CHAPTER ONE

INTRODUCTION

Sudan is an agricultural country with a large animal wealth of which camels. According to statistics camel population in Sudan ranks first among the Arab countries and second in the world according to last estimation of camels in Sudan are 4.715000 heads (MARF, 2011).Camels constitute 22%of the animal biomass in Sudan and 26.3% of the numbers of camel in the Arab world. There are two species of camels: the dromedary or Arabian camel (Camelus dromedarius, one hump) and the bactrian camel (*Camelus bactrianus*, two humps) (Al haj et al, 2010). Dromedary camels with the one hump is living in the arid and desert lands of Africa and Asia, where it is used as provider of both milk and meat (Bayoumi, 1990). The camel may stay several months without drinking under very hot condition, it may drink only every eight to ten days and loose up to 30 percent of its body weight through dehydration (Ramet, 1987). The camel is among the animals mentioned in the Quran as a miracle of the God (Deurasech, 2005).

The camel production systems in central Sudan were maintained under intensive, semi-intensive and traditional system (Idris et al, 2015). The camel had been one of the most neglected species of the domestic animals, although the camel has ability to produce more milk for a longer period of time in arid zones and dry lands (an environment of extreme temperature, drought, and lack of pasture) than other domestic livestock species (Suliman, 2012).

Camel's milk is generally opaque-white, it has a sweet and sharp taste, but some times it taste salty. The changes in taste are caused by the fodder and availability of drinking water (Farah, 1993). Also sometimes there are changes in milk protein and salts (Majacevic and Samardja, 1996). The researchers indicated that camel's milk has many properties that make it very useful to consumers (Farah, 1996).

Camel milk is one of the most important components of the diet of nomads in the Sudan, it is consumed by the owners and herders and is not exploited commercially (El Amin, 1984).

The milk could be sterilized by heating the milk at 110°C for 30 min. All the spores could be killed but this high temperature for long duration affects the milk quality. The UHT could be the best way to sterilize the milk by heating at 130°C for 30 sec or at 145°C for one sec. One should select the heating system which results in less undesirable changes, least expensive and fit in working area. Pasteurization may be one of the most feasible ways to improve the milk shelf life. There are many pasteurization techniques used to preserve milk. They are based on temperature, duration of heating, packaging and type of product to be pasteurized. Holder pasteurizers are used at small scale. They may be used for batch process or for packed e.g. coil vats, glass lined tanks, stainless steel tanks or spray vats etc. High temperature for short time type pasteurizers are used for commercial scales for large quantities e.g. Danish heater, drum heater, internal tubular heater or external tubular heater etc. Autoclaving is most suitable way of bottle pasteurization (Ishaq and Younas , 2014).

Objectives:

The objective of this study are:

1-To evaluate the effect of heat treatments on physiochemical composition of camel milk.

2- To determined the effect of heat treatments on the shelf life of camel milk.

3-To study the impact of heat treatment on the microbial load of camel milk.

CHAPTER TWO

Literature review

2.1 Camel in Sudan:

Camels in Sudan are classified as back (heavy) and riding (light) types according to the function they perform and probably as a result of selection applied for these traits by the various camel-owning tribes. The Sudanese heavy type constitutes the majority of the camels kept by nomads. In this group two types can be identified on the basis of conformation and tribal ownership: The Arab and Rashaidi camels. On the other hand, the riding camels are restricted to the north-east of the country between the Nile and Red Sea. Two main types are recognized, namely Anafi and Red Sea Hills (Bishari) camels (El-Fadil, 1986). The main area of the Sudan inhabited by camels extends between latitudes 10° and 20° north and is bound by the Ethiopian mountains and the Red Sea hills on the East and by the Ingasana mountains and Bahr El Arab in the South (Babiker, 1984). Camels in southern Darfur are commonly raised under nomadic conditions.

2.2 Camel Milk Yield and Production:

Camel milk represents one of the basic ingredients of human food in many parts of the world, especially in the arid and semi-arid zones. Camels even under extreme hostile conditions of high temperatures, drought, lack of pastures and lack of water, can survive and produce good quality milk (Hattem et al, 2011).

Milk is secreted by mammals for the nourishment and to provide immunological protection for their young but .The production systems of camel in Sudan include: traditional nomadic system, transhumant or semi-nomadic system, sedentary or semi-sedentary system and intensive system which is limited to racing and dairy camels. Camels in most pastoral societies are milked by men (one or two herdsmen) and to prevent calves from suckling at pasture during the day it is common among the nomad, to tie up one or more teat with special strings (Eisa and Mustafa, 2011).

The most frequently asked question is “how much milk does a camel give, compared with a cow?” daily milk yield of a camel it is difficult to estimate under pastoralist conditions owing to the inconsistency of milking frequency. Milk yield also varies with species, breed, stage of lactation, feeding and management conditions.The length of lactation can vary from 9 to18 months. This depends mainly on the husbandry practices, which are largely determined by the need for milk, more being required in the dry months than in the wet months when other sources of food are available(Farah, 1993).

Camel milk production, other major factors including breeds, stage of lactation, feeding and management conditions play important role in the inconsistency of data. However, the current unofficial data about the camel milk production are scare and are based on observations of particular research stations and rarely based on pastoral areas (FAO, 2008).Camel can produce more milk for a longer period of time in arid zones and harshy environment than any other domestic livestock species (Ahmed *et al.,* 2015).

In Sudan camel milk yield can reach 10 kg/day in the early lactation and good conditions and declined to 2 kg/day in the late lactation and bad conditions (in best animal) otherwise it range 5 - 10 kg / day. Most of the camel milk in the Sudan is drunk fresh and sometimes sour (fermented) (Garis) or with tea

(Sbanes). Processing and manufacturing of camel milk in to milk products like butter, ghee, cheese, ice cream, etc, not found except in some limited research. It was concluded that the production system and dairy production of camel in Sudan regrettably received little attention (Eisa and Mustafa ,2011).

Weekly milk records of 47 she-camels in a multibreed dairy camel herd were collected for over a period of 5 years. A total of 72 lactation curves were defined, and relationships with parity, calving season, lactation length, milk production level, following lactations, and dam weight was analyzed. Overall mean values were milk yield up to 12 months, 1,970±790 l; lactation length, 12.5 months; persistency, 94.7 %; weekly peak yield, 50.7 l; monthly peak yield, 220±90 l; and the number of weeks to reach peak yield, 28. The highest productivity was recorded in summer with a weekly mean of 48.2±19.4 l, compared with 34.1±16.3 l in winter. The highest average yield recorded was for camels at sixth parity, whereas the highest weekly peak was at eighth parity, and highest persistency at fifth parity. Camels that calved during the cold months (November to February) were most productives, with the highest persistency, peak yield, and longest lactation length. Four types of curves were identified longest lactation length. Four types of curves were identified corresponding to different parities and milk yield levels. Based on these data, specific models for camels are proposed(Musaad *et al.,* 2012).

Milk synthesis involves pregastric and hindgut fermentation of plant cell-walls and cell-contents into volatile fatty acids, ammonia, peptides and microbial mass, which are main substrates for milk secretion . Milk contains essential amino acids, specialized casein and peptides, lactalbumins and immune globulins, nucleosides, nucleotides, unsaturated and conjugated linoleic acids, sphingomyelins, fat soluble vitamins and minerals that function beyond their nutritional value. As an evolutionary testimony, beonatal development of brain network, nervous and immune systems, and body skeleton entirely or mostly rely on milk. Milk consumption is not related to gastrointestinal- related immu malfunctions (Nikkhah, 2011).

2.3 Camel Milk Composition and Properties:

Milk is complex biological fluid and considered a complete food because it contains proteins, fat, carbohydrates, minerals, vitamins and water. (Asresie and Mulugojjam,2014). Camel's milk is generally an opaque white color and has a faint sweetish odor and sharp taste; sometimes it can be salty (Abbas *el al.*, 2013). Its opaque white color because of the fats are finely homogenized throughout the milk whereas, the changes in taste are caused by the type of fodder and availability of drinking water (Yadav *et al.,* 2015)

Seasonal variation effect on milk production in different species in tropical and sub tropical zones are recognized. Concerning camels, large seasonal variations in total solids and fat were reported from Jordon with maxima in mid-winter and minima in August (ElZubeir *el al*., 2008).

