EFFECT OF STORAGE ON THE MICROBIAL CHEMICAL AND SENSORY CHARACTERISTICS OF YOGHURT MADE FROM COW'S MILK AND GOAT'S MILK

By

Mohammed Sid Ahmed Mahgoub Omer

B.Sc. (Honour) Animal Production

Faculty of Animal Production

University of Khartoum

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Of Master of Dairy Production and Technology

supervisor

Dr. Osman Ali Osman Alowni

Department of Dairy Production

Faculty of Animal Production

University of Khartoum

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DEDICATION

To my father, who encouraged me to complete this work.

To my mother, who gave me continuous love, care and tender during study.

To soul of my cousin Al –Tahir Osman Mahgoub.

To my brothers, sisters, friends and colleagues.

I dedicate this work.

Mohammed
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All praise being to Allah, the almighty for his uncounted support. Peace and blessing of Allah be on the soul of prophet and messenger, Mohammed and his pious companions and followers.

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Effect of storage on the Microbial, Chemical and Sensory Characteristics of Yoghurt made from Cow's milk and Goat's milk

Mohammed Sid Ahmed Mahgoub Omer

M.Sc. Dairy production and Technology

Abstract: This study was carried out on cow's and goat's milk set yoghurt at labrotary of Department of Dairy poduction, Faculty of animal production, Univeasity of Kharoum. Chemical, microbiological and sensory evaluations were carried out on the zero, 3rd, 6th, 9th and 12th days of storage.

Analysis of yoghurt samples made from cow's milk during storage revealed significant (p< 0.05) variation in total solids, protein, Streptococcus subsp count, Lactobacillus subsp count, color and texture. High significant (p< 0.01) variation in fat, lactose, acidity, TBC and flavor. Non significant variation was noticed in ash content.

Analysis of yoghurt samples made from goat's milk during storage revealed significant (p< 0.05) variation in total solid, fat, titrable acidity, TBC, Streptococcus subsp count, color, texture and flavor. Moreover significant (p< 0.01) variation in protein, lactose and Lactobacillus subsp count and non significant variation was noticed in ash content.

The comparison between two types of yoghurt showed significant (p< 0.05) variation in protein and flavor and highly significant (p< 0.001) variation in total solids, acidity, TBC, Streptococcus subsp count, color and texture and non significant variation was noticed in fat, lactose, ash content and Lactobacillus subsp count.
This study concluded that quality of set yoghurt was affected during storage and the cow's milk yoghurt sensory characteristics were different from goat's milk yoghurt. For this reason this study recommended that further studies and research are needed to improve the quality and flavor of goat's milk yoghurt.
مقارنة بين الزيادي المصنع من لين الأبقار ولين الماعز

محمد سيد أحمد محجوуб عمر
ماجستير إنتاج وتغذية الألبان

المستخلص: أُجريت هذه الدراسة على الزيادي متماسك الخثرة التي تم تصنيعها وتخزينها وتحليلها في معمل قسم آليّة الانتاج الحيواني جامعة الخرطوم لتقييّم جودة المنتج الكيميائي والميكروبيولوجي والحسية. أُشتملت الدراسة على التحليل الكيميائي (نسبة الجوامد الكلية ونسبة الدهن ونسبة البروتينات ونسبة الاليكزوز وتحديد نسبة الحمضة) والتحليل الميكروبيولوجي (حساب العدد الكلي للبكتريا والبكتريا السببية والبكتريا العصوية) والتحليل البحري (اللون والنكهة والقوام). أُجرى التحليل الكيميائي والميكروبيولوجي والحسبي بعد التصنيع مباشرة وبعد ثلاثة سنوات، وأظهرت الدراسة أن فترة التخزين تأثر معنويًا (p < 0.05) على الزيادي المصنع من لين الأبقار، حيث أظهرت الزيادة في محتوى البروتينات ونسبة الدهن، بينما أظهرت الزيادة في محتوى البروتينات ونسبة الدهن في الزيادي المصنع من لين الماعز. أظهرت الدراسة أيضاً اختلافات معنوية (p < 0.05) في النكهة والقوام واللون والنكهة، وتفيد هذه الدراسة في خلق زيادة في منتج الزيادي المصنوع من أنواع مختلفة من الحيوانات.
الجوامد الكلية والحموضة والعدد الكلى للكلية والأعداد البكتيريا العصوية واللون والقمار ولم تظهر الدراسة وجود اختلافات معنوية في محتواهما من الدهن واللاكتوز والرماد والأعداد البكتيريا السببية.

خلصت الدراسة إلى أن جودة الزيبادي متماسك الخثة تتاثر بسبب التخزين وأن زبادي لين الإبلار يختلف في الصفات الحساسة عن زبادي لين الماعز. لهذه الأسباب توصي الدراسة بمزيد من البحوث لتحسين جودة نكهة زبادي لين الماعز.
CHAPTER ONE

Introduction

The word yoghurt is derived from the Turkish word (Jugurt) and it's a traditional food and beverage in the Bulkan and the Middle East (Tamime and Deeth, 1980). Yoghurt is very popular fermented milk product produced by lactic acid fermentation of milk by addition of starter culture containing Streptococcus salivarius spp. thermophilus and Lactobacillus delbruekii spp. bulgaricus. It's very versatile product that suits all palates and meal occasions. Yoghurt has many forms including drinkable (liquid) or solid, low fat or fat free, fruity or cereal flavored and is a healthy and nutritious food (Tamime and Robinson, 2000 and Mckinley, 2005).

Since the 1960s, the industrial production of fermented milks (especially yoghurt) has increasingly developed world wide. Several factors account for the success of yoghurt. It's natural image, it's organoleptic characteristics (fresh and acidulated taste and characteristic flavor) nutritional, prophylactic and therapeutic properties (Birollo et al., 2000).

Milk from various mammals such as cow, buffalo, goat, sheep, camel, etc. is used for different nutritional purposes, e.g., feeding to young ones and preparation of some nutritional products such as milk cream, butter, yogurt, ghee, sour milk, etc. (Webb et al., 1974; Hassan, 2005).

Today goat milk and its products play an important role in certain parts of the world due to their beneficial health effects. Goat milk is preferred more in the nutrition of babies, children and patients in many
countries like Germany and France according to its outstanding physiological, microbiological and technological properties (Haenlein, 1993). The use of goat's milk becomes an opportunity to diversify the dairy market since it allows us to develop added value fermented products with particular characteristics, in comparison to cow milk (Vargas et al., 2008).

The major differences between cow's milk and goat's milk are related to the different properties of the different kinds of Casein (\(\alpha_{s1}\)-casein, \(\alpha_{s2}\)-casein, \(\kappa\)-casein etc) and also the different structure and size of fat globules and protein micelles (Tziboula – Clarke, 2003). All this differences could lead to the milk behaving differently during the gelation process and gel formation and thus, could affect the final quality of goat's milk dairy products. In this sense, goat's milk yoghurt differs from cow's milk yoghurt in some important properties like the firmness of the coagulum, which tends to be soft and less viscous (Bozanic et al., 1998 and Karademir et al., 2002).

Although the basic composition of goat's milk is similar to the composition of cow's milk, but physicochemical properties of both types of milk differed significantly from each other. These differences come from the distinctive structure, the composition and size of casein micelles, proportions of individual protein fractions and higher quantity of mineral salts and non-protein nitrogen compounds in goat's milk. It does not remain without an influence on rheological properties of yoghurts from goat's milk. Acid gel from goat's milk is more delicate in comparison to gel from cow's milk (Zander, 1998). However, most of the research work developed in this field deals with the manufacturing of special types of cheese. Little information is available on the production of other products.
such as skimmed milk, flavored milk, yogurt, buttermilk, ice creams, butter, condensed milk or powdered milk. The results obtained from industrial use of cow's milk are not always suitable for the use of goat's milk for the same purpose. Therefore, there is a need to develop specific research for the use of goat's milk in the manufacture of the above-mentioned products (Van Dender et al., 1990). Studies of changes in quality characteristics during storage would enable producers to predict the shelf life of the product more accurately (Salvador and Fiszman, 2004).

The aims of this study were to compare the chemical, microbiological and sensory evaluations of set yoghurts from cow's and goat's milk.
CHAPTER TWO

Literature Review

2.1. Milk

The principal constituents of milk are water, fat, proteins, lactose, and minerals. Milk also contains trace amounts of other substances such as pigments, enzymes, vitamins, phospholipids, and gases (Michael, 2003). The quantitative composition of milk ranged as follow: water 85.5-89.5%, total solids 10.5-14.5%, fat 2.5-6.0%, proteins 2.9-5.0%, lactose 3.6-5.5% and minerals 0.60-0.90% (Alfa-Laval, 1996).

Milk covers nutritional requirement for growing children, convulsing adults, pregnant and lactating woman and for old people. Milk can be used in many recipes and many milk products, for these reason the value of milk as human food cannot be over emphasized (Matthewman, 1993). Milk is a precursor for many food products. It's value has been enhanced by an enormous amount of research, especially over the past 50 years, to support the development and commercialization of dairy-based products with an increasing variety of flavor, texture and shelf life (Tamime, 2007). Milk quality and safety, extensions in shelf life, and new product introductions have brought variety and convenience for the consumer (Goff and Griffiths, 2006).

2.2. Goat

About 8000 B.C., goat was the first animal species to be domesticated by the Sumerians in Mesopotamia. Goat had a strong impact on all phases of the Sumerian's life. Goat was considered by ancient people as a holy entity for worship at the side of gods. In modern
times, goats play an important economic role in farming, providing food for farmers in mountains, arid and semiarid areas (Hatziminaoglou and Boyazoglu 2004). Goats rank third in terms of global milk production from different animal species after cattle and buffaloes (Klinger and Rosenthal, 1997). Although they rank second to cattle in number, goats are more important to the subsistence needs and economic development of peasant farmers because they provide a regular supply of meat, milk and cash throughout the year (FAO, 1990). Milk and dairy products from goats and sheep are very important for proper human nutrition, where cow milk is not readily available or affordable. In some countries more than one half or at least one third of all milk is supplied by goats and sheep, which makes their contribution to sufficient protein and calcium nutrition of people very significant (Haenlein, 2001).

Goat is one of milk sources that characterized by the economic important, since goat can utilize feed roughages and crops residues by products undesirable for human consumption convert into desirable food (Devendra and McLeroy, 1982). Goats are reported to play special role in the life of small holder farmers. Their small size makes it possible for farmers to keep a large herd in small area (Boylan et al., 1996). Goat plays an important role in income generation and nutrition provision (Devendra, 1992).

Goats are very adaptable and are capable of utilizing wide range of plants, which make them easy to keep (French, 1970). Goat is the most versatile domestic animals in adaptation to arid and humid, tropical and cold, and desert and mountain conditions (Gall, 1991; Quartermain, 1991 and Silanikove, 2000). Goats and sheep provide home supply and self-sufficiency for families to avoid starving and malnutrition in protein,
calcium, vitamins and energy. It has been noted that more people around the world drink goat milk than cow milk (Campbell and Marshall, 1975 and Haenlein, 1981).

Between 1965 and 1994 the world goat population was estimated to have increased from 373 million to 609 million head, the average increase of eight million head per year (Nu Nu san and DeBoer, 1996). FAO (2001) reported that the largest animal number increase for goats during the last 20 years (1980-1999) from 458 million to 710 million head, respectively. According to the latest estimate of livestock in Sudan there are about 40.719 million heads of goat (Ministry of Animal Resources, 2000). Four local breed types of goats are known in Sudan: Nubian (the only specialized dairy goat), Desert, Nilotic dwarf and Tegri (Hassan and Elderani, 1990).

2.3. Goat milk

Goat milk is a complex emulsion of fat in watery solution, containing fat, proteins, lactose and minerals; being composed of 88.6% water and 11.4% solids; containing 3.28% fat and 8.13% non fat. Non-fat-solids are composed by 4.29% lactose, 3.20% proteins and 0.64% ash (calcium, phosphorous, magnesium and potassium) (Martins et al., 2007).

