

Handling and Hygienic Production Practices of Goat Milk in Degahbur District of Jarar Zone, Somali Regional State, Ethiopia

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Abstract

A cross-sectional study was carried out to assess handling and hygienic production practices of goat milk in Degahbur district of Jarar zone, Somali Regional State, Ethiopia. A total of 120 households were purposively selected for this study using a stratified sampling technique. The data were collected through the questionnaire, field observations, key informants interview and focus group discussions. The study showed that majority of the sampled households were illiterate. The goats were kept in an open *kraal* made of thorny acacia trees on an earthen floor that had no roof. The goats were milked inside these open *kraals*, and were sometimes contaminated with muck and animal dung mainly the rainy season which could raise the possibility of milk contamination & spoilage. Moreover, traditional hand milking was the only milking method and majority of the respondents didn't wash their hands and the udder of the animal before milking, indicating low community awareness and knowledge of sanitary milk production procedures. Plastic equipment which is difficult to clean and can increase milk contamination and spoilage was used. About 43.3% of the pastoralists and 76.67% of the agro-pastoralists were cleaning milk vessels regularly. The most often used plant species for smoking milk handling equipment in the study area to extend shelf life and add flavor & aroma were *Acacia ethaica*, *Blanites galabra*, and *Solanum Careense*. The main constraints to hygienic goat milk in the area were identified to be poor barn hygiene, poor production procedures, disease, source of washing water and lack of extension services. In general, it can be concluded that handling and hygienic production practices of goat milk used in the study area were unsanitary, which may have been primarily caused by the community's lack of awareness & understanding as well as a lack of supporting infrastructures. Therefore, the concerned bodies should place a high priority on the improvement of hygienic practices by carrying out various relevant develop-

ment interventions, such as raising milk producers' awareness, improving the health of goats, and providing the necessities for milk handling.

Keywords

Goat Milk, Handling, Hygienic, Production

1. Introduction

Milk is the lacteal secretion of the mammary glands of a mammal and plays an important role in human nutrition throughout the world where it promotes growth and maintenance of body tissues [1]. It is the most complete food product of animal origin providing more essential nutrients (protein, energy, vitamins and minerals) in significant amounts than any other single food [2].

Milk from good hygienic production practices and the udder of a healthy dairy animal contains very few bacteria. But poor hygiene introduces additional bacteria that cause the milk to spoil very quickly. To ensure that raw milk remains fresh for a longer time, good hygiene practices are required during milking and when handling the milk afterwards [3].

Poor hygiene, practiced by handlers of milk and milk products, may lead to the introduction of pathogenic micro-organisms into the products [4]. Hygienic practices are the major factors to produce safe and quality products for consumption with minimum microbial contamination, and thereby reducing loss of products and improving the position of smallholder milk producers in marketing of quality milk and milk products [5] [6].

Mishandling and disregard of hygienic measures by milk handling personnel may enable spoilage microbes to come into contact with milk and in some cases to survive and multiply in sufficient numbers to reduce the shelf-life of milk and cause spoilage of milk before it reaches its final destination [7] [8]. High spoilage is reported frequently in milk coming from lowland regions due to high ambient temperatures prevalent in the area combined with lack of cooling facilities as well as transport, scattered distribution of producers and long distance to markets, which make it difficult to deliver milk (especially raw milk) to urban centers [9] [10]. The hygienic levels exercised during milk handling practices also influence the levels of contamination of raw milk with pathogenic bacteria as well as the types of pathogens present in raw milk and expose consumers to serious milk-borne public health risks like typhoid, paratyphoid, tuberculosis, dysentery, gastrointestinal illness and others [11].

Moreover, unhygienic practices performed during production and postharvest handling expose goat milk contamination with harmful microorganisms, and cause spoilage of milk before it reaches its final destination points as well as pose public health risk to consumers [12]. The risk of milk including goat milk contamination with harmful micro-organisms is high for milk produced in devel-

oping countries like Ethiopia as their milk production practices is traditional type which lacks appropriate hygienic measures [13]. The risk is high in lowland regions especially in pastoral and agro-pastoral areas of tropical regions. This is mainly due to high ambient temperatures prevalent in the area combined with a lack of cooling facilities, scattered distribution of producers, long distance to markets and lack of transportation [14] [15].

