CAMEL PRODUCTION PRACTICES, PROCESSING AND MARKETING ALONG WITH ITS BLENDED CHEESE WITH BOVINE MILK IN BORENA AND GUJI ZONES, OROMIA, ETHIOPIA

PhD DISSERTATION

BY

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CAMEL PRODUCTION PRACTICES, PROCESSING AND MARKETING ALONG WITH ITS BLENDED CHEESE WITH BOVINE MILK IN BORENA AND GUJI ZONES, OROMIA, ETHIOPIA

A Dissertation Submitted To College Of Veterinary Medicine and Agriculture, Addis Ababa University for Fulfillment of the Requirement of Degree of Doctor of Philosophy in Animal Production

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As members of the examination board of the final PhD open defense, we certify that we have read and evaluated the dissertation prepared by Abebe Gemechu entitled: '**Camel Production Practices, Processing And Marketing Along With Its Blended Cheese With Bovine Milk In Borena and Guji Zones, Oromia, Ethiopia**'', and recommended that it be accepted as fulfilling of dissertation requirement for the degree of Doctor of philosophy in Animal production

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DEDICATION

I dedicated that this PhD dissertation work to my wife Tigist Moti and my beloved family for their love, patience and support throughout my work.

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STATEMENT OF AUTHOR

First I declare that this Dissertation is my bona fide work and that all source of materials used for this Dissertation have been duly acknowledged. This Dissertation has been submitted in partial fulfillment of the requirements for PhD degree at the Addis Ababa University College of Veterinary Medicine and agriculture and is deposited at the University Library to be made available to borrowers under rules of the Library. I solemnly declare that this Dissertation is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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BIOGRAPHICAL SKETCH

The author, Abebe Gemechu was born on November5, 1986 in Tiyo Woreda of Arsi Administrat ive Zone of Oromiya Regional State. He completed his Elementary school education at Berity elementary School and Secondary School education at Chilalo Senior Secondary School in Assela town. He completed his High School and preparatory education at Assela Preparatory School in the same town. Soon after completion, the author joined Jimma University, Ambo College in 2006 to pursue his undergraduate study and awarded B.Sc degree in Animal Production in July 2008. After his graduation, he joined the Ministry of Agriculture and worked as Animal Production and Milk Development Expert in Arsi Zone, Sire Woreda up to March 2009. In March 2009, he joined the graduate program at Haramaya University to pursue his M.Sc study in Animal Production. Again in 2018 G.C he joined to Addis Ababa University college of Veterinary medicine and Agriculture to pursue his PhD degree in Animal Production.

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ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of variances
ASAL	Arid and Semi-Arid Lands
CSA	Central Statistics Agency
GIT	Gastro intestinal tract
GLM	General linear model
HACCP	Hazard Analysis Critical Control Point
IDF	International Dairy Federation
ILRI	International Livestock Research Institute
IUPAC	International Union of Pure and Applied Chemists
LMY	Lactation Milk Yield
PHAC	Public Health Association of Canada
TA	Titrable acidity

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ABSRACT

The current study was conducted on camel milk production practices, processing and marketing along with it blended cheese with bovine milk with the objective of assessing camel milk handling, utilization, processing practice, marketing in selected districts of Borena, East Guji, and West Guji Zone, and evaluating the impact of milk blend on physico- chemical composition of milk and cheese, sensory attributes, time of coagulation and cheese yield. For the purpose of gathering data, 160 respondents from four Zones districts were chosen. The administration of a cross-sectional survey design was used to acquire primary data using deliberate sampling strategies. The majority of participants in the data collection were between the ages of 40 and 50 (41.2%), with a mean family size of five person and camel ownership (13head of the camel). Male respondents made up 45% of the total respondents, while female respondents made up 55% of the group. The majority of respondents (51.3%) could not read or write. In the current study, the overall ranges of milk production (4-13 liters per day), caving interval (12-68 months), milking duration per day (2-4), and lactation length (6-24 months). The traditional methods of preservation utilized by the Borana and Guji communities were washing and smoking the vessels (100%), storing milk in a frigid/cold/ environment (78.75%), and boiling (27.5%). Another activity they have been performing is combining camel milk with cow or goat milk (15.00%) and turning it into sour milk (chuuchee) (94.36%). The traditional containers used for milking and storage by smoking with various plant components include the sorora, gorfa, okole, and plastic jug. Camel milk has been utilized in the areas to cure coughing (60.6), uterine contractions in women (65.5%), malaria (73.1%), and constipation (68.1%). A major obstacle and problem in the districts, meanwhile, has been the spread of understanding about camel dairy processing and development. To reduce the effect of lactation stage on milk composition, a sample of milk was

Obtained from pastoral communities of Gomole district in the Borena zone using stratified sampling procedures. The cheese was made using a starter culture (Thermophilic culture STI-12) and camel chymosin with a blend of camel and cow milk. Prior to the creation of the cheese, the chemical composition of the milk used was examined. Cheese's physicochemical characteristics were also assessed. When compared to the other milk a sample, the yield of cheese made from 100% camel milk (T1) was considerably lower ($P < 0.05$). Higher values were seen in treatments that combined 25% camel milk with 75% cow milk and 100% cow milk, significantly ($P<0.05$). When compared to the other milk samples under treatments T2, T3, T4, and T5, pure camel milk (T1) coagulated in significantly longer ($P<0.05$) time (210 minutes), but pure cow milk (T5) coagulated in significantly shorter ($P<0.05$) time (95.67 minutes). In all of the study's treatments, there were significant variations in the physico-chemical composition of raw milk (p 0.05), in TS, TA, Fat and Ash. Cheese may demonstrate the effects of the camel blend if protein, fat, totals solids, and ash content improved significantly ($p<0.05$). The significance ($p<0.05$) boost in cheese's protein, fat, total solids, and ash content could indicate how camel milk has influenced cheese production. Diseases, occasionally appearances of dough and bush encroachment are the critical problems in camel milk production in the area. The combination of camel milk with cow milk brought the significant improvement in physicochemical properties of cheese, coagulation time and efficiency cheese recovery from camel milk. Also the present of cow milk in blend made the cheese to have a great sound in overall acceptances of the cheese. However, to obtain a cheese of camel milk with a good curd, fifty and more percentages of cow milk should be mixed.

Key Words: cheese, coagulation, *milk processing, pasteurization,* ***preservation****, rennet and starting culture*

1. INTRODUCTION

According to the live animal's statistics, the worldwide camel population is 35,525, 270 heads (FAOSTAT, 2020), most of which are in Somalia, Sudan, Niger, Kenya, Chad, Ethiopia, Mali, Mauritania, and Pakistan. Camels live in the vast pastoral areas of Africa and Asia and are divided into two different species belonging to the *genus Camelus*. Dromedary camels (one-humped) mainly live in desert areas (arid) and the Bactrian camel (two-humped) prefers to live in cooler areas. More than 80% of the camel population inhabits Africa with 60% in eastern African countries(Sudan, Somalia, Ethiopia, and Kenya), which are important exporters of dromedary camels to the Arabian Peninsula and Egypt (Faye, 2015). According to (Entity, 2021) Ethiopia has about 8 million camels and most of them were kept in southern pastoral areas of the country. The majority of camels in the country are found in the drier areas of the Eastern part of the country and kept, among other animals mainly for milk production in these areas. It is widely admitted that dromedary camels produce more milk of high nutritional quality and for a longer period of time than other species in an environment that may be rightly termed as hostile in terms of extreme temperature, drought and lack of pasture.

The camel (*Camelus dromedarius*) play an important role as a milk source in many arid and semi-arid countries, as they can produce more milk over a longer period of time than any other species under these harsh conditions (Farah and Younan, 2005). In the Horn of Africa, where 60% of the world camel population lives, approximately 10% of the total milk produced is of camel origin (Faye and Konuspayeva, 2012). However, their potential to survive on marginal resources in extreme conditions, camels has not been exploited as an important food source.

The total cow milk production for rural sedentary areas of the Ethiopia in 2019/2020 was about 3.89 billion liters (CSA, 2020a), whereas, the camel milk production for pastoral areas of the country was about 1.82 billion liters. The contribution of the different livestock species to the total production is about 81.2% from cattle, 6.3% from camels, 7.9% from goats and 4.6% from ewes (CSA, 2008). Due to the highly perishable nature of milk and mishandling, the amount produced is subjected to high post-harvest losses. Losses of up to 20–35% have been reported in Ethiopia for milk and dairy products from milking to consumption (Feleke, 2003). Total annual milk production increased at a rate of 1.2% for indigenous stock and 3.5% for improved stock (Redda, 2002).

Livestock is the principal asset of most pastoral and agro-pastoral communities. However, the extreme fluctuation of climatic events has been input a significant impact on livestock production and productivity in arid and semi-arid areas of the country(Habte et al., 2022). Currently, the frequent outbreak of drought in dry pastoral parts of the country including the targeted pastoral areas of Borena and both Guji Zones is influencing the productivity of cattle managed under traditional ways (Bogale and Erena, 2022). However, the camel is an exceptional animal that can survive these harsh environmental conditions better than other livestock species. So lowland pastoral communities of Ethiopia including Borena and both Guji are following the tried-and-tested adaptation strategy of shifting from less resilient (but more marketable) cattle and sheep into more resilient camels and goats (Pantuliano and Wekesa, 2008). Some Borena pastoral areas that have not traditionally farmed camels are adopting this species as a means of adapting to less predictable access to water and frequent outbreaks of drought. Because, they experience cattle are less resistant to thirst and are more susceptible to infectious diseases than the camel and goat species (Yosef *et al.*, 2013). Besides the annual expansion of bush encroachment in pastoral areas including Borena and both Guji Zones has made camel to have good attention, because of the unsuitability of the thorny attributes of bush for other kinds of livestock.

Many Ethiopian pastoralists claim that it is difficult to process camel milk to make butter, yoghourt, cheese except some traditionally fermented camel milk in Somali region (Lumadede *et al*., 2010). Butter from camel milk cannot be obtained so easily using the traditional churning methods because camel milk shows little tendency to cream up and the fat in camel milk is firmly bound to the protei(Asresie *et al*., 2013a). Most of the camel milk is drunk fresh in general and in Ethiopia in particularly. It is also consumed when slightly sour. In most camel rearing societies, the milk is mainly consumed in its raw state without being subjected to any sort of processing treatment *(*Lumadede, *et al*., 2010).

On the other hand, nowadays at different place of the world there are modernized camel dairy processing which are able to produce different camel milk product (Isam, *et al*., 2011). Asres *et al.*(2016) revealed that as camel milk has been processed in to butter with low efficiencies and long churning time as compared to goat milk. Processing camel milk into cheese is difficult and has even been considered as impossible, due to the fact that the relative distribution and amino-acid composition of camel milk caseins are different from bovine milk (Yagil, 1982a). Camel milk casein has high beta casein (β-CN) (65% versus 39%), low alpha S_1-casein (α_{s1}-CN) (22% versus 38%), and low kappa casein (κ-CN) (3.5% versus 13%) as compared to bovine milk caseins. Moreover, the camel milk caseins have low homology to bovine milk caseins, being 39% for α_{s1}-CN, 64% for β-CN, 56% for α_{s2}-CN, and 56% for κ-CN (Kappeler*et al.*, 1998). The chymosin cleavage site of camel milk k-CN was found at the Phe^{97}–Ile^{98} amino-acid sequence site, whereas the hydrolysis site in bovine milk is Phe^{105}–Met^{106} (KAPPELER *et al*., 1998). Thus, the amount of κ-CN in camel milk is relatively small and coagulation of milk in cheese making is typically achieved by enzymatic hydrolysis of κ-CN at the surface of casein micelles. Camel milk has been reported to contain higher whey protein to casein ratio compared to bovine milk which is responsible for a soft and easily digestible curd in the gastrointestinal tract (Shamsia, 2009). Camel milk casein has large micelle size with an average diameter of 380 versus 150, 260, and 180 nm compared to bovine, caprine, and ovine milk, respectively (Bornaz *et al*., 2009). Smaller casein micelles have been reported to improve the gelation properties of bovine milk (Glantz *et al*., 2010). Thus, the lower amount of k-CN, the high ratio of whey protein to casein, and the larger micelle size in camel milk are reported reasons for the difficulty of cheese making. These properties result in formation of a less firm coagulum and lower yield during cheese processing.

1.2. Statement of the Problem

Application of different methods in camel processing into milk products both under traditional and advanced techniques in Borana and Guji Zones has been limited. some studies have identified traditional methods to produce fermented camel milk Dhanaan in Somali region and ittitu in Kereyu(Lumadede*et al*., 2010), Suusac in Kenya, and Garris in Somalia (Farah *et al*., 2007). Despite, the claim of pastoral community about the difficulty to process camel milk, different study reports were revived that “there is possibility of camel milk processing to butter and yoghurt but, the efficiency of processing camel milk into cheese under natural condition of processing is very low or impossible (Isam, *et al*., 2011, Mortada and Omer, 2013; Muliro *et al.*, 2013 and Abdulaziz, *et al.*, 2014). This might be due to the high beta casein (β-CN), low alpha S1-casein (αs1-CN), and low kappa casein (κ-CN) as compared to bovine milk caseins. It also stated that, manufacturers of camel dairy products such as cheese, yogurt and butter using the same technology as for dairy products from bovine milk can result in processing difficulties and products of inferior quality (Berhe *et al*., 2017a). Enzymatic treatment methods investigated for soft white cheese have potential for the development of cheese with good acceptability from camel milk.

In the study areas camel milk have been used both for home consumption, selling raw milk and fermented ones (Birhanu *et al*., 2021). The small-scale camel milk fermentation method has been carried out using the fermented milk of other animal species (cow and goat) as a catalyst. By permitting the camel to travel over long distances with milk loaded on its back obtain butter in a minimal way. They used various indigenous knowledge to convert the camel milk into sour milk known as *chuuche*e. This age-old technique could be used to stir milk and quickly turn camel milk into butter. The other traditional way used to speed up the process is to place a hot stone (*Smoky Quartz*)), known locally as "*chabbii*," into camel milk that is ready for processing. Rennet is the most popular coagulant used by cheese-makers to manufacture many different types of cheese (Badmos and Joseph, 2012). An increase in acidity, prolonged heating, or enzyme activity could cause coagulation (Adepoju *et al*., 2012). The process of making cheese aids in keeping milk's important components intact. Due to its high presence of antibacterial components such as lysosome, lactose, and immunoglobulin, processed camel milk has great biological properties. Additionally, it is used medically to treat Spleen disorders, anemia, asthma, and tuberculosis. Lysozyme, lactoferrin, lactoperoxide, immunoglobulin, and secretary immunoglobulin are all present in significant quantities in camel milk. Cheese manufactured from a combination of cow and camel milk has better aroma, appearance, hardness, and textural qualities than cheese made exclusively from camel milk(Ayyash *et al.*, 2018). Because of low attention has given in camel production, little is known about camel dairy production and processing as compared to other livestock species. However, documenting camel milk production, processing and management practices, describing the basic production, handling and utilization of camel dairy and identifying the prevailing constraints have substantial importance to design sustainable camel dairy production improvement strategies. Hence, this study was designed to assess on camel dairy production, processing, utilization, management and evaluating the impacts of mixing cow milk with camel milk on milk coagulation, cheese yield, and chemical composition and sensory attributes of the cheese..

General objective:

- To generate information on the camel milk production, rocessing, marketing, challenge and constraint in exploiting of camel milk, and cheese making from camel milk.

The specific objectives:.

- **T**o assess camel milk production, processing, handling, preservation, marketing, utilization and management practices in the areas
- To evaluate the efficiency of making cheese from camel milk by blending it with bovine milk.
- To evaluate the physicochemical properties and sensory attributes of raw milk and cheese made from camel milk blended

2. LITERATURE REVIEW

2.1. Camel Production Systems in Ethiopia

Livestock production systems in Ethiopia can be broadly classified into two as the traditional production systems (pastoral nomadic, pastoral transhumant, agro-pastoral and smallholder mixed crop-livestock) and the modern production systems (ranching, intensive/semi-intensive peri-urban/urban, feedlot and commercial production).

Camel production system could be classified as traditional nomadic management system and transhumant, sedentary, semi-intensive and intensive management system Fazal *et al.*(2017). They are predominantly kept in the pastoral and agro-pastoral production systems (Tadese, 2018) which is similar with the study reports of Dejene,(2015) on camel production system in Borena and Guji. Only few male camels are to be found in the mixed crop-livestock system. In Ethiopia semi-intensive and intensive management practice not practiced for camel production as compared to other animals. There is no improvement in housing, feeding and watering to advance production system. Management practice in Ethiopia is basically traditional and they house camels in open camp around their home during night and herded during day time in communal grazing land (Gramay and Ftiwi, 2018). The majority of camel herds have kept under an extensive management system are browse and graze together with other species of animals and the pastoralists have been managed the young animals in traditional ways (Yohannes *et al.*,2015).

In different parts of the country camel management is controlled by the responsibility of the husband and sons, while the work includes gathering cut and carry forages and hauling water for relatively immobile young calves, which are kept in near the family hut (Awoke *et al., 2015*). Camel managed under good keeping practices could prolong the improvement of the herd production and productivity.

Pastoralists keep indigenous breeds/types and obtain more than 50% of household income from livestock and livestock products. The system is much simpler than the mixed crop-livestock systems of the highlands. There are few inputs other than labor. Herd and flock composition is regulated to some extent (only few breeding males are maintained). Grazing management and herd movement are determined by the seasonal patterns of rainfall and availability of water. There is little to no interaction with crop agriculture, and although a range of livestock species is managed to reduce risk, one or two species dominate. For example, camels and goats are the main species in Afar and Somali, while in Borana zone; cattle are still the main species.

