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Camel Milk Handling, Processing, And Utilization In Selected Districts Of Borena, East Guji, And West Guji Zone.

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Abstract
The goal of the current study was to assess how camel milk was handled, processed, and used in a few Borena, East Guji, and West Guji Zone areas. 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 people 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) were observed with marginally significant (P<0.05) differences among districts. 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. Therefore, additional research should be needed to close the processing gap in the communities.

Keyword*: Milk Processing; Preservation; handling; camel milk production*

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I. Introduction

According to statistics on live animals, there are 35,500 million camels in the globe (Faye, 2020), with the majority living in Somalia, Sudan, Niger, Kenya, Chad, Ethiopia, Mali, Mauritania, and Pakistan. There are roughly 2.4 million camels in Ethiopia, and the majority of them are kept in the nation's southern pastoral regions(FAO, 2016). Camels are classified into two distinct species that belong to the genus Camelus and are found in the vast pastoral areas of Africa and Asia. The Bactrian camel (two-humped) likes to live in temperate climates, while Dromedary camels (one-humped) primarily inhabit dry desert regions. More than 80% of camels live in Africa, with 60% of them in the eastern African nations of Sudan, Somalia, Ethiopia, and Kenya, which are significant dromedary camel exporters to the Arabian Peninsula and Egypt (Faye, 2015).

The main resource in the majority of pastoral and agro-pastoral communities is livestock. However, in dry and semi-arid regions of the country, the extreme climate variation has had a substantial impact on animal production and productivity(Habte *et al.*, 2022a). Currently, the prevalence of drought in the country's dry pastoral regions, particularly in the targeted pastoral areas of Borena and Guji Zones, is having an impact on the production of cattle raised in accordance with custom (Bogale and Erena, 2022). But unlike other livestock species, camels are remarkable creatures that can endure these challenging environmental circumstance (Habte *et al*., 2022b). Therefore, the less resilient (but more marketable) cattle and sheep in Ethiopia's lowland pastoral settlements, such as Borena and both Guji, are being replaced by the more resilient camels and goats, in keeping

with the tried-and-true adaption approach (Pantuliano and Wekesa, 2008). To adjust to less dependable water supplies and recurrent drought outbreaks, several pastoral regions in the Borena region that have not historically raised camels are now doing so. Compared to camels and goats, cattle exhibit lower levels of thirst tolerance and greater susceptibility to infectious illnesses (Yosef *et al.*, 2013). Due to the bush's unsuitability for other types of livestock due to its thorny characteristics, as well as the annual development of bush encroachment in pastoral areas like the Borena and Guji Zones, camels have attracted a lot of attention.

Many pastoralist communities in Ethiopia assert that processing camel milk to produce butter, yogurt, and cheese is challenging, with the exception of some traditionally fermented camel products (Lumadede *et al*., 2010). This is so that the fat in camel milk, which is tightly bonded to the protein, does not naturally have a propensity to cream up. On the other hand, there are updated camel dairy processing facilities that can create a variety of camel milk products nowadays in various regions of the world (Konuspayeva and Faye, 2021a). According to a particular study, camel milk was converted into butter with lower productivity and longer churning durations than cow and goat milk(Asres *et al*., 2016), and camel milk has a higher whey protein to casein ratio than bovine milk, which results in a soft, quickly digestible curd in the digestive tract (Shamsia, 2009). According to certain studies, it is possible to still use old-fashioned techniques to make fermented camel milk (Dhanaan) in the Somali region, Ittitu in Kereyu, Suusac in Kenya, and Garris in Somalia (Lumadede *et al*., 2010),and (Farah *et al*., 2007). Despite the pastoral community's assertion that processing camel milk is difficult, several investigations suggest that there may be camel milk processing goods (Konuspayeva and Faye, 2021b). However, employing the same technology to produce cheese, yogurt, and butter from camel milk as they do from dairy products made from cow's milk might lead to processing issues and lower-quality goods (Berhe *et al*., 2017).