Therefore, detail investigation of handling and hygienic production practices is very important to identify existing hygiene related problems in order to reduce the risk of public health as well as to improve the livelihood of smallholder farmers by engaging them in quality milk production and handling of dairy products in the district. However, there is a limited study undertaken so far to assess handling and hygienic production practices of goat milk in Degahbur district of Jarar Zone. Therefore, this study was carried out to assess handling and hygienic production practices of goat milk in Degahbur district of Jarar Zone, Eastern Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted from January to August 2020 in Degahbur district of Jarar Zone, Somali Regional State, Ethiopia (Figure 1). It is located at 8°13' North of longitude and 43°34' East latitude at the distance of about 160 km south

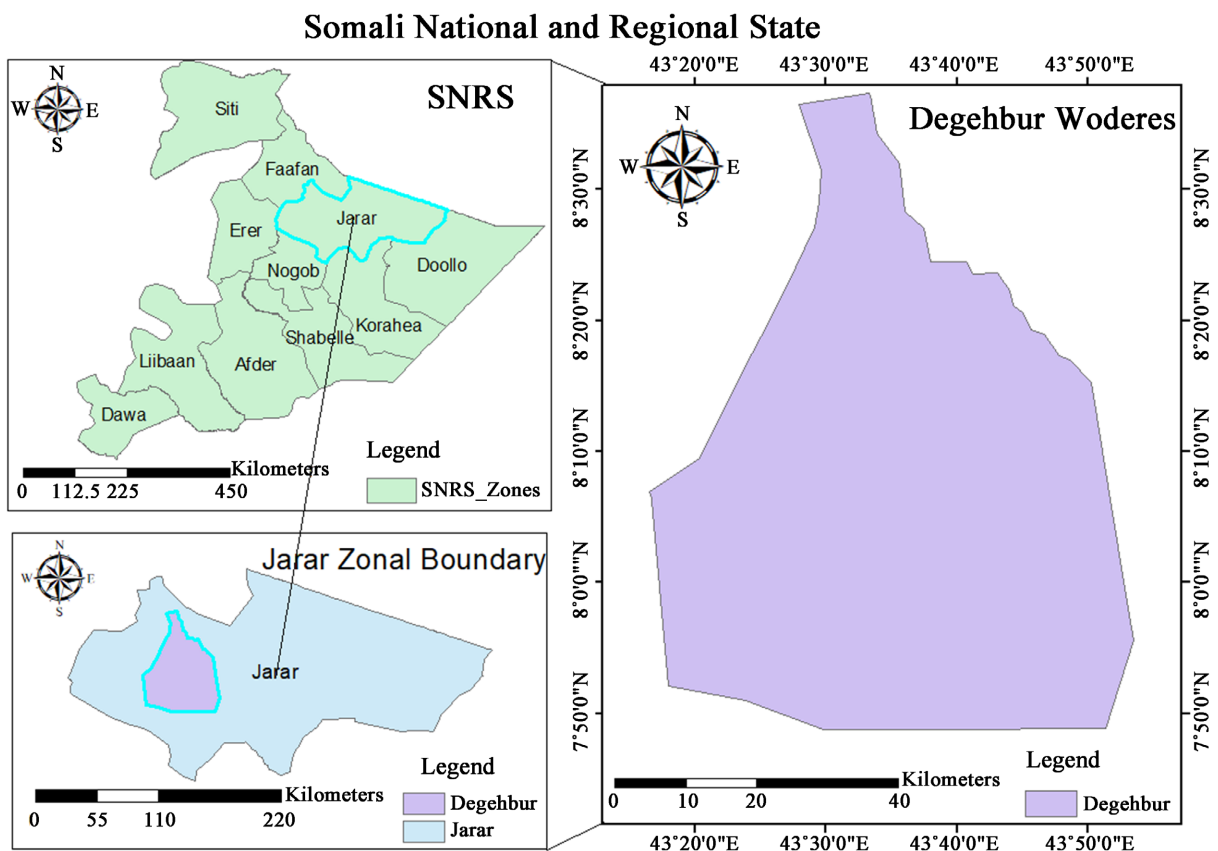


Figure 1. Map of the study area.

of Jigjiga town. The altitude of the district is 1044 meters above sea level. It has mean minimum and maximum temperatures of 11°C and 33°C, respectively. The mean annual rainfall and humidity of the area range from 300 to 400 mm and 31% to 36%, respectively. The rainfall pattern is erratic and has uneven distribution. The farming system in the area is primarily pastoralists, who mainly keep livestock, particularly goat, camel, cattle, and sheep; and to some extent crop (like sorghum and maize) production is also practiced in the district. According to CSA [16] the total human population of the district is estimated at 150,000 of whom 85,000 are men and 65,000 are women.