Milk composition is affected by the goat’s breed, region and sanitary conditions (free pasture or captivity), feeding characteristics, health conditions and normal season lactation conditions (Jandal, 1996; Wong, 1999; Gomes et al., 2004). In Poland, the mean content of basic goat milk formed as follows: fat 2.25-5.52%, protein 2.58-4.15%, lactose 3.92-5.28%, ash 0.74-0.95%, dry matter 10.44-14.83% (Kudełka, 1996)

Goat milk sample was rated superior in terms of nutritional quality with reference to calcium, magnesium, potassium, chloride and vitamins
A, D, thiamine, riboflavin, choline, inositol, nicotinic acid, B₆, and B₁₂. It was also superior in some essential amino acids such as histidine, methionine, phenylalanine and threonine. Total solids, protein, ash, short and medium chain fatty acids, specific gravity and calorific value were higher for goat milk, which was however lower in sodium, citrate and vitamin C. Goat milk was lower in some essential amino acids namely isoleucine, tryptophan and valine, including essential fatty acid a-linoleic acid (Bille et al., 2000 and Haenlein, 2001). Minerals tended to be absorbed better from goat’s milk than from cow’s milk; goat's milk fatty acids tended to be slightly better absorbed than the cow’s milk fatty acids, especially C₁₄:0 and C₁₈:2 (Feverir et al., 1993).

Goat milk exceeds cow milk in monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), and medium chain triglycerides (MCT), which all are known to be beneficial for human health, especially for cardiovascular conditions (Haenlein, 2004). The nutritional advantage of goat milk fat compared with cow's milk has been attributed to the high content of C₆:0 to C₁₀:0 fatty acids, lack of agglutinin, a high percentage of the short- and medium-chain fatty acids esterifies on the carbon 3 of the glycerol skeleton, and to a small size of fat globules; hence making the dairy product easily digestible (Chilliard et al., 2006). Average goat milk fat differs in content of its fatty acids significantly from average cow milk fat (Jenness, 1980).

Goat milk fatty acids have become established medical treatments for an array of clinical disorders (Haenlein, 2004). According to Alférez et al. (2001) goat milk fats have a unique metabolic ability to limit cholesterol deposits in arteries. Goat milk is more easily digested because of the smaller size fat globules and different casein types, but there for
often has a softer curd in cheese making and lower yield than does cow milk (Haenlein, 2001). Le Jaouen, (1981) reported that the higher amount of these small fat globules in the goat milk is responsible for the better digestibility of goat milk.

There have been shown to be differences in the proportions of alpha-S1, alpha-S2, beta and kappa casein between cow's milk and goat's milk protein. Cow's milk protein is predominantly alpha-S1 casein, while goat's milk protein is predominantly alpha-S2 casein. Both cow's and goat's milk contain beta-lactoglobulin and alpha-lactalbumin. Beta-lactoglobulin is mostly responsible for milk allergy (Tayllor, 1986; Heyman and Desjux, 1992). Boulanger et al. (1984) demonstrated that in casein of goat milk the same four proteins (\(\alpha_{\text{s}1}, \alpha_{\text{s}2}, \beta\) and \(\kappa\)-casein) are present as in casein of cow milk, but individual differences may occur in the content of \(\alpha_{\text{s}1}\)-casein, which seems to range from zero in some samples, designated as “null type”, to very high levels in others “high type”, with many intermediate classes. Subsequently, assay tests indicated that \(\alpha_{\text{s}1}\)-casein can exist in null type milk in very low concentration. Milk with low \(\alpha_{\text{s}1}\)-casein had a faster coagulation time, whereas milk with high levels produced the firmer curd associated with a better chemical composition (Ambrosoli et al., 1988).

Goat's milk has been said to be suitable alternative to cow's milk for people with lactose intolerance and cow's milk protein intolerance, but most of the evidence is anecdotal, so there is some marginal differences which distinguish goat's milk from cow's milk, leading to suggestions that in certain cases goat's milk may be tolerated differently from cow's milk (Frances, 2001). The lactose content of goat's milk appears to give slight advantage over cow's milk for mildly lactose intolerant people, but there
is no clinical evidence to support this (Frances, 2001). Lactose is a sugar found only in milk and milk products. Lactose must be broken down (hydrolyzed) by the enzyme lactase, so that the two component sugars may be absorbed into and used by the body. When the enzyme is partially or totally deficient, lactose cannot be digested and absorbed. The lactose is therefore unchanged when it reaches the large intestine. This can cause symptoms of abdominal pain, cramps, gassy distension, flatulence and diarrhoea. The diarrhoea is due to the ability of lactose to retain water in the colon (Robinson, 2000). Lactose intolerance is usually inherited and is racially distributed, being more common among people of Eastern European, Asian and African origins. In these areas, milk drinking after infancy is traditionally uncommon and levels of the lactase enzyme fall during childhood (Rosado, 1997).

Goat milk and its products of yoghurt, cheese and powder have three-fold significance in human nutrition: (1) feeding more starving and malnourished people in the developing world than from cow milk; (2) treating people afflicted with cow milk allergies and gastro-intestinal disorders, which is a significant segment in many populations of developed countries; and(3) filling the gastronomic needs of connoisseur consumers, which is a growing market share in many developed countries (Haenlein, 2004). The feeding of goat milk instead of cow milk as part of the diet resulted in significantly higher digestibility and absorption of iron and copper, thus preventing anemia (Barrionuevo et al., 2002).

Goat milk is known to have better qualities such as digestibility and longer shelf life when processed than cow milk. Goat's milk can be processed into different milk products. These are: yoghurt, fermented
milk (madila), cheese, butter (more difficult than that of the cow), and cream (Ohiokpehai, 2003).

2.3.1. Goat milk flavor

Fat globules are smaller to much larger proportion, they cream up only very slowly over several days, and their membranes are very fragile, liberating easily lipase, then flavourful fatty acids, and causing rancidity and off-flavor readily (Haenlein, 2001). Goat milk is characterized with its offensive odor. This is especially from buck whose odor floats strongly around the premises and can affect the flavor of the milk. The unpleasant odor is obvious in milk if ventilation, milking practices and cooling of milk are improper or insufficient (Eman et al., 2009a).

Recently milked and cooled goat milk is odor free and hard to distinguish from cow milk in odor and taste (Mowelm, 1988). According to Namibian researchers, the main reason for not liking goat milk products is the ‘goaty’ flavor/odour (Bille et al., 2000). The commercial value of goat milk can be enhanced, especially for higher value milk products, if its goaty flavor can be eliminated or reduced to an unobjectionable level (Gupta, 2004).

The formation of the specific flavor of goat milk is closely linked to the nature of the various constituents in the milk, and also to biochemical and enzymatic factors. The latter depended on the technological treatments applied to the milk and result in degradation of its constituents. Lipase activity and spontaneous lipolysis play a major role in the development of flavor in goat milk (Chilliard 1982a, 1982b). Moreover the effect of the free fatty acids content has been established (Skjevdal 1979 and Astrup et al., 1985).
2.3.2. Goat milk Microbiological quality

The quality of goat milk may be considered as its potential to undergo further processing and result in a product which lived up to the consumers, expectations in terms of health (nutritional value), safety (hygienic quality) and satisfaction (sensory attributes) (Jaubert and Kalantzopoulos, 1996). Difficulties in managing the safety of milk derive from the various sources of contamination. Undesirable organism may get into milk either through the body (endogenously) or from some extended source (exogenously) after milk has been drawn (Lowenstein and Speck, 1983). It has become increasingly clear, internationally, that diseases in dairy animals and the production and handling of milk under poor hygienic conditions, can lead to wide spread outbreaks of human diseases (Giesecke et al., 1994).

Some of the diseases that can be transmitted to humans from milk include salmonellosis, tuberculosis, brucellosis, listeriosis, Q-fever, toxoplasmosis, streptococcus infections, staphylococcal infection and campylobacter infection (Devendera and Burns, 1983 and Mowelm, 1988). Goat milk contains significantly lower bacterial counts than cow or buffalo milk, and that variety of microbial organisms can be present in goat milk without being pathogenic to humans (Haenlein, 1992).

2.3.3. Goat milk yoghurt

Nutritionally goat milk yoghurt had an advantage over cow milk yoghurt due to it is higher nutrient density. Goat milk yoghurt was preferred to cow milk yoghurt in appearance, texture and palatability, while yoghurt from cow milk was preferred in aroma and flavor. The preference for cow milk yoghurt was attributed to the higher content of
citrates in cow milk than goat milk; while the higher total solids goat milk had favorable influence on yoghurt appearance, texture and palatability (Bille et al., 2000). According to Stelio and Emmanuel, (2004) Caprine yoghurt from milk from an Alpine breed, which had the lowest dry matter, showed the lowest degree of firmness and total organoleptic acceptance, showing this milk to be unsuitable for the production of yoghurt.

The quality of yoghurts was markedly affected by the proportion of goat’s milk in the mixture since the increase in the content of goat's milk lead to important differences in terms of the physicochemical properties of yoghurts, especially were regard to syneresis, flow properties, gel firmness and whiteness (Vargas et al., 2008). Higher lactose content in goat milk resulted in more acid goat milk yoghurt (Bille et al., 2000).

In comparison to cow and sheep milk yoghurts, goat milk yoghurt had a looser consistency, higher acidity and was less acceptable sensorically (Domagała, 2008). It is possible to process good quality yoghurt from goat milk using low cost technology (Bille et al., 2000).

2.4. Fermentation

Communities in the Middle East and Asia are widely acknowledged as having introduced fermented milks such as yoghurt into their diet almost as soon as men began to domesticate animals. Some fermented milks did, of course, become popular with local populations in regions like Scandinavia and Russia (Koroleva, 1991). Originally fermented milks developed as means of preserving nutrients (Beena, 2000). Fermented milks are manufactured throughout the world and approximately 400 generic names are applied to traditional and industrialized products (Kurmann et al., 1992).
The international dairy federation (IDF, 1992a- IDF, 1992b) published general standards of identity for fermented milk that could be briefly defined as follows: fermented milk as prepared from milk and/or milk product (e.g. any one or combination of whole, partially or fully skimmed, concentrated or powder whey, milk protein, cream and butter, all of which have been at least pasteurized) by the action of specific microorganisms, which results in reduction of the PH and coagulation. These products include cultured batter milk, sour cream, yoghurt, acidophilus milk, kefir and concentrated fermented milk products (Hargrove and Maedonough, 1972).

The term ‘fermented milk’ or ‘cultured milk’ refer to products such as yoghurt, sour milk, cultured butter milk and sour cream, which are usually made from cow's milk by pure lactic acid fermentation. Additionally, some products are made from milk from other species such as ewes, goats or mares, and combined fermentation (by e.g. lactic acid bacteria and yeast) results in products known as kefir or koummiss (Jaros and Rohm, 2003). The considerable increase in demand for fermented milks noted in recent years has resulted, to a great extent, from consumer awareness of their beneficial effects. However, fermented milks are also highly valued for their unique taste and aroma, which contributed to their growing popularity as well (Saint-Eve et al., 2004).

Many parameters that critically affect the fermentation process and product quality such as the activity of the lactic starter, the milk contamination with lactic acid bacteria inhibitors, the adequacy of heat treatment, and the effect of extrinsic factors such as incubation room temperature (Soukoulis et al., 2007).
2.5. Yoghurt

The use of yogurt dates back many centuries, although there is no accurate record of the date when it was first made. According to legend, yoghurt was first made by the ancient Turkish people in Asia (Kurtz, 1981). Yoghurt is a fermented and coagulated milk product with a smooth texture having mildly sour taste and pleasant flavor. It is obtained from pasteurized or boiled milk by souring natural or otherwise using lactic acid fermented bacteria (Soomro et al., 2003).

According to the code of federal Regulation of the FDA (FDA, 1996) yoghurt is defined as “food product by culturing one or more of the optional dairy ingredients (cream, milk, partially skimmed milk and skim milk), with characterizing bacteria culture that contains the lactic acid bacteria, *Lactobacillus delbureckii* sub sp. *bulgaricus* and *Streptococcus thermophilus*. The lactic acid lowers the PH, makes it tart, causing milk protein to thicken and acts as a preservative since pathogenic bacteria cannot grow in acid conditions (Eman et al., 2009b).

Yoghurts are prepared by the fermentation of milk by lactic acid bacteria, which results in the pH of milk decreasing to pH < 4.6. Industrially, yoghurts can be largely divided into 2 types Set-style yoghurt is made in retail containers giving a continuous undisturbed gel structure in the final product. In stirred yogurt manufacture, the gel is disrupted by stirring (agitation) before mixing with fruit and then it is packaged. Stirred yogurts should have a smooth and viscous texture (Tamime and Robinson, 1999).

