al.*, 2014). For these reason acidity content increase as baobab powder increase from 1.23% at 0% powder to 1.49% at 10% powder. Dabora

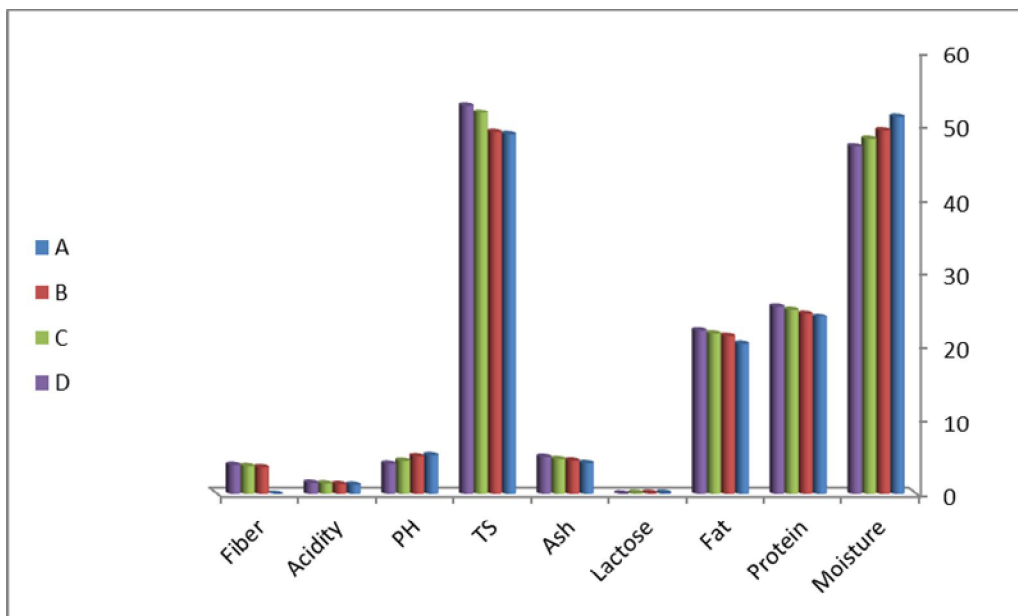
(2016) found that as baobab fruit pulp powder increase the yogurt acidity increase.



**Table 4.2: Chemical composition of goat cheese supplemented with baobab fruit pulp powder**

<b>Treatment (Baobab fruit pulp powder level)</b>	<b>Moisture</b>	<b>Protein</b>	<b>Fat</b>	<b>Lactose</b>	<b>Ash</b>	<b>T.S</b>	<b>PH</b>	<b>Acidity</b>	<b>Fiber</b>
A 0%	51.14 <sup>a</sup> (±0.73)	24.04 <sup>c</sup> (±0.71)	20.36 <sup>d</sup> (±0.15)	0.15 <sup>a</sup> (±0.45)	4.26 <sup>c</sup> (±0.06)	48.86 <sup>c</sup> (±0.74)	5.32 <sup>a</sup> (±0.05)	1.23 <sup>d</sup> (±0.01)	0.00 <sup>d</sup> (0)
B 5 %	49.36 <sup>b</sup> (±0.83)	24.49 <sup>bc</sup> (±0.68)	21.40 <sup>c</sup> (±0.31)	0.15 <sup>a</sup> (±0.05)	4.60 <sup>b</sup> (±0.25)	49.15 <sup>bc</sup> (±0.83)	5.16 <sup>b</sup> (±0.03)	1.33 <sup>c</sup> (±0.05)	3.72 <sup>c</sup> (±0.09)
C 7.5%	48.25 <sup>c</sup> (±1.05)	25.04 <sup>ab</sup> (±0.95)	21.74 <sup>b</sup> (±0.13)	0.15 <sup>a</sup> (±0.05)	4.80 <sup>b</sup> (±0.16)	51.75 <sup>ab</sup> (±0.05)	4.57 <sup>c</sup> (±0.16)	1.40 <sup>b</sup> (±0.03)	3.86 <sup>b</sup> (±0.09)
D 10 %	47.25 <sup>c</sup> (±0.75)	25.46 <sup>a</sup> (±0.70)	22.15 <sup>a</sup> (±0.13)	0.05 <sup>b</sup> (±0.05)	5.10 <sup>a</sup> (±0.16)	52.75 <sup>a</sup> (±0.10)	4.18 <sup>d</sup> (±0.04)	1.49 <sup>a</sup> (±0.07)	4.03 <sup>a</sup> (±0.13)
±SEM	0.35	0.31	0.08	0.02	0.07	0.89	0.04	0.02	0.04

\*Means with different superscript letters in the same column are significantly different (P < 0.5).



**Figure 2. Chemical composition of goat cheese supplemented with baobab fruit pulp powder**

### **4.3 Effect of baobab fruit pulp powder addition on sensory characteristics of goat cheese**

The effect of addition of baobab on sensory properties is shown in Table (5), ranked according to appearance as 5%, 0%, 7.5%, 10% baobab levels.