Most of camel milk is consumed in the raw state without any heat treatments and kept at high temperature with lack of refrigeration facilities during milking and transporting. Camel milk has properties that it can be kept for long periods than cow's milk when refrigerated and even with the desert heat it does not spoil shortly, the milk composition of dromedary camel is excellent from a nutritional point of view. Camel milk also has valuable nutritional properties as it contains a high proportion of antibacterial substances and higher concentration of vitamin C in comparison with cow milk. Camel milk health benefit in diabetic patients. Camel milk is much more nutritious than that of cow milk because it is low in fat and lactose contents, and higher in potassium, iron and vitamin C, Camel milk has medicinal properties and contains protective proteins, which may have a possible role for enhancing the immune defense mechanism. The triglycerides, which contain a great variety of fatty acids (Omer and Eltiny, 2009).

Density of camel milk ranges from 1.026-1.035 and the pH from 6.2-6.5, both are lower than those of the cow‟s milk and maximum buffering capacity of skim milk is at pH 4.95. Many research findings proved that camel milk is closer to human milk than any other milk. Camel milk is different from other ruminant milk, having low cholesterol, low sugar, high minerals (sodium, potassium, iron, copper, zinc and magnesium), high vitamin C. Camel milk is unique from other ruminant's milk in terms of composition as well as claimed health effects (Gul *et al.*, 2015).

Camel milk proteins contained satisfactory balance of essential amino acids. It contains disease-fighting immunoglobulin's which are small in size, allowing penetration of antigens and boosting the effectiveness of the immune system. This review focused on the medicinal properties of camel milk which will be more useful to generate value added product (Yadav *et al.*, 2015). According to most authors the composition of camel milk varies due to difference of geographical origin and year of publication of the published data but other factors such as the physiological stage, feeding conditions, seasonal or physiological variations, genetic or health status of camel have also a paramount importance (Konuspayeva *et.al.*, 2009).

Milk is the most important product obtained from camel milk being a complete food, helps to provide a nutritious and balanced diet to nomadic desert people under harsh conditions. The composition of milk varies widely and contains 2.9- 5.5% fat, 2.5-4.5% protein, 2.9-5.8% lactose, 0.35- 0.95% minerals and 8.9-14.3% solids-not-fat. It also contains the essential vitamins, which include vitamin A, vitamin D, vitamin B1, B2 and B12 and vitamin C.

The content of vitamin C is of specific interest as its levels are three times that of cow milk and one-and-a-half that of human milk. The vitamin C content varies between 5.7 and 9.8 mg percent (Khan *et al*., 2004). The results published in FAO data the average amount of components of camel milk is protein 3.1%; fat 3.5%; lactose 4.4%; ash 0.79%, and total solids 11.9% (Konuspayeva *et.al.,* 2009; Yagil.1982).

2.3.1 Protein Content of Camel Milk

In some previous studies, the total amount of camel milk protein has been reported as being from 2.9 to 4.9%. in FAO data The average amount of components of camel milk is protein 3.1%; also are a heterogeneous group of compounds that differ in composition and properties(FAO ,2008) . Camel milk proteins can be divided into two groups: caseins and whey proteins. These proteins are important components of camel milk and have different functions. The amount and type of amino acids in camel milk are high except for lysine, glycine, threonine, and valine. The most important proteins in camel milk are whey proteins, which contain albumin, lactoferrin, immunoglobulins, etc. (Konuspayeva *et.al.*, 2009). Dromedary camel milk contains 3 to 3.90 percent of protein. It contains two main groups (Caseins and Whey proteins and relatively higher amount of immune proteins (Peptidoglycan Recognition Protein, Lactoferrin, Lysozyme and Lactoperoxidase) and insulin (Abbas *et al*., 2013, Gul *et al.,* 2015).

2.3.2Casein:

Casein is the most important and higher in proportion, while the proportion of whey proteins is relatively low (Shamsia, 2009) comfirmed that camel milk contains higher protein (especially casein) and lower in whey milk than human milk. Casein is a major part of protein in camel milk. Dromedary camel milk has 1.63 to 2.76 percent of casein protein that constitutes 52 to 87 percent of total milk protein (Khaskheli *et al.,* 2013).

2.3.3Whey Protein:

Whey protein is the second biggest fraction of protein of camel milk which covers 20 to 25 percent of camel milk protein. The milk of dromedary camel has a whey protein in range of 0.63 and 0.80 percent (Khaskheli *et al.*,2013). Β-lactoglobulin is found in trace, while α-lactalbumin comprises the major camel milk portion. In the milk of bovines, α-lactalbumin constitute only 25 percent, while β-lactoglobulin made 50 percent of the total whey protein that make it the major whey protein of bovine milk(Laleye *et al.,* 2008). Whey protein of camel milk consists of some other as peptidoglycan, recognition protein, immunoglobulins, lactoferrin and serum albumin (Kappeler *et al.,* 2005).
Camel milk contains a smaller amount of β-lactoglobuline in comparison with cow milk. Camel milk whey at pH bellow 5, aggregation of whey proteins occurs because of the high content of α-lactalbumin. Consequently, whey proteins in camel milk are more sensitive to acidity than whey proteins in cow milk (Laleye et al., 2008)

.2.3.4 Fat Content of Camel Milk:

The fat content of camel milk varies between 1.7 and 4.2% and consists of up to 98% of lipids in the form of triglycerides. Lipids serve as an energy source, act as a solvent for fat- soluble vitamins and supply essential fatty acids. The triglycerides contain a variety of fatty acids and are accompanied by small amounts of di- and monoacylglycerols, cholesterol, free fatty acids and phospholipids(Han et al., 2013). The composition of fatty acids is influenced by the environment and physiological factors such as nutrition, stage of lactation and genetic differences within the species (Farah et al., 1989).

Elobied *et al*. (2014) mentioned that fat content of camel milk is between 1.2 and 6.4 %. Compared with bovine milk, camel milk fat contains smaller amounts of short chain fatty acids and a lower content of carotene. This lower carotene content could explain the whiter colour of camel milk fat. Milk fat serves nutritionally as an energy source, acts as a solvent for the fat soluble vitamins and supplies essential fatty acids. About 99% of milk fat is a mixture of fatty acids (triglycerides) of varying chain length from 4 to 20 carbon atoms (Farah, 1993).The camel milk fat is also different from that of other animals. When left standing, fat is distributed as small globules throughout the milk. The ratio of fat to total solids averages 31.6 percent; this is much lower than that of the buffalo, which is 40.9 percent (Mohamedy, 2010). Farah, (1993) reported the fat content of camel's milk varies between 2.9% and 5.4% and the average size of the fat globules is about the same as cow's milk fat globules.

2.3.5 Lactose Content of Camel Milk:

Lactose is the major carbohydrate fraction in milk and is a source of energy for the young calf. It is made up of two sugars, glucose and galactose, which are fermented to lactic acid when milk goes sour. The lactose content in camel's milk ranges from 4.8% to 5.8% and is slightly higher than the lactose in cow's milk. It seems that the lactose content in camel's milk is relatively constant throughout lactation (Farah, 1993). The lactose content of camel milk varies from 2.40 to 5.80%. The wide variation of lactose content could be due to the type of plants eaten in the deserts. Camels usually prefer halophytic plants such as a triplex, Salosa and Acacia to meet their physiological requirements of salts (Elobied *et al*. 2014).

2.3.6 Vitamin Content of Camel milk:

Camel's milk contains less vitamin A, B1, B2, E, folic acid and pantothenic11 acid than cow's milk while the content of vitaminB6 and B12 is about the same level. However, various studies suggested the variation of minerals in camel milk is linked with genetic and environmental effects (Sawaya *et.al.*, 1984). Mal and Pathak (2010) mentioned that the levels of vitamin A, E and B1 were reported to be low in camel milk compared to the cow milk. These workers reported vitamin A, E and B1 as 20.1±10.0 μg%, 32.7±12.8 μg% and 19.6±6.4 mg% in camel milk and 60.9±25.6 μg%, 171.0±114.4 μg% and 34.7±8.1 mg% in cow milk. Cow milk contains 99.6±62.0 μg% β- carotene and it is not detected in camel milk. The concentration of vitamin C in camel milk in early and late lactation has been reported 5.26±0.47 and 4.84±0.20 mg%. The levels of vitamin A, E and B1 were higher in camel colostrums than mature camel milk. Camel milk was reported to contain various vitamins, such as vitamin C, A, E, D and B group, camel milk is known to be a rich source of vitamin C; the vitamin content was reported to be three times to five times higher than that in bovine milk(Salih and Hamid, 2012). However, the vitamin C content remains higher in mature camel milk. The higher vitamin C content may be attributed to the more synthetic activity in the mammary tissues during early phase of lactation that declined as lactation advanced. The low pH due to the vitamin C content stabilizes the milk and can be kept for relatively longer periods. The availability of a relatively higher amount of vitamin C in raw camel milk is of significant relevance from the nutritional point as vitamin C has a powerful anti-oxidant action. Camel milk can be an alternative source of vitamin C under harsh environmental conditions in the arid and semi-arid areas (Mal and Pathak, 2010).