Yoghurt in different forms with diverse local names is made throughout the world it's a fermented milk product, which has gained great popularity throughout the world for its recognized sensorial,
nutritional, and health-promoting properties. A large variety of yoghurts, resulting from technologically diversified approaches, as well as various fruits and fruit flavours added, are available on the market today (Tamime and Robinson, 1999 and Tarakci and Erdogan, 2003). Typical plain yoghurt contained 3.5% fat, 12.06% total solids, 3.60% protein, 18.94% moisture, 0.76% ash and 4.2% lactose (Athar, 1986). Tamime and Deeth, (1980) reported that, the types differ according to their chemical composition, method of production, flavor and texture of post-incubation processing.

2.5.1. Factor affecting yoghurt quality

The composition of yoghurt is dependent on the type and source of milk and a range of seasonal factors. For example: whole milk or skimmed milk, season, lactation period and the feeding mode. It is also significantly influenced by manufacturing conditions (such as temperature and duration and equipment utilized) and on the presence of other ingredients such as powdered milk or condensed milk (Blance, 1986). The successful production of yoghurt depends upon the processing techniques i.e. correct selection of starter culture, heat treatment, inoculation and incubation temperature, preservation, handling and propagation of starter cultures that help to standardize and maintain uniformity in the quality of end product (Anjum et al., 2007). One of the most important parameter to determine the quality of the yoghurt is total proteins (Kavas et al., 2003).

The most important factors that are influential in rheological properties of yoghurt are: composition and quality of processing milk, way and level of an enrichment of dry matter components, technological parameters in production, the procedure with end-product during its
transport and storage. Very important is also selection of proper starter culture responsible for acidification of milk and giving desirable sensory properties of the product. The sources of flavor compounds in yogurt are milk components (lactose, milk fat, proteins, citrates) and products of their enzymatic degradation. However, it should be kept in mind that other key factors are the quality and kind of milk, heat treatment intensity, the content of fat, the method and parameters of incubation, as well as the time and conditions of storage (Rasic and Kurmann, 1978; Beshkova et al., 1998a; Tamime and Robinson, 1999; Bikowski, 1997).

2.5.2. Manufacture of yoghurt

The method of manufacture is still based on the system employed by nomadic herdsmen many centuries ago. For example, the majority of yoghurt consumed worldwide are manufactured with culture of bacteria with growth optima of 37-45 °C, and this characteristics derives from the fact that the species in question, namely Lactobacillus delbureckii sub sp. bulgaricus and Streptococcus thermophilus, evolved in the Middle East where the ambient temperature in the summer months is often well in excess of 35 °C, similarly, the universal methods of manufacturing satisfactory yoghurt is based on the traditional process (Robinson et al., 2006). Manufacturing methods vary considerably and for example, depend on the country, the type of product manufactured, the raw material used and the product formulation. However number of common principles is general applied (Staff, 1998).

2.5.2.1. The basic requirements for making yoghurt

To ensure high quality end-product, the milk should have a low bacterial count (i.e. maximum of $1.0 \times 10^5$ colony-forming-units (cfu) g$^{-1}$).
Furthermore, the milk and other dairy ingredients should be free from taints, antibiotic compounds, sanitizing agents and bacteriophages. Somatic count should be $< 4.0 \times 10^5$ cells ml$^{-1}$ (Optimum $< 2.5 \times 10^5$ cells ml$^{-1}$) (Tamime and Robinson, 1999; and Oliveria et al., 2002).

Fresh bovine milk is usually the base material for making yoghurt in the western world, although ovine, caprine or buffalo milks can also be employed. The fat content of most retail yoghurts lies in the range 1.0-4.5 g100ml $^{-1}$. The critical feature of the yoghurt is level of solids-non-fat (SNF). The protein together with minerals, such as calcium and phosphorus give rise to the basic gel structure of yoghurt (Tamime and Robinson, 1999).

2.5.2.2. **Standardization of fat content and fortification of solid-non-fat content:**

The fat content in yoghurt made in different parts of the world may range from 0.1g to as high as 3.5-5.0g100ml $^{-1}$ in order to meet existing or proposed compositional standards. Therefore, it is necessary to standardization as follow: (a) removal of all or part of the fat content (b) mix all milk with skimmed milk. (c) Addition of cream to whole milk or skimmed milk. (d) A process that may combine some of these methods (Tamime and Robinson, 1999).

On an industrial scale, the elevation of the SNF can be achieved by evaporation (EV) or ultra filtration (UF); reverse osmosis (RO) is an optional process. The UF and EV process remove water and hence raise the level of both fat and SNF in the yoghurt base, but UF does allow some loss of lactose and minerals (Lankes et al., 1998 and Robinson; et al., 2002). The alternative route is to add skimmed milk powder (SMP) to
the milk base, and system of hoppers, high-speed blenders and in-tank mixing can be employed to ensure full and rapid incorporation of the milk powder (Robinson and Tamime 1993; Fitzpatric et al., 2001; and Fitzpatric and Cuthbert, 2004).

2.5.2.3. Other ingredient

It is general accepted that natural set yoghurt should comprise nothing other than milk and the starter culture, but stirred fruit yoghurts are permitted in some countries to contain stabilizers, fruit, flavors, sweetening, agent, and preservatives (Robinson et al., 2006).

2.5.3. Processing of set yoghurt

Once the desired composition of milk in terms of fat, SNF and, if applicable, other ingredients has been achieved the milk will usually be homogenized (Robinson et al., 2006).

2.5.3.1. Homogenization:

Whole milk is homogenized at pressure of 10-20 MPa in temperature range of 55-65°C, usually prior to heat treatment, to prevent creaming during fermentation. The process results in the disruption of the milk fat globules, which are stabilized by specific fat globules membrane consisting mainly of proteins, phospholipids and neutral glycerides into much smaller one (Jaros and Rohm, 2003).

Homogenization breaks down fat into smaller globules which prevents the formation of cream line. This improves the consistency and viscosity of yoghurt, thus a greater stability to syneresis can be obtained (Rasic and Kurman, 1978; Tamime and Deeth, 1980; Tamime and Robinson, 1985). Furthermore, homogenization of yoghurt mix breaks up
powdered ingredients resulting in uniform distribution of the ingredients (Vedamuthu, 1991). The covering of the homogenization-induced, enlarged fat globule surface area with fragments of milk proteins leads to the development of the secondary fat globule membrane, which is of great importance for the characteristics of fermented dairy products (Schkoda, 1999).

2.5.3.2. Heat treatment

Yoghurt mix is normally heated at higher temperature and longer time than normal pasteurization, ranging from 90 to 95°C for 5 to 10 min, to help improve product consistency through whey protein denaturation (Mottar et al., 1989; Rasic and Kurman, 1978; Tamime and Deeth, 1980 and Tamime and Robinson, 1985). Heating of the base milk is essential in yoghurt manufacture, and temperature-time condition may be varied to adjust physical properties of yoghurt products (Joras and Rohm, 2003). Heat treatment significantly affected viscosity and acetaldehyde development without influencing incubation time and acidity (Soukoulis et al., 2007).

The objectives of heat treatment of yoghurt mix are to kill pathogenic microorganism and to inactivate lipase and hence to prevent lipolysis (Rasic and Kurman, 1978). Milk heat treatment considered to be critical factor for texture formation. Heating induces whey protein denaturation so that whey proteins can associate casein micelles. Whey proteins are bound to caseins through disulfide linkages and hydrophobic interactions (Law, 1996).

Other essential actions of the heating stage are:
(a) Partial breakdown of the whey proteins to amino acid that stimulate the activity of starter culture.

(b) An expulsion of oxygen from the milk that is beneficial for the growth for the microaerophilic starter bacteria.

(c) A reduction in the indigenous microflora in the milk that might otherwise compete against the added bacteria (Robinson et al., 2006).

High heat treatment of the milk base leads to faster gelatin and firmer gels (Lee and Lucey, 2003). Yoghurt prepared with unheated or inadequately heat-treated milk, is characterized by poor texture, weak gel and firmness, and increased susceptibility against wheying off (Tamime and Robinson, 1999).

2.5.3.3. Inoculation and incubation of starter culture

After heat treatment stage, the milk will be cooled to 42-43 °C ready for the addition of the starter culture consisting of a 50:50 mixture of *Lactobacillus delbureckii* sub sp. *bulgaricus* and *Streptococcus thermophilus* (Robinson et al., 2006). These organisms grow in a protocooperative relationship, resulting in rapid acidification by stimulating each other (Joras and Rohm, 2003). Depending on type and activity of the starter cultures, other metabolites such as carbon dioxide, acetic acid, diacetylene, acetaldehyde, large molecular weight exopolysaccharides or several other compounds are produced besides lactic acid, resulting in the characteristic properties of the products regarding flavor, texture and aroma. Since *Streptococcus thermophilus* is weakly proteolytic its growth is stimulated by the rods, which liberate free amino acids and small peptides from casein. The cocci in turn encourage the growth of *Lactobacillus delbureckii* sub sp. *bulgaricus* by
producing formic acid and carbon dioxide (Matalon and Sandine, 1986 and Rajagopal and Sandine, 1990).

The result of this microbial activity is that the acidity of the milk will have risen to around 1.0-1.2 g 100ml\(^{-1}\) lactic acid (around PH 4.2-4.3) after 3-4 hours. At this acidity the milk proteins will have coagulate to form a firm gel (Lucey and Singh, 2003 and Lucey and Singh, 1997). \textit{Lactobacillus delbureckii} sub sp. \textit{bulgaricus} is more capable in both acid and acetaldehyde production compared to \textit{Streptococcus thermophilus} (Singh and Sharma, 1982).

The essential features are temperature control during incubation and means of cooling the product on a preset PH has been reached (Robinson \textit{et al}., 2006). The determination of incubation time is an essential technical parameter in industrial yoghurt production. Due to the complexity of the fermentation process and the great number of factors entangled in yoghurt coagulation, prediction of the incubation step is difficult, so it is a common practice to control it empirically. In addition, definition of the optimal incubation time is significant not only in reducing the manufacturing cost but also in avoiding deterioration of the quality characteristics of the final product. The end point of the fermentation process is usually defined by the PH value (Soukoulis \textit{et al}., 2007). However, the need to avoid contamination of the milk with undesirable bacteria, yeasts and moulds during inoculation is universal, and number of systems has been developed to achieve this aim (Tamime, 2002). Once the milk has been inoculated, it will follow, one of two routes: it will be filled into cartons for incubation as set yoghurt or it will be fermented in bulk tank stirred yoghurt (Robinson \textit{et al}., 2006).
2.5.3.4. Cooling

When the yoghurt reaches the required acidity i.e. around 0.8-1.0 percent lactic acid, cooling of the coagulum commences and the intention is to reduce the temperature of the coagulum to below 20°C within an acceptable time span. Thus below 20°C the metabolic activity of the starter organisms is sufficiently reduced to prevent the yoghurt for becoming unpalatable due to excessive acidity. Hence initiation of cooling depends on the level of lactic acid required in the end product (usually between 1.2 and 1.4 percent lactic acid) and the rate of cooling that can be achieved with the available equipment and in manner that does not damage the texture of the yoghurt (Robinson, 1981).

Knowledge of the behavior of yoghurt during long storage is important, because its shelf life is based on whether the products display any of the physical, chemical, or sensory characteristics that are unacceptable for consumption (Salvados and Fiszman, 2004).

2.6. Starter culture

The classical yoghurt starter culture is a mixture of *Streptococcus thermophilus* and *Lactobacillus delbureckii* sub sp. *bulgaricus*, with acocci-rods ratio of usually 1:1 (Hassan and Frank, 2001; Hutkins, 2001). The two organisms interact synergistically. This interaction depended on the fact that *Streptococcus thermophilus* grows more rapidly than *Lactobacillus delbureckii* sub sp. *bulgaricus* in milk, and ferment lactose homofermentatively to give L (+) lactic acid as principle product. In addition, carbon dioxide is liberated by the breakdown of urea in the milk by urease, and usually, formic acid (up to 40µg mL⁻¹); all three metabolites stimulate the growth of *Lactobacillus delbureckii* sub sp.
Lactobacillus bulgaricus (Robinson, 2000). Lactobacillus delbureckii sub sp. bulgaricus can hydrolyse casein- especially β-casein- by means of a cell-wall-bound protinase to release polypeptides and, by further enzymatic activity, free amino acids as well (Beshkova et al., 1998b).

