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INDIGENOUS KNOWLEDGE ON CAMEL MILK AND CAMEL MILK PRODUCTS HYGIENIC HANDLING, PROCESSING AND UTILIZATION IN BORANA AREA, SOUTHERN ETHIOPIA

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Abstract: *The study was conducted to assess traditional camel milk and camel milk products handling, preservation, processing as well as utilization in Borana area. A total of 132 and 24 respondents were selected from milk producer and supply, respectively through purposive sampling technique and interviewed on various aspects of camel milk and camel milk products using a single-visit multiple-subject diagnostic survey. Survey result revealed that the majority of camel dairying was done by women. Result showed hygienic handling of camel milk and milk products of pastoralists and agro-pastoralists was poor. Respondents reported that they preserved camel milk by washing and smoking milk vessels, keeping milk in a cold place and processing into other milk products. All most all respondents use camel milk mainly in its raw state for home consumption. Most of the respondents in the study area traditionally process camel milk into other camel milk products mainly during surplus milk production. Major fermented sour camel milk produced by respondents locally named chuuchee. According to respondents lack of cooling facilities, improper collection center, lack milk collection equipment, market milk selling shed, quick spoilage of milk due to the hot environment, seasonality of milk supply and marketing are the main constraints. Establishment of milk collection centers and introduction of small-scale milk processing plants with market linkage might help to solve camel milk hygienic handling and marketing problem in the area.*

Keywords: Camel milk, hygienic handling, preservation, traditional processing

1. Introduction

One-humped camels (*Camelus dromedarius*) play an important role as a primary source of subsistence in the lowlands of Ethiopia [1]. Due to their characters, camels are often referred to as the 'White gold of the desert' as they can thrive in areas where crop production is limited and other animals cannot withstand the harsh climatic conditions [2, 3]. The majority of these camels are found in the eastern and southern parts of Ethiopia. Because of their outstanding performance in the arid and semi-arid lowland areas of Ethiopia where browse and water are limited, pastoralists rely mainly on camels for their livelihood. In these areas, camel is generally kept for milk production and produce milk for a longer period of time even during the dry season when milk from cattle is scarce. The major ethnic groups owning camels in Ethiopia are the Beja, Rashaida, Afar, Somali and Borana. Camel has a significant contribution to the livelihood of the pastoralist society who have little alternative mode of production system, particularly for milk production [4, 5, 6]. Currently, climate change is influencing traditional cattle productivity in arid and semi-arid areas and the camel is an exceptional animal capable of surviving in the hostile

climatic conditions; as a result, camel is becoming the subject of increasing scientific and commercial interest [7].

Camel milk plays a vital role in household food security, prevention of malnutrition and acts as a source of cash to camel keepers and traders. It is an essential constituent of human diet in many parts of the world as well as in the pastoral and agro-pastoral areas of Borana [8]. It was observed that camel milk has essential nutrients found in bovine milk composition which has valuable nutritional properties; however, it contains a high amount of antibacterial substances, vitamin C, and nutrient than bovine milk [9, 10, 11].

Pastoralists commonly claimed that camel milk is difficult to process into products and is only suitable for drinking as fresh or sour milk [6]. However, currently, the possibility of producing various products from camel milk including soft cheese, yoghurt and butter has been reported [7]. Milk is an ideal medium for the growth of microbes and loses its quality within a short period of time if not preserved in some way. Poor handling and processing practices of milk usually result in undesirable products. Spontaneous nature of milk fermentation process common in arid areas can result in undesirable products that are sometimes even risky or dangerous for human health [12]. Traditional fermented camel milk has different names and processing methods in different countries. It is known as '*Dhanaan'* in eastern Ethiopia [6], *'Ititu'* in Karayu area of Ethiopia [13], '*Suusac'* in Kenya, '*garris'* in Somalia [12] and similarly it is known as 'Chal, and Shubat' in Turkey and Kazakhstan, respectively [14].

Camel milk production is facing high post-harvest quality deterioration and milk is wasted due to spoilage and quantity losses during the rainy seasons when production is high [15]. It is frequently reported that surplus of camel milk is produced in the Borana pastoral and agro-pastoral areas during the rainy season [8]. However, it was not studied in depth, especially regarding on camel milk handling, preservation and processing into different milk products and shelf-life of camel milk and camel milk products as compared to milk of cow under pastoral condition of Borana area.