Production is mainly for subsistence, but surplus animals are sold. Generally, camel populations have been increasing in the pastoral areas during the past 20 years by at least 10, 20, 25, 15, 25 and more than 200% in Gode, Jijiga, Shinille, Mille, Amibara districts and Borana zone, respectively. On the contrary, cattle populations decreased by 50 to 70% in these districts during the same time (Tadesse *et al*., 2014). According to these authors, about 14, 25, 10 and 8% of the households studied in Gode, Jijiga, Shinille and Borana, respectively; do not possess cattle at present. In the agro-pastoral production system, crop agriculture is combined to a limited extent with livestock rearing. It is practiced in semi-arid areas and may take the form of either sedentary or transhumance way of living. Indigenous breeds/types are reared and livestock contribute between 10 and 50% of household incomes. Mixed crop-livestock production systems prevail in sub-humid and humid central highland parts of Ethiopia. The system is sedentary and livestock is secondary to crop production. It is characterized by smallholdings of about 1 to 3 ha of land and two to four heads of cattle (Mirkena *et al*., 2018a)

2.2. Camel Breeding Management Practices

The Borena and Guji pastoralists have been rearing different camel heard structure whose proportion varies from one category to the other. There were more female than male camels for all age categories. In pastoral herds in Ethiopia, the proportions of breeding females have been reported to be greater than male in percentages (Getahun&Kassa, 2002). Larger proportions of females in herds of the study areas indicate a strong desire of herdsmen to maximize herd size and the importance of milk production in pastoral areas (Dejene, 2015).

Keeping only the male for breeding purpose, the pastoralists have been reducing the population of male camel through selling.

In both Borena and Guji Zones the camel bull is selected at an average age 4.5years for breeding, while the female one is selected at the age of 3.5years old. In Ethiopian the age at which the camel reached range from 3.9 to 4.7 years for female, whereas 5.5 to 6.5 years for male (Mirkena *et al.*(2018a). On average, female camels deliver their first offspring around five years under Ethiopian conditions. Traditionally managed bulls reach age at first service at 5.5 years and achieve full sexual maturity at seven years of age during which time they achieve the capacity to accomplish 11 services per day and also successfully breed 60 to 70 cows in a breeding season (Ahmed Shek *et al.*, 2005). Calving interval is normally two years on average with values ranging from close to 18 months in Borana (Dejene 2015) to 31.2 months in Afar (Keskes *et al.*, 2013). The criteria set for selection are observing the pedigree of dam and sire, body condition and individual animal temperament. In both case the bull has selected from their own herds, only small percentage of the communities are shared from neighbors and purchased from form market, (Dejene, 2015. The camel keeper had owned more than one bull, but only one is active enough to give mating services. The main mating season was during the short rainy season (*Hagaya)* which extends from September to November.

2.3. Milk Production from Camel

Realizing the importance of camel's milk (Al-Swailem *et al.*, 2010).) reported that the ability of camel to convert desert vegetation in to valuable food items was the only reason for its domestication. Camel lactates in adverse conditions, and significantly superior to other livestock animals in terms of food production and many camel breeds have been identified as potential 'dairy' breeds and could be used as a source of protein in drought stricken areas(Staal *et al.*, 2008)

In many arid areas, camels play a central role as producer of milk. The comparative advantage of the camel as a dairy animal over the other species in the same environment is difficult to quantify; however, it is widely recognized that in absolute terms, the camel produces more milk, and for a longer period of time, than any other milk animal kept under the same conditions (Farah, 1996). Some studies in Ethiopia showed that the Afar pastoralists rearing simultaneously cattle and camels get average 1 to 1.5 liters of milk with Afar zebu against 4 to 5 liters with Afar camel (Richard, and Gerard, 1989).

According to FAO (2018) report, the annual camel milk production in Ethiopia is estimated to be 176113 tones. In most parts of the country camel milk is utilized in the form of whole milk. It is essential diets for family in an area that may correctly term as arid and semi-arid. Tekle and Tesfaye (2013) reported that the highest milk yield is obtained during rainy season regardless of production system. This owing to the nutritional status of the feed during the wet season, where feed s are abundance of many types of vegetation and rich in nutrients.

In different parts of the country camel milking practices and amounts of yield obtained has been varies from place to place and breed to breed that depends on agro-ecology in which they kept, feed availability, season, water access and management practices. The annual camel milk production in Ethiopia as a general is estimated to be 170,000 tons (Seifu, 2007a). Seifu, (2007) also stated that a good dam could yield 9 kg of milk per day at the peak of lactation for an unspecified type of camel. Daily milk yield of camels in and around Jijiga was reported as it ranges from 1.0-6.0 liters per day Simenew *et al*, (2013). Mean daily milk yield of 2-6 liters was reported by FAO (2001) in Somalia and according to(Farah *et al.*, 2004) milk production of Somali camels was 5–6 kg. Also, Kebebew, (1998), Tafesse and Tuffa, (2001b) and Wosene, (1991) reported that milk yield of 7.5 kg, 3-10 and 8-10 kg per day in the Ogaden camel keeping area in east Ethiopia respectively.

Gebissa, (2015) reported that high milk and meat production (98.9% and 96.7%) was the primary purpose of camel production in in the Borana followed by income generation (92.4%), and transportation (83.7%)). The lactation length of camels was 13.38 months on average (Gebissa, 2015). The finding is in agreement with the previous finding of Bekele *et al*. (2002) which reported as 13 to 15 months of lactation. However, it is shorter than 15 to 18 months for Afar and higher than 6 months for Kereyu camels as per the report of (Schwartz and Walsh, 1992) and

(Alemayehu, 2001), respectively. According to Gebissa, (2015) camel milk yield in Borana was range from 4-9L/days and frequency of milking could varies from two to three time per a day based on the season of the year. Milk is a usual and favorite food for afar camel owners. Daily milk yield of Afar camels range from 2.01-12.0 liters per day depend on feed availability, season and water access. Lactation length is 12 month in most of the cases but factors affecting lactation length include season of the year and demand for milk for more prolonged time(Simenew *et al.*, 2013a).

Lactation length can be prolonged when there is good feed availability and if demand for milk by the owners is increasing. The frequency of camel milking by the pastoralists vary and it depends up on the following factors: quality of milk produced per animal, extent of demand for milk, season and number of milking camel present in the herd, availability of other food for the camel owner, age and health of the calves. Generally the camels are milked two to three times per day. The variations could be due to the number of animals involved, difference in pastoral practice such as milking frequency and suckling to breed difference as well as other management or environmental difference. FAO (2004) milking practice is also known to affect daily milk yield. Kebebew (1998) also observed that Ogaden camels have high milk yield, long lactation length and long persistency, which suggests that Ogaden camels are good dairy animals in arid and semi-arid areas. Study conducted in Northern Kenya also shows that a camel can produce one liter of milk from about 2 kg of vegetation dry matter consumed; while for equivalent milk production a cow will need more than 9 kg of dry matter (Stiles, 1983).

Allowing the calf to suckle for a few minutes before hand milking makes it difficult to measure actual milk yield while milking without any previous mechanical stimulation of the mammary gland, leads to lower yields.

Traditional hand milking is the only method of milking practiced in the country. Camels are milked between once and three times a day, depending on the season. If a calf seems weak or becomes ill, its dam (mother) will be milked less frequently and the amount of milk taken on each occasion reduced. Traditionally, calves are allowed to suckle their dam before and after milking, to initiate milk let-down and then drain whatever is left in the udder (Kebede *et al.*, 2015a).

2.4. Consumption and Utilization of Camel Milk

The consumption of milk and milk products vary geographically between the highlands and the lowlands and level of urbanization(Ahmed *et al.*, 2003). In the low lands, all segments of the population consume dairy products while in the highlands major consumers include primarily children and some vulnerable groups of women (Ahmed *et al.*, 2003)

Camel milk is consumed in raw form either when it is fresh (*dhai*) or soured (*Karoore*) with tea (*Cadeese*), or added to grain foods or porridges (Asefa, 2011). Similar consumption mode was reported by (Wilson *et al.*, 1990) and in Somalia ((Hashi, 1984)) and with blood in Kenya (Bollig, 1992). However, camel milk is highly preferred for consumption when it is in fresh form with tea (c*adees*). The *karoor* is usually preferred with boiled sorghum (*Gorow*), with rice, or with maize (sorghum) porridges (Asefa, 2011).

Though the habit of milk consumption appears to be similar across camel herder societies of Ethiopia ((Mariam, 1987), the amount consumed out of the total milk off take per households per day varies. Tezera and Bruckner, (2000) reported that majority of households in Jijiga site divide the amount of milk obtained from their herd for consumption and sale per day in each season while the other households take almost all milk directly for consumption. According to the same author in Jijiga site only about 24% of the interviewed households consumed all the milk produced in wet season. However, this figure is increased to 39% during dry season. In the lowland when milk supply in the household increase due to season or high number of herd, they increase their household consumption other than a prerequisite for dairy sale. For instance, in the Borana household, out of the total milk off-take 66% is consumed at household and 24 % is sold or given to other households (Coppock, 1994).

However, a survey reported conducted by Asefa, (2011), showed that, about 73.3% of the interviewed Afar pastoral households indicated that they give surplus camel milk for their relatives and neighbors and it is also given to any other guests who want camel milk. Similar observation was reported by Bekele and Kebebew, (2001) who indicated that camel milk is not commercialized in Afar and thus almost all milk produced were used for home consumptions. Ali *et al*.(2008) also stated that camel milk is often shared among neighbors and guests to show hospitality. Moreover, in the eastern part of Ethiopia Shinile zone, about half of milk of a given camel is contributed, by the better off and most of the middle households, as gift to the needy and guests every morning in normal wet seasons (Save the Children, 2002).

2.6. Composition of Camel Milk

Camel milk has a unique characteristic as compared to bovine milk. It has a white opaque with salty taste and lower pH compared to that of cow milk. Furthermore, the fat globules' average size is smaller compared to bovine, buffalo, and goat milk fat globules (Khalesi *et al., 2017*). The first milk, the colostrum is white and slightly diluted as compared with the colostrum of cow. Other study on the composition of the camel milk depends on the stage of lactation (Khaskheli *et al*., 2005). The total solids declined to 18.4% during the first 2 days of lactation then finally to 9-16%. This decline in total solids was not caused by a variation in fat content, as initially the fat percent was low; rather the decline in total proteins and minerals (Khaskheli *et al*., 2005). However, in most countries camels' milk colostrum is not palatable for human consumption and drinking (Shalash, 1980). The colostrum contains large amounts of antibodies due to this reason it is advisable to suckle calves as it helps for development of passive immunity (Yagil and Etzion, 1980).

The total protein in camel milk is similar to that of cow milk. In camel milk the main protein is casein, that held about 52-87% of total protein, while whey protein contribute only 20-25% (Devendra *et al.*, 2016). He also stated that camel milk has more β-casein than is α-casein 65 to 21% of total casein, respectively. Casein in camel's milk has four fractions and accounts; the ratio of αs1 to αs2 to β to κ-casein significantly varies in camel's milk, being 22:9.5:65:3.5 (Park & Haenlein, 2013). Camel milk casein and their fractions were found to be poor in crud protein when compared with cow milk (Devendra *et al*., 2016).

The protein percentage severely decreased from dehydrated camel milk (Yagil and Etzion, 1980).Again, this demonstrates the direct effect of drinking water on the composition of milk result stress the protein content of feed directly affect milk composition. The mineral content of milk is expressed as total ash. This total ash content of camel milk varies greatly and the lowest percentage of fat, protein and lactose content, ash, calcium, phosphate and magnesium was found in the milk produced by dehydrated camel (Yagil and Etzion, 1980). Therefore, that increase sodium and chloride would account for the salty taste of camel milk at the time of drinking.

2.7. Camel Dairy Processing

Processing of camel milk into different products such as, butter, yoghurt and cheese critical for increasing the shelf life of the products. However, different factors make camel milk is not easily fermented. So, manufacturing of fermented products from camel milk is reported to be difficult due to lack of a desirable curd formation and firmness and the curd is instead fragile and heterogeneous and consists of dispersed flakes (Attia *et al*., 2001a). According to *Izadi et al*.(2019) report the differences in protein profile can affect the composition of fermented camel and cow's milk that resulting in variability of the processed products. As he revealed fermented camel's milk has more antioxidant peptides, probably, due to the structure of β-casein. So, β-casein in camel's milk is shorter and contains more proline. Its hydrolysis results in the formation of bioactive peptides and release of amino acids such as phenylalanine and tryptophan with antioxidant properties (Izadi *et al*., 2019).

The fat content varies from 1.2 to 4.5% in camel's milk (Devendra *et al*., 2016). However, Park & Haenlein (2013) reported that the content of fat in camel's milk may reach up to 6.4%, and its profile is characterized with the presence of unsaturated and long chain fatty acids at higher amounts. This helps in lowering the level of lipids in human serum. The content of long-chain fatty acids is 92–99%, and the percentage of unsaturated acids is 35–50% (Izadi *et al*., 2019). These structural differences impart "waxy texture" to the camel's milk fat. The lower content of carotene makes the color of camel's milk whiter compared to cow's milk (Devendra *et al*., 2016).

Mineral content of camel's milk is similar to cow's milk, especially; in Ca, P, Mg, Na, and K content (Kaskous, 2016). The main distinction is in the content of Zn, Cu, Fe, and Mn, as camel's milk has higher concentrations of these minerals. Increased iron concentration in camel's milk may be useful for the prevention of iron-deficiency anemia. In addition, lower concentration of citrate in camel's milk than in cow's milk increases lactoferrin antimicrobial activity, because it needs small levels of citrate to be beneficial (Park & Haenlein, 2013). The total mineral content of camel's milk fluctuates from 0.60 to 0.90%. The salty taste of camel's milk can be explained by the enhanced content of chloride obtained from the feed eaten by animals (Devendra *et al.*, 2016).

In addition, the content of ascorbic acid is higher in camel's milk. Therefore, it can extend the shelf-life of its products and increase its antioxidant and antiradical abilities (Izadi et al., 2019). The concentrations of mineral salts and vitamins in camel's milk depend on breed, feed, water intake, and stage of lactation. Besides, camel's milk contains higher concentration of vitamin C and niacin compared to cow's milk. But it is deficient in B1, B2 and A vitamins, pantothenic acid and folic acid. Both camel's and cow's milk have almost the same content of vitamins B6 and B12 (Devendra et al., 2016).

On the other hand, camel's milk has better heat stability than cow's milk. The increase of camel's milk temperature to 80 °C causes a break-down of 32–35% whey proteins, while the increase to 90 °C results in denaturation of 47–53% of its whey proteins (Izadi *et al.*, 2019)

Even though that, in different parts of our country certain Authors have been realized in somewhat as camel milk can be processed in to yoghurt and butter (Asresie et al., 2013b)

2.7.1. Butter making

Due to its nature camel milk has blamed not to be processed into butter by pastoralists and certain researcher like (Farah, 1993), but in recent time different authors reported that as converting of camel milk into butter is possible by analyzing their fat contents. The fat content of camel milk ranges from 1.2 to 6.4% (Konuspayeva *et al.*, 2009), which is comparable to that of bovine milk. Nevertheless, butter is not a traditional product made from camel milk and is difficult to produce by using the same technology of production as for butter from bovine milk. The somewhat higher melting point (Berhe *et al*., 2013) of camel milk fat (41–43℃) makes it difficult to churn the cream at temperatures 10–14℃, which is the optimum churning temperature for bovine milk. Processing of camel milk into butter is also difficult because camel milk shows little tendency to cream up due to deficiency of the protein agglutinin, small fat globule size, and a thicker fat globular membrane(Farah, 1996). Camel milk is reported to have a higher proportion of long chain fatty acids and a lower amount of short chain fatty acids. The high melting point of camel milk butter can be attributed to the high proportion of long chain fatty acids in the fatty acid profile.

Butter can be made from camel milk under optimum conditions of churning temperature and agitation method (Berhe *et al*., 2013) reported that vigorous shaking of fermented camel milk in a vertical direction instead of the traditional back- and fro-agitation method at a relatively high churning temperature (22-23℃) was able to extract butter from camel milk with a fat recovery efficiency of 80%. This method exerts more force to rupture the fat globule membrane and allow the globules to adhere to one another. Farah *et al.* (1989) also reported that camel milk butter was made at churning temperatures between 15 and 36℃. According to Farah *et al.* (1989), the highest butter fat recovery of 85% was obtained at a churning temperature of 25℃. Camel milk butter is prominently white with a more viscous consistency compared to bovine milk butter. It is reported that pastoralists in the Sahara region produce small amounts of butter from camel milk and they usually use it for medicinal purposes (Yagil, 1982b).

2.7.2. Cheese making

According to the several authors study reports revealed that processing of camel milk into cheese is difficult and has even been considered as impossible (Yagil, 1982b). The relative distribution and amino-acid composition of camel milk caseins are different from bovine milk. Camel milk casein has high beta casein (β-CN), low alpha S1-casein (-CN), and low kappa casein (κ-CN) as compared to bovine milk caseins which are mentioned in Table1 below. Moreover, the camel milk caseins have low homology to bovine milk caseins, being 39% for -

CN, 64% for β-CN, 56% for -CN, and 56% for κ-CN (Kappeler *et al*., 1998). The chymosin cleavage site of camel milk k-CN was found at the Phe97–Ile98 amino-acid sequence site, whereas the hydrolysis site in bovine milk is Phe105–Met106 (Kappeler *et al*., 1998). Thus, the amount of κ-CN in camel milk is relatively small and coagulation of milk in cheese making is typically achieved by enzymatic hydrolysis of κ-CN at the surface of casein micelles.

Table 1: Casein protein distribution of camel, and bovine.