2.3.7 Mineral Content of Camel Milk:

The total amount mineral dromedary camel milk is between 0.60 to 1.0 percent (Konuspayeva *et al*., 2009). There are significant fluctuations in minerals level due to the differences in feeding, breed, water intake (Haddadin et al., 2008) Camel milk is rich source of various minerals *like* Na, K, Ca, P Mg Fe, Zn, Cu are present in camel milk (Onjoro *et al.,* 2003). The mean values for zinc, manganese, magnesium, iron, sodium, potassium and calcium in mineral contents of dromedary camel milk (100g-1) are 0.53, 0.05, 10.5, 0.29, 59, 156 and 114 mg respectively; milk mineral salts are mainly chlorides, phosphates and citrates of sodium, calcium and magnesium. Although salts comprise less than 1% of the milk, they influence its rates of coagulation and other functional properties (Abas *et al*.,2013). The mineral content of camel's milk expressed in ash ranges from 0.6% to 0.8%. There is still little information about the mineral content of camel's milk. Data available however, indicate that camel's milk is rich in chloride and phosphorous, and low in calcium (Farah,1993).

2.3.8 Water Content of Camel Milk:

Animal feed and consumption of water have the greatest influence on the content of water in camel milk. In the dry period the production of camel milk is reduced and increases in the rainy period. The milk of one-humped camels which dwell in warmer climate zones have less fat and more water (We r n e r y, 2006). The water in the milk is in greater part as free water, while the remaining part is in form of bound water. Milk ingredients soluble in water are lactose, α-lactalbumin and a part of salt, while the insoluble ingredients are milk fat, casein and β-lactoglobuline. The most important component in camel milk is the water content. camel milk fluctuates from 84 to 90 percent of water. The water content of camel milk is affected by amount of drinking water. Water content of fodder would also affect water content of milk. The increasing in water content could be attributed to the decrease in total solids produced by the thirsty camels (Suliman, 2012). El Zubeir *et al.*, (2008) showed that the most important factor in camel milk for people living in dry zone its water content declared that young camel and human livings in dry areas are in need of fluids to maintain homeostasis and thermoregulation.

2.3.9 Camel Milk Enzymes:

Camel milk has activities of aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma glutamyl transferase (γ-GT), acid phosphatase (ACP), alkaline phosphatase (ALP) and lactate dehydrogenase (LDH) found to varies between 7.98-9.21 IU/L, 9.49- 11.00 IU/L, 254.00-296.00 IU/L, 2.74-3.08 IU/L, 16.04-24.93 IU/L and 132.00-168.00 IU/L in Indian dromedary camels respectively. The activity of catalase was ranged from 0.083-0.193 moles/min/gm of protein in Indian dromedary camels. Milk enzymes play an important role in the keeping quality of camel milk. γ-GT was used as an indicator for the proper heat inactivation of camel milk because it is destroyed between 10 to 20 minutes at 72°C (Mal and Pathak , 2010).

2.3.10 Lactoperoxidase :

Lactoperoxidase is present in tears, saliva and milk. It exerts bactericidal activity generally on Gram negative bacteria thus contributing to non immune host defense system. It is thought that the major function of lysozyme in milk is the protection of the udder against infections caused by microbes (Ueda *et al.*, 1997).

2.3.11 Lactoferrin :

Lactoferrin is Known as lactotransferrin and glycoprotein. It belongs to a class of transferrins. A familiar characteristic of this protein family is its ability to bind two metal cations (preferably Fe 3+) to the binding sites that are structurally closely related. The majority of lactoferrin is needed for transportation or storage of iron. Lactoferrin was reported to act as iron scavenging in body secretions (Brock, 1997).). Lactoferrin contents of camel milk (0.22 mg.mL-1) were significantly higher than goat, sheep, buffalo and cow milk (El-Agamy *et al*., 1997). Changes in lactoferrin level in normal camel milk and colostral camel milk showed that the lactoferrin concentration was maximum at first day and then reduced with milking (El-Agamy, 1994).

2.4 Factors Affecting Camel Milk Composition:

There are many factors that can affect milk composition including breed variation (within a species, herd to herd), management, feed considerations, seasonal variation, geographic variations and stage of lactation. Camel milk is highly nutritious. The quality of milk can be affected due to physical, chemical and microbiological factors. Camel milk that handled with good hygiene has high antimicrobial effect and its chemical composition is better when compared with other livestock (Asresie and Mulugojjam,2014).

Season strongly affects camel milk composition through heat stress, feed available quality and water availability by affecting the total solids of milk and this directly affects the other components (Shuiep *et al*.,2014).

Changes milk composition of camels from traditional pasture and farming system at different parities. As shown in the composition of camel milk varies with quality and availability of feed as well as parity differences. Traditional pastoralist in arid and semi-arid regions and some herds are domesticated under farming system with special management and feeding conditions. Traditional pastoral system can provide milk with better nutritional contents compared to the farming system this could be explained by the fact farming system. This could be explained by the fact that natural pasture is more variable in plants and vegetations and provides many varieties preferred by the camels. In addition, camels are physiological the metabolically adapted to certain types of vegetations than the commercial feed provided in the farm management system. However, interventions to improve the production practices through better hygiene and medical diagnosis of camels and their milk is needed(Mustafa et al., 2014).

2.5 Nutritional value of camel milk:

Camel milk could soon become the new super food due to its high nutritional value, easy digestibility and low share of fat. Due to the less daily milk production than in cows, price of milk is higher, what is the only obstacle to the introduction of this food in everyday eating habits. According to its chemical composition, camel milk is most similar to human milk. It is a rich source of vitamins and mineral substances, especially B group vitamins, vitamin C (Zibaee et al., 2015).

Camel milk differs from other ruminant milk as it contains low cholesterol, low sugar, high minerals, high vitamin C and higher protective proteins like *lactoferrin*, *lactoperoxidase*, *Immunoglobulins* and lysozyme. Camel milk lacks of *β-lactoglobulin* and used as an option for the individuals intolerant to lactose of cow's milk Camel's milk is unique in terms of antioxidative factors, antibacterial, antiviral, antifungal, anti-hepatitis, anti-arthritis , treatment for *paratuberculosis*, preventies aging, remedy for autoimmune diseases and cosmetics. Insulin in camel milk is safe and efficacious in improving long-term glycemic control in diabetic patient. Camel milk reduces autism symptoms in children. *Lactoferrin* has ability to inhibit the proliferation of cancer cell. Camel milk is rich in magnesium and zinc thus endowed antiulcer properties. Camel milk has high α-hydroxyl acids which are known to plump and smoothies the skin and also used to treat skin disorders such as dermatitis, Acne, Psoriasis and Eczema. Although camel milk has such values, it's less appreciated thus its consumption is restricted to pastoral area.

Further studies should be conducted on the chemical composition and medicinal value of camel milk.(Jilo, 2016). Camel milk can help treat some liver problems, lower bilirubin output, lighten vitamin inadequacy and nutrient deficiency, and augment immunity. Camel milk is receiving more recognition as a global healthy food. The Food and Agriculture Organization of the United Nations predicts that camel dairy products will appear on European supermarket shelves. However, logistic challenges in manufacturing and processing must be overcome (Nikkhah, 2011).

2.6 Camel milk quality:

The high content of antimicrobial agents in camel milk may explain its potential as an antiviral activity especially against many other diseases. Data also showed that pasteurization and refrigeration of raw camel milk improved the keeping quality and extending the shelf life for 21 days, which could be of beneficial uses as future Industry (Ibraheem, 2013) .

Acidity and pH of the pure fresh camel milk and milk diluted with water and stored at room temperature were 0.12±0.03, 6.42±0.18 and 0.09±0.02, 6.65±0.22 respectively. Other parameters viz. clot on boiling, alcohol and alizarin alcohol tests were observed negative in fresh camel milk. The study indicated that pure and milk diluted with water (1:1) can be stored for 8 and 10 hours respectively at room temperature (Mal et al. 2006). Lactoperoxidase system in fresh camel milk was activated within half an hour of the milking using various levels of thiocyanate and hydrogen peroxide (10-70:10-70 ppm ratios) and efficacy was evaluated. The best lowest activation level 20:20 was found to be effective in preserving raw camel milk up to 18-20 hours at 37˚C (Singh et al. 2006).