Camel milk handling practices at producers and collection points, preservation, processing, immediate acceptor, poor infrastructure, unreliable transportation are the major constraints. In Ethiopia, including Borana area, not only at different dairy cooperatives but also in researches, camel milk post-harvest handling and processing have not been given much attention. Camel milk is one of the economically important livestock products to improve the socio-economic status of camel owners, traders and dairy processing cooperatives. Although, despite the important contribution of camel milk to pastoralists living in the lowlands of the Borana area, little is known about the properties, preservation, processing, shelf-life and keeping quality of camel milk at the high ambient temperatures prevailing at the production area. In addition, identifying traditional methods and types of camel milk fermentation is a paramount for camel milk quality improvement and products development.

Currently, climate change is a worldwide phenomenon throughout the world as well as in Borana agro ecological areas. Consequently, this climate change is causing livestock death specially cattle following recurrent drought. Because of this, Borana communities are diversifying their livelihood towards camel dairy production and the demand of camel milk and milk product is also increasing. However, camel dairy production only is not enough to improve the livelihood of the community unless they convert camel milk into diversified milk products to minimize spoilage and postharvest losses, especially during surplus milk product. Therefore, study was designed to address the information gap on handling, preservation, processing and utilization of camel milk and camel milk products.

2. Materials and Methods

2.1. Description of the study area

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The study was conducted in Yabello, Gomole and Moyale districts of Borana zone, southern Oromia, Ethiopia. These districts are located on Addis-Moyale road. The Borana plateau is the portion of the Southern Ethiopia rangelands which its climate is generally semi-arid with annual rainfall range of 500 mm in the South and 700 mm in the North, the altitude ranges from 1000m in the South to 1500m in the Northwest, the rainfall is bimodal but erratic in distribution. Fifty –nine percent (59%) of annual precipitation occurs from March to May and 27% from September to November, annual mean daily temperature varies from 19 to 24^{o}C. There are four major seasons identifies the Borana plateau. These include: (1) - Ganna (March-May), the long rainy season; (2) Adoolessa (June–August), the cool dry season; (3)-Hagayya (September- November), the short rainy season; and (4) Bona (December-February), the warm dry season [16].

2.2. Methods of survey data collection

Survey was conducted to assess traditional camel milk and camel milk products handling, preservation and processing under pastoralists and along milk supply in Borana area. Three well known districts in camel production potential from pastoral area were purposively selected. From each district, milk-supplies at each town of district and two Pastoral Associations (PAs) were selected. The selection of PAs from each district of Yabello, Gomole and Moyale that had good camel production potential were selected again using purposive sampling technique. Households and milk-supplies at each district were selected based on accessibility of the village and willingness of the camel owners and milk-supplies to take part in the interviews. Information about consumption pattern, preference and importance of camel milk, traditional processing and preservation methods, types of fermented camel milk, types of plant used for processing, types of spoilage and shelf life of camel milk and milk products were collected from respondents by means of semi-structured questionnaires.

In order to develop effective interventions, it is necessary to understand what and how pastoralists and milk-supply cooperatives carry out the kind of camel milk and milk products in a given or particular way. Thus, to make use of existing sources of information, both secondary and primary information were used in the study. To collect required information for this study, a combination of different techniques were applied. Secondary information was collected from zone and district offices of pastoral and agro-pastoral. Moreover, relevant literatures and documents were consulted to provide technical background and to develop a basic understanding of how camel milk and milk products handling and processing operated in the study areas.

Handling, preservation, processing and utilization of camel milk and camel milk products under pastoral and along milk-supplies in Borana zone were assessed by using a single-visit multiple-subject diagnostic survey [17]. A total of 132 respondents at production level and 24 respondents at milk-supply were selected for interview using purposive sampling technique.

2.3. Statistical Analyses

The collected survey data through key informants' interview were analyzed using descriptive statistics by using SPSS version 20 software.

3. Result and Discussion

3.1. General information of respondents and camel handling

General information of respondents was indicated in Table 1. Most of the respondents in the study areas were females (67%) and the remaining (33%) were males. Age distribution of respondents were 18-30 (37%), 31-45 (40%), 46-65 (36%) and >65 (19%) years old. Majority of respondents were illiterate 116 (88%); whereas 10.5% and 1.5% were in grade 1-8 and 9-12, respectively (Table 1).