	Caseins (% of total caseins)	
	Camel	Bovine
αs1-casein	22.0	38.0
αs2-casein	9.5	10.0
β-casein	65.0	39.0
κ-casein	3.5	13.0
Total caseins (g/100 ml milk)	2.4	2.5

Sources.∗ Kappeler *et al*. (1999), Eigel *et al.(*1984), Park and Haenlein, (2008), Martin *et al*. (2013), and (Malacarne et al., 2002), Berhe *et al*.(2017)

Shamsia (2009), reported that alpha-lactalbumin (α-LA) is the major protein in the camel milk whey protein group while the β-lactoglobulin (β-LG) has been absent from camel milk as pointed in Table 2. Camel milk has been reported to contain higher whey protein to casein ration compared to bovine milk which is responsible for a soft and easily digestible curd in the gastrointestinal tract (Shamsia, 2009).Camel milk casein has large micelle size with an average diameter of 380 versus 150, 260, and 180 nm compared to bovine, caprine, and ovine milk, respectively (Bornaz *et al*., 2009). Smaller casein micelles have been reported to improve the gelation properties of bovine milk (Bornaz *et al*.,2009).Thus, the lower amount of k-CN, the high ratio of whey protein to casein, and the larger micelle size in camel milk are reported reasons for the difficulty of cheese making. These properties result in formation of a less firm coagulum and lower yield during cheese processing. Low efficiency of cheese processing trials is reported by Bornaz *et al*.(2009).and (Konuspayeva *et al*., 2007a) .How ever still cheese making from camel milk has taken as impossible.

Table 2: Whey protein distribution of camel, bovine

Whey proteins (g/L) in milk			
	Camel	Bovine	References
β-Lactoglobulin	Absent	1.3	Malacarne *et al.* (2002)
α-Lactalbumin	5.0	1.2	El-Hatmi *et al*. (2006)
Serum albumin	2.4	0.4	Madureira *et al.* (2007
Whey acidic protein	0.16	—	Park and Haenlein, (2008)
Lactoferrin	0.22	0.14	Inglingstad *et al.* (2010)
Immunoglobulins	0.73	0.7	Berhe *et al.*(2017)
Total whey protein	9.3	7.3	

The average values of the result obtained from the references

2.7.3. Yoghurt making

Manufacturing of yoghurt or other fermented products from camel milk is reported to be difficult. Dromedary milk coagulum does not have a desirable curd formation and firmness and the curd is instead fragile and heterogeneous and consists of dispersed flakes (Attia *et al*., 2001b). The problem with camel milk yoghurt is thus the thin consistency and weak texture of the product. Yoghurt texture is a very important parameter that affects the appearance, mouth feel, and overall acceptability. Camel milk has been reported to be not easily fermentable because of its antibacterial properties mainly due to the presence of protective proteins. However, growth of commercial starter cultures in camel milk has been found to be possible Ramet, (2001). The acidification rate in camel milk was, however, lower than in bovine milk(Abu-Tarboush, 1996).

Nevertheless, there are reports that indicate the possibility of yoghurt production from camel milk(Ahmed *et al*., 2010). Study by Hashim *et al.*, (2009) showed that the firmness of camel milk yoghurt could be improved by supplementation of the milk with gelatin, alginate, and calcium. On the other hand, (Al-Zoreky and Al-Otaibi, 2015) reported that supplementation of stabilizers to camel milk could not improve the consistency of camel milk yoghurt. Ibrahim,(2015) suggested that the use of exopolysaccharide producing starter cultures could improve the texture of camel milk yoghurt better than additives. There are also reports that indicate the weak texture of camel milk yoghurt can be improved by mixing of camel milk with milk of other livestock species such as ovine milk (Ibrahem and El Zubeir, 2016).

The weak texture and thin consistency of camel milk yoghurt can be attributed to the compositional properties of the milk such as lack of β-LG and lower amount of k-CN, high whey protein to casein ratio (Shamsia, 2009).

2.8. Environmental and Public Health Benefit of Camel milk

Camel milk is popular in the world as it has excellent nutritive values and many health benefits. There are many dairy and non-dairy products that that could be manufactured from camel milk such as milk powder, yoghurt, and fermented products, creams, ghee, ice-cream, frozen products, sweet, and candy (such as chocolate bars and cookies) (Alhaj *et al., 2019*). Camel milk seems to have many challenges during high temperature treatment as well as creaming to manufacture yoghurt and other fermented dairy products, cream and butter. On other hand, ice-cream, frozen yoghurt, and chocolate bar manufacturing from camel milk seems to be less challenging (citation). Further research is recommended to solve the faced challenges and to develop different version of these products such as skim, low fat, low sugar and flavored products.

The camel milk therapeutic and prophylactic properties was revised as a commonly and traditionally practiced medical intervention, and recently evident by modern research, with emphasis on antimicrobial and anti-inflation (Abdel Gader,2016., Khatoon and Najam,2017) and Hammam, 2019). According to Arab *et al*. (2014) report camel milk is a potential candidate for pharmacological efficacy on inflammatory bowel diseases (IBD) with minimal adverse reactions and It has been consumed as an essential nutritional supplement with high energy and vitamin content to help immune-deficient patients. Moreover, camel milk enhances the absorption and the metabolism of antioxidant vitamins such as vitamins C and E (Hamed *et al*., 2019). Camel milk consumption had a positive effect on antihypertensive agent (Korish & Arafah, 2013).

3. MATERIAL AND METHODS

3.1. Description of Study Area

This study was conducted in selected districts of Borana, East Guji and West Guji administrative Zones of Oromia Regional State of Ethiopia. Research areas were involved four pastoral districts of the Zones. Two pastoral districts from Borana and two from East and West Guji Zones were planned to involve in the study.

Borena zone: Borana is considered for this study because it is typical for the pastoral areas in the horn of Africa where different drought adaptation strategies were experienced. The Borana administrative zone is situated in Ethiopia's Oromia Regional State. The current studies were conducted in two districts of Borena zone are: **Gomole,** and **Yabelo**. These districts were selected purposively because of they are known by camel production.

Borana zone is located in the Southern part of the Region (between 3°26‘ – 6°32‘North latitude and 36°43‘- 40°46‘ East longitude) and borders Kenya. The altitude of the zone ranges between 1,000m and 1,500m above sea level. The semiarid lowlands are predominantly flat, covered with bushes and shrubs (Borana Zonal Administration, 2013). Yabello is the capital town of the Borana zone and lies 567 km south of Addis Ababa. Borana is known for its traditional Gada system, an indigenous and complex socio-political structure that governs the strategic interests that are reflected in all of the day to day life of Borana society. Vegetation in Borana is mainly comprised of a mixed savanna, which is dominated by perennial grasses (Cenchrus, Pennisetum, and Chrysopogon spp.) and woody plants (Acacia and Commiphora spp.)

East Guji zone: The East Guji zone is one zone of Oromia Region which borders in the North with the Gedeo zone and the Sidama, in the South with the Somali Regional state, in the East with the Bale zone, and in the West with Borana and West Guji zones. The Guji zone has districts which are categorized as pastoral and agro-pastoral districts. This study was conducted in pastoral district of **Liban**. The climate of these pastoral and agro-pastoral districts of the East Guji zone is mostly arid and semi-arid.

The pastoral community of this district has camel production in relative to high land districts of the zone.

The rainfall pattern of these districts is bimodal the major season (Ganna) which extend from March to May and received 60% of the annual rainfall, the minor season (Hagayya), which extend from September and November received 40% of the annual rainfall. This is similar with Borana zone rain fall pattern. The mean annual temperature range is 24–30℃ (Adi *et al*., 2003). Drought is common in these woredas every three to five years. The livelihoods of the community in this area are predominantly dependent on livestock production. They are predominantly pastoralists.

West Guji Zone: West Guji zone is the newly formed zone of Oromia Regional State in 2016. It currently contains 9 districts which were under Borena and East Guji zone of Oromia Region. Districts in West Guji zone are; Abaya, Gelana, BuleHora, DugdaDawa, Melka Soda, Kercha, Birbirsa Kojoyha, HambalaWamana and Suro Bar Guda (WGZAO, 2016). **Melka Soda** district was selected for current study because of; they are potential by camel production and pastoral area as well.

The capital town of the zone is Bule Hora; which is far away 467 km from national capital city of Ethiopia (Addis Ababa). This zone is located lies between latitudes 5° 26' and 5° 52' North and longitudes 37° 56' and 38° 31' East and an altitude between 1500 and 2400 meters above sea level (Guji Zone land and environment protection office, 2017). West Guji zone is divided into three agro ecology zones, namely the high lands (Dega) 34%, mid-highland (woinaDega) 55% and lowlands (kola) 11%. The rainfall pattern is bimodal i.e. have two distinct rain seasons. The dry season extends from December to February and to some extent from June to July. The highest mean annual average rainfall of the study area was 1250 mm whereas the lowest mean average was 600 mm recorded. The lowest mean average temperature was 15°C whereas the highest was 22.8°C recorded. The main crops grown are maize, enset, wheat and barley. These crops are grown both for consumption and sale. Coffee is also grown as a cash crop.

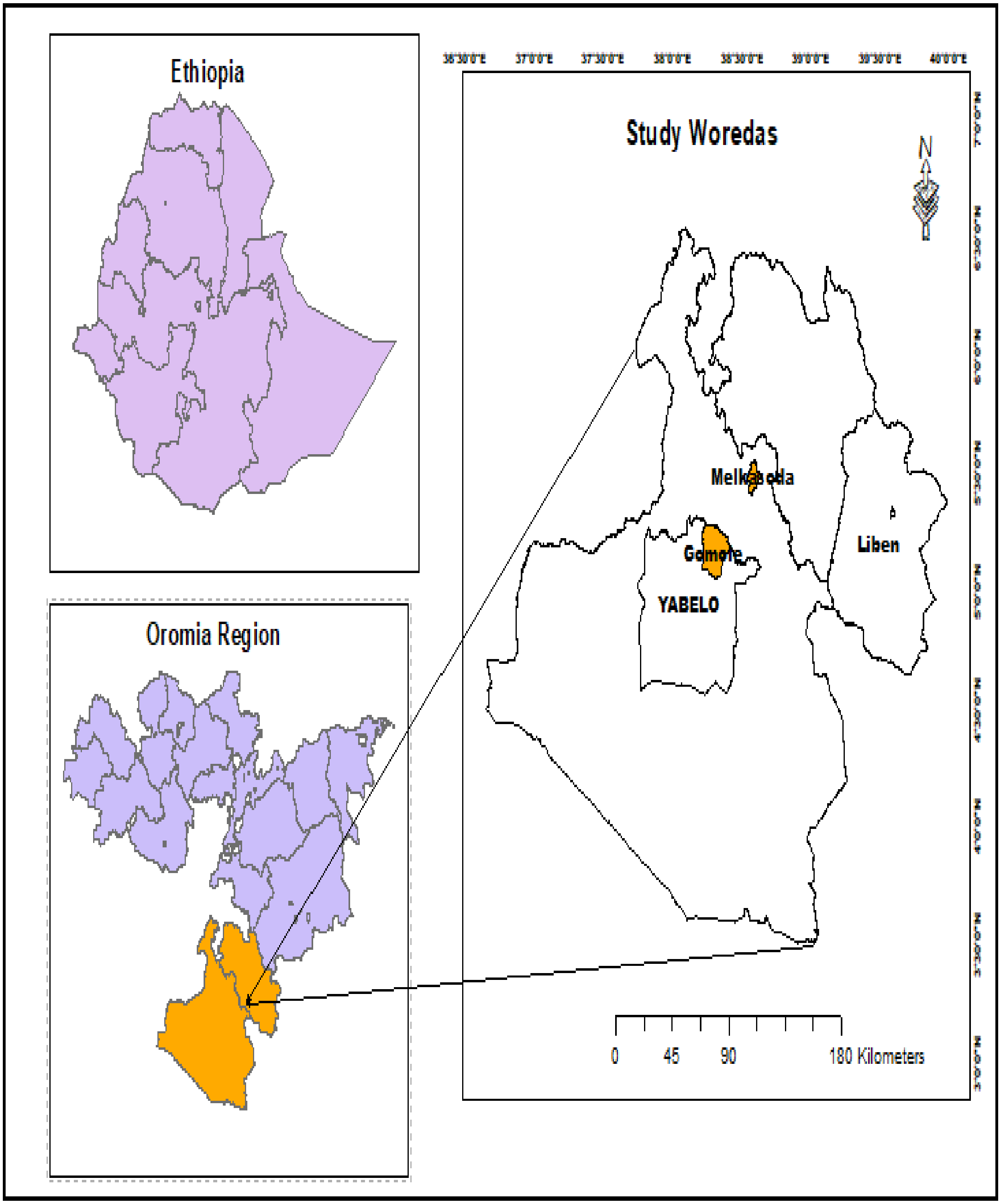

Figure 1. Map of the study areas

3.2. Framework of the Study

The study was comprised of three interrelated studies/ activities which were conducted with the specific titles namely: First one survey part: Assessment of camel dairy production. The purpose of this study is to assess the management practices in terms of camel dairy production, processing, handling, Marketing, utilization, and management practice of camel dairy products. The second study/ activity were focused up on the cheese making from camel milk by blending with cow milk. The purpose of this study is to evaluate whether camel milk could be processed into cheese or not, and the efficiencies of camel milk blending on milk coagulation and cheese yields. The last experiment were evaluating the physicochemical properties of milk, cheese and its sensory attribute that was taken place according to the international standard of cheese quality measurement scale, also by allowing the trained panelists to monitor the cheese quality after process could be completed. Each was required to meet specific objectives but all together intending to give a holistic picture of the overall objective.

3.3. Analysis of Camel Milk Production, Processing and Marketing System

3.3.1. Sampling procedures

In order to ease the formal research design and to gain an overall understanding of the study area, participatory rapid appraisal (PRA) techniques was used at the start of the study to incorporate the opinion of key informants on camel dairy production and its management practices that used to develop the study design. It was undertaken in PA or agricultural offices of the districts, to identify the sources of lactating camel, availability of camel milk processing units, the actors involved in milk processing and milking and the area where camel dairy processing consistently implementing. Based on this information sampled respondents were selected from who has at least three camel.

Four Districts namely: Gomole and Yabello (Borana Zone), Malka Soda (West Guji), and Liban (East Guji) were selected based on their camel population, milk production and socio-economic attribution for this study using purposive sampling procedures. From each District, two kebeles were randomly selected for data collection at the household level. A total of 160 households owned camels, 40 from each District were selected using simple random sampling techniques. The sample size was determined according to the formula 0.25/ $(SE)^2$ of Arsham's (2007). A questionnaire-based survey was used to collect data needed for the assessment of camel milk yield, lactation length, milk processing, marketing, handling (management), and utilization, the therapeutic role of camel milk, and constraints and challenges in camel milk processing. For camel milk yield data, 10 lactating camel from each kebele were selected randomly and milk measurement was taken place from March-May and September-November and households estimated values were also taken under consideration to minimize the variation caused by season and lactation stages. The questionnaire was administered by the researcher and enumerators. A questionnaires survey was designed for the way for assessing relevant data that was translated from English to Afan Oromo (local) languages to make it more understandable by enumerators and interviewees.

The questionnaire was pre-tested and adjusted before its full administration. The content of the structured questionnaire included household characteristics (age, sex, family size, and educational background), camel rearing experiences, milk production, handling, processing and general management (milk storage and milking materials), milk preservation, and plant used for vessel smoking. Focus group discussion was made with members composed of elder men and women and experienced people in camel milk production, processing, utilization, and management were selected from each kebele. To gather the adequate and relevant information, focus group discussion was made with the experienced and elder person that comprises of 10-15 members from each kebele.

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3.3.2. Methods of data collection

In this study, both primary and secondary data were collected. Primary data was collected by using formal and informal surveys. To collect primary data, a structured questionnaire was prepared. The questionnaires were pre-tested and amended based on the feedback to be reviewed. During PRA discussion were held with key camel milk producers, dairy product processors units and agricultural experts from both governmental and non-governmental organization. Primary data on camel management practices, camel diary production, handling and utilization, dairy processing, fermentation methods implementing, the role of milk processing units in the area, constraints of camel milk processing and utilization. The individual interviews was under taken by researcher and trained enumerators who speaks local languages and knowledgeable about local traditions. Accordingly, a total of 6 enumerators were recruited, trained and assigned for the work.

Secondary data were collected from different sources such as government offices, research institutes available in the Region and non-governmental organizations operating in the area. Besides, different and relevant published and unpublished reports, bulletins and websites were consulted to generate relevant secondary data on camel dairy technology. Discussion was held with relevant experts and other officials to seek additional information.

3.4. Cheese Making From Camel Milk by Blending With Cow Milk

3.4.1. Collection of milk for cheese making

From total selected district Gomole district was selected by using purposive sampling techniques based on the availability of lactating camel and cow for milk collection and accessibility of the place after the preliminary assessment had been made. Based on the information, lactating camels was stratified into early (1-3 months), mid (4-6 months) and late (above 6 months) lactation stage, in order to minimize the variation (in cheese quality, production efficiencies, time of coagulation or clotting and its components) caused by stage of lactation. Among those respondents previously considered for survey study, a total 30 respondents (15 for camel and 15 for cow milk) were selected by using purposive sampling techniques to involve the respondents who had lactating camel and cow from the respondents previously selected from the two kebeles of the districts. Then, fresh morning camel and cow milk (50liters from each) were collected. The collected milk was transported to Bule Hora University dairy laboratory by collecting in to airtight plastic Jerican containers with permanent markers, where certain analysis and processing of the cheese was done. By permanently identifying a sterile container with three digital identifiers, the milk was transported into the lab over a three-term period. The milk was mixed according to its level of blending and assigned into treatment.

The mixed raw milk was used for physic-chemical properties. Rennet and a cheese starter culture and calcium chloride (food quality) were used in the study.

3.4.2. Treatments

The experiment had five treatments, i.e., T1, T2, T3, T4 and T5 as shown in Table 3. T1 were 100% camel milk, T2 a mixture of 75% camel milk and 25% cow milk, T3 25% camel milk and 75% cow milk, T4 50% camel milk and 50% cow milk and T5, 100% cow milk which were used as a control. To increase the accuracy of data obtained, each treatment were replicated into three ways. To minimize the errors each treatments were randomly allocated for replication by using lottery methods of sampling techniques.

Table 3. Treatment Combinations

Treatments	Blend level (%)	Amount of milk (liters)
T1	100% camel milk	5
T2	75% camel milk and 25% cow milk	5
T3	25% camel milk and 75% cow milk	5
T4	50% camel milk and 50% cow milk	5
T5	100% cow milk	5

3.4.3. Cheese processing

Milk in five treatments was exploited for cheese making or processing at three levels of replication by following the procedures of Lincourt *et. al*., (2009). Fresh camel milk and cow milk were blended based on the proportion set and assigned to each treatment. The cheese processing was taken place according to the procedure in figure 2. Finally, the curd formed wa separated from the whey by filtration and squeezing with cheese cloth to drain off. The coagulum so obtained were cut, weighed and sampled for laboratory Analysis.

