Original Research

EAST AFRICAN JOURNAL OF PASTORALISM

Volume 3 Issue 2

Utilization, Post-Harvest Handling and Hygienic Practices of Goat Milk in Dollo Zone, Somali Regional State, Ethiopia

Mahamed Hassen[a,*], Kawnin Abdimahad[b], Abdi Abdilahi[c] and Abdihakim Ma'alin[d]

[a]Department of Animal and Range Sciences, College of Dryland Agriculture, Jigjiga University
[b]Department of Animal and Range Sciences, College of Dryland Agriculture, Jigjiga University
[c]Department of Animal and Range Sciences, College of Dryland Agriculture, Jigjiga University
[d]Department of Animal and Range Sciences, College of Dryland Agriculture, Jigjiga University

ABSTRACT

A cross-sectional study was conducted in Dollo zone of Somali Region, Ethiopia, to assess handling and hygienic practices associated with goat milk production. 156 households were purposefully selected using a stratified sampling method. Data were gathered through questionnaires, key informant interviews, and focus group discussions. The majority of sampled households were illiterate. Goats were typically housed in open kraals made of thorny acacia trees with earthen floors and no roofs. Milking was done inside these kraals, sometimes resulting in contamination from muck and animal dung. Most respondents did not wash their hands or the udders of the goats before milking, indicating a lack of awareness about sanitary milk production practices. Plastic equipment, which is challenging to clean and have potential to contribute to milk contamination, was frequently employed. Only 78.2% of households in Warder and 65.1% in Galladi districts cleaned their milk vessels regularly. Smoking milk-handling equipment with plant species such as Acacia ethaica, Blanites galabra, and Solanum Carense was a common practice aimed at extending shelf life and improving the flavor and aroma. The main challenges identified in ensuring hygienic goat milk production were poor barn hygiene, inadequate production procedures, diseases, access to clean water for washing, and a lack of extension services. Overall, the study concluded that handling and hygiene practices associated with goat milk production in the area were unsatisfactory, primarily due to the community's low awareness and knowledge, as well as inadequate infrastructure support. The study recommends prioritizing improvement in hygienic practices through various development interventions, including raising awareness among milk producers, improving goat health, and providing necessary resources for milk handling.

Key Words: Goat milk, Hygienic practices, Post-harvest handling, Utilization

1. Introduction

A vital component of human nutrition worldwide, milk is the lacteal secretion of a mammal's mammary glands and aids in the development and upkeep of bodily tissue (Grimaud et al., 2009). Compared to camel milk, goat milk has a higher medicinal value and is used to treat a variety of infectious and non-infectious diseases, particularly in lowland areas of developing nations (Zenebe et al., 2014). According to (Smith J and R, 2020), goat milk's distinct alkalinity and larger buffering capacity make it a better option for treating stomach ulcers. Higher concentrations of important buffering elements, including phosphate, nitrogen that isn't a protein, and proteins, are the cause of this benefit. Goat milk fat has a higher concentration of conjugated linoleic acid, which has anti-carcinogenic and anti-atherogenic properties, and medium-chain fatty acids. The amount of monounsaturated and polyunsaturated fatty acids and medium chain triglycerides in goat milk is higher than in cow's milk. These nutrients are all recognized to be good for human health, particularly in preventing cardiovascular problems (El-Agamy, 2007).

(B and K, 2008) stated that the main goals of milk hygiene practices are to prevent diseases from spreading from animals to humans, limit communicable diseases spreading from humans to humans, to prevent physical defects or diseases that may result from malnutrition, and to improve the nutritional status of all people, including mothers, infants, and children. Furthermore, milking must always be done in accordance with excellent hygienic practice in order to assure good quality and safeguard the consumers' health (Lore et al., 2006). Goat milk is an excellent growing medium for a large variety of bacteria, while having strong nutritional and therapeutic value; as a result, it contains a wide spectrum of spoilage and pathogenic microorganisms (Azeze et al., 2015). In addition to causing milk to expire before it reaches its final destination and posing a risk to consumer health, unsanitary production and post harvest