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Table 1. General information of respondents

Sex			Age			Educational level		
	N	%		N	%		N	%
Male	43	33	18-30	37	28	Literate	0	0
Female	89	67	31-45	40	30	Illiterate	116	88
			46-65	36	27	1-8 grade	14	10.5
			>65	19	15	9-12 grade	2	1.5
Total	132	100		132	100		132	100

The survey result revealed that the majority of camel dairying gender division of labor was done by women (Table 2). It was indicated that women are generally responsible for milking (61.5%), processing 81.1%), cleaning milk vessels (85%) and marketing of camel milk (80) where accomplished by women. On the other hand, herding (77%) and barn clearing (51%) were performed by adult men and men (husband), respectively.

Table 2. Gender division in camel dairying responsibility

Household members	Milking N (%)	Processing N (%)	Cleaning N (%)	Selling N (%)	Herding N (%)	Barn clearing N (%)
Adult men	2 (1.5)	0	0	0	102 (77)	60(45.45)
Adult female	34 (26)	25 (18.9)	20 (15)	26 (20)	16 (12)	5 (3.79)
Men	15 (11)	0	0	0	14 (11)	67 (50.76)
Women	81(61.5)	107 (81.1)	112 (85)	106 (80)	0	0
Total	132 (100)	132 (100)	132 (100)	132 (100)	132 (100)	132 (100)

According to respondents, all most all 132 (100%) barn types of camel were fenced. Pastoralists use bush fences that do not have roof by separating different age category of camels. They made separate fence for calves. The purpose of making house for calves separating from young breeding male calves is to get morning milk while it is used to control mating for young breeding male. Result of the survey showed that 70 (53.03%) of respondents cleared their camel barn once a month while 40 (30.30) and 22 (16.67) of them cleared once a week and do not clean other than changing fence, respectively (Table 3).

Table 3. Barn facility and cleaning

Variables	Districts			
	Yabello N (%)	Gomole N (%)	Moyale N (%)	Overall N (%)
Types of barn				
Housed	0	0	0	0
Fenced	45 (34.1)	40 (30.3)	47 (35.6)	132 (100)
No barn	0	0	0	0

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Frequency of barn clearing				
Once a week	13 (9.85)	15 (11.36)	12 (9.10)	40 (30.30)
Once a month	27 (20.45)	20 (15.15)	23 (17.42)	70 (53.03)
Do not clean	5 (2.27)	5 (2.27)	12 (4.01)	22 (16.67)

3.2. Camel production

Scholars stated, originally, Borana communities are known for their indigenous cattle production where they have a long experience and a very strong attachment to cattle rearing. Camel production becomes the most common livestock species where most of the Borana pastoralists were commonly need to have. On the other hand, earlier camel production was, in some case like traditional taboo, exclusive to the Borana except Gabbra people. However, now days the proportion of Borana people keeping camels is increasing, even if it is not in accordance with their indigenous knowledge and habits. As a result, camel populations increased Borana area over the same time [18]

Recently, different factors have been induced suppressor impacts on livestock production system of Borana pastoralists. However, cattle have a priority demand in pastoral areas, now a day the preference of pastoralists have changed especially due to drought. Respondents reported that camel and goat become the most important livestock types more importantly as much as cattle only due to climate change. The most reason behind this priority and purpose of choice to produce camel is for milk production (85%) during dry season, drought resistance (64%), good price (59%), meat production (58%) and wealth status (49%) indicated as in Table 4.

Table 4 Purpose of keeping camel

Variables	N	Valid Percent	Rank
Milk production	112	85	1
Drought resistance	85	64	3
Good price	78	59	2
Meat production	76	58	4
Wealth status	65	49	5

Table 5. Frequency of milking and production potential of camel

Variables	Season				Overall mean
	LDS	LRS	CDS	SRS	
Frequency of milking	N (%)	N (%)	N (%)	N (%)	-
One times	0	0	0	0	-
Two times	132 (100)	51(38.64	132 (100)	63 (47.73	-
Three times	0	81(61.36	0	69 (52.27)	-
Milk yield L/day (Mean ± SD)	3.79±0.76	6.39±1.39	4.04±0.73	6.30±1.47	5.13±1.10
Lactation length (months)					12.01±3.00