The practical result of the synergy is that both species grow rapidly and actively metabolise sufficient lactose to lactic acid to complete the fermentation of milk to yoghurt within 3-4 hours. One species alone might take 12-16 hours to produce the same level of acidity (Tamime et al., 1984). Metabolites liberated by two species give yoghurt a flavor that is distinctly different from any other fermented milk. An acetaldehyde at level up to 40ml L⁻¹ is major component of the flavour profile, and the major pathway for its production by Lactobacillus delbureckii sub sp. bulgaricus and to lesser extent, Streptococcus thermophilus, is conversion of threonine to glycine by threonine aldolase (Zourari et al., 1992; and Marshall and Tamime, 1997).

Some strains of the two species can also produce appreciable levels of extracellular polysaccharide materials, such as the glucans, or polymers involving glucose, galactose and rhamnose as the constituent sugars (Robinson, 1999; Devusty et al., 2003). The presence of these metabolites enhances considerably the viscosity and hence consumer appeal of the retail yoghurt, but a number of factors, such as composition and structure of polysaccharide, the amount produced and the acidity of the milk, all influence the properties of the final product (Laws and Marshall, 2001; and Zoon, 2003).

The most common inoculating material used by the modern dairy plants is the culture comprising Streptococcus thermophilus and Lactobacillus bulgaricus. These microorganisms grow together
symbiotically and are responsible for the production of good taste and aroma in yoghurt. An incubation temperature lies somewhere between 39 °C and 45 °C for the optimum acid production by the two species (Anjum et al., 2007). Lactic acid bacteria are fastidious microorganisms and their growth is often restricted in milk because of its paucity in essential nutrients, thus the success of milk fermentation relies most often upon the synergy between *Streptococcus thermophilus* and *Lactobacillus bulgaricus*. Because both bacteria are able to grow alone in milk, this indirect positive interaction is called proto-cooperation (Courtin and Rull, 2004).

Traditionally, yoghurt is manufactured using *Streptococcus thermophilus* and *Lactobacillus delbrueckii spp. bulgaricus* as starter cultures. These organisms are claimed to offer some health benefits however, they are not natural inhabitants of the intestine. Therefore, for yoghurt to be considered as a probiotic product, *Lactobacillus delbrueckii spp. bulgaricus* and *Streptococcus thermophilus* are at a daily dose of $10^9$ cfu and several authors have indicated that a minimal concentration of $10^6$ cfu/g of a product is required for a probiotic effect (Kumar and Singh, 2007; and Birollo et al., 2000). France and Spain established the requirement of a minimum viable lactic acid bacteria number during yoghurt’s shelf-life of $5 \times 10^8$ cfu ml$^{-1}$. Other countries have established values of $10^6$ cfu ml$^{-1}$ (Switzerland and Italy), $10^7$cfu ml$^{-1}$ (Japan), $10^8$ cfu ml$^{-1}$ (Portugal) and $10^7$cfu ml$^{-1}$ (Turkey) (Birollo et al., 2000 and Anonym, 2001).

**2.7. Nutritional and health yoghurt**

The nutritional and therapeutic effects of yoghurt are well known and mainly attributed to fermentative change in the milk and/or the
metabolic effects of the yoghurt microflora (Irkin and Eren, 2008). Yoghurt has richer composition than milk due to its production conditions and more different substances exist in its combination compared to milk because of fermentation. Thus its nutritional property increases and digestion gets easy as it contains particularly viable yoghurt bacteria and their metabolites, many undesired microorganisms couldn’t grow up in yoghurt and existence of these bacteria has been correlated with several benefits for consumer. Hence, yoghurt is accepted to be safety product (Rasic and Kurman, 1978).

Fermentation improved food safety, nutritional quality through the biosynthesis of vitamins, essential amino acids and proteins. Also through fermentation the digestibility of proteins and carbohydrate is improved. Furthermore, harmful toxic substances are broken down and the bioavailability of minerals is improved (Baltcock and Azam-Ali, 1998). The nutritional and health benefits of yoghurt are numerous. It is a good source of proteins, energy (calories), vitamins and minerals. As a fermented product, it may also have therapeutic value and may also result in reduced incidences of lactose intolerance (Fernandez-Garcia. et al., 1994 and Robinson and Dombrowski, 1983). Certain therapeutic properties associated with yoghurt have increased both its production and consumption all over the world. Many health benefits like protection against gastrointestinal upsets, lowering cholesterol, improved lactose digestion, enhanced immune response, better protein, iron and calcium assimilation are due to live bacteria present in yoghurt (Marona and Pedrigon, 2004)
2.8. Sensory Evaluation

The importance of milk grading lies in the fact that dairy products are only as good as the raw materials from which they were made. It is important that dairy personnel have knowledge of sensory perception and evaluation techniques. The identification of off-flavors and desirable flavors, as well as knowledge of their likely cause, should enable the production of high quality milk, and subsequently, high quality dairy products (Goff, 2008). According to Delahunty (2002) the sensory properties of dairy products, categorized as flavor, texture and appearance attributes, determine consumer acceptability and willingness to repeat purchase of a product, with some additional contribution from their nutritional value and wholesomeness. A majority of sensory properties are complex by definition as they are stimulated by the integrated involvement of many different compositional and structural properties of the product which means that they cannot be adequately detected or represented by instrumental or chemical techniques.

It is important to define flavor, taste and odor. From a sensory perspective, flavor is the total non-textural, non-visual and non-aural perception of food as it is eaten. It comprises taste, which is governed by sensors on the tongue, and odor, which is governed by sensors in the olfactory system on the upper surface of the nasal cavity (Meilgaard et al., 1999). However, due to the sophisticated functioning of the human sensory systems, even a slight change in composition can be detected as a change in sensory character and, therefore, sensory evaluations, in one form or another, has become routinely applied in the dairy industry, in particular for quality control (Delahunty, 2002).
CHAPTER HTREE

Material and methods

3.1.1. Source of material:

Fresh cow’s milk was obtained from the University of Khartoum dairy farm, and goat’s milk was obtained from local farm at Shambat. The milk samples were collected, cooled and transported to the Dairy laboratory, Faculty of Animal Production, Khartoum University for analysis and processing.

The yoghurt (Streptococcus thermophilus and Lactobacillus bulgaricus) were kindly supplied by Khartoum Dairy Products Company, Khartoum North. Plastic cups were purchased from the local market. Yoghurt was manufactured from cow’s and goat’s milk, which subjected to the same procedures.

3.2. Manufacture of experimental yoghurt:

The milk was heated to 95°C for 10 minutes. Heated milk was allowed to cool with constant gentle agitation to an incubation temperature (42 – 43) °C. A starter culture taken from previously manufactured yoghurt was added at rate of 3% (w/v). The inoculated milk was distribution into plastic cups were incubated at 45°C for four hours. Then the set yoghurt cups were removed from the incubator and cooled to 10°C and kept for 12 days. The samples were analyzed for chemical, microbiological, and sensory evaluation during storage at interval of zero, 3rd, 6th, 9th, and 12th days.
3.3. Analysis of milk and yoghurt samples:-

3.4. Chemical analysis:-

3.4.1. Total solid content (T.S %):

The total solid content was determined according to the method of AOAC (1990). Three grams of the milk samples were weighted in dry clean flat bottomed aluminum dish and heated in steam bath until there is little or no free liquid movement in dish (< 25 minutes) the dishes were placed in an oven at 100°C for three hours. Then cooled in a desiccatior and weighed quickly. Weighing was repeated until the difference between the two readings was less than 0.1mg.

The total solid (T.S) content was calculated as follow:

\[ T.S\% = \frac{W_2 - W}{W_1 - W} \times 100 \]

\( W \) = weight of dish

\( W_1 \) = weight of dish + milk test portion

\( W_2 \) = weight of dish + dry milk

3.4.2 Fat content:

Fat content was determined using Gerber methods (Bradley et al., 1992). 10 ml of sulphuric acid (specific gravity 1.820-1.825 at 15.5°C) were measured into Gerber butyrometer. From a well mixed sample, 11 ml of milk or yoghurt was gently added into the butyrometer tube. One ml of amyl alcohol was added and lock stopper was inserted securely
with the stopper end up. The Gerber tube was grasped and shacked with precaution until the curd was completely digested. The Gerber tubes were centrifuged at 1100 revaluation per minute (rpm) for 4 minutes. The butyrometers were placed in a water bath (60-63°C) for 5 minutes. The fat percent was then read out directly from the fat column.

3.4.3. Ash content:

The Ash content was determined according to the method described in the AOAC (1990). Five grams of the samples were weighed in crucible and evaporated to dryness on steam bath. The crucibles were then placed in muffle furnaces at 550°C until ash were carbon free (2-3 hours), then crucibles were cooled in a desicator and weighed. The ash content was calculated using the following equation.

\[
\text{Ash\%} = \frac{W_2 - W}{W_1 - W} \times 100
\]

Where:

\[W = \text{weight of dish}\]

\[W_1 = \text{weight of dish} + \text{milk test portion}\]

\[W_2 = \text{weight of dish} + \text{ash}\]

3.4.4. Protein content:

Protein content of milk samples was determined according to Kjeldahl method as described by AOAC (1990). Five ml of each milk samples were weighed in dry Kjeldahl flasks. Kieldahl tablets of CuSO₄ and concentrated H₂SO₄ (25ml) were added to the flasks. The flasks were heated until clean solutions were obtained (1.8-2.25 hours). The flasks were then removed and allowed to cool.
The digested milk samples were diluted by added 300 ml distilled water to flask. Then 50 ml H$_3$BO$_3$ 4% solution with indicator (bromocresol green / Methyl red) were added to graduated 500ml titration flask and placed flask under condenser tip so that tip is well below H$_3$BO$_3$ solution surface. Seventy five mlNaOH50% were drown side wall of Kjeldahl flask with no agitation. The flask was immediately connected to distillation bulb on condenser. The flask was vigorously swirled to mix content thoroughly; until all NH$_3$ has been distilled. Titratationat H$_3$BO$_3$ was done by receiving solution with standard 0.1 HCl solutions to first trace of pink.

The protein content was calculated as follows:

\[ N\% = \frac{T \times 0.1 \times 0.014 \times 100}{W} \]

\[ P\% = N\% \times 6.38 \]

Where:

\[ T = \text{Reading of titration.} \]

\[ W = \text{Weight of original sample.} \]

\[ P = \text{Total protein.} \]

3.4.5. Titratable acidity:

The acidity of milk samples was determined according to Foley et al. (1974). By measuring 10 ml of milk into a white porcelain dish. Then 0.5 ml of a 1.6% solution of phenolphthalein were added and Titrated with N/9 caustic soda until a faint pink color which lasts for not less than 30 secs was obtained. The titration figure was divided by 10 to give the acidity of the sample expressed as percentage lactic acid (W/V).
1 ml of N/9 NaOH = 1 ml of N/9 lactic acid = 0.01g lactic acid
y ml of N/9 NaOH = 0.01g x y lactic acid
0.01y in 10ml i.e % = 0.1y

Where y is the titration figure.

3.4.6. Lactose content:

The lactose content was determined by subtracting the sum of protein%, fat%, and ash% from total solid T.S%.

Lactose% = T.S% - (Protein% + Fat% + Ash %)

3.5. Microbiological examination:-

3.5.1. Sterilization:-

Glassware such as Petri-dishes, test tubes, pipettes and flasks were sterilized in hot oven at 160°C for one hour (Harrigan and Mc Cance, 1976). Ringer solution used in the preparation of serial dilution was sterilized by autoclaving at 121°C for 15 minutes (Harrigan and Mc Cance, 1976).

3.5.2. Type of culture media used for microbial examination:

All media were prepared according to manufacturer’s instruction:

3.5.2.1. Plate count agar (Scharlau 01-161):

This media was prepared according to Harrigan and Mc Cance (1976), 23.5 grams of the medium were dissolved in 1000 ml distilled water, and then it was sterilized by autoclaving at 121°C for 15 minutes. The medium was then distributed using the pour plate technique.