2.7 Medicinal Properties of Camel Milk:

Camel milk so called white gold of the desert is more similar to human milk than any other milk and differs from other ruminant milk because it contains low cholesterol, low sugar, high minerals (sodium, potassium, iron, copper, zinc and magnesium), high vitamin C,protective proteins like as lactoferrin, lactoperoxidase, immunoglobulins, lysozyme (Yadav et al., 2015). Health benefit potentials of camel milk are obtained through a number of bioactive components in camel milk and medicinal value of camel milk. indicated camel milk treatment of gastritis, asthmatics, stomach discomfort, HIV, hamot (kar), tuberculosis, fever, urinary problems and hepatitis Interviewed pastoralists claimed that camel milk is used to treat a number of illnesses in human beings such as Jaundice, Malaria, Constipation, to clear the stomach, post-partum care of women, to detoxify snake venom and flatulence, jaundice, malaria and constipation for reason that camels browse on various plant species and active agents with therapeutic properties from these plant species are secreted into the Milk(Jilo and Tegegne,2016) .

Camel milk has powerful bactericidal properties and can rehabilitate the immune system. It was observed that drinking non-pasteurized camel milk is beneficial to people with all the variety of symptoms associated with infection of the alimentary canal camel milk has medicinal properties suggesting that this milk contains protective proteins which may have possible role for enhancing immune defense mechanism. Camel milk also contains higher amount of zinc. The rapidly dividing cells of the immune system are sensitive to zinc deficiency. The role of Zn in the development and maintenance of a normally functioning immune system has been well established. Antibacterial and antiviral activities of these proteins of camel milk were studied (Mal and Pathak, 2010).

Camel milk contains good amounts of lysozyme, lactoferrin, lactoperoxidase, immunoglobulin G and secretory immunoglobulin A; these antimicrobial factors were present at significantly greater concentrations in camel milk and were more heat stable compared with those in cow and buffalo milks (Salih and Hamid, 2012). Mal and Pathak (2010) mentioned that the camel milk lysozyme showed a higher lysis value towards Salmonella typhimurium compared to egg white and bovine milk lysozymes. The inhibition of pathogenic bacteria by camel's milk was also observed. Camel milk is used for treating dropsy, jaundice, spleen ailments, tuberculosis, asthma, anemia and piles. The patients suffering from chronic hepatitis had improved liver functions after drinking of camel milk. Camel milk has insulin like activity, regulatory and immune15 modulatory functions on β cells. Camel milk exhibits hypoglycemic effect when given as an adjunctive therapy, which might be due to presence of insulin/insulin like protein in it and possesses beneficial effect in the treatment of diabetic patients elsewhere, raw camel's milk and a fermented product (named shubat) have always been an important food for Kazakh peoples. Shubat is especially renowned and is used for some medicinal purposes (Konuspayeva *et al*., 2009).

Camel milk has been used for the treatment of food allergies and autism. Camel milk can be used for the treatment of different types of tuberculosis. Camel milk possesses medicinal properties to treat different ailments such as multiple sclerosis, psoriasis, lupus and allergies-asthma. Camel milk drinking has shown good effect for treating crohn's disease (Mal and Pathak, 2010). The ingredient's vitamin B, C carotin and iron content are crucial for skin. The milk contains lanolin and other moisturizing properties providing a calming and soothing effect on the skin. In addition to keeping the skin beautiful used to treat skin disorders such as dermatitis, Acne, Psoriasis and Eczema. Moreover, camel milk is natural source of alpha-hydroxy acids for softening the skin, keeping it supple, smooth and preventing wrinkles. (Jilo and Tegegne,2016).

Camel is a vital animal to daily life of people in desert areas as a source of food, means of transportation and its milk uses as medicine for several diseases. In the harsh environment it can produce more milk for longer period than any other livestock species. The aim of this manuscript was to review currently available articles on the camel milk focusing on its composition and medicinal values by systemic overview of literatures. Camel milk is more similar to human milk as it contains low cholesterol and sugar, high minerals and vitamin C and higher protective proteins like lactoferrin, lactoperoxidase, immunoglobulins and lysozyme. It is unique in terms of antioxidative factors, anti-microbial activities, anti-ulcer, anti-cancer and anti-arthritis properties, autoimmune diseases treatment, cosmetic and detergent values. Additionally, insulin in camel milk is safe and efficacious in improving long-term glycemic control in diabetic patient. Moreover, camel milk reduces autism symptoms in children. High level -hydroxyl acid in camel milk smoothies the skin and is effective for treatment of skin disorders such as dermatitis, acne, psoriasis and eczema. Additionally, camel's milk can be used as an option for the individuals intolerant to cow's milk and is useful water source for dehydrated calves and the humans. Although camel milk has a lot of health benefits; its consumption is restricted to the pastoral areas. Hence, camel is scientifically abandoned animal documentations on camel milk composition and its medicinal importance is limited which created information gap in this area. So, further studies should be conducted on the chemical compositions and medicinal values of camel milk.

Camel is a vital animal to daily life of desert dwellers review of the scientific evidence. As a source of food and a means of transportation and just University Medical Sciences, ailments(Jilo and Tegegne,2016).

There was a report that camel milk had medicinal properties suggested that milk contains protective proteins which may have possible role for enhancing immune defense mechanism. Camel milk also contains higher amount of zinc. The rapidly dividing cells of the immune system are sensitive to zinc deficiency. The role of Zn in the development and maintenance of a normally functioning immune system has been well established. normally functioning immune system has been well established. Antibacterial and antiviral activities of these proteins of camel milk were studied (Mal and Pathak, 2010). Camel milk contains good amounts of lysozyme, lactoferrin, lactoperoxidase, immunoglobulin G and secretory immunoglobulin A; these antimicrobial factors were present at significantly greater concentrations in camel milk and were more heat stable compared with those in cow and buffalo milks (Salih and Hamid, 2012).

2.8. Pasteurization:

The first holder pasteurization system was introduced in Germany in 1895 and in the USA in 1907. Thus by 1895, it was well recognized what was required for an effective pasteurization process: ‘we know that this process (pasteurization) if properly carried out will destroy all disease germs’ and ‘a thoroughly satisfactory product can only be secured where a definite quantity of milk is heated for a definite period of time at a definite temperature. Then too, an apparatus to be efficient must be arranged so that the milk will be uniformly heated throughout the whole mass. Only when all particles of milk are actually raised to the proper temperature for the requisite length of time is the pasteurization process complete.’ This sound advice has withstood the test of time and forms the main thrust of current milk heat treatment regulations (Komorowski, 2006).

Pasteurization is the heating of every particle of milk or milk product to a specific temperature for a specified period of time without allowing recontamination of that milk or milk product during the heat treatment process (Hattem et al, 2011). Pasteurization is a heat treatment aimed at reducing the number of any harmful microorganisms in milk and liquid milk products, if present, to a level at which they do not constitute a significant health hazard. In addition, it results in prolonging the keepability of milk or the liquid milk product and in only minimal chemical, physical and organoleptic changes also pasteurisation conditions are designed to effectively destroy the organisms (*Mycobacterium tuberculosis* and *Coxiella burnetti*). After the treatment by pasteurisation of milk and cream results in a negative alkaline phosphatase reaction immediately. For milk, the minimum pasteurization conditions are those having bactericidal effects equivalent to heating every particle of the milk to 72◦C for 15 s continuous flow pasteurization) or 63◦C for 30 min (batch pasteurization). Other (equivalent conditions can be obtained by plotting a line joining these points on a log time versus temperature graph (Lewis and Deeth , 2008). All thermal processes involve three distinct periods: a heating period, a holding period and a cooling period. In theory, all three periods may contribute to the reactions taking place, although in situations where heating and cooling are rapid, the holding period is the most significant. However, procedures are needed to evaluate each of these periods individually to determine the overall effect one such example of this approach is offered (Browning *et al.* , 2001).

For pasteurization processes, the range of interest is 60–80◦C, and for sterilization, from 100 to over 150◦C. Chemical reaction rates are less temperature-sensitive than microbial inactivation rates. Thus, using heat treatment at higher temperatures for shorter times will result in less chemical damage occurring for an equivalent level of microbial inactivation. In practice, deviations from first order reaction kinetics are often encountered (Gould, 1989). Camels milk production in the world is reported to be about 5.3 million tones are consumed by humans, whereas, the remaining amount is fed to calves (FAO, 2008).