*Corresponding author:Mahamed Hassen: raabi6947@gmail.com

Article Information:
Article Received for review: 15 March 2022
Article Reviewed: 10 May 2022
Revised Comments: 30 August 2022
Accepted for publication: 31 October 2022 Available Online: 31 December 2022
How to Cite this Article:
Mahamed H, Kawnin A, Abdi A, Abdihakim M (2022): Utilization, Post-Harvest Handling and Hygienic Practices of Goat Milk in Dollo Zone, Somali Regional State, Ethiopia East African Journal of Pastoralism, 3(2):28-33.

handling methods expose goat milk to hazardous pathogens (Nanu et al., 2007). Because traditional milk production methods in underdeveloped nations like Ethiopia lack adequate hygienic procedures, there is a significant risk of contamination of milk, notably goat milk, with harmful microbes (Getachew, 2003). In lowland areas, the risk is greatest in pastoral and agro-pastoral areas. This is due to the area's high average temperature, which is exacerbated by a lack of cooling facilities, producers' dispersed location, the distance to markets, and the absence of transportation (Alexopoulos et al., 2011).

Goat milk has the potential to be produced in the Dollo zone, but little is known about the sanitary production, utilization, and handling of goat milk in the Somali Regional State as a whole, and in the Dollo zone in particular. Documented data on hygienic goat milk production and handling procedures must therefore be made available. This is because the government, non-governmental, and other developmental organizations may need this information in order to carry out relevant development interventions. These interventions require milk producers to have an in-depth understanding of the hygienic practices necessary for safe milk production and handling after harvest. Thus, the objective of this study was to evaluate the post-harvest handling, utilization, and hygienic practices related to goat milk in the Dollo zone of the Somali Region.

2. Materials and Methods

2.1. Description of the study Area

This study was conducted in Dollo Zone, which is located in Somali regional state of Ethiopia. Dollo zone shares borders with Somalia to the northeast and southeast, the Jarar Zone to the northwest, and the Korehei Zone to the southwest. Warder serves as the zone's principal administrative center. It is located at approximately 6°58N 45°21E with an elevation of 541 meters above sea level. The area experiences an average annual temperature of 28C. Warder is approximately 537 km away from Jigjiga and 1131 km from Addis Ababa. . The Dollo zone has a total livestock population of about 681,190 cattle, 783,334 sheep, 640,848 goats, 29,147 donkeys, 308,295 camels, and 181 poultry (Agency), 2021).

2.2. Study Design and Sampling Targets

A cross-sectional study was conducted to gather relevant information on, utilization, post-harvest handling and hygienic practices of goat milk in the study area. The sample selection process employed purposive sampling, taking into account the potential of goat milk production and road accessibility, in consultation with livestock experts from the zonal and district bureaus. To achieve the study objectives, purposive sampling was applied to select two districts, which were identified as having significant potential for goat milk production. Six kebeles (three from each district) were purposively selected based on the availability of goat milk as a primary livestock product. Lists of goat milk producer households were obtained from the respective administrations, and subsequently, twenty-six milk producing households from each rural kebele were randomly selected. The sample size of 156 households was determined using a simplified formula provided by (Yamane, 1973), with a confidence interval level of 95%, a variability degree of 0.05, and a precision level of 8%.

$$n = \frac{N}{1 + N(e)^2}$$

Where: n= the sample size N= the total population size of the zone e= is the level of precision

2.3. Data Collection Procedures

This study was applied primary and secondary data sources. Primary data was collected through semi-structured questionnaires, focus group discussions, and key informant interviews involving knowledgeable individuals such as elders, community leaders, and goat milk producers. Each study kebele hosted one focus group discussion with ten participants. Secondary data, on the other hand, was gathered from organizational documents, published research, and local livestock development offices. The study focused on various aspects including household demographics, livestock trends, production systems, hygienic practices in goat milk production, post-harvest handling, utilization patterns, as well as identifying opportunities and challenges related to hygienic and post-harvest handling practices of goat milk.