3.5.2.2. M17 medium (Scharlau 01-247):

The medium was prepared by suspending 66 gms in 1000 ml distilled water. It was bring to boiling with constant stirring until complete dissolution and sterilized by autoclaving at 121°C for 15 minutes.
3.5.2.3. MRS broth (Scharlau 01-135):

The medium was prepared by suspending 57 gms of powder in 1000 ml of distilled water and it was soaked. It was heated to boiling and sterilized by autoclaving at 121°C for 15 minutes.

3.5.3. Enumeration of microorganism:

3.5.3.1. Total bacterial count:

The pour plate technique using plate count agar medium, was used for total bacterial count. The plates were incubated at 32±1°C for 48±3 hours and colonies were counted according to Houghtby et al. (1992).

3.5.3.2. Streptococcus thermophilus:

This was carried out using modified M17 medium, 0.1ml from suitable dilutions were spread on the surface of sterile modified M17 medium. The plates were incubated at 37°C for 48±3 hours according to Frank et al. (1992).

3.5.3.3. Lactobacilus bulgaricus:

This was carried out using modified MRS medium, 0.1ml from suitable dilutions were spread on the surface of sterile modified MRS medium. The plates were incubated at 37 °C for 48 ± 3 hours according to Frank et al. (1992).

3.6. Sensory evaluations:

The sensory evaluation of yoghurt was done by participant uses a nine-point scale (9 for ‘like extremely’ down to 1 for ‘dislike extremely’) to score each attribute (Lawless and Heyman, 1999). The following quality properties were evaluated: color, flavor and texture, using untrained panelists. Samples of yoghurt for sensory evaluation were presented in plastic cups of a volume of 40 gms.
3.7. Statistical analysis:

All the data of this experiment were analyzed statistically by using complete randomized design (CRD). The analysis of variance and the significant differences between means were determined using Duncan Multiple Range Test using SPSS (Statistical Package for Social Science) version 10. Figures were done using Microsoft excel.
CHAPTER FOUR

Result

Table (1) shows the comparison of chemical composition and log10 count of microbial content of cow’s and goat’s milk before and after pasteurization.

The mean total solids values of cows, milk were 13.87±0.12% and the minimum was 13.83% and the maximum was 13.91% for unpasteurized milk and for pasteurized milk were 13.84±0.19%, 13.67% and 14.01% for mean, minimum and maximum values, respectively.

The mean total solids values of goat’s milk were 13.52±0.06% and the minimum was 13.34% and the maximum was 13.69% for unpasteurized milk and for pasteurized milk were 13.68±0.09%, 13.50% and 13.85% for mean, minimum and maximum values, respectively.

The fat content of cow’s unpasteurized milk has mean of 4.60±0.08% and the minimum was 4.48% and the maximum was 4.72%, while fat content in pasteurized milk were 4.58±0.05%, 4.45% and 4.70% for mean, minimum and maximum values, respectively.

The fat content of goat's unpasteurized milk has mean of 4.58±0.10% and the minimum was 4.45% and the maximum was 4.70%, while fat content in pasteurized milk were 4.55±0.13%, 4.43% and 4.67% for mean, minimum and maximum values, respectively.

The protein content of cow's unpasteurized milk has mean of 3.58±0.09% and the minimum was 3.49% and the maximum was 3.67%, while protein content in pasteurized milk were 3.76±0.18%, 3.67% and 3.85% for mean, minimum and maximum values, respectively.
The protein content of goat’s unpasteurized milk has mean of 3.47±0.07% and the minimum was 3.38% and the maximum was 3.56%, while protein content in pasteurized milk were 3.50±0.09%, 3.41% and 3.59% for mean, minimum and maximum values, respectively.

The lactose content of cow’s unpasteurized milk has mean of 4.82±0.07% and the minimum was 4.76% and the maximum was 4.88%, while lactose content in pasteurized milk were 4.87±0.05%, 4.80% and 4.94% for mean, minimum and maximum values, respectively.

The lactose content of goat's unpasteurized milk has mean of 4.81±0.06% and minimum was 4.74% and the maximum was 4.88%, while lactose content in pasteurized milk were 4.88±0.06%, 4.81% and 4.95% for mean, minimum and maximum values, respectively.

The ash content of cow’s unpasteurized milk has mean of 0.75±0.03% and the minimum was 0.72% and the maximum was 0.79%, while ash content in pasteurized milk were 0.73±0.03%, 0.70% and 0.77% for mean, minimum and maximum values, respectively.

The ash content of goat’s unpasteurized milk has mean of 0.74±0.04% and the minimum was 0.71% and the maximum was 0.77%, while ash content in pasteurized milk were 0.75±0.03%, 0.71% and 0.78% for mean, minimum and maximum values, respectively.

The acidity percent of cow’s unpasteurized milk has mean of 0.17±0.01% and the minimum was 0.16% and the maximum was 0.17%, while the acidity percent in pasteurized milk were 0.19±0.01%, 0.18% and 0.19% for mean, minimum and maximum values, respectively.
The acidity percent of goat’s unpasteurized milk has mean of 0.18±0.01% and the minimum was 0.17% and the maximum was 0.19%, while the acidity percent in pasteurized milk were 0.185±0.01%, 0.18% and 0.19% for mean, minimum and maximum values, respectively.

The mean for log total bacterial count (T.B.C) in unpasteurized cow’s milk was 7.33±0.02 and minimum was 7.30 and maximum was 7.35, while in pasteurized milk were 5.99±0.06, 5.99 and 6.04 for mean, minimum and maximum values, respectively.

The mean for log total bacterial count in unpasteurized goat’s milk was 7.31±0.01 and the minimum was 7.28 and the maximum was 7.33, while in pasteurized milk were 5.99±0.06, 5.96 and 6.01 for mean, minimum and maximum values, respectively.
Table (1) : Chemical composition and microbial content of cow’s milk and goat’s milk before and after pasteurization :

<table>
<thead>
<tr>
<th>Items</th>
<th>types</th>
<th>Cow milk</th>
<th>Goat milk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>treatment</td>
<td>Means±sd</td>
<td>min</td>
</tr>
<tr>
<td>Total solids (%)</td>
<td>before</td>
<td>13.87±0.12</td>
<td>13.83</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>13.84±0.19</td>
<td>13.67</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>before</td>
<td>4.60±0.08</td>
<td>4.48</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>4.58±0.05</td>
<td>4.45</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>before</td>
<td>3.58±0.09</td>
<td>3.49</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>3.76±0.18</td>
<td>3.67</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td>before</td>
<td>4.82±0.07</td>
<td>4.76</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>4.87±0.05</td>
<td>4.80</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>before</td>
<td>0.75±0.03</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>0.73±0.03</td>
<td>0.70</td>
</tr>
<tr>
<td>Acidity (%)</td>
<td>before</td>
<td>0.17±0.01</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>0.19±0.01</td>
<td>0.18</td>
</tr>
<tr>
<td>logTBC</td>
<td>before</td>
<td>7.33±0.02</td>
<td>7.30</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>6.02±0.06</td>
<td>5.99</td>
</tr>
</tbody>
</table>
Table (2) shows variations of some quality tests of cow’s milk set yoghurt during storage. The minimum of total solids was 13.55% and the maximum was 13.86%. The total solids of set yoghurt revealed significant (p< 0.05) variations during storage.

The fat content of set yoghurt showed values of 4.48% and 4.63% for minimum and maximum values, respectively. The fat content of set yoghurt revealed significant (p< 0.01) variations during storage.

The protein content of set yoghurt showed values of 3.39% and 3.80%, for minimum and maximum values, respectively. The protein content of set yoghurt revealed significant (p< 0.05) variations during storage.

The lactose content of set yoghurt showed values of 4.52% and 4.85, for minimum and maximum values, respectively. The lactose content of set yoghurt revealed significant (p< 0.01) variations during storage.

The ash content of set yoghurt showed values of 0.71% and 0.74%, for minimum and maximum values, respectively. The ash content of set yoghurt revealed not significant variations during storage.

The minimum of acidity percent of set yoghurt was 0.91% and the maximum was 1.35%. The acidity of set yoghurt revealed significant (p< 0.01) variations during storage.

The minimum count of log total bacterial count (TBC) was 10.55 and the maximum was 12.59. The (TBC) of set yoghurt showed significant (p< 0.01) variations during storage.
The minimum count of log *Streptococcus subsp.* was 8.94 and the maximum was 11.71. The *Streptococcus subsp.* of set yoghurt showed significant (p< 0.05) variations during storage.

The minimum count of log *Lactobacillus subsp.* was 9.39 and the maximum was 11.58. The *Lactobacillus subsp.* of set yoghurt showed significant (p< 0.05) variations during storage.

Table (3) show variations of some quality tests of goat’s milk set yoghurt during storage. The minimum of total solids was 13.10% and the maximum was 13.73%. The total solids of set yoghurt revealed significant (p< 0.05) variations during storage.

The fat content of set yoghurt showed values of 4.40% and 4.60%, for minimum and maximum values, respectively. The fat content of set yoghurt revealed significant (p< 0.05) variations during storage.

The protein content of set yoghurt showed values of 3.31% and 3.66%, for minimum and maximum values, respectively. The protein content of set yoghurt revealed significant (p< 0.01) variations during storage.

The lactose content of set yoghurt showed values of 4.31% and 4.81, for minimum and maximum values, respectively. The lactose content of set yoghurt revealed significant (p< 0.01) variations during storage.

The ash content of set yoghurt showed values of 0.71% and 0.74%, for minimum and maximum values, respectively. The ash content of set yoghurt revealed not significant variations during storage.
The minimum of acidity percent of set yoghurt was 1.18% and the maximum was 1.51%. The acidity of set yoghurt revealed significant (p< 0.05) variations during storage.

The minimum count of log total bacterial count (TBC) was 11.18 and the maximum was 12.20. The (TBC) of set yoghurt showed significant (p< 0.05) variations during storage.

The minimum count of log Streptococcus subsp. was 9.41 and the maximum was 11.59. The Streptococcus spp. of set yoghurt showed significant (p< 0.05) variations during storage.

The minimum count of log Lactobacillus subsp. was 8.85 and the maximum was 11.68. The Lactobacillus subsp. of set yoghurt showed significant (p< 0.01) variations during storage.
Table (2): Variations of some quality tests of set yoghurt produced from cow's milk during storage:

<table>
<thead>
<tr>
<th>Items</th>
<th>(0) mean±sd</th>
<th>(3) mean±sd</th>
<th>(6) mean±sd</th>
<th>(9) mean±sd</th>
<th>(12) mean±sd</th>
<th>L.S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Solids (%)</td>
<td>13.84±0.11  c</td>
<td>13.86±0.08  c</td>
<td>13.77±0.15  b</td>
<td>13.59±0.16  b</td>
<td>13.55±0.10  a</td>
<td>*</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>4.60±0.08   b</td>
<td>4.58±0.13   b</td>
<td>4.63±0.10   c</td>
<td>4.48±0.10   a</td>
<td>4.50±0.08   a</td>
<td>**</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.71±0.17   c</td>
<td>3.66±0.10   c</td>
<td>3.80±0.09   c</td>
<td>3.53±0.17   b</td>
<td>3.39±0.14   a</td>
<td>*</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td>4.79±0.15   b</td>
<td>4.83±0.07   b</td>
<td>4.52±0.22   a</td>
<td>4.85±0.09   c</td>
<td>4.83±0.21   b</td>
<td>**</td>
</tr>
<tr>
<td>Ash%</td>
<td>0.74±0.03   a</td>
<td>0.74±0.04   a</td>
<td>0.73±0.02   a</td>
<td>0.73±0.03   a</td>
<td>0.71±0.02   a</td>
<td>N.S</td>
</tr>
<tr>
<td>Acidity (%)</td>
<td>0.91±0.12   a</td>
<td>1.21±0.06   b</td>
<td>1.31±0.19   b</td>
<td>1.32±0.07   b</td>
<td>1.35±0.07   b</td>
<td>**</td>
</tr>
<tr>
<td>Log Streptococcus</td>
<td>10.10±0.34   c</td>
<td>11.71±0.26   c</td>
<td>10.29±0.78   b</td>
<td>10.53±0.34   b</td>
<td>8.94±0.053  a</td>
<td>*</td>
</tr>
<tr>
<td>Log Lactobacillus</td>
<td>9.57±.022   a</td>
<td>11.58±.036   c</td>
<td>10.29±0.40   b</td>
<td>10.63±0.19   b</td>
<td>9.39±0.09   a</td>
<td>*</td>
</tr>
<tr>
<td>Log TBC</td>
<td>10.55±0.60   a</td>
<td>12.59±0.55   d</td>
<td>11.63±0.52   c</td>
<td>11.77±0.43   c</td>
<td>11.12±0.07   b</td>
<td>**</td>
</tr>
</tbody>
</table>