LDS = Long dry season, LRS = Long rainy season, CDS = Cool dry season, SRS = short rainy season and SD = standard deviation

In Borana area, southern Ethiopia, pastoralists and agro pastoralists keep mixed livestock species (livestock diversification) each for a particular purpose. The domestic livestock species kept by them for milk production in the study areas include camels, cows, goats and sheep. Among these, cows and camels are the major milk producing animals in the area. Cow milk followed by camel milk was highly preferred by the pastoralists in the study sites. With regard to preference, cow, camel, goat and sheep milk ranked first, second, third and fourth, respectively (Table 6).

According to the respondents view, milk type from each species has its own unique characteristics and properties. Pastoralists and agro-pastoralists gave many reasons for preference of milk types of their domestic animals. They stated that cow milk can be processed into other milk products easily whereas processing of camel milk into other dairy products is difficult. Cows' milk tend to make people fat, that causes obesity but camel milk gives strength, endurance and stamina. Unlike cows' milk, camel milk has medicinal values and can be used to treat a number of aliments in human beings. The informants also indicated that cows' and sheep milk have high fat content than camel milk and thus suitable for butter-making.

In the study area, camel milk is largely consumed in its raw state without being subjected to any sort of processing treatment. All the households interviewed reported that they use camel milk when it is fresh (Table 6). This observation is in agreement with that reported earlier [19, 6] indicated that camel milk is consumed fresh in most camel rearing societies. On the other hand, pastoralists and agro-pastoralists exercised making of fermented camel milk (*chuuchee*) and butter from camel milk alone or by mixing it with cow or goat milk (Table 6).

Table 6. Preference of milk type, consumption and marketing of camel milk

Preference of milk type	**Valid percent**	**Rank**
Cow	46.21	1st
Camel	39.39	2nd
Goat	12.12	3rd
Sheep	2.27	4th
Consumption of camel milk	**N**	**Proportion (%)**
Fresh raw milk	132	100
Chuche (sour milk)	62	49.97
Butter	9	6.87
Blended with other milk type	32	23.48

3.3. Camel milk hygienic handling and processing

3.3.1. Camel milk handling and preservation

The survey result revealed that from the total of 132 respondents 96.97% of them did not take training on camel milk hygienic handling and utilization. Study showed that 68.18% of respondents practiced washing hand before milking (Table 7). In the study area, the majority of respondents (72.73%) use pond water while 12.88% and

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14.39% bore holes and tape water, respectively for camel dairying activities. Study result indicated that almost all pastoralists and agro-pastoralists heat or warm water before milking to wash milking vessels and clean and smoke milk containers regularly before milking. Respondents explained that the purpose of smoking milk vessels is give flavor and increase shelf life (Table 7). The major traditional methods of Borana pastoralists and agro-pastoralists used to preserve camel milk in the study area include washing and smoking milk vessels (57.5%), keeping milk in a cold place (18.94%) and processing (23.48%) into other products particularly chuche (Table 7).

Table 7. Camel milk handling

Variables	Districts			
	Yabello N (%)	**Gomole N (%)**	**Moyale N (%)**	**Overall N (%)**
Previous training on camel milk				
Yes	1 (0.75)	2 (1.52)	1 (0.75)	4 (3.03)
No	44 (33.33)	38 (28.78)	46 (34.85)	128 (96.97)
Washing of hand before milking				
Yes	30 (22.73)	28 (21.21)	32 (24.24)	90 (68.18)
No	15 (11.36)	12 (9.09)	15 (11.36)	42 (31.82)
Source of water for milking activity				
Pond	35 (26.51)	34 (25.76)	27 (20.45)	96 (72.73)
Bores holes	2 (1.52)	6 (4.54)	9 (6.82)	17 (12.88)
Tap water	8 (6.06)	0	11(8.33)	19 (14.39)
Heat water before milking				
Yes	45 (34.09)	29 (21.97)	46 (34.86)	132
Cleaning and smoking milk containers regularly				
Yes	45 (34.09)	40 (30.30)	47(35.61)	132
Purpose of milk vessels smoking				
Give flavor and increase shelf life	45 (34.09)	35 (26.52)	47 (35.61)	132