The taste and flavor score are shown in Table (5), generally as baobab powder increase the flavor decreased. Control sample has the highest score 6.20, while 10% was the lowest score 4.54. These observations were similar to that obtained by (Dabora, 2016).

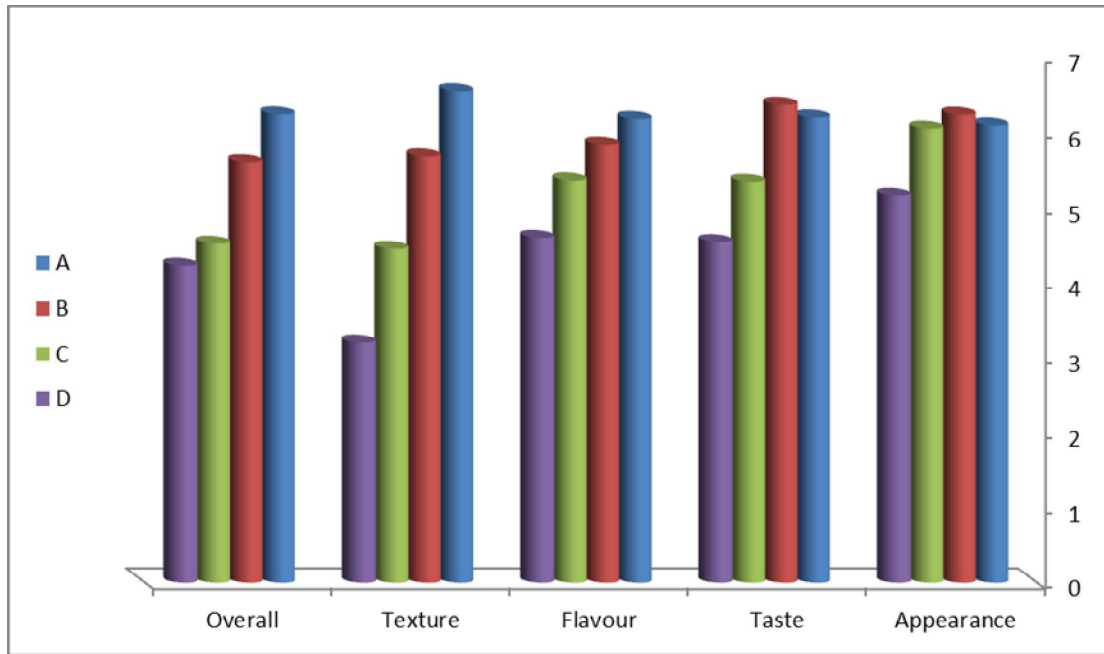
The panelists detected that the incorporation of baobab powder decreased texture of the goat cheese, 0% baobab had the highest score 6.55 of texture among all other treatments.

Within each treatment over all acceptability decreased with increase in baobab powder from 6.24 to 4.22. These results were consistent with that reported by Dabora (2016).

**Table 4.3: Sensory evaluation of goat milk cheese supplemented with baobab fruit pulp powder**

<b>Treatment</b>	<b>Appearance</b>	<b>Taste</b>	<b>Flavors</b>	<b>Texture</b>	<b>Over. All</b>
A 0 %	6.09 <sup>a</sup> (±0.0)	6.20 <sup>a</sup> (±0.23)	6.18 <sup>a</sup> (±0.16)	6.55 <sup>a</sup> (±0.12)	6.24 <sup>a</sup> (±0.07)
B 5 %	6.24 <sup>a</sup> (±0.26)	6.37 <sup>a</sup> (±0.26)	5.84 <sup>b</sup> (±0.20)	5.68 <sup>b</sup> (±0.22)	5.60 <sup>b</sup> (±0.28)
C 7.5%	6.05 <sup>a</sup> (±0.43)	5.35 <sup>b</sup> (±0.40)	5.36 <sup>c</sup> (±0.11)	4.45 <sup>c</sup> (±0.41)	4.52 <sup>c</sup> (±0.19)
D 10 %	5.16 <sup>b</sup> (±0.33)	4.54 <sup>c</sup> (±0.21)	4.60 <sup>d</sup> (±0.47)	3.21 <sup>d</sup> (±0.83)	4.22 <sup>d</sup> (±0.15)
±SEM	0.15	0.09	0.09	0.15	0.08

\*Means with different superscript letters in the same column are significantly different (P< 0.5).



**Figure 3. Sensory evaluation of goat cheese supplemented with baobab fruit pulp powder**

## **CHAPTER FIVE**

### **CONCLUSIONS AND RECOMENDATIONS**

#### **5.1 Conclusions**

Based on the results obtained in the present study, the following conclusions can be drawn:

- Addition of baobab fruit pulp powder to goat milk cheese had increased protein content, total solids, fat, ash, fiber.
- Goat milk cheese supplemented with baobab fruit pulp powder was found to have better flavour, texture and appearance.
- Sample treated with 10% baobab fruit pulp powder was found to have the best nutritional value with lower acceptability score for taste and flavour.