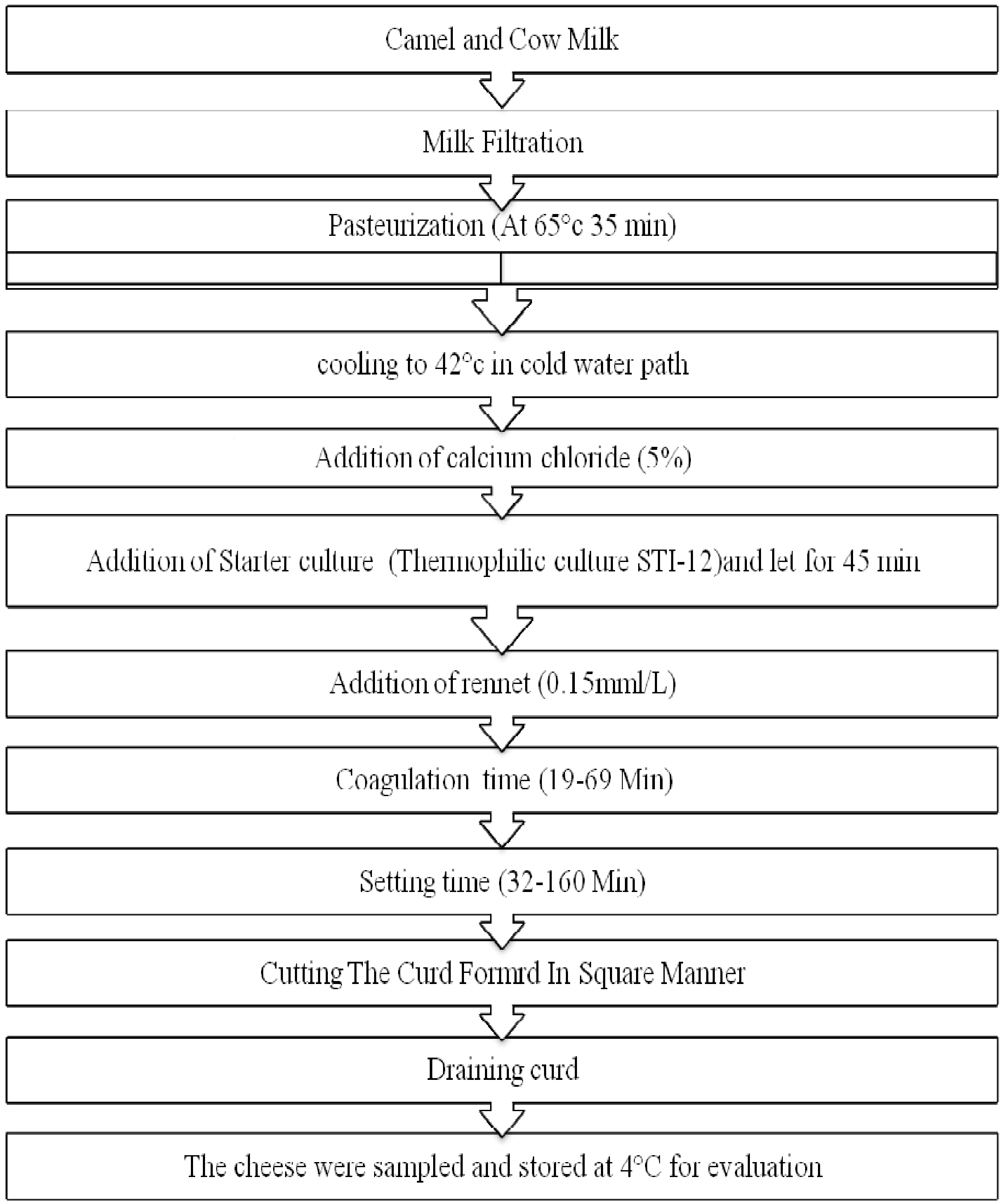

Figure. 2. Manufacturing procedures for fresh soft white cheese from camel milk

3.5. Physico-Chemical and Sensory Analysis

3.5.1. Physico-chemical analysis of milk

All the milk treatments and the processed cheese were analyzed for total solid, ash, titratable acidity, pH and specific gravity.

3.5.1.1. Total solids

Five grams of milk samples were placed into pre-dried and weighed crucible. The samples were dried at 100℃ in a hot air oven for three hours. The dried samples were taken out of the oven and placed in desiccators to cool to room temperature. Then it was weighed again and total solids content of milk samples was expressed as percentage (Richardson, 1985). The total solids content are calculated using to the following formula.

Total solids (percentage) = (weight of dried sample/weight of fresh sample) × 100

3.5.1.2. Fat content

Fat content of milk samples was determined by the Gerber method. First 10ml of sulphuric acid and then 11ml of milk sample was slowly added into duplicate butyrometer followed by 1ml of isoamyl alcohol. The contents of the butyrometers was thoroughly mixed and centrifuged at 1100 rpm for 5 minutes. Then butyrometer was transferred to a water bath at 65℃ for 5 minutes and the percent fat was recorded directly from the butyrometer reading (Richardson, 1985).

3.5.1.3. pH determination

pH of milk samples was measured using digital pH meter. Well mixed 40ml milk sample was put into a beaker and the pH was measured by immersing the pH meter electrode into the milk sample. A buffer solution of pH 4 and 7 was used to calibrate the pH meter Richardson (1985).

3.5.1.4. Titratable acidity

Nine ml of milk sample was pipette into a beaker and then 3-5 drops of 0.5 percent phenolphthalein indicator was added into the milk. Then the sample was titrated with 0.1N

NaOH (UK, 8001321) solution until definite pink color persists (O'Connor, 1994). Percent of lactic acid were calculated as:

$$TA = \frac{ml\ 0.1\ N\ NaOH\ x\ 0.009x\ 100}{ml\ \ of\ milk\ sample\ used}$$

Where 1 ml of 0.1N NaOH would neutralize 0.009g of lactic acid.

3.5.1.5. Specific gravity

Specific gravity of the milk samples were determined by a Lactometer (Socientosk. Tokyo). The specific gravity of milk samples were calculated according to the following formula (O'Conner, 1994).

$$\frac{L}{1000} + 1 = Specific\ gravity$$

Where, L is the lactometer reading.

3.5.2. Physico-chemical properties of cheese

3.5.2.1. Moisture content of cheese

First 5g of cheese sample was placed in crucible and immersed into hot water at 39℃ and shacked well until creamy consistency is obtained. Then it was dried in atmospheric oven (EDSC, 96H203: England) at 100℃ for 24h until constant weight was obtained.

After drying weigh the cheese sample and the crucible. The IUPAC (1979) method was used to determine the moisture content of cheese.

$$\text{Moisture Contents of Cheese } = \frac{w - w2}{W1} \times 100$$

Where, W2 = weight of cheese sample after drying (final weight)

W1 = weight of cheese sample before drying (original weight)

3.5.2.2. Fat content of Cheese

Fat content of cheese samples were determined by the Gerber method. First 10ml of sulphuric acid and then 11ml of cheese sample was slowly added into duplicate butyrometer followed by 1ml of isoamyl alcohol. The contents of the butyrometers was thoroughly mixed and centrifuged at 1100 rpm for 5 minutes. Then butyrometer was transferred to a water bath at 65℃ for 5 minutes and the percent fat was recorded directly from the butyrometer reading (Richardson, 1985). Finally, the oil content was calculated as.

$$\text{Fat content } = \frac{weight\ of\ flask\ containing\ oil - weight\ of\ empty\ flask}{sample\ weight \times DM\ percentage} \times 100$$

$$\text{DM\%} = \frac{weight\ of\ cheese\ after\ drying\ in\ oven}{weightof\ cheese\ before\ drying} \times 100$$

3.5.2.3. pH of cheese

According to Weckel (1932), 35g of a representative and well mixed samples of cheese was taken. It was then be warmed in a water bath at 55-60℃. The flask was whirled in a centrifuge at a speed of 60 revolutions per minute, for one minute. The serum of the cheese was separated out and placed in a flask. Then the pH of the serum was measured using digital pH meter.

3.5.2.4. Acid degree value

Hydrolytic rancidity develops when milk fat has under gone lipolysis due to the action of the enzyme lipase of lipolytic microorganisms. One measure of rancidity is measuring the acid degree value or the level of free fatty acids in the fat component. For determination of acid degree value, 6g of well mixed cheese samples was dissolved in 50ml ethanol alcohol solution and titrated with 0.25NNaOH solution in the presence of phenolphthalein as indicator until faint pink color persisted. Free fatty acid was determined by titration (IUPAC, 1979).After measuring the free fatty acids, the acid degree value (ADV) was calculated as follows.

$$\text{\%FFA} = \frac{(ml\ NaOH \times N\ NaOH \times 282 \times 100)}{(1000 \times sample\ weight)}$$

Where 282 is average molecular weight of the free fatty acids expressed as oleic acid.

3.5.2.5. Cheese yield

Cheese yield was calculated as the ratio of mass of the cheese obtained by the mass of milk used. It was calculated as:

$$\text{Cheese yield} = \frac{weight\ of\ cheese}{\text{weight of milk}} \times 100$$

3.5.3. Sensory analysis of cheese

The cheese was obtained, presented to the panelists in three coded replications on flat platters. Twelve trained panelists comprised of M.Sc students, staffs from the Department of Animal and Range Sciences, and local cheese and camel milk consumers evaluated the sensory qualities of the cheese samples for roughness, surface moisture, firmness, a taste, adhesiveness, solubility, saltiness, appearance, and overall acceptance using a seven-point hedonic scale ranging from 7 (the highest score) to 1(Lowest score). Using the criteria established by Hashim (2009), the panelists were chosen to be between the ages of 25 and 40 years old. The descriptive sensory analysis method used category scaling procedures.

3.6. Statistical Analysis

The statistical analysis tool Statistical Package of Social Sciences (SPSS) version 21 was used. An ANOVA was used to evaluate the main effects of milk blending level, rennet on cheese yield, physico-chemical properties of milk and cheese and the panel mean scores of the quantitative descriptive data for cheese sensory evaluation to differentiate the significant mean from the rest of the significant means. Chi-score method was used for categorical data analysis. For the evaluation of cheese, a completely randomized design was adopted. The panel means scores of the quantitative descriptive data for cheese sensory evaluation. Statistically significant differences in the results were tested by Fisher's protected least significant difference (LSD) test.

The model used for the analysis of cheese yield.

$Y_{ij} = \mu + ti + \varepsilon_{ij}$,

Where, Y_{ij} = the yield of cheese, μ = overall mean, t_i= the treatment effect (T1, T2, T3, T4 and T5) of the i^{th} treatment and ε_{ij} = the random error

The model 2 used for milk yield per a day

$Y_{ij}= \mu+ti +\varepsilon_{ij}$,

Where, $Y_{ij=}$Milk yeild, μ = overall mean, t_i= the treatment effect (D1, D2, D3, and D4) of the i^{th} treatment and ε_{ij} = the random error

4. RESULTS

4.1. Socio-economic Characteristics of the Respondents

Table 4 displayed the respondents' general backgrounds of the study areas. The majority of respondents (55%) were women; while as 45% of them were men. With a maximum of eleven and a minimum of two family members per household, the average family size was 5.43. The majority of the population was represented by the respondents to the interviews, who ranged in age from 30 to 70 and had an average age of 46 years. Household camel ownership varies from one district to another. The Liban district has the highest mean value (16.8) of camel ownership per family that followed by Gomole with a mean value of 15.1 camels (Table 4). The respondents' experienced years in raising camels ranged from 8 to 42 years with, the average of 22.3 years. The camel is regarded as the secondary milk producer in these all the study districts, because of its remarkable resistance to the repeated droughts that exacerbate the paucity of water and food. However, due to the pastoral and agro-pastoral communities in the country, including the current study areas, having poor educational status, the contemporary method of raising camels and its dairy products has not yet been tested.

Table 4. Socio-economic characteristics of the respondents (N=160)

Variables		Districts					Over all	P value
		Liban (N=40)	Gomole (N=40)	Yabello (N=40)	M/Soda (N=40)	Range	mean (N=160)	
	Male	-	-	-	-		72(45%)	
Sex	Female	-	-	-	-		88(55%)	
Age (years)		38.8(6.94)	48.3(8.60)	48.4(8.50)	49.6(9.04)	30-70	46.3(9.52)	0.078
FS (N)		5.02(1.90)	4.5(1.50)	5.8(0.76)	6.5(2.9)	2-11	5.43(2.10)	0.000
COPHH (N)		16.8(8.30)	15.1(5.10)	6.8(2.30)	10.1(3.7)	3-36	12.2(6.66)	0.00
CRE (Years)		16.3(7.11)	23.8(7.38)	22.9(7.42)	26.3(9.33)	8-42	22.3(8.62)	0.014

The figure represents mean and standard error, COPHH=Camel owner per household. M/Soda= Malka Soda, CRE= camel rearing experiences, FS=family size, According to the figure below about 51.3% of the interviewed respondents were illiterate, whereas just 7.6% of those who reached the secondary and higher education levels in the study areas shared that experience (Figure 3). Due to their pastoral lifestyle and the absence of a suitable facility, they are more heavily involved in livestock keeping activities now than they were before to beginning their studies. So lack of education has made the communities does not use the advantages of using advanced camel techniques of camel milk production, processing and utilization.

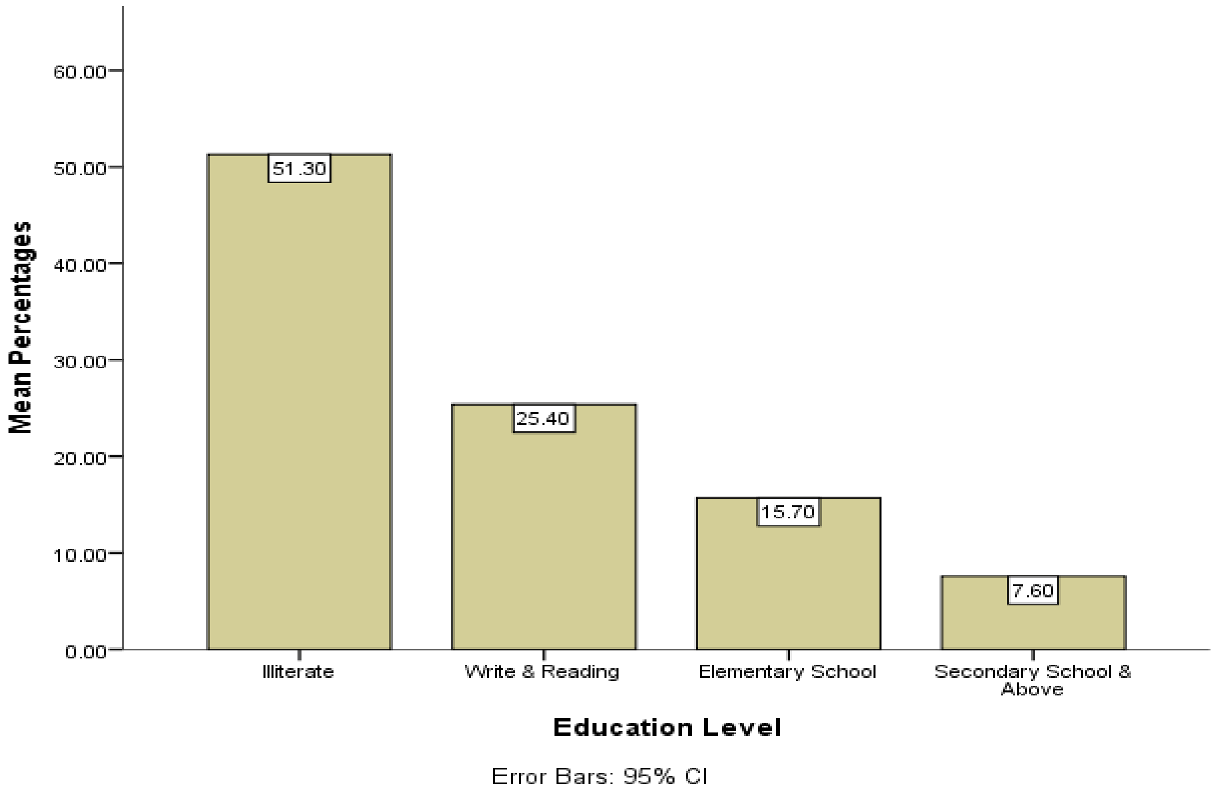

Figure. 3. Education status of the respondents

4.2. Trends of Camel Population in the Study Districts

Figure 4 shows that the camel population number has been becoming increase from the years range 2009-2013. This might be due to the high capability camel in withstanding patterns of frequently occurrences of drought and fluctuation of the agro-ecological condition in the area which result in increamentation of desert that has been danger for other livestock species compared to camel. Also the respondents said that camel is better fit with harsh environmental condition under which they resides compared to cattle, for that cause why the numbers of camel became increase after the adverse condition of 2008, that cause for the loose of huge numbers of cattle on time being in the study area. Camel has the ability to withstand harsh climatic conditions with the ability to cope with shortage of water and feed during prolonged dry seasons. Despite these adverse conditions, camels have the ability to supply pastoral households with milk during such periods. This ability the camel has help it to survive under harsh environmental condition that create a good opportunities made the camel population could be enhance in number and production performances. Under prolonged dry season and drought conditions, the productivity and performance of most animals are significantly affected by the lack of water and feed resources. Most of the time, cattle are most adversely affected compared to camels, although cattle are the main livestock species in the study area

The respondents were said that camel is the critical dairy animal of the study areas. The figure below clearly put the trends of camel population starting from 2009-2013 years is becoming increase, might be due to the point declared above in addition to the interest the pastoral communities have to keep camel as the main sources of milk. The fact the respondent ensured that camel could be able to leave for a long periods of time without drinking water which makes them to live under marginalized area, even the crop could not be produced well.