2.4. Data Analysis

The collected data was analyzed using descriptive statistics such as mean, percentage with the assistance of the SPSS statistical package (version 20). The data related to the purpose of keeping goats and the main constraints on goat milk hygiene were assessed using an index formula. The following model was used for data analysis:

$$Y_{ij} = +a_i + e_{ij}$$

Where, = the overall mean, a_i = production system (i = 1, 2, pastoral & agro-pastoral), $e_i j$ = error

3. Results and Discussion

3.1. Results

3.1.1. Household Characteristics

Table 1 shows the demographic characteristics of the sampled households, including their sex, age, educational status, and family size. The majority of respondents were male, constituting 78.8% of the sample, while females made up the remaining 21.2%. The average age of respondents ranged between 30 to 40 years, accounting for 59% of the total, followed by the 40 to 50 age group, which represented 17.9%. Furthermore, the study revealed that a high number of respondents (85.2%) were illiterate. This high level of illiteracy aligns with the findings of **(Yasin et al.,2018)**, who also noted a similar prevalence of illiteracy in Eastern Ethiopia. Education plays a significant role in influencing

Table 1: Sex, age, educational level and family size of the respondents (%)

Variables	Study locations			
	Category	Warder	Galladi	Overall
Sex	Male	23.1	19.2	21.2
	Female	76.9	80.8	78.8
Age (year)	<30	6.4	14.1	10.2
	30-40	44.8	73	59
	40-50	25.6	10.3	17.9
	>50	21.7	2.6	12.1
Education level	Illiterate	78.2	92.3	85.2
	Primary grades	6.4	0	3.2
	Junior grades	3.8	0	2
	Religious School	11.5	7.7	9.6
Family size (Mean+SE)		7.21±1.32a	6.37±1.98b	6.79±1.65

Means in the same column are significantly different at ($P < 0.05$), SE = Standard Error.

various aspects of household well-being, including income, technology adoption, demographics, health, and overall socioeconomic status (Ejigu et al., 2009). Additionally, insufficient education and training regarding hygienic milk production and postharvest handling practices can leave raw milk vulnerable to microbial contamination (Omore et al., 2005). The average family size across the districts was found to be 6.79 ± 1.6 (Table1.), which aligns with the findings of (Abdi M and A, 2018) who reported an average family size of 6.7 ± 1.8 in Dollo Zone of Somali region, Ethiopia.

3.1.2. Purpose of Goat Keeping

The purposes of goat keeping in the study area are presented in Table 2. The primary purpose of goat keeping in the study area was for milk production. The second main reason of goat keeping in the study area was for meat production. This aligns with the findings of (Mengestie et. al., 2010) and Fsahatsion et al., 2013).Income generation through sell of live animals and the cash obtained might be used to buy food, clothes and other family needs was ranked as third purpose of goat keeping in the study area.

Water Sources Used for Hygienic Practices In the Warder District, 49.3% of respondents used water from wells for their hygienic practices. Conversely, in the Galladi District, 39.1% of respondents relied on pond water for similar purposes, as detailed in Figure 1. This finding is consistent with research by **(Bereda et. al.,2013)**, which reported that a majority (64.4%) of people in the Ezha District, Ethiopia, used non-tap water sources for their hygiene needs. The significant reliance on non-tap water sources, such as wells and ponds, highlights a critical issue in these regions: the shortage of reliable and clean water infrastructure. In areas like Warder and Galladi, the availability of tap water is limited, forcing residents to depend on less reliable sources that may not always meet hygiene standards. This shortage poses a significant constraint, impacting the overall health and sanitation practices of the communities **(Bereda et al., 2013)**.