For the Borana and Guji people of several ethnic groups in the zones, camel milk is a major food. They have been utilized for selling fermented and raw milk in addition to for use in the home (Gebissa, 2015). 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, they used various indigenous knowledge to convert the camel milk into sour milk known as *chuuche*e and butter in a minimal way. 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. Little is known about traditional camel milk processing, usage, preservation, management, handling, and difficulties to processing camel milk, despite the significant contribution of camel milk to the pastoral and agro-pastoral populations of Borena and Guji. The purpose of the current study is to fill the knowledge gap regarding camel milk handling, processing, and preservation, as well as the difficulties associated with current camel milk processing techniques and the use of camel milk and its byproducts.

II. Material And Methods

Description of the Study Area

The Borana, East Guji, and West Guji administrative zones of Ethiopia's Oromia Regional State were the sites of the study. The research areas are situated in the southern portion of the region, near the borders with Kenya, Gedeo, Sidama Region, Somali Region, and Bale Zone (between 3°26' and 6°32'North latitude and 5°26' and 5°52'East longitude). The zones are located between 7,000 and 3,500 meters above sea level (CSA, 2018). Yabello, Nagele Borana, and Bule Hora are the capital cities of their respective Zones. It is located 467–567 kilometers south of Addis Abeba. The region is renowned for its historic Gada system, an intricate sociopolitical structure that governs the strategic interests that are reflected in every aspect of Borana, Guji and its surrounding communities. The zones are made up of three types of terrain: dega, mid-highland, and lowland. According to the zonal Administration's (2018) report, the semiarid lowlands are primarily flat, covered in bushes and shrubs, and have a mixed savanna ecosystem with perennial grasses (*Cenchrus, Pennisetum*, and *Chrysopogon spp*.) and woody plants as their dominant plant species (*Acacia and Commiphora spp*.). There are two different seasons of rainy weather, making the rainfall pattern bimodal. December to February and, to a lesser extent, June to July are the dry months. The research areas' mean annual average rainfall ranged from 600 mm to 1250 mm, with 1250 mm being the highest. The highest recorded temperature was 22.8°C, while the lowest mean average temperature was 15°C. Wheat, barley, enset, and maize are the principal crops farmed.