During focal group discussion, ideas raised that were, the anatomical feature like length of the legs, flat of foot and others could help the camel to live in the area with a little challenges comparatively. The ability to consuming the thorny plant species like acacia, herbaceous, shrubs and other desert plants that would not be consumable by another livestock species due to its natural characteristics. In addition to that make it to acceptable dairy animals in the study area is its ability to travel long distances to drink water and browse, also they can compromise the water lost in the time of scarcity. Even though the capability of the camel has been appreciated approached, that the frequently seen drought in the area were the one that be taste the camel to deliver the desired levels of products, particularly in dry periods of the year might be due to the daily journey they make to access the feed and water as the respondents were revealed.

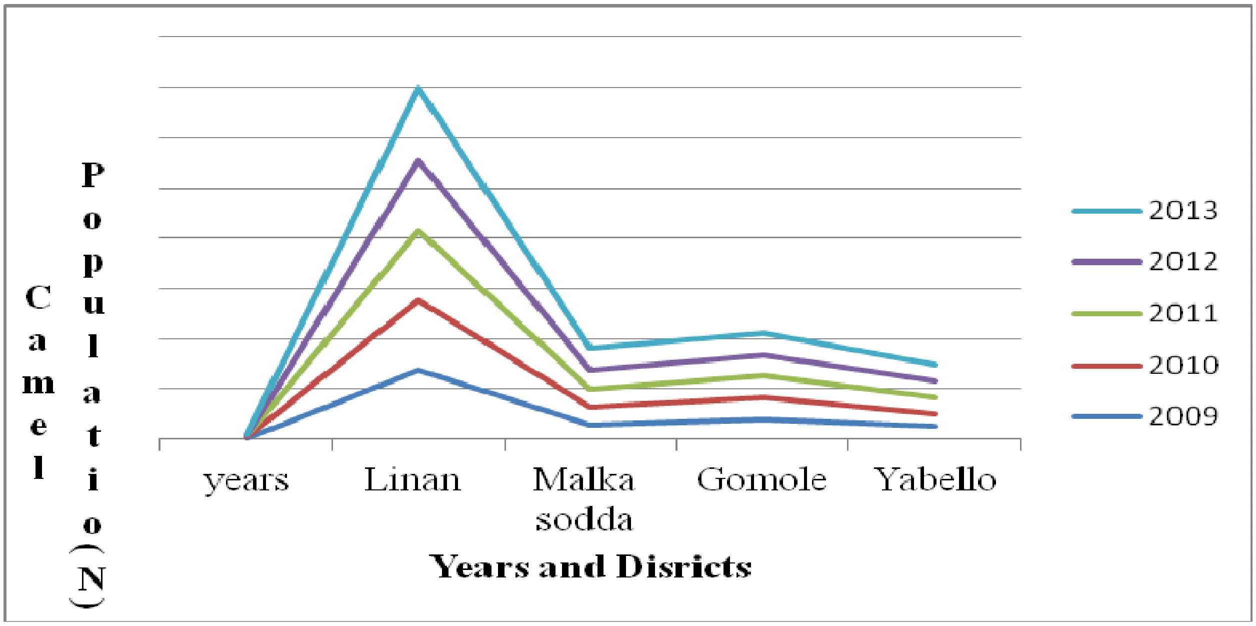

Figure 4. Trends of camel population in the study areas

4.3. Lactation and Reproductive Performances of Camel in the study Areas.

An average camel lactation length of Gomole, Malka Soda, Liban, and Yabello were 12.65, 11.80, 16.20 and 10.80, respective. While the average length of the four districts were 12.86 months (Table 5). As compared to other district Liban was scored the longest lactation length. This might be due to the ever green of the areas as compared to others. The average milk production per a day was 8.9, 6.97, 7.05 and 7.94 liters in Gomole, Malka Soda, Liban and Yabello respectively. The overall mean values of milk production for the four districts were 7.71L/d. Milk yield is significantly ($P<0.05$) difference between each districts of the study areas. Two to four times a day was typical for camel milking, while three times milking is more frequently done than other methods. The majority of the respondents were reported that they milk three times per a day in the range of 2 to four times of milking. Camels can milk in the early morning (*Baraaqa*), middle of the day *(Bobbaa)*, early evening (*Galchuma*), and evening *(Galgala)* during the winter when water and feed resources are abundant (Table 5). According to the report of the respondents, camel calving interval ranged from 12-68 months, whereas the longest one was observed in Malka Soda (Table 5).

Table.5. Milk yield, lactation length, and caving interval of camel in Districts,

Variables	Districts				Range	Overall mean
	Gomole N=40 Mean±SD	Malk Soda N=40 Mean±SD	Liban N=40 Mean±SD	Yabello N=40 Mean±SD		
LL (M)	12.65±2.43[a]	11.80±2.55[a]	16.20±5.0.86[b]	10.80±2.41[a]	6-24	12.86
CI (M)	25.45±3.53[ab]	30.10±6.55[b]	28.50±3.96[ab]	24.60±.95[a]	12-68	27.16
MF(T)	2.45±.50[a]	2.50±.51[a]	3.10±0.55[b]	2.32±0.47[a]	2-4	2.60
MYPD (L)	8.90±2.32[c]	6.97±1.39[a]	7.05±1.25[d]	7.94±2.57b	4-13	7.71

M=months, T=time, L=liter, LL=lactation length, CI=calving interval, MF=milking frequency, MYPD=milking yield per a day

4.4. Preservation and Processing Methods of Camel Milk

In the area, methods for preserving camel milk include washing and smoking milk storage containers, storing milk in a cold environment, allowing milk to ferment and turn sour and boiling milk. According to the results, keeping milk in a cold location by the house and under trees close to the homestead (78.75%) and washing and smoking vessels (100%) are the two methods of preservation that are most frequently used in the area, while about 27.5% of the interviewed respondents have used boiling as method of milk preservation (Table 3). As they ferment camel milk to create sour milk known as *chuuchee*, nearly all of the respondents (94.38%) agreed that. By adopting a traditional method, such as loading raw camel milk on a camel back while traveling and using a heated white stone (*Smocky Quartz*) locally referred to as "*chabbii*," camel milk was processed into butter to a minor level (10.0%). To speed up the fermentation, about 15.0% of responders mix camel milk with cow or goat milk, but none of them may be attempting to turn it into cheese (Table 3). By providing a pleasant sensory experience, milk and milk products kept in a cool environment can boost a user's acceptance and desire to drink. This locally used method of camel milk cooling predominates in the research locations, which is likely a result of a lack of infrastructure for electric services and other community-related services associated to community dispersal.

Table 6. Preservation and processing of camel milk (N=160)

Preservation Methods	Categories	Districts				Overall
		Gomole (N=40)	M/soda (N=40)	Liban (N=40)	Yabello (N=40)	(N=160)
Washing and Smoking	Yes	40(100)	40(100)	40(100)	40(100)	160(100)
Vessels	No	-	-	-	-	-
Keeping in Cold area	Yes	29(72.5)	35(87.5)	33(82.5)	29(72.5)	126(78.75)
	No	11(27.5)	5(12.5)	7(17.5)	11(27.5)	34(21.25)
Boiling	Yes	11(35)	18(52.5)	13(400	12(37.5)	44(27.5)
	No	29(72.5)	22(55.0)	27(67.5)	28(70.0)	116(72.5)
Camel milk Processing						
Chuuchee (sour milk)	Yes	36(90)	37(92.5)	38(95)	40(100)	151(94.38)
	No	4(10)	3(7.5)	2(5)	0	9(5.63)
Butter	Yes	4(10)	4(10)	5(17.5)	3(22.5)	16(10.00)
Cheese	Yes	-	-	-	-	-
	No	40(100)	40(100)	40(100)	40	160(100)
Blending	Yes	9(22.5)	4(10)	6(12.5)	5(27.5)	24(15.00)
	No	31(77.5)	36(90)	34(85.0)	35(85.5)	136(85.00)

Notice: (-) =No body said yes or no, the figure in the parenthesis represent percentages

4.5. The Vessels used for Milking and Storage

Locally known as Sorora, Gorfa/Cico , Okole , and plastic jug , these distinctive camel milking and storing jars have been utilized by pastoral and agricultural communities in Borena and Guji (Figure, 5). Each milk vessel might be fumigated with a smoking plant prior to usage for two to five minutes, the source said in answer. Since smoking vessels have anti-microbial effects and are used to extend milk's shelf life. In addition to being used for milk preservation, it also enhances the flavor and aroma of milk (communication). Also, it is providing anti-microbial, appealing flavor, and food additives, the substance emitted by specific smoking plant species could be exploited as a source of antibiotics for consumers.

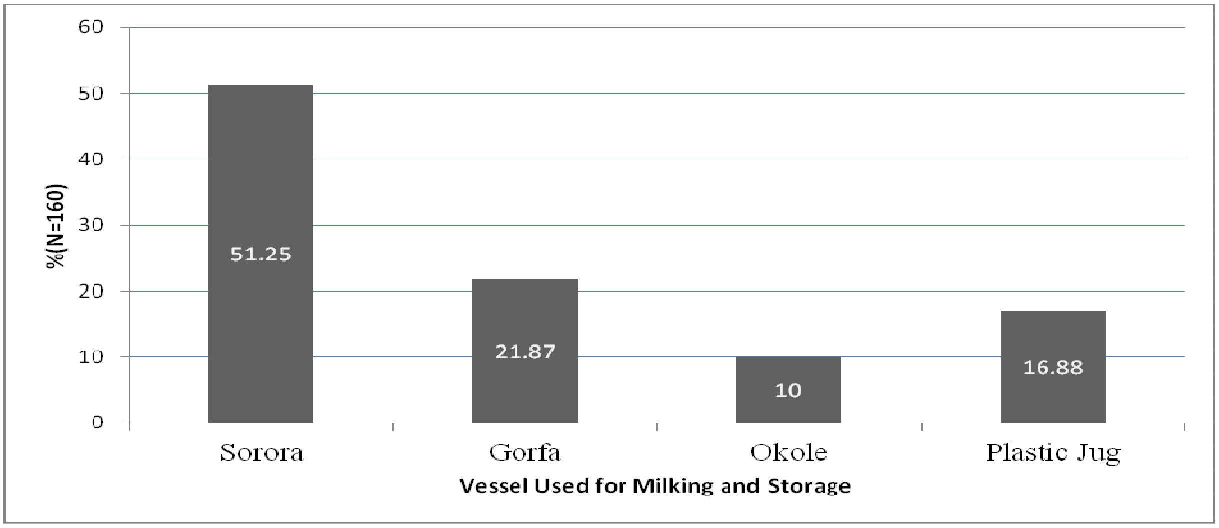

Figure 5. Camel milking and milk storage vessels

4.6. Plant Used for Smoking

In order to produce milk with good flavor and scent in the research area's pastoralist and agro-pastoralist communities, milking and storage vessels practiced smoking by using different plants. This used increase customer acceptability of the product. *Olea Africana* (Ejersa), *Rhus abyssinica* (Xaaxxessa), and *Acacia brevispica* (Hammaressa) are ranked from one to three in order of importance's the most often used plant in the study area (Table 4). When the primary smoking plant is not nearby, there is yet another variety that is infrequently utilized. They reported the steam is the most crucial part used for smoking. This is because it is appropriate to prevent the lingering effects of tiny plant fragments in the milk; as a result, it can continue to be appealing with nice flavor and scent. In accordance with this finding, the primary justification given by homes for smoking dairy production equipment is to enhance the flavor and shelf life of milk products who revealed that smoking milking and storage equipment can be highly accepted by the consumer than milk handled in the non-smoked utensil.

Table 7. A plant used for the smoking of milk vessel (1=mostly used, 4=occasionally used)

Types of the plant used for smoking		Rank mean values	Ranks
Local name	Scientific Name		
Ejersa	*Olea Africana*	1.25 (0.046)	1
Hammaressa	*Acacia brevispica*	2.14 (0.062)	3
Xaaxxessaa	*Rhus abyssinica*	1.56 (0.051)	2
Birreessa	*Terminalia brownie*	2.56 (0.063)	5
Dansee	*Faurea speciosa*	2.45(0.042)	4

The Figure Represents rank mean and standard error

4.7. The Shelf Life of Camel Milk

The result of the study were revealed that camel milk could be stay for 24-72hours (43.75%) without any changes while as, a tiny bit of a sour taste can linger in camel milk for 4-5 days (28.3%). This might occur if the milk is pure camel milk without any additives and is stored in a cold environment. Also, some respondents reported that fermented camel milk can be stored for 5 to 7 days (6.25%) during the winter with a pleasant product odor (Figure 6). According to the current assessment camel milk has a longer shelf life than other milk kinds because it naturally possesses anti-microbial, protective protein, and other essential features.

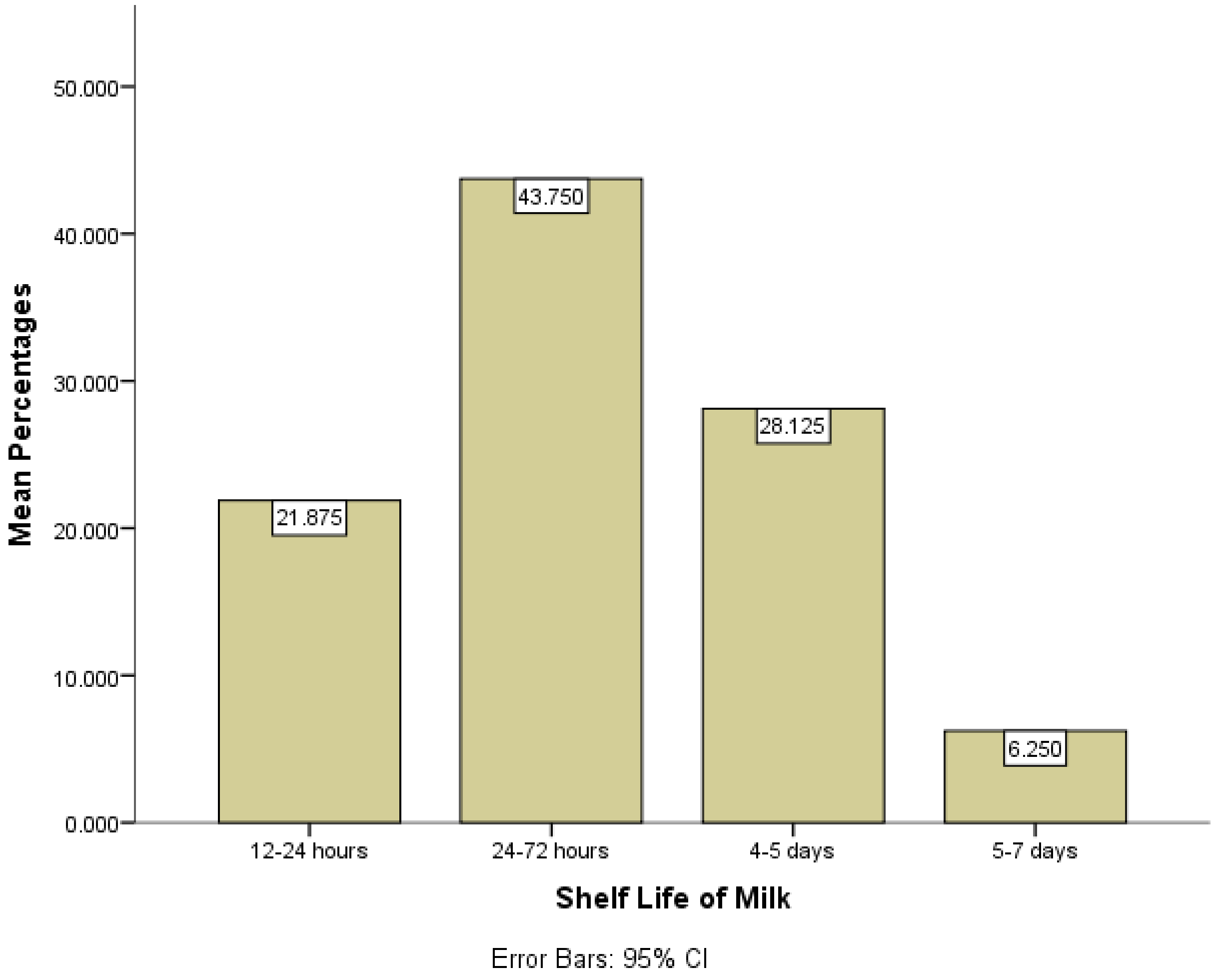

Figure 6. Shelf life camel milk including sour milk

4.8. Camel Milk Handling and Utilization

The majority of the respondents (69.38) in the study area were practiced smoking storage and milking vessels before milking. However, the Liban district is where it is most prevalent (90). About 65 and 67.5% of the respondents in the Gomole and Malka soda districts, respectively, reported that they practicing hand and udder washing. While the others started milking untreated right after the calf had finished nursing. Camels are frequently milked as a herd (65%), while only (46.25%) were milked on their own. Borana and Guji pastoralists use camel milk in a variety of ways, including fresh raw milk, tea, and *chuuchee*. In this group, around 77.5% of the respondents reported as they preferred drinking tea, while 55.5-66.25% of them preferred drinking *chuuchee* (fermented camel milk). Unlike the milk and milk products of other animal species, camel milk is typically consumed untreated and undisturbed in the areas. On the other hand, user in the districts they preferred the spontaneously fermented camel milk known as *Chuuchee* for consumption (Table 8).