* = p≤0.05  
** = p≤0.001  
NS = P>0.05

Means with the same raw being similar subscript letter are not significantly (P> 0.05) affected.
Table (3): Variations of some quality tests of set yoghurt produced from goat’s milk during storage:

<table>
<thead>
<tr>
<th>Items</th>
<th>(0)</th>
<th>(3)</th>
<th>(6)</th>
<th>(9)</th>
<th>(12)</th>
<th>L.S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean±sd</td>
<td>mean±sd</td>
<td>mean±sd</td>
<td>mean±sd</td>
<td>mean±sd</td>
<td></td>
</tr>
<tr>
<td>Total Solid (%)</td>
<td>13.73±0.10 a</td>
<td>13.60±0.09 a</td>
<td>13.55±0.10 b</td>
<td>13.27±0.29 c</td>
<td>13.10±0.32 c</td>
<td>*</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>4.58±0.10 b</td>
<td>4.60±0.14 b</td>
<td>4.58±0.10 b</td>
<td>4.55±0.20 b</td>
<td>4.40±0.08 a</td>
<td>*</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.48±0.18 b</td>
<td>3.53±0.17 b</td>
<td>3.44±0.22 b</td>
<td>3.66±0.31 c</td>
<td>3.31±0.10 a</td>
<td>**</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td>4.81±0.14 c</td>
<td>4.73±0.20 b</td>
<td>4.69±0.30 b</td>
<td>4.31±0.38 a</td>
<td>4.68±0.17 b</td>
<td>**</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>0.74±0.03 a</td>
<td>0.74±0.04 a</td>
<td>0.73±0.02 a</td>
<td>0.73±0.03 a</td>
<td>0.71±0.02 a</td>
<td>N.S</td>
</tr>
<tr>
<td>Acidity (%)</td>
<td>1.18±0.07 a</td>
<td>1.31±0.10 b</td>
<td>1.43±0.19 b</td>
<td>1.51±0.13 b</td>
<td>1.51±0.15 b</td>
<td>*</td>
</tr>
<tr>
<td>Log Streptococcus</td>
<td>9.62±0.21 a</td>
<td>11.59±0.30 b</td>
<td>9.92±0.40 a</td>
<td>10.61±0.24 a</td>
<td>9.41±0.10 a</td>
<td>*</td>
</tr>
<tr>
<td>Log Lactobacillus</td>
<td>10.11±0.36 b</td>
<td>11.68±0.31 c</td>
<td>10.32±0.43 b</td>
<td>10.59±0.29 b</td>
<td>8.85±0.59 a</td>
<td>**</td>
</tr>
<tr>
<td>Log TBC</td>
<td>11.30±1.00 a</td>
<td>12.16±0.03 b</td>
<td>12.20±0.11 b</td>
<td>11.80±0.43 b</td>
<td>11.18±0.12 a</td>
<td>*</td>
</tr>
</tbody>
</table>

* = p ≤ 0.05

** = p ≤ 0.001

NS = P > 0.05

Means with the same raw being similar subscript letter are not significantly (P > 0.05) affected.
Table (4) and figure (1) shows variations of sensory evaluation tests of cow’s milk yoghurt during storage. The minimum of color was 6.47% and the maximum was 7.27%. The color of set yoghurt showed significant (p< 0.05) variations during storage. The minimum of flavor was 6.60% and the maximum was 7.57%. The flavor of set yoghurt showed significant (p< 0.01) variations during storage. The minimum of texture was 6.77% and the maximum was 7.37%. The flavor of set yoghurt showed significant (p< 0.05) variations during storage.

Table (5) and figure (2) shows variations of sensory evaluation tests of goat’s milk yoghurt during storage. The minimum of color was 7.27% and the maximum was 7.73%. The color of set yoghurt showed significant (p< 0.05) variations during storage. The minimum of flavor was 6.03% and the maximum was 6.53%. The flavor of set yoghurt showed significant (p< 0.05) variations during storage. The minimum of texture was 6.60% and the maximum was 7.07%. The flavor of set yoghurt showed significant (p< 0.05) variations during storage.
Table (4): Variations of sensory evaluation tests during storage of set yoghurt produced from cow's milk:

<table>
<thead>
<tr>
<th>Items</th>
<th>(0) mean±sd</th>
<th>(3) mean±sd</th>
<th>(6) mean±sd</th>
<th>(9) mean±sd</th>
<th>(12) mean±sd</th>
<th>L.S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>7.10±1.19 c</td>
<td>7.27±0.87 c</td>
<td>7.13±1.04 c</td>
<td>6.80±1.19 b</td>
<td>6.47±0.90 a</td>
<td>*</td>
</tr>
<tr>
<td>Flavor</td>
<td>7.57±0.86 c</td>
<td>7.30±1.15 c</td>
<td>6.97±0.93 b</td>
<td>6.93±1.29 b</td>
<td>6.60±1.28 a</td>
<td>**</td>
</tr>
<tr>
<td>Texture</td>
<td>7.37±0.77 c</td>
<td>7.07±1.29 b</td>
<td>7.07±0.94 b</td>
<td>7.03±1.16 b</td>
<td>6.77±0.77 a</td>
<td>*</td>
</tr>
</tbody>
</table>

*=p≤0.05

**=p≤0.001

NS=P>0.05

Nine-point scale (9 for "like extremely" down to 1 for "dislike extremely")

Means with the same row being similar subscript letter are not significantly (P> 0.05) affected.
Table (5): Variations of sensory evaluation tests during storage of set yoghurt produced from goat’s milk:

<table>
<thead>
<tr>
<th>Items</th>
<th>(0) mean±sd</th>
<th>(3) mean±sd</th>
<th>(6) mean±sd</th>
<th>(9) mean±sd</th>
<th>(12) mean±sd</th>
<th>L.S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>7.73±0.83 c</td>
<td>7.50±1.10 b</td>
<td>7.53±1.40b</td>
<td>7.33±0.99 a</td>
<td>7.27±0.98 a</td>
<td>*</td>
</tr>
<tr>
<td>Flavor</td>
<td>6.43±1.25 d</td>
<td>6.53±1.14 d</td>
<td>6.03±1.19 a</td>
<td>6.40±1.16 c</td>
<td>6.20±1.40 b</td>
<td>*</td>
</tr>
<tr>
<td>Texture</td>
<td>7.07±0.91 b</td>
<td>6.83±0.83 a</td>
<td>6.63±1.16 a</td>
<td>6.60±1.04 a</td>
<td>6.70±1.15 a</td>
<td>*</td>
</tr>
</tbody>
</table>

*=p≤0.05

Nine-point scale (9 for "like extremely" down to 1 for "dislike extremely")

Means with the same raw being similar subscript letter are not significantly (P> 0.05) affected.
Table (6) and figure (3-4) shows variations of some quality tests between two types of yoghurt. The mean of total solids for cow’s milk yoghurt was 13.72±0.14%, while the mean total solids for goat’s milk yoghurt was 13.49±0.33%. The total solids of set yoghurt revealed highly significant (P< 0.001) variations between the two types.

The mean of fat content for cow’s milk yoghurt was 4.56± 0.11% while the mean fat content for goat’s milk yoghurt was 4.54±0.14%. The fat content of set yoghurt showed not significant variations between the two types.

The mean of protein content for cow’s milk yoghurt was 3.62±0.19%, while the mean protein content for goat’s milk yoghurt was 3.48±0.22%. The protein content of set yoghurt showed significant (P< 0.05) variations between the two types.

The mean of lactose content for cow’s milk yoghurt was 4.79±0.21%, while the mean of lactose content for goat’s milk yoghurt was 4.68±0.31%. The lactose content of set yoghurt showed not significant variations between the two types.

The mean of ash content for cow’s milk yoghurt was 0.73±0.03; similarly the mean of ash for goat’s milk yoghurt was 0.73±0.03. The ash content of set yoghurt revealed no significant variations between the two types.

The mean of acidity percent for cow’s milk yoghurt was 1.22±0.19%, while the mean of acidity percent for goat’s milk yoghurt was 1.39±0.18%. The acidity percent of set yoghurt revealed highly significant (P< 0.001) variation between the two types.
The mean of log TBC for cow’s milk yoghurt was 11.53±0.82, while the mean of log TBC for goat’s milk yoghurt was 11.73±0.60. The TBC of set yoghurt revealed highly significant (P< 0.001) variations between the two types.

The mean count of log *Streptococcus subsp.* for cow’s milk yoghurt was 10.31±1.01, while the mean of log *Streptococcus subsp.* for goat’s milk yoghurt was 10.23±0.85, the count of *Streptococcus subsp.* of set yoghurt showed highly significant (P< 0.001) variations between the two types.

The mean count of log *Lactobacillus subsp.* for cow’s milk yoghurt was 10.29±0.85, while the mean of log *Lactobacillus subsp.* for goat’s milk yoghurt was 10.31±1.00 the count of *Lactobacillus subsp.* of set yoghurt revealed not significant variations between the two types of yoghurt.

Table (7) and figure (5) showed variations of sensory evaluation tests between the two types of set yoghurt. The mean of color for cow’s milk yoghurt was 6.94±0.97, which the mean of color for goat’s milk yoghurt was 7.47±1.02. The color of set yoghurt showed highly significant (P< 0.001) variations between the two types. The mean of flavor for cow’s milk yoghurt was 7.07±1.15 while the mean of flavor for goat’s milk yoghurt was 6.32±1.23. The flavor of set yoghurt revealed significant (P< 0.05) variation between the two types of yoghurt. The mean of texture for cow’s milk yoghurt was 7.06±1.01, while the mean of texture for goat’s milk yoghurt was 6.77±1.03. The texture of set yoghurt showed highly significant (P< 0.001) variation between the two types of yoghurt.
Table (6): variation of some quality test between types of set yoghurt produced from cow’s milk and goat’s milk.

<table>
<thead>
<tr>
<th>Items</th>
<th>Cow</th>
<th>Goat</th>
<th>L.S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean±sd</td>
<td>mean±sd</td>
<td></td>
</tr>
<tr>
<td>Total solid %</td>
<td>13.72±0.14 b</td>
<td>13.49±0.33 a</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>Fat %</td>
<td>4.56±0.11 a</td>
<td>4.54±0.14 a</td>
<td>0.709 NS</td>
</tr>
<tr>
<td>Protein %</td>
<td>3.62±0.19 b</td>
<td>3.48±0.22 a</td>
<td>0.030</td>
</tr>
<tr>
<td>Lactose %</td>
<td>4.79±0.21 a</td>
<td>4.68±0.31 a</td>
<td>0.116 NS</td>
</tr>
<tr>
<td>Ash %</td>
<td>0.73±0.03 a</td>
<td>0.73±0.03 a</td>
<td>0.912 NS</td>
</tr>
<tr>
<td>Acidity %</td>
<td>1.22±0.19 a</td>
<td>1.39±0.18 b</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>Log Streptococcus</td>
<td>10.31±1.01 b</td>
<td>10.23±0.85 a</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>Log Lactobacillus</td>
<td>10.29±0.85 a</td>
<td>10.31±1.00 a</td>
<td>0.085 NS</td>
</tr>
<tr>
<td>Log TBC</td>
<td>11.53±0.82 a</td>
<td>11.73±0.60 b</td>
<td>0.000 ***</td>
</tr>
</tbody>
</table>

* = p ≤ 0.05

*** = p ≤ 0.0001

NS = p > 0.05

Means with the same raw being similar subscript letter are not significantly (P > 0.05) affected.
Table (7): Variations of sensory evaluation tests between types of set yoghurt produced from cow’s milk and goat’s milk:

<table>
<thead>
<tr>
<th>Items</th>
<th>Cow</th>
<th>Goat</th>
<th>L.S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean±sd</td>
<td>mean±sd</td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>6.94±0.97 a</td>
<td>7.47±1.02 b</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>Flavor</td>
<td>7.07±1.15 b</td>
<td>6.32±1.23 a</td>
<td>0.013 *</td>
</tr>
<tr>
<td>Texture</td>
<td>7.06±1.01 b</td>
<td>6.77±1.03 b</td>
<td>0.000 ***</td>
</tr>
</tbody>
</table>

* = p≤0.05
*** = p≤0.0001

Means with the same raw being similar subscript letter are not significantly (P> 0.05) affected.