Housing and Cleaning Practices In the study area, all participants housed their goats in separate open kraals

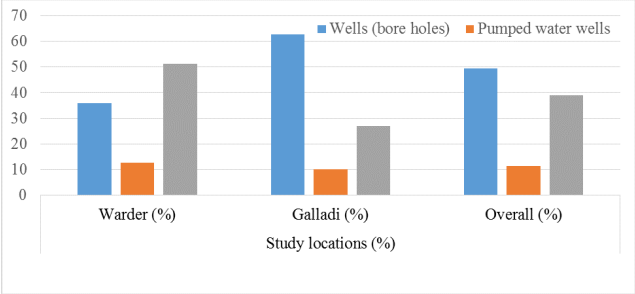

Figure 1: Sources of water in the study area (%)

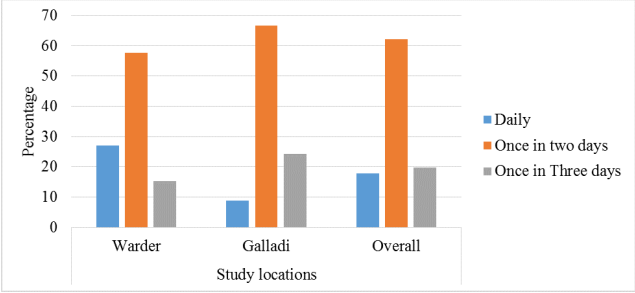

Figure 2: Cleaning frequency of goat house in the study area

surrounded by thorned acacia trees, serving as protection against predators, harsh nighttime weather, theft, and aiding in husbandry practices. This finding is consistent with the research conducted by (Fikru and Omer, 2015) in the Awbare district and by (Legese et al., 2014) in the Shinile district, which also observed similar housing practices. The primary purposes of goat housing were to safeguard them from predators and extreme nighttime weather, prevent theft, and facilitate husbandry activities. The majority of respondents (62.1%) cleaned the goat houses (kraals) every two days, while 19.8% and 17.9% cleaned them every three days and daily, respectively, according to Figure 2. This finding aligns with (Ahmed et al., 2022) study, where 55.8% of respondents cleaned goat houses (kraals) every two days. However, it was noted in the study that all observed kraals lacked roofs, were built on earth floors with poor drainage, and were challenging to clean, often becoming contaminated with mud and urine, especially during rainy seasons. Consequently, this led to the soiling of teats, udders, flanks, and other body parts of milking goats while they rested in muddy kraals, resulting in microbial contamination of milk during milking, particularly when teats and udders were inadequately cleaned beforehand.

3.1.3. Milking and Hygienic Practices During Milking

All individuals in the study area were seen milking their goats in open kraals without roofs or walls, posing a risk of milk contamination with debris and animal waste, especially during rainy seasons, which could result in spoilage. Surprisingly, none of the participants practiced udder washing

Table 2: Purposes of keeping goat in the study area as ranked by the respondents

Purpose	Study locations											
	Warder						Galladi					
	R1	R2	R3	R4	R5	Index	R1	R2	R3	R4	R5	Index
Milk	27	15	9	5	0	0.27	26	14	9	5	0	0.26
Meat	15	16	12	4	5	0.25	6	22	11	8	3	0.24
Income	8	11	19	4	6	0.23	3	11	14	12	6	0.22
Social Cultural	0	5	8	14	9	0.17	2	4	7	13	12	0.18
Rituals	0	0	4	5	6	0.07	0	0	4	6	8	0.09

Index= [(5 for rank 1) + (4 for rank 2) + (3 for rank 3) + (2 for rank 4) + (1 for rank 5)] divided by the sum of all weighed purposes of camel keeping mentioned by the respondents, R=Rank

Table 3: Milking frequency and hygienic practices during milking in the study area