Camel raw milk may contain pathogenic microorganisms from the farm environment, including vegetative bacteria, such as Staphylococcus aureus, Campylobacter jejuni, Salmonella spp., Escherichia coli, Yerisinia enterocolitica, and spore formers, such as Bacillus and Clostridium species. These major vegetative pathogens can be effectively controlled by pasteurisation, and are not the main determinants of keeping quality. The main interest is in what survives pasteurization or mild heat treatments.

Thermoduric bacteria are defined as thosewhich survive pasteurisation conditions, e.g. 63◦Cfor 30 min or 72◦Cfor 15 s,whereas spores produced by spore-forming bacteria survive 80◦C for 10 min. Bacillus cereus spores are relevant here, being the main pathogen which will survive pasteurization and grow at low temperature. Bacillus can cause defects in heat-treated milk, for example bitty cream, and produce an intense bitter flavour, but it rarely causes food poisoning because infected products are so unacceptable (Lewis and Deeth , 2008).

2.9 Effect of heat treatment on camel milk

Camel milk represents one of the basic ingredients of human food in many parts of the world, especially in the arid and semi-arid zones. Camels, even under extreme hostile conditions of high temperatures, drought, lack of pastures and lack of water, can survive and produce good quality milk. Camel‘s milk has attracted the attention of researchers over the past few decades. The composition, chemical properties and suitability of processing camel milk were studied by a number of researchers. The chemical composition, properties processing and products were studied recently. Camel milk is consumed raw by the camel keepers and there may be risk of developing milk born infections. It is generally thought that heating of camel milk will destroy the important active and beneficial constituents present in the camel milk, whey proteins. Consumption of total whey proteins in the diet has been associated with the retardation of chemically induced cancers in several animal models.(Mal and Pathak ,2010).

Mal and Pathak , (2010)reported that the chemical composition of camel milk affected by different thermal treatments. The fat content was not affected by the applied treatments when the average value of fat remained constant being 3.2±0.189%. The highest average value of protein (3.4±0.136%) was found in thermal milk at 80°C for 30 min. and 90°C for 30 min. compared with raw milk, the highest ash content was achieved in the thermally treated milk at 90°C for 30 min. followed by the average value of 0.71±0.056% in milk treated by heating at 80°C for 30 min. or 72°C / 15 sec. moreover chemical composition of camel milk was found to be affected by the heat treatment at 63°C for 30 minWernery et al (2005) found that pasteurization had very little effect on the constituents of camel milk. Moreover, heating the samples for 5 min at 72 C failed to significantly alter any of the parameters tested .Fat soluble vitamins A, D and E as well as vitamins of the B complex are relatively insensitive to heat and There are generally no losses of these vitamins when milk is heated slight reductions may occur in vitamins A , E and B2 when milk is sterilized .The fact that vitamin C was not significantly reduced by the pasteurization process used for tremendous advantage in relation to the commercial production of camel milk. Pasteurization does not destroy mineral in cow milk the same seen to apply to copper, iron, zinc and calcium in camel milk . The temperature and duration of heating had an interaction affect on the milk quality. In the thermization, the milk is heated at 60-69°C for 20 sec. Low pasteurization includes the heating of milk at 63°C for 30 min or at 72°C for 15 sec. The low pasteurization of milk killed all the bacteria except some species of Mycobacterium tuberculosis but the proteins are not denatured. This treatment is bacteriostatic. In high pasteurization, the milk is heated at 85°C for 20 sec. This heating results in inactivation of lactoperoxidases (Ishaq and Younas, 2014).

Omer and Eltinay (2009) stated that a total of 70 samples of individual dromedary raw milk were collected from different areas in UAE. The milk samples were divided into three portions under sterile conditions the 1st portion stored at 40°C, the2nd portion stored at 70°C, the 3rd portion stored at room temperature (25-30^{o}C). Samples were examined for pH, acidity, fat, protein, lactose, total solids and ash contents. The results showed that there were significant changes in pH, acidity, lactose, total solids and insignificant changed in fat, protein, during storage. The storage duration of raw camel milk was 40°C, 15 days at 70°C, 3 days.

2.10 Shelf life of camel milk

Mohammed and El Zubeir, (2014) showed the differences of microbial counts were found between raw milk and heat treated milk during storage.

Moreover, the shelf life of heat-treated camel milk was high compared with raw milk, It was concluded that heat treatment improves the microbial quality and extends the shelf life of camel milk. Moreover the procedure of heat treatment is known to improve the quality of dairy product by killing the pathogenic microorganisms and increasing the shelf life (Harding, 1999). Also the microbial content revealed that the count for total bacterial, coliforms, total yeast and mould, psychrotrophic bacteria, and thermoduric bacteria showed minimum values at the beginning of the storage period, and then increased slightly until the end of storage period;the slight increase might be due to the presence of antimicrobial factors in the camel's milk (El Agamy et al., 1992).

The long shelf life of the two products (raw and heat treated) might be due to the presence of antimicrobial and antibacterial agents in the camel's milk (Wernery et al., 2005). The heat treated milk showed longer shelf life compared raw milk. Moreover, pasteurization of the milk had an effect on the keeping quality of the product, since the heat treatment is used to kill the pathogens and the thermoduric organisms in raw milk if refrigeration is poor might restrict the shelf life of pasteurized milk (Harding, 1999).

CHAPTER THREE

MATERIALS AND METHODS

This study was conducted during the period from December 2015 – to January 2016 at DAL DAIRY FACTORY in biochemistry and microbiology laboratory.

3.1 Experimental Design:-

In this study four treatments were carried out the first treatment was control the camel milk was heated at 72 ˚C/ 15 sec., in the second treatment the milk was heated at 65ºc/30 min., in the third and fourth treatments the pasteurization temperature was 75 ºc/10 min and 80 ºc/5 min respectively.

3.2. Material:

Camel milk, plate count agar, Petri dishes, thermometers, glass bottle and PH meter .

3.3. Milk sampling and storage:

Fresh raw bulk camel milk sample (4 liter) was purchased from one-humped camels herd in Sharg El Neele region. Milk was well-preserved and saved in air tight plastic and stored at refrigerator (4 °C) then transferred to the Dal Dairy Factory for chemical using Milcoscan and for microbiological analysis.

3.4. Method of analysis:

3. 4.1. Preparation of milk samples and heat treatment:

In plant laboratory all equipment tools used in the analysis was sterilized to avoid any contamination during the heat treatment also all the devices were properly calibrated, which was used in the readings milk samples were divided into 4 equal portions (1000 ml) then each portion was divided into 10 equal parts (100ml) packed into glass bottle (100 mg capacity).

`The pasteurized milk samples in all treatments were stored at referigeration temperature (7c^{o}) for 14 days. Chemical and microbiological analysis of milk samples was determined at intervals of; 0, 5, 10, 12 and 14 days of storage .The experiment was carried out in triplicates.

3.4.2. Determination of chemical composition of camel milk:-

All camel milk samples were determined fat, protein , ash, total solids (TS), acidity, casein ,lactose ,free fatty acid (FFA) were determined using the device (milko scan). And pH as given in the (AOAC, 2007).

3.5. Milkoscan Operation Procedure:-

(Device name: Milkoscan)

FTI(Fourier Transmission Infra Red) Brand: FOSS)

Eight mls of homogenous camel milk sample at 5 – 55 ˚C were taken for reading the chemical parameters by Milkoscan only .1.3 ml of the samples were red by the device within 30 seconds two readings were made by the Milkoscan and printed the average results of readings.

3.6. pH Determination :-

The pH was determined at room temperature (27 c^{o}), using a digital pH meter (JENWAY 3510).The pH meter calibrated with buffer standards of pH 7 and 4 prior to use the probe of the pH meter was inserted into the sample and the reading was recorded. The probe was rinsed with distilled water before it used on sample.

3.7. Microbial analysis

3.7.1.Total Bacterial Count(TBC)

3.7.1.1. Preparation of sample dilutions and counting:-

A sample from dilution (0.1 ml) was deposited into the solidified agar medium and spread over the surface of the agar medium using sterile bent glass rod, (Violet red bile agar, VRBA for enumerating coliform bacteria and Yeast extract glucose chloramphenicol agar YGC for yeast and mold) then the dishes were incubated in an inverted position at 37°C for 48 hours for Coliform and 28°C for Yeast and Mold. Plates were counted using colony counter. The number of colony-forming units (cfu) in each dilution was obtained by multiplying the number of colonies in the dish by the reciprocal of each dilution (Harrigan and McCance, 1976).