Score = nine-point scale (9 for "like extremely" down to 1 for" dislike extremely").
CHAPTER FIVE

Discussion

Table (1) shows the composition of goat’s milk. These results are in range with that of Kudelka (1996) who reported that in Poland, the mean content of basic goat milk formed as follows: fat 2.25-5.52%, protein 2.58-4.15%, lactose 3.92-5.28%, ash 0.74-0.95%, dry matter 10.49-14.83%, but higher than the findings of Stelios and Emmanuel (2004) they reported that caprine milk from an alpine breed had the lowest value. It’s also supported Domagała and Juszczak (2004) expet the ash content was higher. These results are lower than that of Bille et al. (2000). The result was confirmed Jandal (1996); Wong (1999) and Gomes et al. (2004) who reported that milk composition is affected by the goat’s breed, region and sanitary conditions (free pasture or captivity), feeding characteristics, health conditions and normal season lactation conditions.

Table (1) shows the log count of TBC of goat’s milk. The result obtained was higher, that because large numbers are often related to poor farming practices and poor cleaning system (IDF 1994). The result was higher value than that of Muehlherr et al. (2001) who reported that the log count of TBC for bulk milk tank samples from dairy goat farms was 4.69 cfu/ml. These results were in agreement with Bille et al. (2000) who reported that goat milk was also higher in microbial load than cow milk, which was attributed to difference in milking technique and the goats were milked by hand and the cows were milked more hygienically by machine.
Table (1) shows total solids and fat content of the cow’s milk. The results obtained were in agreement with total solids reported by Webb et al. (1974) and Hassan (2005) and disagreement for fat reported by Webb et al. (1974) and Hassan (2005) who reported that the total solids in the milk ranged from 10% to 17%, which include fat and non-fat materials. The amount of fat materials is 3% to 4% and the amount of non-fat material is in the range of 7% to 10%.

Table (1) shows the protein content of cow’s milk. The result was in agreement with that of Webb et al. (1974) and Hassan (2005) who found that the total protein content of milk range from 2% to 4%, and the milk protein have the high nutritional value and the principal component of the milk proteins is casein, which constitutes about 75% of all milk proteins.

Table (1) shows the lactose and ash content of the cow’s milk. These results are in range for lactose and high for ash with that of Webb et al. (1974) and Hassan (2005) who found that the lactose in the milk was from 2% to 5%, while ash content was about 0.65%.

Table (1) shows the acidity percent of the cow’s milk. The obtained result was in agreement with that of Rehman and Salaria (2005) they reported that the lactic acid ranged from 0.15±0.03% to 0.26±0.03%.

Table (1) shows the log count of TBC of the cow’s milk. The result was higher value than that of FDA (2008) reported that the standard limit for standard plate count as 20,000 CFU/ml.

The results of cow’s milk composition were in range reported by Alfa-Laval (1996) who reported that the quantitative composition of milk
ranged as follow: water 85.5-89.5%, total solids 10.5-14.5%, fat 2.5-6.0%, proteins 2.9-5.0%, lactose 3.6-5.5% and minerals 0.60-0.90%.

Table (2) shows significant variations of total solids during storage. The result was in agreement with Anjum et al. (2007) who reported that treatment and storage period had significant effect on the total solids of yoghurt samples prepared by locally isolated starter culture and commercial starter culture. It is evident from the result that reduction in total solids throughout storage period might be due to change of lactose into lactic acid by lactose fermenting bacteria in yoghurt. These results were confirmed Tamime and Robinson, (1985). In general the present result was lower than that of Hussain et al. (2009) who reported that the average total solids content of natural yogurt was of 19.2 with a standard deviation of 0.035.

Table (2) shows significant variations of fat content during storage. The result was in agreement with that of El-abbassy and Sitohy (1993) they reported that during storage the fat/Dm% decreased as a result of probable fat hydrolysis. The result was disagreement with Anjum et al. (2007) who reported that the fat content of yoghurt, displayed statistically not significant difference for reduction in fat content at the end of storage period that might be due to production of volatile fatty acids by yoghurt organisms.

Table (2) shows significant variations of protein content during storage. The result was in agreement with that of Tamime and Robinson (1985) they reported that the protinase activity of *Lactobacillus bulgaricus* hydrolyses the casein to yield polypeptides and broken down by the peptidases of *Streptococcus thermophilus* with liberation of amino acids. This supported El-abbassy and Sitohy (1993) they reported that
during storage, there was slight decrease in TN of yoghurt samples. El-abbassy and Sitohy (1993) and El-Shibiny et al. (1979) reported that non-protein-nitrogen (NPN) content of yoghurt samples gradually increased during storage period, this could be attributed to limited hydrolysis of milk protein. In general the protein content of milk cow yoghurt was lower than that stated by Turkish Food Codex Fermented Milk Bulletin (Anonym, 2001) that the minimum protein content requirement was 4%.

Table (2) shows significant variations of lactose content during storage. The result was in accordance with Anjum et al. (2007) who reported that lactose content of the sample manifested a decreasing trend. It’s also supported Toba et al. (1983) who reported that lactose content of yoghurt mix progressively decreased during storage period and glucose content of mixed progressively increased during storage.

Table (2) shows not significant variations of ash content during storage. The result was discordance with that of Shanley (1973) who found that the protein and ash contents of yoghurt decreased with progress of storage period. The result was lower than that of Nahar et al. (2007) who reported that the ash percent of cow’s milk dahi was 0.809±0.04. It also supported Lingathurai et al. (2009) who reported that the average level of ash was 0.80%. The result was higher value than that of El-Bakari and El-Zubeir (2009) they reported that the mean of ash content of plain yoghurt was 0.678±0.146.

Table (2) shows the acidity percent of yoghurt during storage. The present study revealed increased acidity during storage; increase in acidity was due to the formation of lactic acid by bacteria present in yoghurt during storage period Anjum et al. (2007). It also supported Hussain et al. (2009) and Guller and Mutlu, (2005) who observed an
increase in total titrable acidity during storage period. The result was
disagreement with Salvador and Fiszman (2004) they found that the PH
value barely changed over storage time indicating that the yoghurt
samples did not developed much acidity under any of storage condition
studied.

Table (2) shows significant variations of number of *Streptococcus*
*subsp.* and *Lactobacillus* *subsp.* during storage. These results were
revealed decreased in number during storage, a number of factors that
affect the loss of viability of probiotic organisms in yoghurt, including
acidity of products, acid produced during refrigerated storage (also
known as post acidification), level of oxygen in products and oxygen
permeation through the package, sensitivity to antimicrobial substances
produced by starter bacteria, lysogenic charcter of bacteria and lack of
nutrients in the milk Dave and Shah (1997) and Tamime *et al.* (2005). It
also supported Salvador and Fiszman (2004) they reported that at 10c° a
considerable reduction in both cultures was observed at the end of
storage. The results were disagreement with Vargan *et al.* (1989) who
stated that there were no reports on the changes in yoghurt flora during
storage of fermented soy milk. In general these results are higher than
that of Irkin and Eren (2008) they reported that viable *Streptococcus*
*thermophilus* and *Lactobacillus bulgaricus* number were between 10⁷-10⁸
cfug⁻¹ for yoghurt producing with starter culture.

Table (2) shows significant variations of number of TBC during
storage. The result was in agreement with that of Reps *et al.* (2008) who
found that, the decrease of number of living bacteria was observed in
yoghurt during storage. The result was higher value than finding of El-
Bakari and El Zubeir (2009) they reported that the means of
microbiological measurement for the plain yoghurt samples were log 9.10±9.86.

Table (3) shows significant variations of total solids during storage. The result was agreement with that of Anjum et al. (2007) who reported that total solids decreased gradually during storage period in both type of samples. The result was disagreement with that of Kavas et al. (2003) who reported that it is accepted that the increase during 14 days on total solids content were not significant and attributed to the evaporation, it’s supported Akalin (1993) who reported that the increase determined during the storage period is normal.

Table (3) shows significant variations of fat content during storage. The result was in agreement with that of Koestanti and Romziah, (2008) they reported that the decreasing of fat in yoghurt happened due to the breakage of lipid during fermentation process splitting-up fresh milk becomes deep yoghurt, so that fat content decrease. The result was disagreement with Anjum et al. (2007) who reported that fat% did not change during storage. The result was higher value than that of Guler and Mutlu (2005) they reported that the fat content of bio-yoghurt made from goat’s milk was 3.1%.

Table (3) shows significant variations of protein content during storage. The result was in agreement with that of Serra et al. (2009) who reported that in all treatments studied, caseins were hydrolyzed and hydrophobic peptides were increased during storage, as reflected by the increase in soluble nitrogen at the end of the storage. The result disagreement with Koestanti and Romziah (2008) they reported that at the fermentation process, biomass microbe Lactobacillus bulgaricus and Streptococcus thermophilus increase, thus the sum of microbe protein
increase, that automatically increasing protein inside the yoghurt. El-shibiny et al. (1979) reported that the increase in free amino acids of yoghurt during storage suggests limited proteolysis of milk protein.

Table (3) shows significant variations of lactose content during storage. The result was in accordance with Anjum et al. (2007) who reported that lactose content decreased as dose of starter culture and storage period increased, it’s supported Goodenought and Kleyn (1976) they reported that the decrease in lactose content during storage is due to production of lactic acid.

Table (3) shows not significant variations of ash content during storage. The result was disagreement with that of Hidiroglou and Proulx (1982) they reported that milk Ca, P and Mg contents were all highest during the first day of storage then decrease sharply at 2nd day. The result was lower than that of Nahar et al. (2007) who reported that the ash percent of goat’s milk dahi was 0.784±0.06; it’s supported Bille et al. (2000) who reported that ash content of goat milk was 0.83%.

Table (3) shows the acidity percent of yoghurt during storage. The present study was revealed increased acidity during storage; the result was in accordance with that of Kavas et al. (2003) who reported that the acidity increase in yoghurt during the storage was also to be significant. It’s supported El-abbasy and Sitohy (1993) they found that the acidity increased and PH decreased gradually in yoghurt samples until the end of storage period. Fernandez-Garcia et al. (1994) found that the content of organic acids in yoghurt during fermentation and cooled storage of yoghurt continuously changed, and this affect PH of yoghurt during storage.
Table (3) shows significant variations of number of *Streptococcus subsp.* and *Lactobacillus subsp.* during storage. The results were revealed decreased in number during storage; that could be due to the lower storage temperature and over acidification have been reported to limit the growth of *Lactobacillus delbureckii spp. blugaricus* Kenifel et al. (1992). The results were in accordance with that of Ekinic and Gurel (2008) they reported that the viable counts of *Streptococcus thermophilus* in control during storage changed from 8.33 log (cfu g\(^{-1}\)) on day 1 to 6.33 log (cfu g\(^{-1}\)) on day 15. The results were in agreement with that of Kumar and Singh (2007) they reported that yoghurt to be considered as a probiotic product. *Lactobacillus delbrueckii ssp. bulgaricus* and *Streptococcus thermophilus* are at a daily dose of 10\(^9\) cfu. It’s also supported Irkin and Eren (2008) they reported that yoghurt which are produced by starter culture have high numbers of yoghurt bacteria means that yoghurt produced by using starter culture have higher therapeutic and/or antimicrobial properties beside their organoleptic characteristics.

Table (3) shows significant variations of number of TBC during storage. The result agreed with that of Sun and Griffiths (2000) they reported that during storage and distribution, the cell number significantly decreases due to the over produced lactic acid. It’s also supported Sofu and Ekinci (2007) they reported that total plate counts were lower for whole-fat yoghurt samples, possibly due to the decrease in PH during storage. The result was higher value than that of Nahar *et al.* (2007) who showed that the total viable bacteria count per ml of dahi prepared from goat milk was 5.859±0.05 (log value).

Table (4) and figure (1) shows significant variations of colors during storage. The result agreed with Vargas *et al.* (2008) who reported
that the compaction of the solid matrix and the increase in the syneresis index during storage explain these color change, it’s also supported Hutchings (1999) who reported that the changes in color coordinates can be attributed to the different level of opacity.