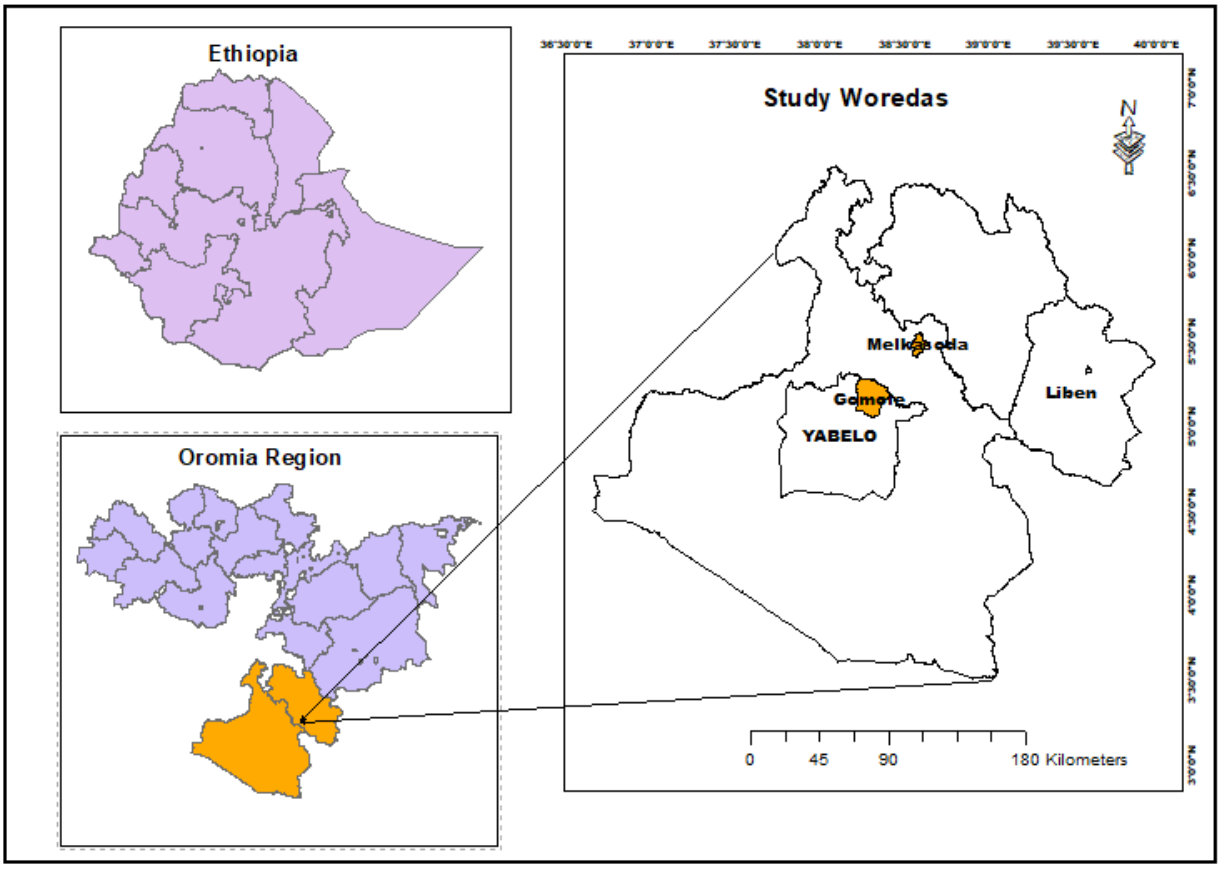

Figure 1. Map of the study area

Data Collection

The initial survey carried out to obtain data pertinent to the study primarily gave a general impression of the area. Using purposive sampling techniques, four districts—Gomole and Yabello (Boranaa Zone), Malka Soda (West Guji), and Liban (East Guji)—were chosen for this study due on their potential for camel production and socioeconomic significance. Two kebeles were chosen at random from each District to collect data at the household level. There were 160 camel-owning households in total, and using straightforward random sample methods, 40 of them from each district were chosen. The sample size was calculated using Arsham's algorithm 0.25/(SE)2 (2007). Data on camel milk supply, lactation length, milk processing, handling (management), and consumption, the therapeutic value of camel milk, and restrictions and problems in camel milk processing were gathered using a questionnaire-based survey. To reduce variation brought on the season and lactation phases, values from collective direct observation and household estimates were utilized to calculate camel milk yield. The researcher and enumerators distributed the questionnaire. To help interviewees and enumerators better comprehend the pertinent data, which was provided in both English and the native Afan Oromo language, a questionnaire survey was created.

Before the questionnaire was fully administered, it was pre-tested and tweaked. 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 were all included in the structured questionnaire's content. Elder men and women and people with experience in camel milk production, processing, utilization, and management were chosen from each kebele to participate in focus groups. In order to obtain sufficient breadth and depth of information, this study involved 10–15 focus groups (Hancock *et al.*, 2007)

Methods of Data Analysis

Using SPSS(2011) software ver.20, descriptive statistics were used to assess all variables, including socioeconomic traits, milk yield, lactation duration, calving interval, milk processing, preservation techniques, problems, and constraints in camel milk processing.

III. Result And Discussion

Socio-economic Characteristics of the Respondents

Table1 displayed the respondents' general backgrounds. The majority of respondant (55%) were women, and the remainder (45%) was men. With a maximum of eleven and a minimum of two family members per household, the average family size was 5.43. The total mean household sizes reported by (Befekadu *et al.*, 2018) and (Adebabay, 2009a) and 6.2 and 6.75 respectively in Borena were slightly comparable to the average family sizes observed in this study. However, it is less than the discovered average family size of 7.76 (Worku *et al*., 2014). 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. The average age of the study's questioned respondents was the same as that reported by (Adebabay, 2009b), who found that in the Bure District, the average respondent was 45.08 years old. Household camel ownership varies from one district to the next. The Liban district has the highest mean value of camel ownership per family at 16.8, followed by Gomole with a mean value of 15.1 camels (Table 1). 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 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.

Table 1. Socio-economic characteristics of the respondents

Variables		Districts					Over all	P value
		Liban (N=40)	Gomole (N=40)	Yabello (N=40)	M/Soda (N=40)	Range	mean (N=160)	
Sex	Male	-	-	-	-		72(45%)	
	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)	23-42	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,

About 51.3% of people who responded to the survey were unable to complete their education, whereas just 7.6% of those who reached the secondary and higher education levels in the study areas shared that experience. This finding was consistent with Befekadu *et al*. (2018) .'s estimate that 85.9% of the observed respondents in related study areas did not attend their education. 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. However, education also has a significant impact in the socioeconomic position of the family and the generation of household income, technology adoption, health, and wholeness (Kerealem, 2005).