3.7.1 .2. Sterilization of equipment

Glassware such as flasks, test tubes, Petri dishes, pipettes and bottles were sterilized in a hot oven at 170°C for two hours, whereas distilled water was sterilized by autoclaving at 121°C for 15 minutes (Marshall, 1993).

3.7.1 .3. Preparation of culture media

3.7.1.4. Plate Count Agar

This medium was used to determine total bacterial count(TBC) and for sub culturing of bacteria. It was obtained in a dehydrated form. The component of the medium was peptone, yeast extract, Lab-Lemco powder, sodium chloride and agar. It was prepared according to the manufacturer's directions by using 40g in one liter of distilled water and boiled in a water bath until it was completely dissolved. The pH was adjusted to pH 7.2 and then autoclaved at 121°C for 15 minutes.

3.7.1.5. Enumeration of the (TBC)

One ml was pipetted from 10\ 10^2, 10^3 or 10^4dilution into Petri dishespromptly, 15 ml of PC agar medium melted and allowed to cool to 45°C was poured into the Petri-dishes. Immediately, aliquots were mixed with agar medium by tilting the dish to four 5 times in one direction, rotating it clockwise 5 times, tilting it to four again 5 times in direction at right angles to that used the first time and rotating it counterclockwise 5 times. After solidification, the Petri-dishes were inverted and incubated at 37°C for 24h. Colony counter was used to count all colonies. The number of presumptive colony-form units was computed per g of specimen by multiplying by the reciprocal of the dilution used (Marshall, 1993).

3.7.2 . Enumeration of Total Spores

The colony count method to determine the total spores was followed as described by (Harrigan and MacCance 1976). A test tube of suitable dilution is heated in water bath at 80°C for 10 minutes. Then the tube is cooled and ml from this dilution was aseptically transferred into sterile Petri-dishes. Then to each plate nutrient milk agar (NMA) was added. The inoculums were mixed with the medium and allowed to solidify. The plates were then incubated at 37°C for 2 days.

3.8 . Statistical analysis :-

The SPSS (2007) program, version 12 was used for the Data analysis. General linear models was used to estimate the effect of heat treatment on chemical compotation and microbiological contents of camel milk.Means were separated using LSD(Least Significant Difference).

CHAPTER FOUR

RESULTS

4.1.Effect of heat treatment on the chemical composition of camel milk :-

The average chemical composition of the raw camel milk used in this study was as followed; the fat content was 3.42%, the protein content was 2.34%, Total solids 11.35%, lactose is 4.45%, pH 6.53, Free fatty acids 0.59 and the casein content was 1.68%.

The effect of heat treatment on chemical composition (table 1) showed significant difference in all chemical parameter except pH. The highest fat content (3.04%) and total solid (10.33%) were for 80 C°/5 min while the lower values were for 75C°/10 min. Moreover protein (2.17%) and lactose (3.97) were the highest in 75C°/10 treatment however, the lower protein (2.06%) was in 65 C°/30 min and the lactose was lowest (3.95%) in 75C°/10 min .

The highest FFA% was in 72C°/15 sec and was the lowest in 75C°/10 min however casein was the highest in 75C°/10 min and it was the lowest in 65 C°/30 min .

4.2. Effect of storage period on the chemical composition of camel milk:-

Data in (table 2) showed the Effect of storage period on the chemical composition of camel milk. The result indicated that storage period had significant ($P<0.01$) effect on the fat content of camel milk. the highest fat content (3.03±0.02%) was at day zero and the lowest value (2.72±0.29%) was at day14 moreover the result indicated that the storage period had he significant effect on protein content. the highest protein (2.33±0.04%) was at day12.The lowest value (1.51±0.18%) was at day14.

The result of the study demonstrated that the storage period had significant effect on total solids the highest value (10.41±0.26%) was at day10.The lowest value (10.12±0.56%) was at day12, moreover lactose(3.98±0.05%) was the highest in day12 and was lowest(3.10±0.06%) in day10 .

The statistical analysis revealed that storage period had no significant ($P<0.01$) effect on PH content of the camel milk .

The results indicated that the storage period had significant ($P<0.01$) effect on FFA content .the highest FFA content (0.70±0.15%) was at day 10 .the lowest value (0.31±0.26%) was at day12. The result indicated that the storage period had he significant effect on casein content. The highest casein (1.65±0.01%) was at day5.The lowest value (1.51±0.18%) was at day14.

4.3. Effect of different heat treatments and storage period on the total bacterial count of Camel milk: -

The results indicated that the heat treatment and storage period had significant ($p<0.05$) effect on the total bacterial count of camel milk (table 3). The highest bacterial count (2.77%) was for the control heat treatment (72 °C/15 Seconds) and the lowest value (2.45log CFU/ml) was for the (80 °C/5 min).Also the highest bacterial count (3.67Log CFU/ml) was for the day 14, the lowest bacterial count (0.73log CFU/ml) was for day zero.

4.4. Effect of heat treatments and storage period on the total bacterial count of camel milk:-

The results indicated that the different heat treatment and different storage period had significant ($P<0.001$) effect on the total bacterial count of camel milk (table 4). The highest bacterial count (3.91, 3.87, 3.83 and 3.72 log CFU/ml) were for the (72°C/15 Sec, 75°C/10 min, 80°C/5min all on day14 and 65°C/30 min on day 12) respectively and were lowest (1.08,0.59,0.26 and

0.99)were for the (72°C/15 sec, 75°C/10 min, 80°C/5min and 65°C/30min at day zero respectively.

4.5. Effect of interaction between heat treatment and storage time on chemical composition

The results indicated that the heat treatment and storage period time had significant ($p<0.01$) effect on the fat content of camel milk (table 5) .the highest fat content (3.10±0.00%) was for the heat treatment (72℃/15sec) on day zero and The lowest value (1.97±0.00%) was for the treatment (75℃/10min) on day 12.

The results revealed that the heat treatment and storage period time had significant ($p<0.01$) effect on the protein content of camel milk (table 6) moreover highest protein content (2.38±0.01%) was for the heat treatment (72℃/15sec) on day 12 and The lowest value (1.24±0.01%) was for the treatment (65℃/30min) on day 14 .

The results of the study showed that the heat treatment and storage period time had significant ($p<0.01$) effect on the lactose content of camel milk (table 7) moreover highest lactose content (10.58±0.01%) were both for the heat treatment (72℃/15sec) on day 12 and (80℃/5min) on day 10 and lowest value (1.24±0.01%) was for the treatment (65℃/30min) on day 14 .

The results of the study indicated that the heat treatment and storage period time had significant ($p<0.01$) effect on the total solids content of camel milk (table8) moreover highest total solids content (4.05±0.01%) was for the heat treatment (75℃/10min) on day 10 and lowest value (3.10±0.00%) was for the treatment (72℃/15sec) on day zero.

The results revealed that the heat treatment and storage period time had no significant difference effect on the pH content of camel milk (table 9) however highest pH content (6.67±0.01%) was for the heat treatment (72℃/15min) on day Five moreover lowest value (3.88±3.22%) was for the treatment (80℃/5min) on day 12 .

The results of the study showed that the heat treatment and storage period time had significant ($p<0.01$) effect on the FFA content of camel milk (table10) moreover highest FFA content (0.67±0.00%) was for the heat treatment (80℃/5min) on day 10 and lowest value (0.04±0.04%) was for the treatment (65℃/30min) on day 12 .

The results indicated that the heat treatment and storage period time had significant ($p<0.01$) effect on the casein content of camel milk (table 11) .the highest casein content (1.69±0.01%) was for the heat treatment (75℃/10 min) on day 12 and The lowest value (1.24±0.01%) was for the treatment (65℃/30min) on day 14.