#### **5.2 Recommendations**

- It is recommended that the usage of baobab fruit pulp powder in goat milk cheese could enhance their quality characteristics.
- Further research is needed to make goat milk cheese more acceptable to consumer.

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# APPENDICES



**Appendix 1: Baobab Tree**



**Appendix 2: Preparation of baobab fruit pulp powder**



**Appendix 3: The Pressing**

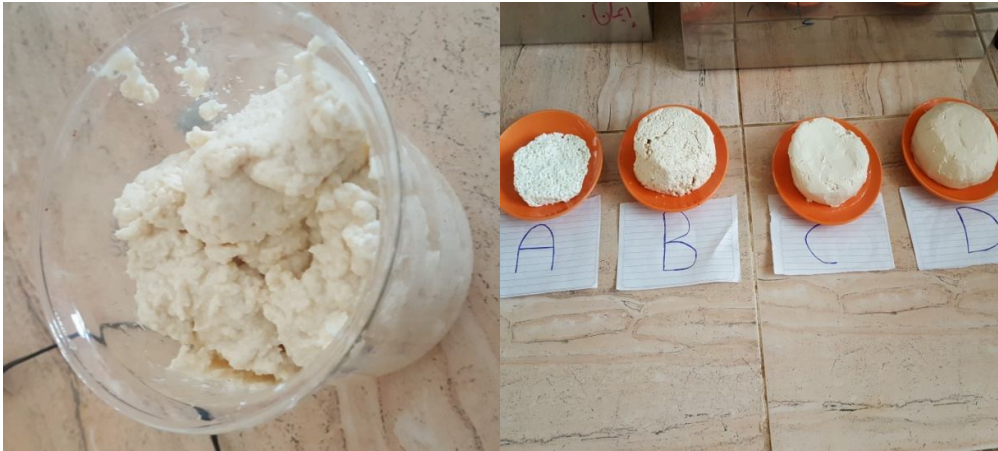


**Appendix 4: Drainage of whey**





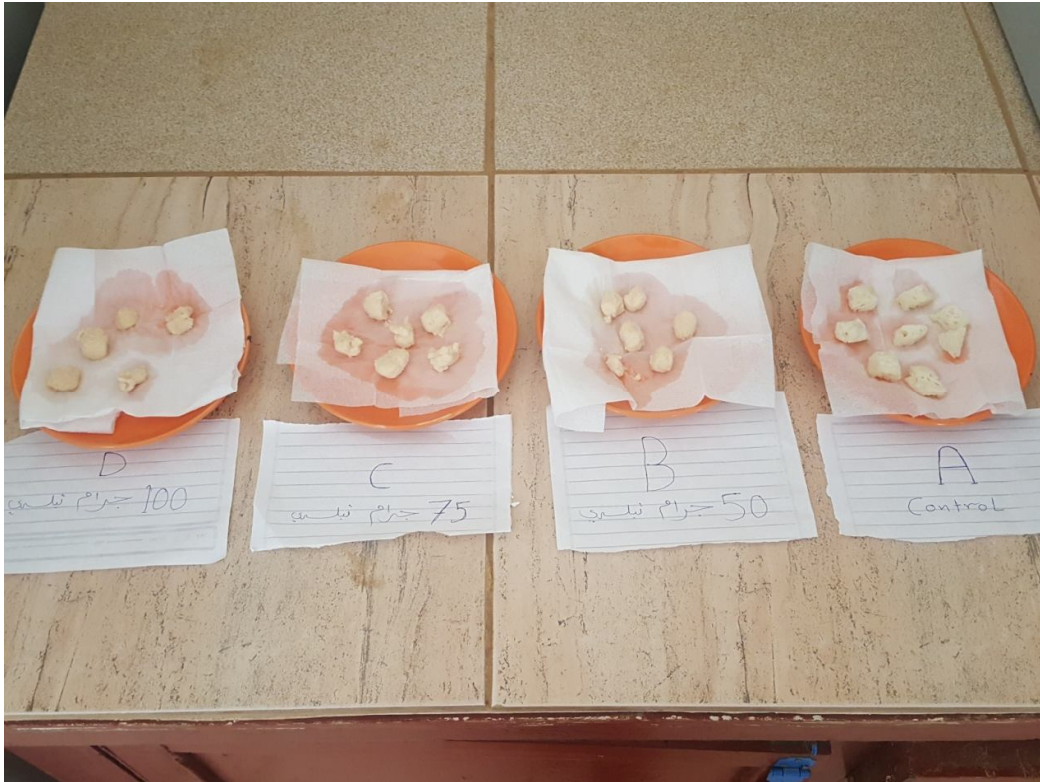
**Appendix 5: The Whey**



**Appendix 6: The Crud**



**Appendix 7: The Salting**



**Appendix 8: Sensory evaluation of goat milk cheese supplemented with baobab fruit pulp powder**

## Sensory Evaluation Form

**Date:**.....

**Number:**.....

7= Extremely like

6= Moderately like

5= Like

4= Slightly like

3= Slightly dislike

2= Dislike

1= Extermely dilike

Sample code	A	B	C	D
Color				
Aroma				
Taste				
Texture				
Overall acceptability				

If you have any question please ask