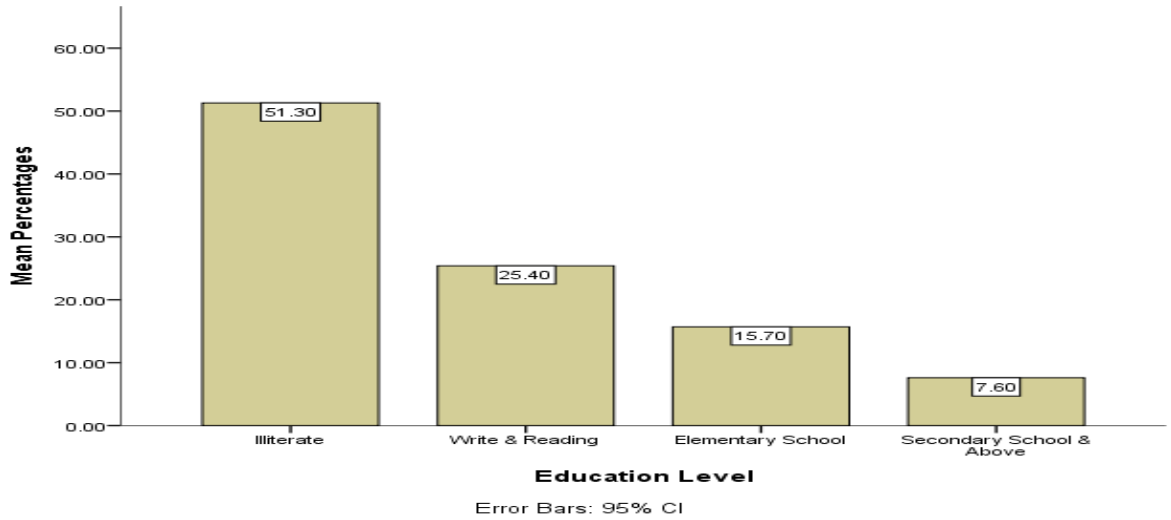

Figure. 2. Education Status of the Respondents

Camel Milk Production

The research area's primary milk animal is the camel, which can withstand environmental changes that result in repeated droughts. In the research areas of Gomole, Malka Soda, Liban, and Yabello, the lactation

length (month) of camels is 12.65, 11.80, 16.20, and 10.80, respectively. While the average length of lactation in the four districts is 12.86 months overall (Table, 2). The Liban District experienced the longest lactation period compared to other districts. This result was consistent with the findings of (Simenew *et al*., 2013). The output of camel milk may differ from one District to another (Table 4). There were 8.9, 6.97, 7.05, and 7.94 liters of camel milk produced daily in the research locations of Gomole, Malka Soda, Liban, and Yabello, respectively. The overall mean values of milk production for the four districts were 7.71L/d. The outcome is comparable to Simenew *et al.*(2013), result's of 6.42-9.92L/d Malka Soda and Yabello districts showed a highly significant difference. This may be a result of the district's varied feed resources that were accessible during lactation times. Two to four times a day was typical for camel milking. Three times milking is more frequently done than other methods, nevertheless. According to the majority of respondents, 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). 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.2. 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
MYPL (L)	8.90±2.32[c]	6.97±1.39[a]	7.05±1.25[a]	7.94±2.57b	4-13	7.71

Notice: M=months, T=time, L=liter, LL=lactation length, CI=calving interval, MF=milking frequency, MYPL=milking yield per lactation

Preservation and Processing Methods of Camel Milk

In the research 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 for milk preservation (Table 3). The results corroborated those of (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. As they ferment camel milk to create sour milk known as *chuuchee*, nearly all of the respondents (94.38%) agreed with the report of the study (Birhanu *et al*., 2021). Milk could be refrigerated for more than two weeks to extend its shelf life. 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 (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). As a starting culture for raw camel milk, soured milk from other species can be utilized (Benkerroum *et al.*, 2011). 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.