Table. 8. Camel milk handling and preferences

Activities	Categories	Districts				Over all (N=160)
		Gomole (N=40)	M/soda (N=40)	Liban (N=40)	Yabello (N=40)	
Washing hand and udder	Yes	26 (65)	27(67.5)	24(60)	22(55)	99(61.88)
Smoking milking vessel	Yes	24(60)	27(67.5)	36(90)	24(60)	111(69.38)
Separating lactating camel apart	Yes	25(62.5)	18(45)	17(42.5)	14(35)	74(46.25)
Keeping with herds	Yes	23(57.5)	36(90)	26(65)	19(47.5)	104(65)
Preferences of the respondents						
Raw milk drinking	Yes	2767.5)	24(60)	31(77.5)	24(60)	106(66.25)
Use as tea	Yes	31(77.5)	27(67.5)	31(77.5)	35(87.5)	124(77.5)
Drinkin ng as sour milk *(chuuchee*)	Yes	21(52.5	22(55)	21(52.5)	24(60)	88(55)

Figure inside of parenthesis represent percentage

4.9. Camel Herd Composition.

Production of milk, transport, and meat are the main reasons for keeping camels are managed in the study area. In these areas, camel milk is preferred to meat as a food source. It is a colossal activity in the districts to organize camel herds according to their role in rearing, age, sex, and other management circumstances. Because of this, the majority of the herd was made up of reproductive female camels (62.5%), young females (21.875%), young males (9.375%), and only little bulls (6.25%) (Figure 7). The more productive female camel in the area could be chosen in the conventional manner and kept in the herds. According to the selection criteria like the length of the leg, tail, good appearance and triangular shape of camel female camels might be divided into two types: *Korti* (more productive) and *Gelleba* (less productive).

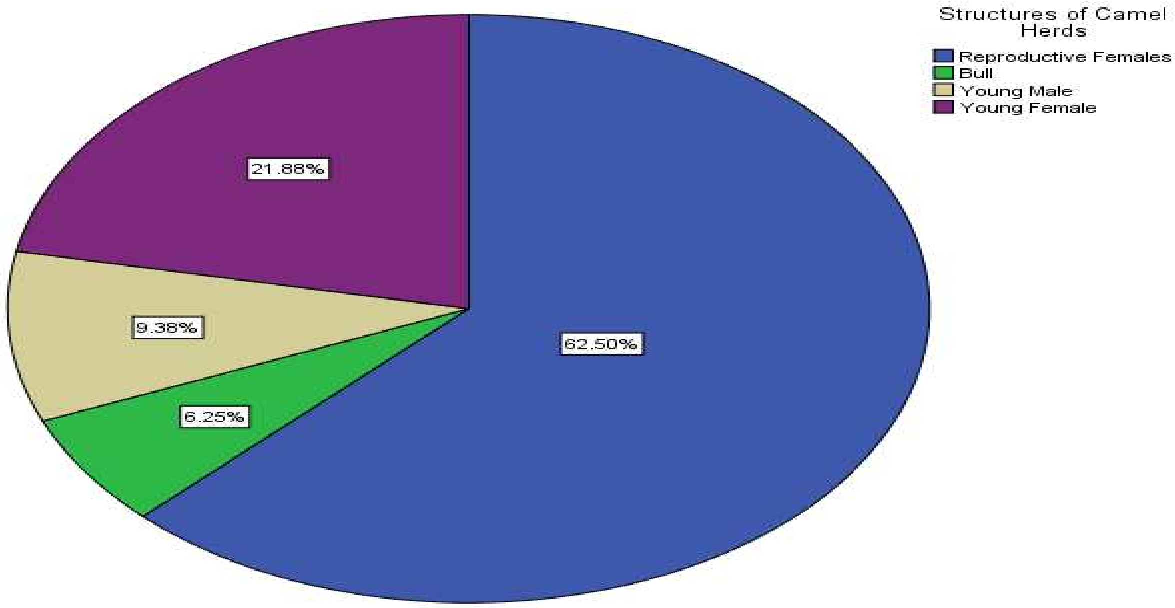

Figure. 7. Structures of camels herds in the area

4.10. Feeding, Watering, and Housing System

Camel feeding is influenced by the local climate and amount of rainfall. With some supplemental feeding techniques of minerals (51.3%), free-range grazing and browsing make up the majority of the diet (78.8%) Table (9). The primary feed sources in the research areas include grass, bushes, and trees for browsing. The three most significant plants that camels like to browse are *Acacia brevispica*, *Opunta ficus indica*, and *Dichrostachys ciniarea*, all of which are currently present in the research locations. The minerals that are most frequently used in the districts are black salt (*Magadoo*) and white salt (*Booke*). It has been provided as a supplement to the morning feed once to twice a week. This mineral may be used to fatten camels and make up for mineral deficiencies that occur during dry seasons in the years supported by the study. In a minor way, straw (Digirti) is utilized as additional feed in some locations in addition to supplementing with tree leaves when there are feed shortages. In the research locations, camels that are pregnant or ill are the main herds that share extra feeding. Due to camels' ability to conserve water, roughly 69.4%, 55.0%, and 36.3% of respondents agreed that camels are typically watered twice a month, once a week, and once a day, respectively. Wells, ponds, and rivers are the main water sources for camels in the area. Young males are responsible for water consumption under the supervision of elder people of both sexes during the dry season, when an artificially constructed deep well known as *Eela* is frequently used.

Table 9. Feeding, Housing, and watering management of camel

Variables		Categories	Overall values N (%)
Feeding	Free Ranging only	Yes	126(78.8)
	Free Ranging +supplementation	Yes	82(51.3)
	No barn	Yes	26(11.2)
Housing	Fenced(Moonaa)	Yes	142(88.80
	Once per a day	Yes	58(36.3)
Watering	Once per a week	Yes	88(55.0)
	Twice per Month	Yes	111(69.4)

Figure in parenthesis represent percentage

About 88.80% of those surveyed could confirm that mature camels were kept in herds during the day on shared grazing rangeland and at night in traditional Kraals (Moonaa) built around homesteads or dwellings to protect them from predators and thieves (Figure 8), while 11.2% of them were kept in the side of the man house. To keep them apart from other camel herds, calves are kept in a small enclosure composed of thorny bushes and wood. To protect their camels from some predators, nearly all camel breeders kept their animals in the traditional kraal, which is built of thorny plants.

Figure 8. Kraal/Moonaa/

4.5. Transportation and Marketing of Camel Dairy Products

Along with food, camel milk serves as the economic engine for the pastoral and agro-pastoral in the study areas. Comparable to cow milk, camel milk can be sold for enough money to pay for the family's costs (90.63%). However, 9.63% of them claimed that they had only utilized it for domestic consumption and had fermented the milk to offer it to esteemed foreigners. The majority of respondents (83.13%) stated that camel milk may be supplied to middlemen with little left over to sell to local consumers and shops at lower costs. This is due to disorganized milk marketing websites that connect producers and consumers in the area with places to live. They responded that they lost milk at cheap prices on time since there was no milk marketing unit or shade in the town close to where they lived, which was a marketing issue. Although there is a significant demand for camel milk in pastoral and agro-pastoral regions of the country, including the research areas, camel milk marketing is limited by price volatility, cooling facilities, and a well-organized transportation and marketing system. In order to decrease the degradation of raw milk since the cooling facility is a major issue in the areas, the marketing life of the milk has been extended by fumigating the milk containers or carrying kits.

In general, the marketing of dairy products was influenced by transportation problems like insufficient transportation services, traveling time (on time) due to high population, and sharing common public transport with humans in the study areas. According their respond on foot transportation is the predominant way of camel milk transporting in the areas. The households identify Yabello, Bule Hora, Moyale, and Negele Borana town as the district's terminal feeder town. For terminal users, camel milk is mostly supplied by Surupa and Malka Soda Town.

Table 10. Camel milk and milk products marketing

Variables	Categories	Districts				Over all
		Gomole (N=40)	M/soda (N=40)	Liban (N=40)	Yebello (N=40)	
Sale raw milk	Yes	34(85)	37(92.5)	39(97.5)	35(87.5)	145(90.63)
Chuuchee (Sour Milk)	No	-	-	-	-	100
Butter	No	-	-	-	-	100
To whom the milk is sold?						
Costumer	Yes	10(25)	11(27.5)	3(7.5)	14(35)	38(23.75)
Middle Trader	Yes	32(80)	33(82.5)	37(92.5)	31(77.5)	133(83.13)
Retailer	Yes	17(42.5)	21(52.5)	4(10)	18(45)	60(37.5)
Hotel/cafteria	Yes	16(40)	9(22.5)	4(10)	9(22.5)	38(23.75)

The figure in parenthesis represents percent, (-) nobody said yes

4.12. **The Role of Camel Milk in Human Health**

Camel milk naturally possesses antimicrobial qualities that protect people from bacteria that spread disease. In the specifically study areas of both Guji and Borena zones used camel milk to treat diarrhea, constipation, malaria, heart conditions, and uterine construction. About 73.1% of them believed that camel milk can be used to treat malaria, which is the most common disease with regard to constipation and strength (67.5%). Also they reported that, camel milk can enhance the skin's softness and smoothness qualities. The respondents reported that, camels browse on a variety of plant species, and active compounds with therapeutic properties from these plant species are released into the milk. In accordance with the study report of, rough boiling of camel milk can effectively protect the patient from serious cough problems in respiration movement and other respiratory diseases (60.6%) (Table 11), while diarrhea (45.6%) and heart diseases (21.9) are the other diseases believed to be treated with camel milk in a limited manner in the study areas. In addition, the respondents reported that consuming camel milk does not cause one to gain weight but rather makes one stronger. This most likely goes hand in hand with the natural phenomenon of camel feeding and feed type

Table 11. Therapeutic use of camel milk (the highest percentage is rank first) (N=160)

Diseases Types	Number and proportion(%) of responses	Ranks
Constipation	109(68.1)	2
Diarrhea	73(45.6)	6
Malaria	117(73.1)	1
Heart Diseases	35(21.9)	7
Respiratory diseases	97(60.6)	5
Women uterus contracts	105(65.6)	4
Strengthen	108(67.5)	3
Skin smoothness	71(44.4)	8

N= numbers of respondents/householders/

4.13. Challenges in Camel Milk Production, Processing and Marketing

In many regions of the country, including the study areas, camel milk processing has traditionally been thought to be impossible or not possible under natural circumstances, with the exception of turning it into fermented (sour) milk with a small amount of butter but no cheese. However, the most significant obstacle in the current research, which shared the top spot on all lists, was the lack of understanding regarding camel milk processing practices (Table 9). Lack of milk processing facilities, a lack of interest in the procedure, and a refusal to consume are the issues that rank second, third, and fourth, respectively. About 89.3% of those who responded to the survey reported that the primary obstacle to profiting from their production is the lack of organized camel milk selling channels. Other difficulties faced by camel herders in the research locations include the growth of encroaching bush, the yearly loss of feed pasture and browse plants owing to repeated drought, issues with transportation services to get the products to the needed markets, and unidentified camel diseases. Poor infrastructure like far away from the main road, transportation system, communication network, water and School inaccessibility were also the other challenges in camel milk production.

Table 12. Challenges in camel milk processing and milk marketing (1=less challenge, 4=highly challenge)

Processing Challenge	Districts Mean±SD				Overall mean	Ranks
	Gomole	M/soda	Liban	Yabello		
Lack of awareness	3.48±0.72	3.65±0.30	3.90±0.69	3.08±0.97	3.52	1
Lack of processing unit	3.33±0.47	3.42±0.50	3.43±0.59	3.32±0.47	3.38	2
Less interest to process	2.93±0.85	2.45±0.41	2.20±0.63	2.10±0.75	2.42	3
Camel milk Marketing Challenges						
ITM	2.65±0.48	3.30±0.46	3.70±0.46	3.33±0.47	3.24	2
Poor infrastructure	3.35±0.66	2.88±0.88	3.10±0.70	2.10±0.77	2.85	4
Lack of cooling facility	2.85±0.69	2.95±0.74	3.25±0.63	3.30±0.64	3.09	3
No organized market link	3.48±0.64	3.80±0.40	3.87±0.33	3.15±0.92	3.57	1

Notice: ITM=inadequate transport means

4.14. Cheese Making From Camel Milk by Blending It with Cow Milk

4.14.1. Chemical composition of milk used to make Cheese

According to the chemical composition data, cow milk had higher total solid, solid not fat, TA, fat, CP, lactose, and specific gravity than camel and their blends, with the exception of ash content (Table 13). Camel milk had a considerably ($P<0.05$) greater ash value than cow milk, whereas the CP values of the three treatments (T2, T3, and T3) did not differ significantly ($P>0.05$).

Table .13. Physicochemical composition of raw milk of camels, cow and their blends used for cheese making

Variable	Treatments (Mean±SD)				
	T1	T2	T3	T4	T5
T S (%)	11.537±0.14^{a}	11.55±0.11^{a}	13.77±0.17^{c}	12.82±0.16^{b}	14.23±0.38^{d}
Ph	6.210±0.36^{a}	6.363±.31^{ab}	6.727±.02^{bc}	6.393±0.25^{ab}	6.727±0.05^{bc}
TA(%)	0.1435±0.0^{a}	0.1465±0.02^{a}	0.172±0.10^{b}	0.1685±0.30^{c}	0.1725±0.02^{b}
Fat (%)	3.61±0.14^{a}	3.72±0.13^{b}	4.18±0.10 ^{c}	4.07±0.87^{d}	4.520±0.36^{e}
Protein (%)	3.195±0.18^{b}	3.220±0.2^{a}	3.350±0.15^{a}	3.265±0.20^{a}	3.353±0.16^{c}
Lactose(%)	4.077±0.57^{a}	6.579±0.34^{a}	3.350±0.16^{ab}	5.767±0.81^{ab}	4.3347±0.75^{c}
SNF (%)	8.05±0.10 ^{a}	7.85±0.17^{a}	9.65±0.17^{d}	8.82±0.16^{c}	9.78±0.38^{d}
SG	1.027± 0.01^{a}	1.032±0.05^{ab}	1.037±0.02^{b}	1.038±0.09^{b}	1.039±0.08^{b}
Ash (%)	0.774±0.06^{c}	0.7384±0.06^{b}	0.728±0.04^{b}	0.7351±0.04^{b}	0.690±0.19^{a}

Note: Means within different subscripts in the row differ significantly (P<0.05), T1=100% camel milk, T2=75%camel milk and 25%cow milk, T3=25%camel milk and 75%cow milk , T4=50%camel milk and 50%cow milk, T5=100% cow milk , SD= standard deviation.

4.6.1.2. Milk Coagulation and cheese yield

The results revealed significant variations (P0.05) in the mean values of the coagulation and setting times across the study's five treatments (Table 14). For both categories, the sample with the purest and highest percentage of camel milk took longer. Contrarily, pure cow milk had much lower levels of coagulation and setting time. The findings showed that milk coagulation and setting times decreased as cow milk percentage rose (Table, 14). The PH value, however, did not indicate a significant difference (P>0.05). This means the PH of treatments was not significantly affected by the effects of various camel and cow milk samples. The cheese yield created from cow milk had higher values, however treatment one's (T1) cheese values were noticeably lower than those of the other samples. The cheese output in T3 and T4 had greater values than the other milk samples because it had higher percentages of cow milk (Table, 14). Whereas, the significant difference (P>0.05), between T1 and T2 was not observed.

Table. 14. Cheese yield and coagulation efficiency of camel milk and it blend

Variables	Treatments (Mean ±SD)				
	T1	T2	T3	T4	T5
CT(M)	69.00±1.00^{e}	60.67±3.79^{d}	26.67±2.08^{b}	51.67±2.9 ^{c}	19.00±1.00^{a}
ST(M)	1160.0±5.84^{d}	96.33±5.85^{c}	32.83±0.29 ^{a}	65.00±5.00^{b}	31.67±0.58^{a}
pH	4.79±0.43^{a}	4.73±0.18^{a}	4.57± 0.15^{a}	4.74±0.8^{a}	5.07±0.68^{a}
Y (g/100g Milk)	17.96±0.28^{a}	18.50±2.18^{a}	19.70±0.27^{ab}	21.18±1.26^{b}	24.70±0.48^{c}

Note: Means within different subscripts in the row differ significantly (P<0.05), CT=coagulation time, ST=setting time, Y=yield, T1=100% camel milk, T2=75%camel milk and 25%cow milk, T3=25%camel milk and 75%cow milk, T4=50%camel milk and 50%cow milk, T5=100% cow milk, SD= standard deviation, Min=minutes, L=liter

4.6.3. Camel milk cheese's chemical makeup when combined with cow milk

Table 15 present the physicochemical characteristics of cheese prepared from camel milk and a combination of cow milk. In contrast to the ash and moisture percentages of the cheese, the protein, fat, and total solids of the analyzed cheese are raised with higher level cow milk. From T1 to T3, the ash and moisture content levels were noticeably (P<0.05) increased. According to this research, treatment four, which contains 50% camel milk and 50% cow milk, had the greatest value for fat content. While the sample of 100% camel milk had cheese with a much reduced fat level.

Table. 15. Physicochemical composition of a cheese made from cow and camel with its blend

Treatments	Components				
	Protein (%)	Fat (%)	TS (%)	Ash (%)	Moisture (%)
T1	14.89±.13^{a}	17.60±1.00^{a}	40.23±6.95^{a}	2.59±0.06^{d}	59.79±1.00^{c}
T2	15.85±.14^{b}	19.12±0.57^{b}	46.89±1.87^{b}	2.39±0.06^{bc}	53.13±6.98^{b}
T3	16.17±0.02^{bc}	20.66±0.9^{b}	45.79±0.38^{ab}	2.49±0.02^{cd}	54.20±1.84^{bc}
T4	16.12±0.03^{c}	20.60±0.10^{d}	48.36±2.08 ^{b}	2.32±0.06^{ab}	51.63±2.08^{b}
T5	22.69±0.33^{d}	21.78±0.19^{b}	57.85±1.27 ^{c}	2.26±0.09 ^{a}	42.15±1.27^{a}

Means within different subscripts in the row differ significantly (P<0.05), TS= total solid, T1=100%camel, T2=75%camel milk and 25%cow milk, T3= 25% camel milk +75%cow milk, T4=50%camel milk +50%cow milk, T5=100% cow milk

4.6.4. Cheese sensory assessment

Table 16 displays the sensory characteristics of a cheese made with various ratios of a blend of camel and cow milk. The cheese prepared from pure camel milk scored higher than others in terms of roughness, surface moisture, hardness, adhesiveness, and saltiness, while the cheese made from pure cow milk scored lowest (Table 16). Contrary to popular belief, pure cow milk cheese received good marks for its flavors, solubility, looks, and general acceptance. A 25% addition of cow milk to camel milk did not, almost universally, result in a significant difference ($P<0.05$), while 50% and 75% additions had a substantial impact on the cheese's physical characteristics. Compared to other samples of the mix, the cheese made from 50% cow milk was more widely accepted (Table 16), while the cheese made from 75% cow milk had a good appearance. The greater quantity of cow milk cheese may have been preferred over the lower percentage due to its tasty texture. Pure camel milk cheese may have a more pronounced salty feel than other samples due to the camel milk's salinity flavor.