Table 8. Traditional preservation methods

Traditional preservation methods	**Number and proportion (%) of responses**
Washing and smoking milk vessels	76 (57.58)
Keeping milk in a cold place	25 (18.94)
Processing (*Chuuchee*)	31(23.48)

As indicated in figure 1, based on households interviewed, the four most frequently used plant for smoking milk vessels in the study area were *Premnaschimperi* (Xaaxessaa), *Olea Africana* (*Ejersa*), *Acacia brevispica*

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(*Hammaressaa*) and *Faurea speciosa* (*Dansee)*, Smoking milk containers has been reported to exert anti-microbial properties and prolong the shelf life of cow milk [20]. Compounds released from these tree species during smoking of the milk containers may in part be responsible for the longer shelf life of camel milk observed in the present study. Pastoralists and agro-pastoralists in the study area used different milking vessels. Accordingly, 79%, 29%, 21% and 3% of respondents used wood, gorfa, plastic, and okole, respectively for milk vessels (Figure 2). In addition, pastoralists and agro-pastoralists also used garican (89.4%) and sororo (10.6%) vessels for shipping milk to market (Figure 3).

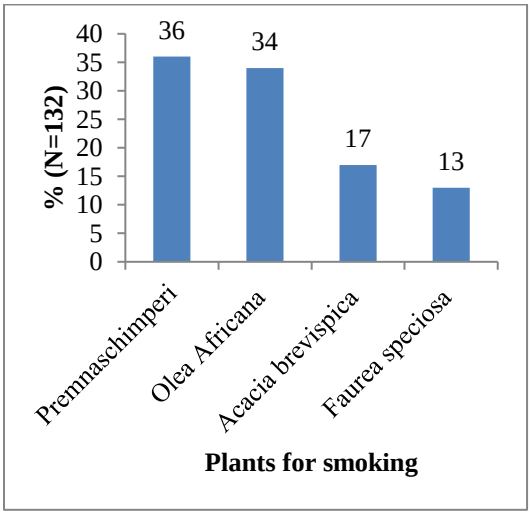

Figure 1. Mostly used plants for smoking

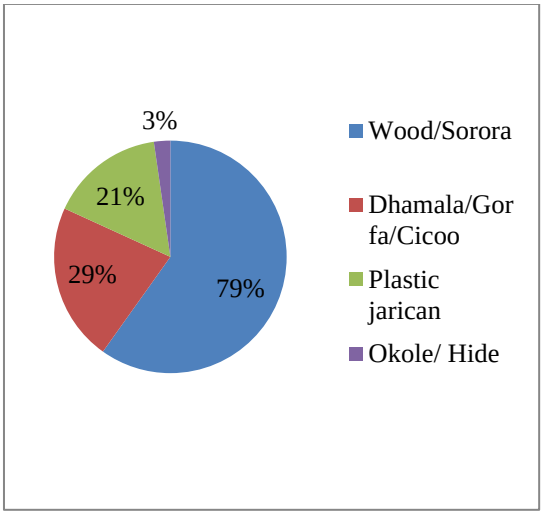

Figure 2. Types of milking vessels

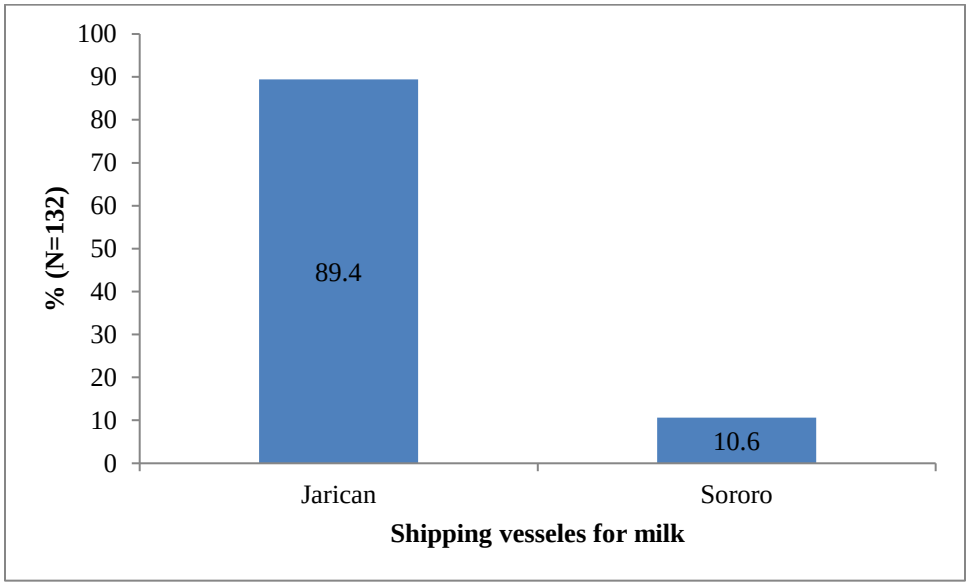

Figure 3. Types of vessels for shipping milk to market

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3.3.2. Traditional camel milk processing and utilization

The survey result shows that all most all respondent use raw milk for home consumption in the study area. The majority (80.30%) of respondents did no boil milk before consumption. Most of pastoralists and agro-pastoralists (77.27%) in the study area traditionally process camel milk into other camel milk products mainly during surplus milk production (Table 9). Camel milk products that are traditionally made by pastoralists and agro-pastoralists in the study area are indicated in Table 9. Pastoralists and agropastoralists in the study area produce naturally fermented sour camel milk called *chuuchee*. *Chuuchee* is made by placing fresh camel milk in a clean/smoked container and keeping it in a warm (ambient temperature) to allow spontaneous fermentation. *Chuuchee* is said to have a shelf life of about 3 months. Similar products like *dhanaan*, *shubat* and *gariss* are traditionally made from camel milk were reported from Ethiopia Somali [6], Kenya (21), and Sudan [19], respectively.