Parameters	Study locations		
	Warder	Galladi	Overall
Milk frequency			
Once a day	-	-	-
Twice a day	100	100	100
Udder washing			
Udder washing before milking	-	-	-
No washing at all	100	100	100
Hand washing before milking			
Yes	19.2	3.8	11.5
No	80.7	96.1	88.4
Checking normality before milking			
Yes	-	-	-
No	100	100	100

before milking, potentially due to a lack of awareness, which could introduce harmful microorganisms into the milk, as noted by (Mohammed et al., 2016). Ensuring the provision of hygienic milk is crucial for consumer health. Moreover, approximately 80.7% and 96.1% of respondents in Warder and Galladi districts, respectively, did not wash their hands before milking, consistent with findings by (Ahmed et al., 2022) in the Degahbur area. Proper handwashing before milking, as recommended by the (Agency), 2006), significantly reduces milk contamination risks. According to (Kurwijila et al., 2006), using unclean hands during milking significantly increases milk microbial content by transferring dirt into the milking container. Additionally, the study noted that goats were milked in open kraals without roofs or walls, lacking designated milking areas, which increases the risk of contamination and spoilage, as highlighted by (Kahuta, 2013). Therefore, milking areas should be designed to minimize contamination risks from various sources such as dust, flies, birds, and other animals.

3.1.4. Milking Equipment, Smoking and Cleaning Practices

All participants in the study region were observed using plastic equipment for milking and milk handling, which are not suitable and can lead to milk contamination and spoilage, as shown in Table 5. Additionally, information gathered through key informant interviews and focus group discussions revealed that recommended and appropriate milk equipment were not utilized in the area due to accessibility and affordability constraints. Similarly, (Omore et al., 2005) noted that in Kenya, milk producers resort to using plastic containers instead of stainless steel ones due to cost factors, despite the difficulty in cleaning and disinfecting plastic containers, potentially leading to poor milk quality. Residue of milk and other debris left in the containers may contribute to milk contamination. (Omore et al., 2005) also highlighted that lack of formal training and the use of plastic containers are primary factors contributing to the low quality of raw milk sold by producers and informal milk traders.

The utilization of plastic equipment is discouraged due to its susceptibility to scratching by typical cleaning methods, leading to difficulties in cleaning and creating hiding spots for microorganisms. This facilitates the proliferation of microorganisms during intervals between milk handling, posing a potential source of microbial contamination during milking and handling processes (Omore et al., 2005). Aluminum cans and stainless-steel equipment are recommended as the preferred milking utensils (Omore et al., 2005; Zelalem et al., 2003).

In the study area, all participants were observed fumigating milking equipment using smoke from burning stems of specific plant species such as Sogsog (Acacia ethaica), Kadi (Blanites galabra), Kariir (Solanum carense), and Wigir (Olea Africana), as indicated in Table 6. This practice is commonly done to enhance the desired flavour of the milk (Table 6). Similarly, (Hassen et al., 2022) found that the majority of respondents in the Degahbur district used smoking to improve taste, flavour, and shelf life of milk. This finding is consistent with (Bereda et al., 2013), who reported that smoking was employed to enhance the taste, flavour, and shelf life of milk products in the Ezha district of Gurage zone. Furthermore, it aligns with the research by (Negash et al., 2012), who noted that approximately 93.3% of respondents smoked their milk handling equipment to improve the flavour and aroma of milk and milk products in the mid-rift valley of Ethiopia. In pastoral communities of Kenya, smoking milking equipment with herbs is utilized to disinfect the equipment, enhance milk flavour, and prolong shelf life (Wafula et al., 2016). Furthermore, smoking helps inhibit the growth of microorganisms in milk due to its antimicrobial properties, consequently extending the milk's shelf life (Ashenafi and Beyene, 1993). Similarly, (Fita et al., 2004) noted that smoking milk vessels with burning wood chips from specific trees and shrubs offers the advantage of imparting a distinct taste and odor to the product while also disinfecting the vessels, reducing microbial counts, and thereby prolonging the product's shelf life.