Table(1) Effect of heat treatment on the chemical composition of camel milk

Chemical composition (%)	Heat treatments				
	72 C°/15sececonds	75C°/10 minutes	80 C°/5 minutes	65 C°/30 minutes	Significant
Fat	2.92±0.13[c]	2.64±0.46[d]	3.04±0.02[a]	2.94 ±0.10[b]	**
Protein	2.11±0.35[c]	2.17±0.27[a]	2.15±0.27[b]	2.06±0.44[d]	**
Total solids	10.30±0.03[b]	9.98±0.51[c]	10.33±0.13[a]	10.29±0.12[b]	**
Lactose	3.95±0.05[c]	3.97±0.04[a]	3.96±0.04b[c]	3.96±0.04[ab]	**
pH	6.29±0.29	6.27±0.30	5.84±1.51	6.32±0.37	NS
FFA	0.67±0.13[a]	0.39±0.18[c]	0.47±0.17[b]	0.49±0.31[b]	**
Casein	1.55±0.07[c]	1.66±0.01[a]	1.63±0.01[b]	1.48±016[d]	**

N=3

Different superscript letters in the same row means significance different at $P<0.05$

**= significant difference at $P<0.01$

NS= No significant different

Table:2 Effect of storage period on the chemical composition of camel milk

Chemical composition (%)	Storage period (days)					
	0	5	10	12	14	Significant
Fat	3.03±0.02^{a}	2.99±0.10^{b}	2.97±0.15^{c}	2.73±0.47^{d}	2.72±0.29^{d}	**
Protein	2.24±0.17^{c}	2.25±0.15^{c}	2.30±0.04^{b}	2.33±0.04^{a}	1.51±0.18^{d}	**
Total solids	10.24±0.07^{b}	10.21±0.1^{c}	10.41±0.26^{a}	10.12±0.56^{e}	10.15±0.30^{d}	**
Lactose	3.95±0.02^{b}	3.92±0.01^{c}	3.10±0.06^{d}	3.98±0.05^{a}	3.95±0.01^{b}	**
pH	6.59±0.03	6.57±0.06	6.23±0.02	5.60±1.65	5.1±0.12	NS
FFA	0.53±0.05^{b}	0.55±0.08^{b}	0.70±0.15a	0.31±0.26d	0.42±0.29^{c}	**
Casein	1.64±0.01^{a}	1.65±0.01^{a}	1.57±0.09^{b}	1.56±0.10^{c}	1.51±0.18^{d}	**

N=3

Different superscript letters in the same row means significance different at $P<0.05$

**= significant difference at $P<0.01$

NS= No significant different

Table 3: Effect of different heat treatments and storage period on the total bacterial count of Camel milk

Factor	Parameter
Heat treatment	Total Bacterial Count (CFU/ml)
72 °C/15 Seconds	2.77^{a}
75 °C/10min	2.65^{b}
80 °C/5 min	2.45^{d}
65 °C/30 Minutes	2.57^{c}
Standard error	0.013
Significant	**
Storage period (days)	
Day zero	0.73^{e}
Day 5	2.31^{d}
Day 10	2.82^{b}
Day 12	2.53^{c}
Day 14	3.67^{a}
Standard error	0.015
Significant	**

N=10

Different superscript letters means significant difference at $P<0.05$

**: significant difference at $P<0.01$

Table (4)Effect of heat treatments and storage period on the total bacterial count of camel milk

Treatments		Parameter
Heat treatment	Storage/days	Total Bacterial Count (log CFU/ml)
	Day zero	1.08
	Day 5	2.37
72°C/15 Seconds	Day 10	2.88
	Day 12	3.64
	Day 14	3.91
Standard error	0.03	0.030
Significant		***
	Day zero	0.59
	Day 5	2.42
75°C/10min	Day 10	2.86
	Day 12	3.50
	Day 14	3.87
Standard error	0.03	0.030
Significant		***
	Day zero	0.26
	Day 5	2.20
80°C/5min	Day 10	2.72
	Day 12	3.26
	Day 14	3.83
Standard error	0.03	0.03
Significant		***
	Day zero	0.99
	Day 5	2.26
65°C/30 Minutes	Day 10	2.83
	Day 12	3.72
	Day 14	3.08
Standard error	0.03	0.030
Significant		***

N=10

***: significant difference at P<0.001

Table 5: Effect of interaction between heat treatment and storage time on fat content of camel milk

Storage period (days)	Heat treatment				Significant
	72℃/15sec	75℃/10min	80℃/5min	65℃/30min	
0	3.10±0.00	3.06±0.01	3.03±0.01	3.01±0.00	**
5	3.05±0.01	2.83±0.04	3.03±0.00	3.03±0.01	**
10	2.74±0.00	3.08±0.01	3.08±0.01	2.99±0.01	**
12	2.98±0.00	1.97±0.00	3.02±0.01	2.95±0.00	**
14	2.84±0.04	2.29±0.01	3.13±0.01	2.94±0.02	**

N=12

**= significant different at $P<0.01$

Table 6: Effect of interaction between heat treatment and storage time on protein content

Storage period (days)	Heat treatment				Significant
	72°C/15sec	75°C/10min	80°C/5min	65°C/30min	
0	2.24±0.00	2.27±0.01	2.25±0.01	2.22±0.01	**
5	2.25±0.01	2.26±0.01	2.25±0.00	2.23±0.01	**
10	2.26±0.01	2.33±0.01	2.33±0.04	2.27±0.01	**
12	2.38±0.01	2.35±0.01	2.28±0.01	2.36±0.00	**
14	1.51±0.01	1.66±0.04	1.64±0.00	1.24±0.01	**

N=12

**= significant different at P<0.01

Table 7: Effect of interaction between heat treatment and storage time on total solids content

Storage period (days)	Heat treatment				Significant
	72℃/15sec	75℃/10min	80℃/5min	65℃/30min	
0	10.28±0.00	10.33±0.03	10.21±0.01	10.17±0.01	**
5	10.28±0.00	10.05±0.04	10.28±0.00	10.21±0.00	**
10	9.99±0.01	10.10±0.02	10.58±0.02	10.47±0.02	**
12	10.58±0.01	9.24±0.01	10.28±0.01	10.39±0.00	**
14	10.35±0.03	9.67±0.01	10.34±0.01	10.23±0.02	**

N=12

**= significant different at P<0.01

Table 8 Effect of interaction between heat treatment and storage time on lactose content

Storage period (days)	Heat treatment				Significant
	72°C/15sec	75°C/10min	80°C/5min	65°C/30min	
0	3.10±0.00	3.98±0.00	3.95±0.01	3.93±0.00	**
5	3.93±0.00	3.94±0.01	3.93±0.02	3.93±0.01	**
10	3.90±0.00	4.05±0.01	4.04±0.02	4.00±0.00	**
12	4.03±0.00	3.94±0.00	3.93±0.01	4.02±0.01	**
14	3.95±0.02	3.96±0.01	3.96±0.01	3.95±0.00	**

N=12

**= significant different at $P<0.01$

Table 9: Effect of interaction between heat treatment and storage time on pH content :-

Storage period (days)	Heat treatment				Significant
	72℃/15sec	75℃/10min	80℃/5min	65℃/30min	
0	6.61±0.00	6.62±0.04	6.57±0.01	6.59±0.01	NS
5	6.67±0.01	6.56±0.01	6.55±0.00	6.51±0.01	NS
10	6.26±0.01	6.22±0.01	6.25±0.00	6.22±0.01	NS
12	5.96±0.01	6.11±0.01	3.88±3.22	6.47±0.70	NS
14	6.14±0.01	5.87±0.01	5.98±0.01	5.85±0.01	NS

N=12

NS= No significant difference

Table 10: Effect of interaction between heat treatment and storage time on FFA content :-

Storage period (days)	Heat treatment				Significant
	72℃/15sec	75℃/10min	80℃/5min	65℃/30min	
0	0.56±0.00	0.49±0.04	0.58±0.04	0.50±0.00	**
5	0.58±0.04	0.47±0.11	0.54±0.01	0.61±0.10	**
10	0.58±0.04	0.60±0.04	0.67±0.00	0.94±0.01	**
12	0.58±0.01	0.24±0.04	0.27±0.02	0.04±0.04	**
14	0.87±0.04	0.15±0.02	0.32±0.02	0.36±0.06	**

N=12

**= significant different at P<0.01

Table 11: Effect of interaction between heat treatment and storage time on casein content:-

Storage period (days)	Heat treatment				Significant
	72℃/15sec	75℃/10min	80℃/5min	65℃/30min	
0	1.65±0.00	1.65±0.00	1.65±0.01	1.64±0.01	**
5	1.65±0.01	1.66±0.01	1.64±0.00	1.64±0.01	**
10	1.53±0.01	1.67±0.01	1.64±0.01	1.47±0.01	**
12	1.50±0.01	1.69±0.01	1.62±0.01	1.44±0.01	**
14	1.51±0.01	1.66±0.01	1.64±0.00	1.24±0.01	**

N=12

**= significant different at P<0.01

CHAPTER FIVE

DISCUSSION

The effect of heat treatment on chemical composition (table 1) of the camel milk showed significant difference in all chemical parameters ($P<0.05$) except pH. The highest fat content (3.04±0.02 %) were in treatment of 80 C°/5min high temperature long time probably due to stimulation of oxidation reactions which caused fat and protein deterioration. Our finding were in line with the result of Constantin and Csatlos (2010) and disagree with the finding of Sahan (1996) who reported that heat treatment had no significant effect on the fat value of milk.