Chuuchee is made by spontaneous fermentation without using a starter culture. Some respondents stated that they mix camel milk with goat milk to make viscous *chuuchee* than alone make it from camel milk. Research report showed that the quality of *susac*, fermented camel milk, improved using selected mesophilic lactic starter cultures rather than spontaneous fermentation; the resulting fermented milk had a uniform taste and a longer shelf life [22]. Isolation and identification of microorganisms that are responsible for the fermentation and production of the indigenous fermented camel milk product, *chuuchee*, would help to develop a commercial starter culture and to standardize the manufacturing method for this product in the future.

The majority of the respondents reported that it is difficult to make butter from camel milk. However, small proportion of pastoralists and agro-pastoralists reported that they mix camel milk with cows and goats milk when intentional to make butter (Table 9). Few respondents revealed that butter can be made from camel milk when fermentation is undergone for 7 days. Production of butter from camel milk cannot be achieved easily because camel milk shows little tendency to cream up and also because the fat in camel milk is firmly bound to the protein [23]. Factors that affect manufacture of butter and optimization of churning and cream separation processes from camel milk may help alleviate the difficulty of butter-making from camel milk.

Table 9. Camel milk processing

Variables	Districts			
	Yabello N (%)	Gomole N (%)	Moyale N (%)	Overall N (%)
Use raw milk for home consumption				
Yes	45 (34.09)	40 (30.30)	47 (35.61)	132 (100%)
Boil milk before consumption				
Yes	3 (2.27)	11(8.33)	12 (9.09)	26 (19.70)
No	42 (31.82)	29 (21.97)	35 (26.52)	106 (80.30)

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Camel milk processing				
Yes	29 (21.97)	32 (24.24)	41(31.06)	102 (77.27
No	16 (12.12)	8 (6.06)	6 (4.55)	30 (22.73)
Type of camel milk products processed				
Chuche	10 (7.58)	13 (9.85)	39 (29.55)	62 (46.97)
Butter	2 (1.52)	4 (3.03)	3 (2.27)	9 (6.82)
Blending	15 (11.36)	14 (10.61)	2 (1.52)	31(23.48)

3.4. Camel milk marketing

Apart from its food value, pastoralists and agro-pastoralists generate income from sale of camel milk. Almost all respondents 132 (100%) reported that they sale camel milk to generate income. There are no cooling facilities in the market of study area. Survey result indicated that 75 (56.82) and 73 (55.30) of respondents reported there were spoilage of raw milk due to market problem and problem of marketing fresh milk, respectively (Table 10). Pastoralists and agro-pastoralists sale their camel milk to individuals (44 (33.33%)), retailers (72 (54.55%)) and hotel/cafeteria (16 (12.12%)). Study result revealed that 120 (90.91%) of respondents buyers did not put milk quality criteria; whereas 12 (9.09%) gave attention on quality milk for buying (Table 10). All the households interviewed in the present study reported that they sale camel milk implies that camel milk has high demand in the market. Even though, camel milk has high demand in the area, camel milk marketing is constrained by price fluctuation, cooling facilities and well-organized transportation and marketing systems.