Table.16. Sensory Attributes of Cheese. (1=lowest, 7=highest score)

Variables	Treatment (Mean ±SD)				
	T1	T2	T3	T4	T5
Roughness(F)	5.67 ±0.76^{d}	4.50±.0.87^{cd}	3.67±0.29^{bc}	3.35 ± 0.29^{ab}	2.37 ±0.32^{a}
SM(F)	6.13 ±0.23^{d}	5.17 ±0.29^{cd}	4.50 ±0.50^{bc}	3.87±0.38^{b}	3.00 ±0.50^{a}
Tastes(M)	2.53 ± 0.15^{a}	2.13 ±0.15^{a}	3.27±0.30^{b}	4.47 ±.0.23^{c}	5.73 ±0..25^{d}
Firmness(mo)	6.17±0.16^{d}	5.50±0.30^{d}	5.10 ±0.17^{b}	4.60±0.30 ^{c}	4.70±0.10^{a}
Adhesiveness (M)	5.93 ±1.00^{b}	5.23 ±0.34^{ab}	3.93 ±0.64^{a}	5.00^{ab} ±0.57	3.87 ±0.81^{a}
Solubility(M)	2.30 ± 0.30^{a}	2.80 ±0.100^{b}	4.63 ± 0.15^{d}	3.57 ±0.40^{c}	5.57 ±0.20 ^{e}
Saltiness	5.83 ±0.58^{c}	5.27±0.06^{c}	3.27±0.41^{a}	4.40±0.35^{b}	3.43±.0.25 ^{e}
Appearance	3.53±0.30^{a}	4.20±0.20 ^{b}	5.17±0.11^{c}	4.27±0.26^{b}	5.30±0.10 ^{c}
Acceptance	3.30±0.17^{a}	4.20±0.65^{a}	5.13±1.07 ^{b}	5.47±0.47^{b}	6.80± 0.44 ^{b}

Means within different subscripts in the row differ significantly ($P<0.05$), Values are in the mean of triplicate data ±stander deviation (SD) of the mean. F=finger, M=mouth T1=100%camel, T2=75%camel milk and 25%cow milk, T3= 25% camel milk +75%cow milk, T4=50%camel milk +50%cow milk, T5=100% cow milk. SM=surface moisture

5. DISCUSSION

5.1. Socio-economic Characteristics of the Respondents

In the study areas the women have been played a great role in camel milk production, handling and overall management than men, so they held the higher percentage in this study. The family members of the interviewed respondent were range from two to eleven, whereas, the majority of them were had more than five family sizes. The total mean household sizes reported by Befekadu *et al.*, (2018) in similar areas were slightly comparable to the average family sizes observed in this study. Most of sampled respondents were elder in age with a long camel rearing experiences. This implies that the camel herds have been held by the person whose, go in age than the youth one. Household camel ownership varies from one district to the next. The Liban district has the highest mean value of camel ownership per family. This might be due to the favorability of the area for camel rearing and high community interest in keeping camel than other livestock species. Gomole is the second district in which the large camel population has kept, owning to the conducive camel managing environment, more experienced in camel milk production, utilization and marketing as compared to others. The camel is regarded as the secondary milk producer in these regions because of its remarkable resistance to the repeated droughts that exacerbate the paucity of water and food. However, due to the pastoral and agro-pastoral communities in the country, including the current study areas, having poor educational status, the contemporary method of raising camels and its dairy products has not yet been tested

5.2. Lactation and Reproductive performances of Camel.

Camel lactation length were varies from district to district in the study areas. The longest lactation period in month was recorded d in Liban District as compared to others. The feed availability and good management practices might be the reason of variation saw between the districts. Therefore, the values saw in Liban district were the indicator this one. According to the report of Simenew *et al.*(2013b), and Abdelgadir *et al*.(2013) the management practices has a great contribution in lengthen of the lactation period, that is in line with the current report. However, the present lactation length was higher reported by Mutairi *et al.* (2010). Particularly, this problem has been seen in Yabello and Malka Soda districts. The overall mean values of the current finding is in line with (Musaad *et al*., 2013), who reported that the average lactation length of camel is 12.5 months.

The highest daily camel milk production was observed in Gomole district, while the lowest one was in Malka Soda. However, the overall mean values of milk production for the four districts are comparable to Simenew *et al*.(2013), with the finding of camel milk yield range from 6.00-9.90L/d. This might be a result of the district's varied feed resources that were accessible during lactation times. Three times of milking per day is implemented, as opposed to the responses of those who have adopted four or two times of milking, which is consistent with the conclusion reached by Gebremichael *et al*.(2019). The fluctuation of environmental condition had a great impact on camel daily milking time that correlated the availability of the feed. However, it was difficult to estimate the exact lactation length and daily milk yield of the camels under pastoralist conditions, because milk variability is subject to milking practices, breed, season, feeding, stage of lactation, calf survival and household milk demand (Nega and Tefera, 2012). Winter is the period in which lactating camel is milking four times per a day in all districts of the study area.

5.3. Preservation and Processing Methods of Camel Milk

Lack of standardized camel milk processing and preserving facility in the areas, had made the communities to used different option to keep saved their products. Washing and smoking storage containers, storing milk in a cold environment, allowing milk to ferment and turn sour and boiling milk is the one practiced in area. Due to the hot environmental characteristic of the study area keeping milk in cold area has commonly been implemented in four districts of the study. This result is in line with Yeserah *et al*. (2020a), who found that milk producers in the vicinity of Hawassa and Yirgalem were chilling their milk by storing it in a cold environment. By providing a pleasant sensory experience, milk and milk products kept in a cool environment can boost a user's acceptance and desire to drink Eyassu, (2007b) and Bekele *et al*.(2021). This locally used method of camel milk cooling predominates in the research locations, which is likely a result of a lack of infrastructure for electric services and other community-related services associated to community dispersal. Almost all respondents in the study area reported that smoking of milking vessels after washing has been believed that, it used keep the milk for certain time without any physical and odor change. This result is agreed with Bekele *et al*. (2015)

who reported all the respondents practice washing the milk utensils used for milking, storing and processing of milk in Dangila town district. In all districts of the study small percentages of the communities were used milk boiling for preservation, while the majority of them have not applied.

Milk processing is the other way of preserving the dairy product. The ferment camel milk locally known as *chuuchee*, is used as processed product, that agreed with the report of (Birhanu *et al*., 2021). By adopting a traditional method, such as loading raw camel milk on a camel while traveling and using a heated white stone (*Smocky Quartz*) locally referred to as "*chabii*," camel milk was processed into butter to a minor level. To speed up the fermentation, soured cow and goat milk was used, which supported with the report of (Benkerroum *et al.*, 2011), who revealed that, as starting culture for raw camel milk, soured milk from other species can be used..

5.4. Vessels used for Milking and Storage

The respondents selected for the current study used the distinctive camel milking, processing and storage vessels. As they reported Sorara and Gorfa could be used for storage and processing, while Okkole that made from skin and plastic jug used for milking. Each milk vessel can be fumigated with a smoking plant prior to usage for two to five minutes. Since smoking vessels have anti-microbial effects and are used to extend milk's shelf life. In addition to being used for milk preservation, it also enhances the flavor and aroma of milk. Also, it is providing anti-microbial, appealing flavor, and food additives, the substance emitted by specific smoking plant species could be exploited as a source of antibiotics for consumers ((Eyassu, 2007b) and (Al-Manhel and Niamah, 2015). Additionally, it has been discovered in vitro that plant metabolites such as tannins, flavonoids, and alkaloids have antibacterial effects (Dahanukar *et al*., 2000).

4.5. Plant Used for Smoking

In order to produce milk with good flavor and scent in the research area's pastoralist and agro-pastoralist communities, milking and storage vessels can be smoked using locally accessible plants. This could increase customer acceptability of the product. The major plant used for vessels smoking used in all district of the study are *Olea Africana* (Ejersa), *Rhus abyssinica*

(Xaaxxessa), and *Acacia brevispica* (Hammaressa). When the primary smoking plant is not nearby, there is yet another variety that is infrequently utilized. They acknowledged that the steam is the most crucial component of the tree they employed. As they revealed the most important part of the tree they used is steam. This is because it is an appropriate to prevent the lingering effects of tiny plant fragments in the milk; as a result, it can continue to be appealing with nice flavor and scent. This result was consistent with the results of(Yeserah *et al.*, 2020b), which found that milk handled with smoked utensils was less likely to be accepted by consumers. In accordance with this finding, the primary justification given by homes for smoking dairy production equipment is to enhance the flavor and shelf life of milk products who revealed that smoking milking and storage equipment can be highly accepted by the consumer than milk handled in the non-smoked utensil. In line with this result, the major reason outlined by the households for smoking dairy production equipment is to improve the taste or flavor of the milk products and to increase the shelf life(Melesse, 2013)

5.6. The Shelf Life of Camel Milk

As the interviewed respondent said that camel milk could able to keep long periods of time than the milk of bovine. This can be happened when the milk is kept purely. According to their report the fresh camel milk can be stored for 3-4 days, which is agreed with Nimesh Khakhariya, (2019) who, reported that, the shelf life of Amul fresh camel milk was just four days. Contrary, Birhanu *et al*, (2021) reported that camel milk can be stored for three days. The current result was also consistent with that of Muthukumaran *et al*. (2022), who showed that camel milk may be stored for 18 to 20 hours without changing and for four days when kept in the refrigerator. Contrarily, it was noted in certain publications that camel milk could have a two-day shelf life (Bekele *et al*., 2021). As the report in this study indicated that camel milk has a longer shelf life than other milk kinds because it naturally possesses anti-microbial, protective protein, and other essential features.

5.7. Camel milk Handling and Utilization

Camel milk could be handled and utilized in similar manner in all study areas. However, in liban district smoking milking and storage vessel before utilizing commonly practiced than other.

Hand and udder washing is the little practices in all districts of the study. While the others started milking untreated right after the calf had finished nursing. Camels are frequently milked as a herd, while only small were milked on their own.

In the Study areas camel milk is used in a variety of ways, including fresh raw milk, tea, and *chuuchee*. Most of the respondents were reported that, camel milk tea is more preferable than *chuuchee* next to raw milk drinking. Unlike the milk and milk products of other animal species, camel milk is typically consumed untreated and undisturbed. This study's findings concur with those of other studies (Eyassu, 2007a) and (Bekele *et al.*, 2021), which found that most camel-rearing societies eat fresh camel milk. The research by Amenu *et al.* (2019), also showed that raw milk drinking is widespread among pastoral communities in the Borana Zones. On the other hand, communities in the districts favored the spontaneously fermented camel milk known as *Chuuchee* for consumption. Similar to this, Somale, Kenya, Somalia, and Sudan make the naturally fermented camel products Dhaanan, Susac, Shubat, and gariss (Seifu, 2007b)

5.8. Camel Herd Composition

Camel is the main sources of milk in next to cow in selected district of three zones. In these specific locations, camel milk is preferred over meat as a food source. Tegegne *et al*.(2013) reported that camel milk is consumed along with goat and cow milk in lowland pastoral or agro-pastoral areas of Ethiopia while consumption of camel milk in the mainly Christian highland areas was limited due to a traditional taboo. It is a colossal activity in the study districts to organize camel herds according to their role in rearing, age, sex, and other management circumstances. Because of this, the majority of the herd was made up of reproductive female camels and young females. This study report is comparable with Elhadi *et al*. (2015) who reported that 70% camels in Kenya are female, which shows households were keeping camels for milk production. Similarly, Temesgen *et al*.(2011) reported, in Kereyu 90% of camel herd composition are female. This implies that female camels far exceed male camels to ensure reproductive potential and good milk production for pastoralists as food. The more productive female camel in the area could be chosen in the conventional manner and kept in the herds. More bull is not allowed to live the herds, because they used it as income sources. The findings report of Gebremichael *et al.*(2019), which revealed that female camel herds make up more of the structural makeup of Afar camel herds provided support for this study.

5.9. Feeding, Watering, and Housing System

The primary sources of camel feed in the study areas are grass, shrub, bush and various thorny plant species that easily not consumable by other livestock. The major plant species feed by camel in the study areas are, *Acacia brevispica*, *Opunta ficus indica*, and *Dichrostachys ciniarea*. Also, cacti (*Oputia ficus indica*) and different agriculture leftovers are used as camel feed in the areas. In similar way Bekele *et al*. (2002b) and Mirkena *et al*. (2018) reported that , several saltbush plants in the family Chenopodiaceae, the forage species, leguminous trees and bushes are like by camel. Camel also like eating, as well as *Euphorbia tirucall*(Aklilu, 2011).

Free-range browsing is the commonly used camel feeding with little supplementation practices. In a minor way, straw (Digirti) is utilized as additional feed in some locations in addition to supplementing with tree leaves when there are feed shortages. Black salt (*Magado*) and white salt (*Book*e) have been supplemented at morning one to twice a week. In Liban district these salt are more available and utilized than other study districts. According to the ideas of the interviewed respondents, feeding these salts could help in minimizing the case of bloating and contrarily increased the status of the animal. Also, it used to smooth the skin and strength the fetus bone during gestation period which is agreed with the finding of (Gebisa, 2019). In the research locations, camels that are pregnant or ill are the main herds that share extra feeding. On the other hand, camel in the jijiga and Shinile areas are fed supplemental feed in addition to unimproved perennial natural plants with low nutritional contents (Seifu, 2009).

In the dry season it is customary to water camel every twice a month, , however the interval can be up to one month in the water sources is far away in the study areas. During this season manually collecting of water from deep wells locally known as *Eela* is the most practicing way of camel watering in the area. This finding is in line with the report of (Befekadu *et al.,* 2018) who revealed that well is the crucial water sources in dry season. Young males are responsible for water consumption under the supervision of elder people of both sexes during the dry season,.

In the study area matured camels were kept in the herds during the day time on shared grazing rangeland and at night in traditional Kraals (Moonaa) built around homesteads or dwellings to protect them from predators and thieves. A little of them could kept in the side of the man house. To keep them apart from other camel herds, calves are kept in a small enclosure composed of thorny bushes and wood. To protect their camels from some predators, nearly all camel breeders kept their animals in the traditional kraal, which is built of thorny plants *(*Faraz *et al.*, 2021)

5.9. Camel Milk and Milk Product Marketing

Along with food, camel milk serves as the primary economic engine for the pastoral and agri-pastoral villages of Borena and Guji in the research areas. The interviewed respondents were stated as comparable to cow milk, camel milk can be sold for enough money to pay for the family's costs, while small number of them claimed that they had only utilized it for domestic consumption and had fermented the milk to offer it to esteemed foreigners. Contrarily Birhanu *et al*. (2021), reported that fermented milk has been sold for income generation in this particular areas.

In the areas camel milk may be supplied to middlemen with little left over to sell to local consumers and shops at lower costs. This is due to disorganized milk marketing websites that connect producers and consumers in the area with places to live. They responded that they lost milk at cheap prices on time since there was no milk marketing unit or shade in the town close to where they lived, which was a marketing issue. Although there is a significant demand for camel milk in pastoral and agro-pastoral regions of the country, including the research areas, camel milk marketing is limited by price volatility, cooling facilities, and a well-organized transportation and marketing system, which is similar to the statement (Bekele *et al*., 2021). In order to decrease the degradation of raw milk since the cooling facility is a major issue in the areas, the marketing life of the milk has been extended by fumigating the milk containers or carrying kits. The households identify Yabello, Bule Hora, Moyale, and Negele Borana town as the district's terminal feeder town. For terminal users, camel milk is mostly supplied by Surupa and Malka Soda Town. Sudden drought outbreaks, seasonal variations in milk pricing, and a lack of camel milk processing infrastructure (including facilities for transportation and chilling) are all issues that affect the production and processing of camel milk

5.10. The Role of Camel Milk In Human Health

Camel milk naturally possesses antimicrobial qualities that protect people from bacteria that spread disease. In selected location of both Guji and Borena zones might use camel milk to treat diarrhea, constipation, malaria, heart conditions, and uterine construction. According to their believe camel milk might be used to treat malaria, which is the most common disease with regard to constipation and strength. Tea made from camel milk is used to treat coughs. This may be because camel milk is regarded as a functional diet for treatments and cures for conditions including asthma, diabetes, edema, sciatica, and seasonal fever (Abrhaley and Leta, 2018) and (Khalesi *et al.*, 2017). Additionally, camel milk can enhance the skin's softness and smoothness qualities (communication). This may be because camel milk contains more lysine amino acid than milk from other livestock species.

According to the respondents surveyed, camels browse on a variety of plant species, and active compounds with therapeutic properties from these plant species are released into the milk. This finding is supported by a report of (Eyassu, 2007a),), which claimed that camel milk has higher medicinal values than milk from cows and other livestock species In accordance with the study report of, rough boiling of camel milk can effectively protect the patient from serious cough problems in respiration movement and other respiratory diseases. Diarrhea and heart diseases are the other diseases believed to be treated with camel milk in a limited manner in the study areas, which is in line with report of (Bekele *et al.*, 2021). Salmonella Typhimurium, Escherichia coli, Listeria monocytogenes, Staphylococcus aureus, and other Gram-positive and Gram-negative bacteria have all been reported to be resistant to camel milk's antibacterial properties (Elagamy, 2000). According to reports, camel milk has larger concentrations of protective proteins such lysozymes, lactoferrin, lactoperoxidase, and immunoglobulin, which are thought to be the cause of this inhibitory effect (Konuspayeva *et al.*, 2007b). In addition, the respondents said that consuming camel milk does not cause one to gain weight but rather makes one stronger. This most likely goes hand in hand with the natural phenomenon of camel feeding and feed type

5.11. Challenges in Camel Milk Production, Processing and Marketing

Camel milk processing has traditionally been thought to be impossible or not possible under natural circumstances, with the exception of turning it into fermented (sour) milk with a small amount of butter but no cheese. Despite the fact that this topic is currently highly taboo, camel milk is processed into the product using cutting-edge methods that are remarkably applied. However, the most significant obstacle in the current research, which shared the top spot on all lists, were the lack of understanding regarding the introduction of camel milk processing practices, lack of milk processing facilities, a lack of interest in the procedure, and a refusal to consume are the issues raised in the communities. .