Table 4: Milking equipment, smoking and cleaning practices in the study area (%)

Parameters	Study locations		
	Warder	Galladi	Overall
Cleaning milk vessels regularly			
Yes	83.3	58.9	71.2
No	16.6	41	28.8
Smoking milk containers			
Yes	82	88.5	85.3
No	18	11.5	14.7
Purpose of smoking containers			
Give favor & aroma	24.3	25.6	25
Increase shelf life	19.2	14.1	16.7
Both	56.4	60.3	58.3
Milking equipments			
Stainless steel	100	100	100
Plant used for smoking			
Maygaag (Boscia minimifolia	52.5	58.9	55.8
Sogsog (Acacia ethaica)	26.9	32.1	29.5
Kadi (Blanites galabra)	20.5	9	14.7

3.1.5. Major Constraints of Goat Milk Handling and Hygienic Practices

In the Warder District, goat milk hygiene is primarily constrained by poor barn hygiene (index 0.25), followed by inadequate hygienic production practices (index 0.20), and insufficient quality and availability of washing water (index 0.17). Disease and parasites (index 0.14), lack of veterinary services (index 0.13), and limited marketing channels (index 0.11) also affect milk quality and production. In the Galladi District, the main issue is poor hygienic production practices (index 0.24). Clean water availability (index 0.18), disease and parasites (index 0.17), lack of veterinary services (index 0.15), barn hygiene (index 0.13), and marketing channels (index 0.13) follow as significant constraints. While both districts face similar challenges, Warder prioritizes barn hygiene, and Galladi focuses on production practices. Addressing these issues with tailored strategies, such as improving water quality, veterinary services, and production practices, is crucial for enhancing goat milk quality and safety. This aligns with studies by (Mohammed et al., 2016; Tollossa Worku et al., 2014; Yeserah et al., 2020), which highlighted the impact of poor hygiene and handling practices on milk safety in Ethiopia.

Goat Milk Utilization

Table 6 presents the utilization of goat milk in the study area, where both domestic consumers consume sheep and goat milk and its products. Some consumers believe that children who drink sheep and goat milk will remain healthy without facing any health issues. Consumption of sheep and goat milk is common in pastoral and lowland areas, with some highland regions like Atsbi also consuming it (Legese et al., 2014). Furthermore, the majority of respondents (80.7%) stated that the primary reason for milk utilization was to enhance resistance to illnesses. This is in line with a study by **(Kedija et al,2008)**, which reported that goat milk producers in certain rural areas of Ethiopia traditionally mix goat's milk with various herbs and apply it on wounds as a curative measure.

4. Conclusion and Recommendations

The study reveals that goat milk production in the Warder and Galladi Districts faces significant challenges due to poor barn hygiene, inadequate production practices, and limited access to clean water and veterinary services, resulting in compromised milk quality and safety. High illiteracy rates among respondents exacerbate these issues, as there is a lack of awareness and education on hygienic milk handling. Traditional housing and milking practices, such as using open kraals and plastic equipment, further increase contamination risks. Addressing these constraints with targeted strategies, including improving water infrastructure, veterinary care, and education on hygiene, is essential for enhancing milk quality and safety. These findings align with prior research emphasizing the critical role of hygiene in milk production and the need for comprehensive interventions to support the socioeconomic well-being of goat-keeping households. Therefore, governmental and non-governmental organizations should focus on improving hygienic practices through targeted development interventions. This involves raising awareness and building capacity among milk producers on hygienic milk production, enhancing goat health, and providing essential resources for milk handling. Further research with broader geographic coverage is needed to identify various microorganisms that may pose public health risks in the study area.

Acknowledgments

The authors express their gratitude to Jigjiga University for funding this work. They also thank the data collectors and interviewees for their willing participation and the valuable information they provided.

Conflict of Interest

Authors declare that there is no conflict f interests involve in publishing this research paper.

References

Abdi M, A. T. and A, Y. (2018). Family structure and household size in somali region, ethiopia. *Journal of African Population Studies,*, 25(4):234–248.

Agency), C. C. S. (2021). Agricultural sample survey. report on livestock and livestock characteristics. addis ababa, ethiopia.