Table 10. Camel milk marketing

	Districts			
Variable	**Yabello N (%)**	**Gomole N (%)**	**Moyale N (%)**	**Overall N (%)**
Sell fresh whole milk				
Yes	45 (34.09)	40 (30.30)	47 (35.61)	132
Cooling at market				
No	45 (34.09)	40 (30.30)	47 (35.61)	132
Problem of marketing fresh milk				
Yes	24 (18.18)	20 (15.15)	31(23.48)	75 (56.82)
No	21(15.91)	20 (15.15)	16 (12.12)	57 (43.18)
Spoilage of raw milk due to market problem				
Yes	21 (15.91)	22 (16.67)	30 (22.73)	73 (55.30)

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No	44 (33.33)	18 (13.64)	17 (12.88)	79 (59.85)
For whom do you sale your fresh milk				
Individuals	12	15 (11.36)	17 (12.88)	44 (33.33)
Retailers	33 (25)	19 (14.39)	20 (15.15)	72 (54.55)
Hotel/Cafeteria	0	6 (4.55)	10 (7.58)	16 (12.12)
Buyers put quality criteria				
Yes	5 (3.79)	3 (2.27)	4 (3.03)	12 (9.09)
No	40 (30.30)	37 (28.03)	43 (32.57)	120 (90.91)

3.5. Camel milk and camel milk products along supply

This particular assessment of camel milk and camel milk products hygienic handling and processing along milk supply covers Yabello, Gomole and Moyale districts of Borana zone with the specific dairy marketing sites of Yabello, Surupa and Moyale towns. The major sources of raw camel milk supply to traders in Gomole district at Surupa are producers and collectors around Surupa. Traders and collectors check quality of milk by using organoleptic test (watching cleanliness and tasting by tongue). It was stated that milk that below the acceptable limit was rejected. There was no quality based standard payment for milk; however, payment was made as market price for acceptable milk by sensory evaluation. As reported by the traders and other key informants in the area; milk quality problem is not much common except slight poor milk handling at producers and collectors as well as camel milk price fluctuation. Collectors and traders clean and fumigate their milk Jericans using water and locally available wood chips to reduce deterioration of milk. There were no transportation access and cooling facilities for raw camel milk. Traders supply collected camel milk from Surupa to Moyale in major volume and also to Bule Hora in small quantity depending on seasonal camel milk production. The main agents of raw camel milk suppler to Yabello town were producers, collectors that encampment around Yabello and some traders from Gomole district. Milk supplied to Yabello is consumed and used in the town without shipping to other area since Yabello is capital city of Borana and has high population than other towns in the study areas.

The terminal milk supply for camel milk and milk products in the study area was Moyale. The main suppliers of milk to Moyale are producers in the nearby Moyale town, traders from different parts of Borana and brokers at Moyale. The problem of camel milk is variation of price of milk and price fluctuates greatly seasonal. During surplus production, at wet season, milk left from selling was changed to other camel milk product *chuuchee* and sold as sour camel milk. As to traders and brokers perception supply of raw camel milk is inadequate during dry season and the problem of supply shortage is severe during and after incidence of drought. Quality problem is also more common during dry than wet season. However, modes of transportation used are the basic causes of quality deterioration as the opinion of traders and brokers. Prior to milk storage, traders and brokers clean their milk Jeri cans with boiled water and then fumigate with locally available wood chips.

According to camel milk collectors, traders and key informants, adulteration and lack of cooling facilities are the major problems of milk quality at milk supply of the study area. Milk and milk products are very susceptible to adulteration. In the study area respondents revealed that camel milk adulteration increases as the product is moved

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to market from areas where closer to the pre-urban and urban centers. May be there is less adulteration at production level. Water is used as substance for milk adulteration. In addition, in the study area, lack milk collection equipment like stainless steel, market milk selling shed, quick spoilage of milk due to hot environment, seasonality of milk supply in which excess supply in wet season and extremely low supply in dry season are the main constraints.