Table 3. Preservation and processing of camel milk, N=160

Preservation Methods	Categories	Districts				Overall (N=160)
		Gomole (N=40)	M/soda (N=40)	Liban (N=40)	Yabello (N=40)	
Washing and Smoking Vessels	Yes	40(100)	40(100)	40(100)	40(100)	160(100)
	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						
Chuche (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

The Vessels used for Milking and Storage

Locally known as Sorora (51.25%), Gorfa/Cico (21.8%), Okole (10%), and plastic jug (16.88%), these distinctive camel milking and storing jars have been utilized by pastoral and agricultural communities in Borena and Guji (Figure, 2). 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 ((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).

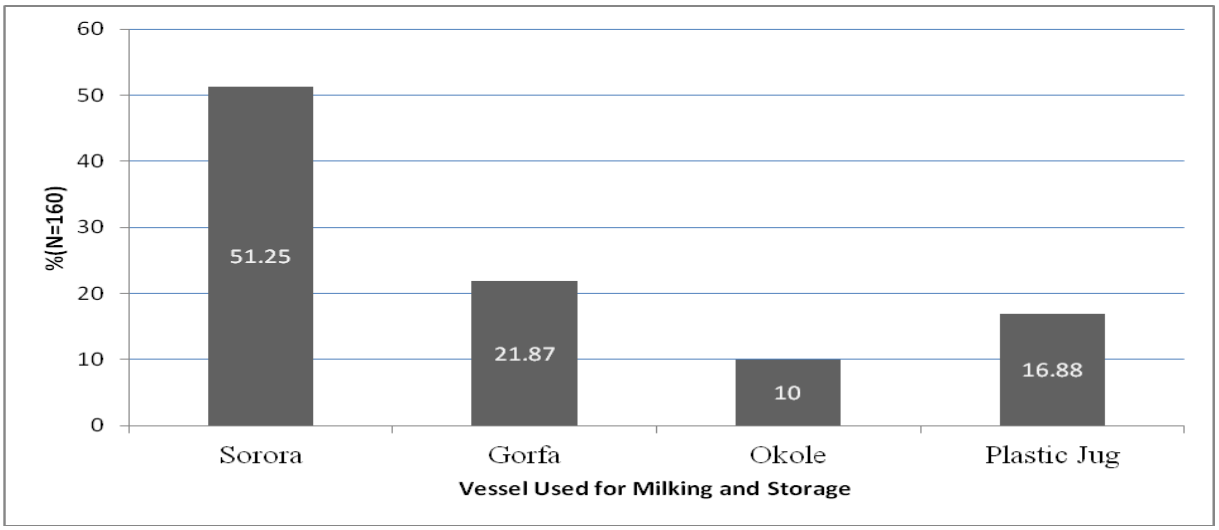

Figure 3. Camel Milking and Milk Storage Vessels

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. Olea Africana (Ejersa), Rhus abyssinica (Xaaxxessa), and Acacia brevispica (Hammaressa) are ranked from one to three depending on 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 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 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)

Table 4. 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

The Shelf Life of Camel Milk

About 43.75% of the respondents were revealed that camel milk could be stay for 24-72hours 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 chilly environment. According to their theories, it can be maintained for 5 to 7 days (6.25%) during the winter with a pleasant product odor (Figure 4). The current conclusion was 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). It was discovered in the current assessment that camel milk has a longer shelf life than other milk kinds because it naturally possesses anti-microbial, protective protein, and other essential features.