Agency), F. F. S. (2006). Milk hygiene on the dairy farm- a practical guide for milk producers. food standards agency, london.

Ahmed, A., Amentie, T., Abdimahad, K., and Mohamed, M. (2022). Handling and hygienic production practices of goat milk in degahbur district of jarar zone, somali regional state, ethiopia. *Open Journal of Animal Sciences*, 12(3):524–536.

Alexopoulos, A., Tzatzimakis, G., Bezirtzoglou, E., Plessas, S., Stavropoulou, E., Sinapis, E., and Abas, Z. (2011). Microbiological quality and related factors of sheep milk produced in farms of ne greece. *Anaerobe*, 17(6):276–279.

Ashenafi, M. and Beyene, F. (1993). Effect of container smoking and udder cleaning on the microflora and keeping quality of raw milk from a dairy farm in awassa. *TROPICAL SCIENCE-LONDON-*, 33:368–368.

Azeze, T., Yilma, Z., Nurfeta, A., and Welearegay, H. (2015). Utilization and quality of goat milk in hadiya zone, southern ethiopia. *Global Journal of Food Science and Technology*, 3:197–203.

B, B. S. and K, S. B. (2008). *Hygienic Production of Milk. Technical Bulletin No: 11,*. ICAR Research Complex for Goa (Indian Council of Agricultural Research), Ela, Old Goa- 403 402, Goa, India.

Table 5: Ranking of major goat milk hygienic constraints in the study area

Constraints	Study locations											
	Warder						Galladi					
	R1	R2	R3	R4	R5	Index	R1	R2	R3	R4	R5	Index
Barn hygienic	27	17	11	3	0	0.25	3	9	11	8	1	0.13
Poor hygienic production	11	17	13	7	0	0.20	9	20	16	9	4	0.24
Sources of washing water	9	6	12	10	2	0.17	10	7	18	9	0	0.18
Lack of veterinary Service	0	7	6	8	10	0.13	8	6	0	13	9	0.15
Disease & parasites	4	5	7	8	9	0.14	6	5	10	6	13	0.17
Lack of marketing	0	3	5	9	10	0.11	0	7	2	6	16	0.13

Index= [(5 for rank 1) + (4 for rank 2) + (3 for rank 3) + (2 for rank 4) + (1 for rank 5)] divided by the sum of all constraints of camel production mentioned by the farmers, R= Rank

Table 6: Goat milk utilizers and reasons of goat milk utilization in the study area

Parameters	Study locations		
	Warder	Galladi	Overall
Goat milk utilizers			
Nursing Mothers	17.9	11.5	14.7
Children	68	79.5	73.8
Elders	9	6.4	7.7
Pregnant Mothers	5.1	2.7	3.8
Reason of goat milk utilization			
To satisfy hunger	14.1	6.4	10.2
To provide better resistance to illnesses	8.2	83.3	80.7
For its medicinal value	7.7	10.3	8.9

Bereda, A., Yilma, Z., and Nurfeta, A. (2013). Handling, processing and utilization of milk and milk products in ezha district of the gurage zone, southern ethiopia. *Journal of Agricultural Biotechnology and Sustainable Development*, 5(6):91.

Ejigu, K., Gebey, T., and Preston, T. R. (2009). Constraints and prospects for apiculture research and development in amhara region, ethiopia. *Livestock Research for Rural Development*, 21(10):172.

El-Agamy, E. (2007). The challenge of cow milk protein allergy. *Small Ruminant Research*, 68(1-2):64–72.

Fikru, S. and Omer, A. (2015). Traditional small ruminant production and management practices in awbare district of ethiopian somali regional state. *Journal of Animal Production Advances*, 5:697–704.

Fita, L., Beyene, F., and Hegde, P. (2004). Rural smallholders milk and dairy products production, utilization and marketing systems in east shoa zone of oromia. In *Participatory Innovation and Research: Lessons for Livestock Development Proceedings of the 12 annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia*, page 137. Citeseer.