The interviewed respondents in all selected district of the study areas said that the primary obstacle to profiting from their production is the lack of organized camel milk selling channels. Other difficulties faced by camel herders in the research locations include the growth of encroaching bush, the yearly loss of feed pasture and browse plants owing to repeated drought, issues with transportation services to get the products to the needed markets, and unidentified camel diseases. Unknown camel diseases has made the camel to be died and sick frequently without showing any septum and had a great position in camel milk decline. In similar way Kebede *et al*.(2015b) and Gebremichael *et al*.(2019b), revealed, that, low milk yield due to camel diseases was a major worry for pastoralists in Somalia and the Afar Region.

Even though it is difficult to make processed products naturally because of the relative distribution and amino-acid composition of camel milk caseins being different from bovines milk, the lack of advanced camel milk processing practices would present a challenge in extending the shelf life of the product in pastoral communities(Bekele *et al*., 2002b). Lack of conventional milk value addition was partly caused by inadequate infrastructure(Noor *et a*l., 2013).

5.12. Cheese Making From Camel Milk by Blending It with Cow Milk

5.12.1. Chemical Composition of milk used to make Cheese

The current finding result was demonstrated that the chemical composition of blended milk improved with increasing cow milk proportion. This result is consistent with the findings of (Derar and El Zubeir, 2016a) and (M. S. Mustafa *et al.*, 2015) who observed that the chemical composition of camel milk rose when it was combined with cow and sheep milk. On the other hand, (Eissa *et a*l., 2010) observed that during yoghurt preservation periods, the fat content of mixed camel and cow milk remained steady. The results of earlier research (Asresie *et al.*, 2013c) and, (Omer and Eltinay, 2009) revealed that total solids content of camel milk was 8.62%, 8.64%, and 9.78%, respectively. The total solids of pure camel milk in the current study are higher than those results. However, the result of 12-15% in total solid cow milk is consistent with the findings of (Mehta *et al*., 2014) and (Al Kanhal, 2010). Climate, feeding method, and cow lactation stage may be to blame for the variance in total solids content between the current study and previous findings. According to the findings of (Asresie et al., 2013c) and *(*Musaad *et al.*, 2013), who reported pH values of 6.2–6.7 for fresh camel milk, which is consistent with this finding.

5.12.2. Milk Coagulation and cheese yield

The camel milk's ability to coagulate may be increased by adding cow milk to the mixture. The milk's coagulation time was kept lower with a lower amount of camel milk, but a higher percentage of cow milk considerably sped up the production of curd. This is probably brought on by the fact that cow milk contains more solids than camel milk does. The current finding was consistent with the reports of (Shahein *et al*., 2014) and (El Zubeir and Jabreel, 2008), which showed that camel milk blended with Bufallo milk might be better in coagulation than pure camel milk. The present coagulation time of camel milk, however, is longer than the results reported by (Walle *et al*., 2017a), who found that the shortest gelation times, 348 and 433 seconds, were recorded with the highest chymosin concentrations. Additionally, Vos *et al.*(2017) found that a higher chymosin content could reduce the time required for milk to coagulate, which is somewhat consistent with the current investigation. As the amount of cow milk in the mixture grew, the coagulation time continued to shrink.

In the current investigation, the cheese prepared from pure camel milk was in consistent with the earlier result of 17.2–18.10g/100g milk (Habtegebriel and Admassu, 2016). The pure cow milk and its larger proportion in the mixture led to a higher cheese yield. The fact that the fat globules in cow milk are practically completely absorbed into the casein network during the coagulation process, which is analogous with the report of the higher output of cheese in mixture of camel milk than pure camel milk, may be the cause of this (Derar and El Zubeir, 2016b). The cheese yield obtained in this finding is significantly higher than that reported by (Walle *et al*., 2017a)) who found that the highest cheese yield was obtained with goat milk cheese. This might be explained by higher solid recovery and more moisture being incorporated into the curd in uncooked cheese samples, which leads to the production of more cheese(Guo *et al*., 2004). The shape of the curd and the cheese yield are influenced by the interaction of the fat globule and protein. The cheese yield in the current study could be raised from 17.96g to 21.18g/100g milk by mixing cow's milk with camel's milk.

5.12.3. Camel milk cheese's chemical makeup when combined with cow milk

Similar findings regarding to the cheese's protein, fat, total solids, and ash concentrations were made in a prior study using a similar experimental design (Al-Zoreky and Almathen, 2021), (Hamad, 2015) and (Walle *et al*., 2017b). While the moisture of cheese manufactured from cow milk in the current study is much lower than the 59.98% reported by (Jung *et al.*, 2013). Contrarliy the moisture contents of cheese created from camel milk were significantly higher than the 48.9% reported by (Akinloye and Adewumi, 2014). According to findings by (Habtegebriel and Admassu, 2016), the cheese production of real camel milk was 18.10g/100g of milk, which is comparable to values for pure camel milk but much lower than the blend one in this study. Different camel milk blend ratios would have produced cheese with higher ash content. The ash contents of cheese manufactured from camel milk were 1.60 and 1.98-20.20%, respectively, according to (Walle et al., 2017b) and (Derar and El Zubeir, 2016b), which is lower than the study's of present finding . The varieties of vegetation that camels browse during their feeding behavior contribute to the high salty characteristics of pure camel milk cheese.

The cheese made from camel milk and high percentages of camel milk mixed with cow milk produced the highest values for roughness, surface moisture, firmness, adhesiveness, and saltiness in the current finding/study/, whereas the cheese made from pure cow milk and high percentages of cow milk proportion in the treatment produced the best values for solubility, tastes, appearance, and acceptances. This result is consistent with(E. Mustafa *et al.*, 2015), who showed that the general acceptance of yoghurt was significantly increased by the larger percentages of cow milk in the blend of camel and cow milk. The glandular surface of cheese manufactured with 100% camel milk may help to increase the roughness features of cheese made with a higher percentage of camel milk in the milk mixture. As a consequence of the panelists' evaluation, camel milk's contribution to the cheese's roughness was maintained at a lower level than pure cow milk. This may be because camel milk still contains some unhydrolyzed fat globulin compared to cow milk, which is corroborated by (Delahunty and Drake, 2004), that found uncompletely hydrolyzed fat globulin in raw milk could raise the amounts of surface moisture in the final products. Also, Pandey *et al.*(2000) found that cheese created from pure camel milk had higher surface moisture than cheese manufactured from cheese that contained 50% cow milk.

5.12.4. Cheese Sensory Assessment

According to Kraggerud *et al*.(2012a), the combination of cow and camel milk may alter the physical characteristics of cheese, which is consistent with the findings of this investigation. Overall appearance of the camel milk cheese, as reported by (Walle *et al*., 2017c), was 4.40, which was somewhat higher than the present rating of the cheese produced from only camel milk. According to this study's findings, camel milk cheese received fewer overall acceptances than combined camel and cow milk cheese (Kraggerud *et al*., 2012b)

6. CONCLUSION AND RECOMMENDATION

6.1. Conclusion

Camel dairy production practices and cheese making from camel milk by blending with cow milk via enzymatic treatment is the main finding of this research. Based on the result obtained, it was concluded as follows.

- This study concluded disease, frequently appearance of drought and expansion of encroachment of bush is the critical problem in camel dairy production
- The most significant difficulties seen in the areas, however, are a lack of knowledge about cutting-edge camel dairy processing methods, a lack of camel milk processing units, a reluctance to process camel milk into byproducts, poor infrastructure, and the absence of a formalized market link.
- Blending of camel milk with cow milk could be improved the processing properties of camel milk for cheese making
- The blend of milk brought the significant difference with the proportion of milk mixed in all patterns of study that was included physicochemical properties of milk and cheese, cheese yield, coagulation and setting time and sensory attributes of cheese.
- The present of cow milk in the blend made the cheese produced to have a great sound in over all acceptances of the cheese.

6.2. Recommendations

To improve the camel dairy production, Processing and Utilization the following point can be recommended.

- To improve the camel dairy production, Processing and Utilization the following point can be recommended.
- Introduction of pastoral communities in camel milk processing and consumption, subsequencial awareness should be required.
- To obtain a cheese of camel milk with a good curd, fifty and more percentage of cow milk should be mixed.
- Additional Investigation should be required to analysis the contribution of *Smoky Quartz* stone in milk coagulation

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8. APPENDIX

8.1. Supplementary Tables.

Appendix.1. ANOVA Challenge and Constraints of camel milk processing

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Lachk of awarness in technology	Between Groups	14.450	3	4.817	9.458	.000
Lack of camel milk processing unit	Between Groups	.400	3	.133	.506	.679
Unwillingness to consume	Between Groups	8.150	3	2.717	3.963	.009
Less interest to process	Between Groups	16.269	3	5.423	11.641	.000

Appendix . ANOVA Milk Coagulation Time and Cheese Yields

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Coagulation time of milk	Between Groups	5631.600	4	1407.900	242.741	.000
setting time of milk	Between Groups	18332.267	4	4583.067	243.564	.000
cheese yield	Between Groups	88.404	4	22.101	21.158	.000
pH	Between Groups	.399	4	.100	2.156	.148

Appendix 4. ANOVA Chemical Composition of Milk used for Cheese Making

Univariate Tests

Dependent Variable		Sum of Squares	df	Mean Square	F	Sig.
freezing point		.308	4	.077	311.865	.000
Total Solid	Contrast	18.478	4	4.620	100.592	.000
pH Values	Contrast	.647	4	.162	2.818	.084
Lactose	Contrast	2.248	4	.562	3.645	.044
Titratable Acidity	Contrast	.002	4	.001	.	.
Fat content	Contrast	1.641	4	.410	139.830	.000
Cruide Protein	Contrast	2.733	4	.683	72.487	.000
Soilid Not fat	Contrast	2.422	4	.606	4.830	.020
Specific grafity of milk	Contrast	.000	4	7.441E-005	3.103	.067
Ash of milk	Contrast	.011	4	.003	28.509	.000

The F tests the effect of treatments T1, T2, T3, T4 &T5. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Appendix 5. ANOVA Chemical Composition of Cheese

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
protein of cheese	Between Groups	118.687	4	29.672	1063.507	.000
fat of cheese	Between Groups	310.304	4	77.576	172.184	.000
Total solid of cheese	Between Groups	490.239	4	122.560	10.589	.001
Ash of cheese	Between Groups	.216	4	.054	14.910	.000
moisture contents of cheese	Between Groups	491.436	4	122.859	10.530	.001

Appendix 6. ANOVA Sensory Attributes of Cheese

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Rouphess	Between	13.943	4	3.486	10.870	.001
Surface moisture	Between	17.273	4	4.318	27.682	.000
Firmness	Between	4.467	4	1.117	36.865	.000
Adhesiveness	Between	9.403	4	2.351	4.658	.022
Solubility	Between	21.349	4	5.337	72.126	.000
Taste in mouth	Between	15.049	4	3.762	27.529	.000
Acceptance of cheese	Between	13.723	4	3.431	8.506	.003
Appearance	Between	6.489	4	1.622	42.693	.000

8.2. Supplementary Figures

Appendix Figure 1.*Magadoo*(Black Salt) Appendix Figure 2. Bookee (White Salt)

Appendix Figure 3. *Chabbii* (*Smoky Quartz*)

Appendix Figure 4. Browsing Camel

Appendix Figure 4.Cheese Made from 50% camel milk +50%cow milk

Appendix Figure 5. Cheese from 100% camel milk

Appendix Figure 6. 75% cow milk plus 25% camel milk

Appendix Figure 7. 75% camel plus 25% cow milk

8.3. Publication Articles

1.Camel Milk Handling, Processing, And Utilization In Selected Districts Of Borena, East Guji, And West Guji Zone.‖ *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS),* 16(1), 2023, pp. 01-13.

Abebe Gemechu, Balako Gumi, Sisay Girma, Zelalem Ayana, Gebeyehu Goshu

2. Efficiency of Cheese Making from Camel Milk by Blending with Cow Milk at Different Proportion**.** *Asian Journal of Research in Animal and Veterinary Sciences. Volume 11, Issue 2, Page 135-143, 2023; Article no.AJRAVS.96450*

8.4. QUESTIONNAIRES

Remainder to enumerators

1. Make brief introduction to each household/respondents/ before starting any question, get introduced to the farmers/pastoralists/ get his name, tell him yours, the institution you are working for, and make clear the purpose and objectives of your question.

2. Ask each question so clearly and patiently until the farmer/pastoralist/ understands.

3. Fill up the questionnaire according to the farmers /pastoralists/ replay (do not put your opinion).

4. Try not to use technical terms while discussing with farmers/pastoralists/ and do not forget the local unit.

5. Describe the question to the farmers/pastoralists/ in clear and understandable way by using local languages

Enumerator's

name_______________________________Signature___________Date_________

Part One: Back Ground of Individual Household

1.1. Name of interviewed household------------------------, Sex-----, Age--------years

1.2. Zone -------------District------------------Kebele------------Ethnics group------------

1.3. Level of education of the interviewed household (encircle one)

Level	Illiterate	Basic Education	Elementary School	High School	University/collage	Religious Education
Mark						

1.4. Religion:

a) Christian Orthodox ☐ b) ☐ Protestant ☐ C) Muslim ☐ d) W☐fata e) Other

1.5. Family size (including the head of the household) under different age category:

Age category		≤5 years	5-15 years	15-64 years	> 64 years	Total
Sex	Male					
	Female					
Total						

1.6. Economic Sources

(a) Farm☐ (b) Pas☐alist (c) Both farmer☐d pasto☐ist (d) other

Part two: Dairy Production and Processing

2.1. What types of livestock have you been used for milk production

a) Cat☐ b) C☐el ☐ Sheep ☐ d) ☐at f) all

2.2. If your answer is **'all'** rank based on the milk produced and utilized for your families

Types of	Cattle	Camel	Sheep	Goat	Others(if there)

livestock					
Rank					

2.3. If your first choice is **camel** for how many long of time you have been kept?

a) one year ☐ b) two years ☐ c) three years ☐ d) four years ☐ e) five and above

2.4. Fill Up The Production Status of Camel As Follow:

Categories	Lactation length (months)	Caving interval(years)	Milk Yield (liter)		Milking time
			Per a day	Per lactation	Per a day

2.5. In Which Season You Have Get High Milk Yield

(i) **Kiremt(**Summer) ☐ (ii)**Bega(**Winter) ☐ (iii) ☐ **Tseday (**Spring) ☐ (iV) **Belg (**Autumn)

2.6. For what purpose you have been kept camel rather than milk

(i) For Meat_____(ii) Transport_____ (iii) Pack_________

2.7. Could You Process The Camel Milk In to **Yoghur**t, **Butter**, and **Cheese**?

a) Yes ☐ b) No ☐

2.8. If Your Answer is **Yes**, Write the Steps You Have Used to Manufactured These Products

a)Yoghurt	**b) Butter**	**c) Cheese**
Steps ---------------------------------- ---------------------------------- ---------------------------------- ---------------------------------- ---------------------------------- ---------	**Steps** -------------------------------- -------------------------------- -------------------------------- -------------------------------- -------------------------------- ------------	**Steps** -- -- -- -- -------------------

2.9. Could you used different initiative ingredients/spices/ to process the milk

A. yes B. No

2.10. If your answer is **yes**, from where you have gone these ingredients/spices/

a) From locally available material   b) commercial

2.11. If your choice is **'a''**, list it with specific name and steps of processing

a------------------------------b----------------------------c----------------------------d-------------------

Steps:____

____

____

2.12. What is the role you expect from these ingredients/spices/ in milk processing?

a_________________________b_________________________c________________________

2.13**.** Is there any new technology that has been practiced in camel milk processing in your area? If there explain it____

____

2.14. What kinds of machine/materials/ can be used to implement the processing activities?

a) Commercial churner b) Cream Separator c) clay pot traditional materials

2.15. For what purpose you can process camel milk?

a) for home consumption b) for selling c) for preservation

Part Three: Camel Dairy Management

3.1. Who milk the camel?

a) Wife b) Husband c) Daughter d) Son

3.2. At what time the milking practices has been taken place

a) At morning b) after noon c) Just at middle of a day d) others

3.3. List the kinds of equipment you can used for camel milking and storages

a________________________b______________________c_____________d___________

3.4. How do you have kept the camel milk and its products for a long periods of time?

a) By using the preservative spices /agents/ c) By keeping it in refrigerator

b) By heat treating/ pasteurizing / d) Other methods

3.5. Where do you keep the camel at night?

a) In open shade near to home b) In fenced area near to home

c) In confined house d) others

3.6. How to manage the camel in terms of feeding and watering

a) Free ranging/browsing/ b) keeping at feedlot

c) Free ranging and supplementing with some agro-industrial byproducts

d) Drinking at home by using water trough

e) Drinking water by traveling along distances to water sources

3.7. List any treatment you have made for camel

a) During dry period

- .____
- ____
- ____

b) During pregnancy and lactation periods

- ____
- ____
- ____

3.8. What are the main constraints of processing camel milk into byproducts? List if there:

a)________________________b)_________________________c)____________d)__________

Secondary Data

1. Total Camel population of the Zone___________

2.Trends of camel population

A) (Zone) 2009__________2010___________2011___________2012__________

B) (Liban districts) 2009_________2010________2011_________2012_________