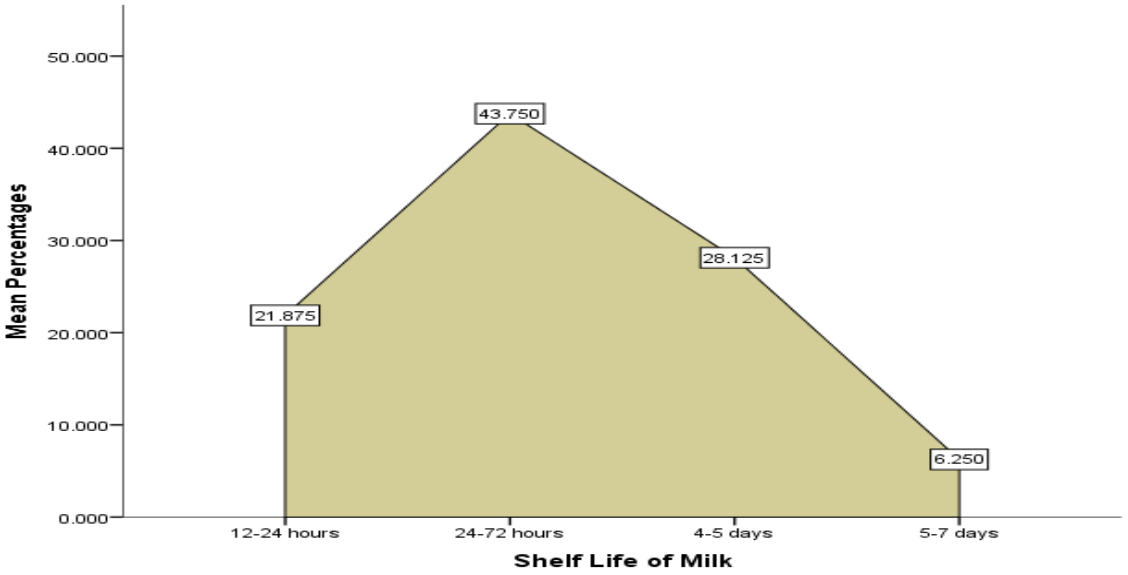

Figure 4. Shelf life of raw camel milk without spoilages

Camel milk Handling and Utilization

Over the entire study area, 69.38 percent of responders 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, were 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 said they preferred drinking tea, while 55.5-66.25% said they preferred drinking *chuuchee* (fermented camel milk). 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, 2007).

Table. 5. 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)
	No	14(35)	13(32.5)	16(40)	18(45)	61(38.13)
Smoking milking vessel	Yes	24(60)	27(67.5)	36(90)	24(60)	111(69.38)
	No	16(40)	13(32.5)	4(10)	16(40)	49(30.63)
Separating lactating camel apart	Yes	25(62.5)	18(45)	17(42.5)	14(35)	74(46.25)
	No	15(37.5)	22(55)	23(57.5)	26(65)	86(53.75)
Keeping with herds	Yes	23(57.5)	36(90)	26(65)	19(47.5)	104(65)
	No	17(42.5)	4(10)	14(35)	21(52.5)	56(35)
Preferences of the respondents						
Raw milk drinking	Yes	2767.5)	24(60)	31(77.5)	24(60)	106(66.25)

	No	13(32.5)	16(40)	9(22.5)	16(40)	54(33.75)
Use as tea	Yes	31(77.5)	27(67.5)	31(77.5)	35(87.5)	124(77.5)
	No	9(22.5)	13(32.5)	9(22.5)	5(12.5)	36(22.5)
Drinkin ng as sour	Yes	21(52.5	22(55)	21(52.5)	24(60)	88(55)
milk (chuuche)	No	19(47.5)	18(45)	19(47.5)	16(40)	72(45)

The Figures out and on the side of parenthesis represent frequency and percentage

Herd structuring management

Production of milk, packaging, and meat are the main reasons why camels are managed in these places. In these specific locations, camel milk is preferred over 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 5). 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, female camels might be divided into two types: *Korti* (more productive) and *Gelleba* (less productive). The findings report of (Gebremichael *et al*., 2019a), which revealed that female camel herds make up more of the structural makeup of Afar camel herds (87.1%), provided support for this study.