Getachew, F. (2003). Milk and dairy products, post-harvest losses and food safety in sub saharan africa and the near east. assessments report in the dairy sub sector in ethiopia. action programme for the revention of food losses. fao, rome, italy.

Grimaud, P., Sserunjogi, M., Wesuta, M., Grillet, N., Kato, M., and Faye, B. (2009). Effects of season and agro-ecological zone on the microbial quality of raw milk along the various levels of the value chain in uganda. *Tropical Animal Health and Production*, 41:883–890.

Hassen, M., Amentie, T., Abdimahad, K., Ma'alin, A., and Mahamed, A. (2022). Hygienic production and post-harvest handling practices of raw camel milk in degahbour district of jarar zone, somali regional state, ethiopia. *Open Journal of Animal Sciences*, 12(2):303–316.

Kahuta, G. (2013). *Milk quality and on-farm factors leading to milk spoilage in Bugaaki Sub County, Kyenjojo District*. PhD thesis, Makerere University.

Kurwijila, L. R., Omore, A., Staal, S., and Mdoe, N. (2006). Investigation of the risk of exposure to antimicrobial residues present in marketed milk in tanzania. *Journal of food protection*, 69(10):2487–2492.

Legese, G., Haile, A., Duncan, A. J., Dessie, T., Gizaw, S., and Rischkowsky, B. (2014). *Sheep and goat value chains in Ethiopia: A synthesis of opportunities and constraints*. ILRI (aka ILCA and ILRAD).

Lore, T. A., Kurwijila, L. R., and Omore, A. O. (2006). Hygienic milk production: a training guide for farm-level workers and milk handlers in eastern africa.

Mohammed, H., Hailu, S., Geberegiorgis, A., Zeru, F., and Feyisa, A. (2016). Assessment on safety status of camel raw milk marketed in samara-logia town of afar national regional state, northeast ethiopia. *Assessment*, 49.

Nanu, E., Latha, C., Sunil, B., Prejit, P., Thomas, M., and Menon, K. (2007). Quality assurance and public health safety of raw milk at the production point.

Negash, F., Tadesse, E., Aseffa, E., Yimamu, C., and Hundessa, F. (2012). Production, handling, processing, utilization and marketing of milk in the mid rift valley of ethiopia. *Livestock Research for Rural Development*, 24(9):1–12.

Omore, A. O., Lore, T. A., Staal, S. J., Kutwa, J., Ouma, R., Arimi, S., and Kang'ethe, E. K. (2005). Addressing the public health and quality concerns towards marketed milk in kenya.

Smith J, D. A. and R, J. (2020). The therapeutic benefits of goat milk for gastric ulcers. *Journal of Dairy Science*, 103:1234–1245.

Tollossa Worku, T. W., Edessa Negera, E. N., Ajebu Nurfeta, A. N., and Haile Welearegay, H. W. (2014). Milk handling practices and its challenges in borana pastoral community, ethiopia.

Wafula, W. N., Matofari, W. J., Nduko, M. J., and Lamuka, P. (2016). Effectiveness of the sanitation regimes used by dairy actors to control microbial contamination of plastic jerry cans' surfaces. *International Journal of Food Contamination*, 3:1–8.

Yamane, T. (1973). Statistics: An introductory analysis.

Yeserah, B., Tassew, T., and Mazengia, H. (2020). Handling practices of raw cow's milk and major constraints of clean milk production in and around bahir dar city, ethiopia. *J Adv Dairy Res*, 8:234.

Zelalem, Y., Yohannes, G., Gizachew, B., Alemu, G., and Sendros, D. (2003). Major milk chemical composition and feed dry matter intake of multiparous boran cows as affected by level of milk production under bucket feeding and partial suckling calf-rearing methods. In *Proceedings of the 11th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia*, pages 397–402.

Zenebe, T., Ahmed, N., Kabeta, T., Kebede, G., et al. (2014). Review on medicinal and nutritional values of goat milk. *Academic Journal of Nutrition*, 3(3):30–39.