3.6. Shelf life and spoilage of camel milk and milk products

The majority of the respondents reported that fresh camel milk can be kept unspoiled for about 2 days (Table 11). This is much shorter than the shelf life of camel milk reported previously [24, 6] that took 7 days for camel milk to sour. When compared to cow milk, camel milk has longer shelf life than cow milk. The better keeping quality of camel milk suggests that it probably contains compounds or substances with strong anti-microbial properties. The majority of respondents stated that *chuuchee* can stay for a week whereas some of them revealed that *chuuchee* can stay up to 3 months. According to respondents, the shelf life of butter was 1 day. However it can be stay for 7 days if it can be kept in quality. The most common types of spoilage that occur in camel milk include souring, ropiness and whey separation (syneresis), (Table 11). These defects are similar to the types of spoilage that occur in cow milk.

Table 11. Shelf life and spoilage of camel milk and milk products

Product type	**Shelf life (%)**				
Raw milk	1 day (5.30)	2 days (78.79)	3 days (15.91)	-	-
Chuuchee	1 week (50.76)	2 weeks (17.42)	1 month (3.79)	2 months (3.03)	3 months (2.3)
Butter	1 day (4.58)	1 week (2.27)		-	-
Spoilage types	**N (%)**				
Whey separation	20 (15.15)				
Ropiness	30 (22.73)				
Souring	82 (62.12)				

3.7. Therapeutic properties of camel milk

The other benefit of camel milk is its curative value against a number of human diseases. Pastoralists and agro-pastoralists stated that camel milk is used to treat a number of sicknesses in human beings (Table 12). The respondents reported that camel milk is used to treat backbone pain, diarrhea, malaria disease, heart disease, respiratory deceases, and women uterus contracts and shrinks (post delivery). According to the pastoralists and agro-pastoralists prospect, the revealed beneficial property of camel milk is attributed to the fact that camels browse on various plant species and active agents with therapeutic properties from these plant species are secreted into the milk of camels. The medicinal value of camel milk has also been reported by other authors [25, 6].

Table 12. Therapeutic use of camel milk

Type of disease	**N**	**Proportion (%)**
Backbone pain	13	8.33
Diarrhea	11	6.82
Malaria disease	18	12.12
Heart disease	8	4.55
Respiratory deceases	22	15.15

Women uterus contracts and shrinks (*abdominal pain)*	24	16.67
Missed (had no knowledge)	48	36.36

4. Conclusion and recommendation

The hygienic practice during camel milk production in the study area was poor and camel milk handling practices were also susceptible for contamination. In the study area, the majority of respondents use pond water which is poor in water quality for camel dairying activities. Yet, in the study area most of the respondents did not implement proper hygienic practices except hand washing before milking. The major traditional methods of Borana pastoralists and agro-pastoralists used to preserve camel milk in the study area were practices smoking and washing milking and storage vessels. All most all respondents use raw milk for home consumption in the study area. The majority of respondent did no boil milk before consumption. Most of pastoralists and agro-pastoralists in the study area traditionally process camel milk into sour camel milk *chuuchee* and other camel milk products mainly during surplus milk production. According to camel milk traders and key informants, adulteration and lack of cooling facilities are the major problems of milk quality at milk supply of the study area. In addition, lack milk collection equipment like stainless steel, market milk selling shed, quick spoilage of milk due to hot environment, seasonality of milk supply in which excess supply in wet season and extremely low supply in dry season are the main constraints.

Pastoralists and agro-pastoralists generate income from sale of camel milk apart from its food value. Almost all respondents reported that they sale camel milk to generate income. All the households interviewed in the present study reported that they sale camel milk implies that camel milk has high demand in the market. Although camel milk has high demand in the area, camel milk marketing is constrained by price fluctuation, cooling facilities and well-organized transportation and marketing systems. The high ambient temperature prevailing in the area which coupled with lack of cooling facilities reduces the shelf life of the milk and thus makes delivery of raw camel milk to the market difficult. Awareness creation for camel dairy value chain actors on camel dairy production, handling, processing and establishment of milk collection centers as well as introduction of small-scale milk processing plants might help to solve the marketing problem of camel milk in the area.

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