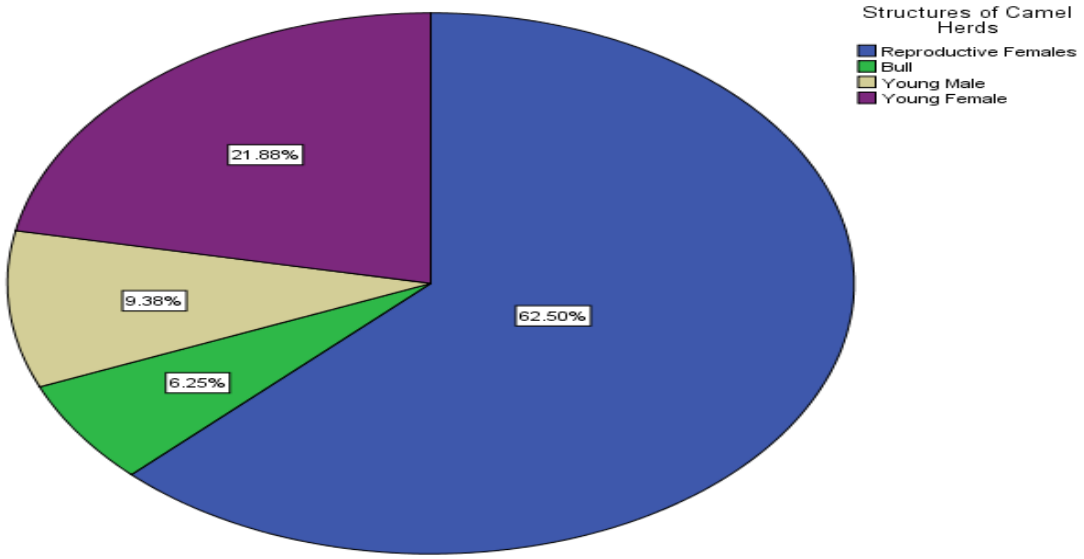

Figure. 5. Structures of camels herds in the area

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 (5). The primary feed sources in the research areas include grass, bushes, and trees for browsing. According to the findings of (Bekele *et al*., 2002) and (Mirkena *et al.*, 2018), several saltbush plants in the family Chenopodiaceae, the forage species are primarily leguminous trees and bushes. 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. Camel also like eating cacti (*Oputia ficus indica*) and different agriculture leftovers, as well as *Euphorbia tirucall*(Aklilu, 2011). 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. It may also be thought to smooth skin and strengthen the fetus bone during the gestation periods of female camel(Gebisa, 2019). 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. 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). 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 5. 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(Faraz *et al*., 2021)

Figure 8. Kraal/Moonaa/

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. 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 current results showed that fermented camel milk (Chuuchee), in contrast to the report of (Birhanu *et al.*, 2021),), has not been sold in all of the study districts (Table 6). 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, 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

Table 6. 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)
	No	6(15)	3(7.5)	1(2.5)	5(12.5)	15(9.38)
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)
	No	30(75)	29(72.5)	37(92.5)	26(65)	122(76.25)
Meddle Trader	Yes	32(80)	33(82.5)	37(92.5)	31(77.5)	133(83.13)
	No	8(20)	7(17.5)	3(7.5)	9(22.5)	27(16.88)
Retailer	Yes	17(42.5)	21(52.5)	4(10)	18(45)	60(37.5)
	NO	23(57.5)	19(47.5)	36(90)	22(55)	100(62.5)
Hotel	Yes	16(40)	9(22.5)	4(10)	9(22.5)	38(23.75)
	No	24(60)	31(77.5)	36(90)	31(77.5)	122(76.25)

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

The Role of Camel milk in human health

Camel milk naturally possesses antimicrobial qualities that protect people from bacteria that spread disease. The locals in the Guji and Borena zones might use camel milk to treat diarrhea, constipation, malaria, heart conditions, and uterine construction (communication). About 73.1% of them believed that camel milk might be used to treat malaria, which is the most common disease with regard to constipation and strength (67.5%). 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 (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 (60.6%) (Table 7), 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, 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*., 2007). 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

Table 7. 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)	7

N= numbers of respondents/householders/

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. 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, was the lack of understanding regarding the introduction of camel milk processing practices (Table 8). 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 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. Low milk yield due to camel diseases was a major worry for pastoralists in Somalia and the Afar Region (Kebede *et al*., 2015) and (Gebremichael *et al.*, 2019b). 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.*, 2002). Lack of conventional milk value addition was partly caused by inadequate infrastructure(Noor *et al.*, 2013).

Table 8. 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

IV. Conclusion And Recommendation

The traditional management method has been used to produce and consume camel milk. The most important methods of preservation include boiling, washing and smoking the vessel, and storing the milk in a cool environment. In this region, camel milk has a longer shelf life than is generally reported. *Chuuchee*, a camel milk product with a small amount of butter added, is the most processed one that is readily available in the areas. It was possible to see the major differences in camel milk yield, calving interval, and lactation length across the study's district. In the current study, camel milk is essential for the food security of pastoral communities. Camels' milk also has therapeutic benefits and can be used to make money. 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, a lack of cooling facilities, and the absence of a formalized market link. Modern camel dairy processing methods and infrastructure should therefore receive special attention. Therefore, modern camel dairy processing techniques and facilities are the points that should be required attention.

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