Table (4) and figure (1) shows significant variations of flavor during storage. The result was observed confirmed the finding of Oberman (1985) who found that diacetylene reductase enzyme becomes responsible for loss of the flavor after long storage. Foda et al. (2007) reported that prolonging cold storage period affect the flavor significantly could be due to the strong taste. The results were disagreement with that of Salvador and Fiszman (2004) they reported that no significant changes in relation to the storage time were found in color and flavor intensity for either type of yoghurt.

Table (4) and figure (1) shows significant variations of texture during storage. The result disagreement with that of Becker and Puhan (1989) they found that high protein content gives higher firmness values, indicating that this characteristic was not greatly affected by the different storage conditions. It’s also supported Herrero and Requena (2006) they found that the textural properties of yoghurt showed no significant differences throughout the shelf period of 28 days. Abu-Jdayil and Mohemed (2002) reported that throughout storage, protein rearrangement was continuing, and more protein-protein contacts were being established, leading to increasing viscosity during storage.

Table (5) and figure (2) shows significant variations of colors during storage. The result agreed with Sofu and Ekinci (2007) they reported that the color block with grayish-greenish yellow color was dominant in both whole- and low-fat yogurts at the end of storage. The
presence of these colors is associated with microbial spoilage of the food product. The color analysis data were parallel to PH and microbial count data. The result obtained was disagreement with the finding of Salvador and Fiszman (2004) they reported that no significant changes in relation to time were found in color, flavor intensity and sweetness for either type of yoghurt. The score of all sensory parameters significantly decreased after the addition of goat milk, except whiteness and creaminess which increased significantly when more goat’s milk was added.

Table (5) and figure (2) shows significant variation of flavor during storage. The result observed confirmed the finding of Ekinci and Gurel (2008) they reported that, in general, the level of carbonyl compounds decreased during cold storage, this could be associated further with metabolic activity of the starter cultures during the storage period. It’s also supported Ozer (2006) and Radi et al. (2009) who reported that acetaldehyde, which is main flavor substance in yoghurt, metabolized to ethanol via alcohol dehydrogenase of Streptococcus thermophilus. Flavor scores at zero time were significantly higher than of two weeks.

Table (5) and figure (2) shows significant variations of texture during storage. The result was in accordance with Mumtaz et al. (2008) who reported that texture was affected significantly during storage in all experimental yoghurts. The result was disagreement with Radi et al. (2009) who reported that the different yoghurt samples showed similar texture after two weeks of storage as that of zero time. This supported Herrero and Requena (2006) they found that the texture properties were maintained constant throughout the shelf-life of the product.

Table (6) and figure (3) shows significant variations of total solids between goat’s and cow’s milk yoghurt. This might be due to the
increased total solids in cow’s milk compared to goat’s milk. The result was in agreement with Soukoulis et al. (2007) who reported that yoghurt quality may be improved by properly selecting the parameters associated with fermentation process and compositional properties of the milk base. Similarly it supported Brendehaug and Abrahamsen (1986) they reported that the goat milk is characterized by very large inconstancy in it is chemical composition during lactation period which results in differences in dry matter (DM) content of that raw material. The results were disagreement with that of Kavas et al. (2003) who reported that milk kind and concentration method are not effective on total solids content of the yoghurt samples.

Table (6) and figure (3) shows not significant variations of fat content between goat’s and cow’s milk yoghurt. The results were in agreement with that of Kavas et al. (2003) who reported that milk kind and storage affects were found not to be significant on the fat contents of the yoghurt samples. The results were disagreement with the that of Salvador and Fiszman (2004) they reported that the major difference between cow’s milk and goat’s milk were those concerning lipid and casein content, which was significantly higher for goat’s milk, similarly it supported Jenness (1980) who reported that average goat milk fat differ in content of its fatty acids significantly from average cow milk fat.

Table (6) and figure (3) shows significant variations of protein content between goat’s and cow’s milk yoghurt. This might be due to the differences in the protein content of the cow’s milk and goat’s milk. The results were in agreement with that of Domagała (2008) who reported that an important role is also played by the composition and physicochemical properties of milk which yoghurt prepared from. It’s
also confirmed Morón et al. (2000) and Chandan et al. (1992) who reported a comparative study on the composition of proteins in goat and cow milk and, specifically, of their amino acid profile. The latter parameter was similar in both types of milk, except with respect to sulphur amino acids, which were present in a higher concentration in the goat milk protein in comparison with cows. Other differences were also found, but these concerned more the physico-chemical nature of the proteins, and in particular, the different concentrations of the casein fraction in the two types of milk. Such differences could produce a different degree of utilization at the digestive level. The results were disagreement with finding of Kavas et al. (2003) who reported that the concentration method and the milk kind were found not to be effective on the protein contents of the yoghurt samples.

Table (6) and figure (3) shows not significant variations of lactose content between goat’s and cow’s milk yoghurt. The results were disagreement with that of Bille et al. (2000) who reported that higher lactose content in goat milk resulted in more acid goat milk yoghurt than cow milk yoghurt under the same treatment. It’s also supported Salvador and Fiszman (2004) they reported that goat’s milk has higher total protein, lactose, ash, and total solids content than cow milk. On the other hand Fox and Mc Sweeney (1998) and Antunac et al. (2001) reported that goat milk has lower concentration of lactose than cow milk.

Table (6) and figure (3) shows not significant variations of ash content between goat’s and cow’s milk yoghurt. The results were in agreement with that of Gupta (2004) who reported that the mineral content of goat milk and cow milk is generally similar. The results were disagreement with that of Nahar et al. (2007) who reported that the
maximum ash percent was seen in buffalo milk dahi followed by cow milk dahi, and lowest in goat milk dahi. It’s also supported Rutherfurd et al. (2006) who reported that the mineral composition of the prepared goat milk formula was higher than that of the prepared cow milk formula for most minerals.

Table (6) and figure (3) shows significant variations of acidity percent between goat’s and cow’s milk yoghurt. The acidity of goat’s milk yoghurt was higher than cow’s milk yoghurt. The faster acidification and lower PH value in goat milk yoghurt could be explained by the enhancement of growth, acidity progress and peptidase activity of *Lactobacillus delbureckii ssp. blugaricus* in goat’s milk Rysstad and Abramamsen (1987); Bozanic et al. (1998) and Tamime and Robinson (1999). It’s also supported Domagał (2008) and Abramamsen and Rysstad (1991) who reported that yoghurt from goat milk had a higher acidity on comparison to the acidity of cow milk yoghurt, this can be explained by a faster increase of acidity in goat milk due to its lower buffering capacity and higher content of non protein nitrogen (NPN) and vitamins, which are needed for fast microorganism development.

Table (6) and figure (4) shows the number of *Streptococcus subsp.* and *Lactobacillus subsp.* between goat’s and cow’s milk yoghurt. The results were higher than that obtained by Noni et al. (2004) who reported that *Lactobacillus bulgaricus* and *Streptococcus thermophilus* bacteria count were between $10^7-10^8$ cfu g$^{-1}$ for 10 days yoghurt samples. These were also confirmed of Irkin and Eren (2008) they reported that viable *Streptococcus thermophilus* and *Lactobacillus bulgaricus* number were determined between $10^7-10^8$ cfu g$^{-1}$ for yoghurt produced with starter culture. It’s also IDF (1988) reported that the beneficial effects of the
regular ingestion of yoghurt on the consumer’s health have always been related to the presence of high concentration of viable lactic acid bacteria in the product. Several countries have established minimum values of lactic acid bacteria for yoghurts and/or fermented milks during shelf-life. The value ranged between $1 \times 10^6$ to $5 \times 10^8$ cfu g$^{-1}$. The present study showed that not significant variations of *Lactobacillus bulgaricus* between the two types of yoghurt. On the other hand *Streptococcus thermophilus* cow’s milk yoghurt was higher than that of goat’s milk yoghurt that could be due to the lysogenic character of *Streptococcus thermophilus* is important on bacteria viability during storage period of yoghurts and high fat content of yoghurts are more inhibitory of probiotic bacteria Husson *et al.* (2000) and Vinderola *et al.* (2000).

Table (6) and figure (4) shows significant variations of number of TBC between goat’s and cow’s milk yoghurt. The results were higher than that observed by Hussain *et al.* (2009) who found that the average total viable count of natural yoghurt was $\log 4.6 \times 10^8$ cfu g$^{-1}$. The results were revealed that the TBC of goat’s milk yoghurt were higher than that of cow’s milk yoghurt, the results were in agreement with that of Bille *et al.* (2000) who reported that goat milk was also higher in microbial count than cow’s milk, this was attributed to the difference in milking technique whereby the goat’s were milked by hand and the cow’s milk were milked hygienically by machine. It’s also confirmed Muehlherr *et al.* (2001) who reported that the microbiological counts for bulk tank milk from goat’s milk was high. The results were agreement with that of Nahar *et al.* (2007) who reported that highest average total viable count was recorded for dahi sample of buffalo milk, cow milk and goat’s milk, respectively.
Table (7) and figure (5) shows significant variations of color between goat’s and cow’s milk yoghurt. The color of goat’s milk yoghurt score was high than cow’s milk yoghurt, that might be due to the white color of goat’s milk. Similarly it’s supported Vargas et al. (2008) and Alichandidis and Polychroniadous (1996) they reported that the absence of β-carotene in goat milk together with its elevated proportion of small fat globules as compared to cow’s milk. The results were in accordance with that of Salvador and Fiszman (2004) they reported that the score of all sensory parameters significantly decreased after the addition of goat milk, except whiteness and creaminess which increased significantly when more goat’s milk was added.

Table (7) and figure (5) shows significant variations of flavor between goat’s and cow’s milk yoghurt. The flavor of goat’s milk yoghurt was lower than that of cow’s milk yoghurt, and this might be due to the “goaty” flavor or high acidity. The results were in agreement with that of Vargas et al. (2008) who reported that goat’s milk yoghurt was as less consistent and more acid, with non-typical taste and flavor. It’s supported Karademir et al. (2002) who found that goat’s milk contains a higher level of short chain fatty acids than cow’s milk, which explain the characteristics flavors of caprine dairy products. It’s also supported Bille et al. (2000) who reported that citrate plays role in flavor of milk and milk products, in which goat milk was poor in sodium and citrate. Similarly it’s confirmed Pazáková et al. (1999) who reported that goat milk yoghurt had a markedly (a goat) flavor which negatively influenced the sensory quality. The results werevdisagreement with that of Mowelm (1988) who reported that recently milked and cooled goat milk is odor free and hard to distinguish from cow milk in odor and taste.
Table (7) and figure (5) shows significant variations of texture between goat’s and cow’s milk yoghurt. The texture of goat’s milk yoghurt was lower than that of cow’s milk yoghurt, and this might be due to the different types of milk. The results were in agreement with that of Stelio and Emmanuel (2004) they reported that the texture differences between goat’s and cow’s milk yoghurt are attributed to the kind of milk used and their compositional differences. It’s also confirmed Domagała (2008) who found that yoghurts from goat milk have a loose and weak consistency, high syneresis and higher acidity than yoghurts from cow and sheep milk. The results were disagreement with that of Bille et al. (2000) who reported that goat milk yoghurt texture was much superior to cow milk yoghurt that because dry matter content of goat milk was reflected in higher viscosity and superior texture of its yoghurt samples.
CHAPTER SIX

CONCLUSION AND RECOMMENDATION

Conclusion:

The result of this study concluded that quality of set yoghurt was affected during storage. The cow's milk yoghurt sensory characteristics were different from goat's milk yoghurt. This study suggested utilization of goat's milk yoghurt acceptance by consumers.

Recommendation:

. More attention should be given to production, collection, transport and cooling of goat's milk.

. Standardization of goat's milk for yoghurt manufacture should be observed to meet specification.

. Yoghurt must be kept under cold condition.

. Further studies and research are needed to improve the quality and flavor of goat's milk yoghurt.
Reference


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Figure (1): Variation of sensory evaluation test during storage of set yoghurt produced from cow’s milk.
Figure (2): Variation of sensory evaluation test during storage of set yoghurt produced from goat’s milk.
Figure (3): variation of chemical composition test between types of set yoghurt produced from cow’s milk and goat’s milk.
Figure (4): variation of microbial test between types of set yoghurt produced from cow’s milk and goat’s milk.
Figure (5): Variation of sensory evaluation test between types of set yoghurt produced from cow’s milk and goat’s milk.