The highest and lowest protein values (table 1) were in treatment of $75C^{\circ}$/10min and 65 C°/30 min. respectively.The high protein content in the camel milk samples treated at 75˚C/10min. probably due to the effect of high pasterurization temperature and long time on the inhibition of the microbial load (Constantin and Csatlos, 2010) . These findings were in accordance with the those of Hattem (2011) who reported that the non protein nitrogen (NPN), non casein nitrogen (NCN) and whey protein nitrogen (WPN) gradually decreased with increase in thermal treatments but casein number and the percentage of denaturation were increased.

The highest Total solids content (table 1) was 10.33% for treatment 80 C°/5 min while the lower one was for $75C^{\circ}$/10 min . This result probably due to moisture loss with high temperature pasteurization. These results were in accordance with the finding of Mal and Pathak (2010).

The results (table 1) showed that lactose content of camel milk sample affected with heat treatment it increased at $75^{\circ}C$/10 min and decrease at 72

$C^{\circ}/15se$. This result might be due to reactions of protein cross-linking. The above results in agreement with those by Musabal (2006) who reported that the lactose in gariss increase by pasteurization and decrease within boiling and did not agreed with the finding of El Magli, (2004) who reported that there was a decrease lactose value of pasteurized milk.

The pH contents of the camel milk samples in this study were not affected significantly by different heat treatments (table 1) these results were in agreement with those of Farah (1996). And were not in line with those by Khaskheli *et al.(* 2013);Petrus *et al.(* 2011); Hassan *et al.* (2009), and Hussain. (2011) who found that increase in temperature results in increasing the pH of milk samples reported that heat treatment causes some possible physico-chemical changes that results in decreasing the pH of milk due to increase in concentration of lactic acid produced from degradation of lactose content. They also reported that changes in Calcium phosphate is also responsible for decreasing the pH and thus increases the acidity of milk samples.

The free fatty acid contents (table 1) was highest in $72C^{\circ}/15$ sec and was the lowest in $75C^{\circ}/10$ min . This results might be due to the supposed that pasteurization temperature insufficient for inactivation the native lipases and sable bacterial lipases according with Chavari *et al.,* (1998). Our findings are in line with the those of Regula et al., *(* 2005) whose reported that the pasteurization had an influence on SFFA (total free fatty acid) contents in ewes milk .Heating at $72C^{\circ}/30s$ caused an increase in butyric and in capric acid, but temperature $95C^{\circ}/5min$ and $85C^{\circ}/20min$ decrease butyric acid content by 75%and 54% respectively.

The casein content was high in $75C^{\circ}/10$ min. while it was low in 65 $C^{\circ}/30$ min. They showed increase with the thermal treatment of samples. This attributed to the impact of whey proteins denaturation that co-precipitated with the caseins. This agreed with the result obtained by Hattem (2011) who reported that increasing the severity of thermal treatments, of camel milk resulted in increase in the values of casein number and whey protein. On the other hand, the results of CN came also in agreement with those achieved by (Hassan *et al.,* 2009) for raw and thermally treated (85°C /5 min.) samples of camel‘s milk. The corresponding values were 0.102 and 0.059 % for WPN and 0.348 and 0.391 % for CN, respectively.

The storage period affected on chemical composition of the camel milk significantly ($P<0.01$) except the PH content (Table 2) .

The fat content of camel milk (table 2). The highest fat content was at day zero and the lowest value was at day14 this could be due to the lipolytic activities and oxidation .this result agree with Musabal (2006) who reported that fat content of gariss stored in the refrigerator at (10°C) for 1day, 4 days, 7 days and 15 days were found to be 3. 27% ± 0.47, 3.20% ± 0.52, 3.22% ± 0.32 and 3.15% ± 0.31respectively, the percentage for the first day was higher than those of the end of storage period.

The protein contents results indicated that the storage period had significant effect on protein content. the highest protein was at day12 and the lowest value was at day14 (Table 2) .this might be due to reaction products like proteolytic activities of protein .this was in agreement with Bylun (1995) who reported that there is changes in chemical composition of camel milk during storage, these changes are normally of two kinds oxidation and lipolysis.

The results (Table 2) showed that total solids of camel milk samples increased till day at day10 and decreased at day12.this probably due to the loss of moisture and proteolytic activities during storage. These results were in accordance with the findings of Omer and Eltinay (2009) who reported that total solid of camel milk storage at 40˚C decreased slightly from 9.8-9.5-9.0% at the

1st, 2nd and 3rd readings, respectively, and are in disagreement with Abubakar *et al., (* 2005) whose reported that total solid increase up to 15.60% ±0. 6 during storage of yoghurt.

The lactose contents in this study was highest in day12 and lowest in day10, this probably due to the activity of microorganisms and breakdown of lactose .These results were in disagreement with those of Omer and Eltinay, (2009) who reported that the lactose content was affected by storage at different temperatures.

The statistical analysis revealed that storage period had no significant ($P<0.05$) effect on pH content of the camel milk (table 2).These results were in agreement with those of Yagil, (1982) who reported no change in the pH of camel's milk, stored at 40˚C after 2 days of collection. Titratable acidity at 40˚C rose from 0.2-0.4-0.6% for the 1st, 2nd and 3rd readings, respectively. And were not in agreement with that of Omer and Eltinay, (2009) who reported that the mean value of pH at 40˚C of fresh camel milk during storage. On the day of collection (1st reading) as 6.6, accompanied by a slight decrease in 3rd week (2nd reading) and a further decrease to 5.8 at day 42 (3rd reading).

The storage period affected the free fatty acid content (table 2) of the camel milk samples significantly ($P<0.01$) the highest FFA content was at day 10 .the lowest value was at day12.

The results (table 2) showed that casein content was highest at day5 and lowest value was at day14. These results could be attributed to a proteolysis, These result is similar to the finding Musabal(2006) who recommended that casein in gariss was high in the first day than other days, day 1 was 2.33% ± 0.58, in day 4 was 2.25% ± 0.49, in day 7 was 2.21% ± 0.38 and day 15 was 2.14% ± 0.43.

The interaction between the different heat treatments and storage period had significant ($p<0.05$) effect on the total bacterial count of camel milk (table 3). The highest bacterial count was for the control 72 °C/15 Sec and lowest value was for the 80 °C/5 min .also the highest bacterial count was for the day 14.The lowest bacterial count was for day zero. These results were in agreement with those by Lewis and Deeth(2008) . Moreover the procedure of heat treatment is known to improve the quality of dairy product by killing the pathogenic microorganisms and increasing the shelf life recommended by Harding.

The interaction between the heat treatment and different storage period had significant($P<0.001$) effect on the total bacterial count of camel milk (table 4). The highest bacterial counts; 3.91,3.87,3.83and 3.72 log CFU/ml were for the 72°C/15 Sec, 75°C/10 min., 80°C/5min. all on day14 and 65°C/30 min. on day 12 respectively and were lowest; 1.08,0.59,0.26 and 0.99 log CFU/ml for the72°C/15 Sec, 75°C/10 min, 80°C/5min and 65°C/30 min. on day zero respectively ,these results might be due to the presence of antimicrobial factors in the camel's milk and agreement with the objectives of pasteurization. These was in agreement with El Agamy et al.(1997) .

The interaction between the heat treatment and storage period had significant ($p<0.01$) effect on the chemical composition of camel milk samples in all treatments (tables 5 ,6 ,7 ,8 ,9 , 10 and 11) .The highest fat content (3.10±0.00%) was for the heat treatment (72°C /15sec) on day zero . however, the lowest one was for the treatment (75°C /10min) on day 12.This could be due to oxidation reactions that caused fat deterioration. These results disagreed t with those of Omer and Eltinay (2009) who reported that no significant change in fat content of fresh camel milk observed when milk was refrigerated at 7 C.

CONCLUSION AND RECOMMENDATION

6.1. Conclusion:

It is concluded that heat treatment showed significant effect on the chemical composition and microbial load of the camel milk the best heat treatment was found to be the pasteurization of camel milk at 80 ˚C/5 min..

6.2 Recommendation:

- The effect of different heat treatment on the vitamin contents of camel milk required further studies.
- The sensory evaluation of the effect of heat-treatment should be considered in the further studies.
- The shelf life of the camel milk under different heat treatment for longer period of time needs further research.

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