2.2. Study Design

A cross-sectional study was undertaken to collect relevant information on handling and hygienic production practices of goat milk in Degahbur district, Ethiopia.

2.3. Sampling Technique and Sample Size

Degahbur district was stratified into pastoral and agro-pastoral production systems. Each production system was further stratified into rural *kebeles* (RKs, *Kebele* = smallest administrative unit in Ethiopia). Then, a total of four *kebeles* (2 from pastoral & 2 from agro-pastoral production systems) of high goat milk production potential were purposively selected for this study. Finally, thirty goat milk producer households were selected randomly from each rural *kebele*. As a result, a total of 120 households were selected and involved in this study.

2.4. Data Collection

After stratification and identification of milk producer households, focused group discussions were held with key informants (such as milk producers having good experience on the subject, community leaders and experts) in each production system to generate information on demographic characteristics of goat milk producer households as well as on their goat milk production and handling practices. The resulting information was then used for the development of a survey questionnaire which was pre-tested before administration, and this was followed by questionnaire survey. Moreover, field observations were conducted to gather some information that was not addressed in the interviews and was not described properly during the questionnaire survey.

2.5. Data Analysis

The data were analyzed using Statistical Package for Social Science (SPSS, version, 26.0). Descriptive statistics were used to quantitatively express the responses of the study participants with respect to their demographic characteristics as well as goat milk production and handling practices in the study area. Chi-square test was employed to examine the differences among categorical variables. The differences were considered to be significant at the level $P < 0.05$.

The data related to purposes of keeping goats and constraints of hygienic goat milk production were evaluated using index formula.

3. Results and Discussion

3.1. Demographic Characteristics of the Households

Majority of the respondents in pastoral (63.3%) and agro-pastoral (88.3%) production systems were females (**Table 1**). The average age of the respondents was between 30-45 years of age, which accounted for 54.2% followed by 46 - 60 years of age that counted for 27.5%. Moreover, this study showed that majority of the respondents in pastoral (93.3%) and agro-pastoral (78.33%) production systems were illiterate (**Table 1**). This finding is in agreement with the previous study of Hassen *et al.* [17] who reported a higher proportion of illiteracy for this area. The role of education is obvious in affecting household income, technology adoption, demography, health and the whole socio-economic status of the family as well [18]. Moreover, lack of education and training on hygienic milk production and postharvest handling practices expose raw milk for microbial contamination [19].

The information generated through key informants interview and focus group discussion revealed that none of the households received a training on hygienic milk production procedures and standards. Thus, households need to get basic education and training on hygienic milk production procedures and standards.

Table 1. Demographic characteristic of the respondents (%).

Variables	Pastoral	Agro-pastoral	Overall	<i>P-value</i>
Sex				
Male	36.7	11.7	24.2	0.001
Female	63.3	88.3	75.8	
Age (years)				
<30	5	<30	5	0.4
30 - 45	55	30-45	55	
46 - 60	31.7	46-60	31.7	
>60	8.3	>60	8.3	
Educational level				
Illiterate	93.33	78.33	85.83	0.008
Primary grades	0	6.67	3.33	
Junior grades	0	3.33	1.67	
Religious school	6.67	11.67	9.67	
Family Size (Mean ± SD)	6.37 ± 1.98 ^b	6.83 ± 2.32 ^a	6.60 ± 2.16	

*Means followed by different superscript letters in the same row are significantly different at $P < 0.05$, SD = Standard deviation.

The average family size of the respondents in the study area was 6.60 ± 2.16 (Table 1). This finding agrees with the report of Hassen *et al.* [17] who reported an average family size of 6.89 ± 0.30 in Degahbur district, Ethiopia.

3.2. Purpose of Keeping Goats

Goats were kept in the study area for several reasons, including income generation, milk production, meat production, social & cultural functions, and rituals (Table 2). The primary purpose of goat keeping in pastoral and agro-pastoral production systems in the study area was for income generation through sell of live animals and the cash obtained might be used to buy food, clothes and other family needs. The second main reason of goat keeping in the pastoral and agro-pastoral was for meat production followed by milk production. This finding is in line with the report of Kocho *et al.* [20] who indicated that goats are mainly kept for milk and meat production. Similar to this, Zereu *et al.* [21] indicated that the third main purpose of goat keeping in Humbo District of Wolaita Zone, Ethiopia was for milk production.

3.3. Housing and Cleaning Practices

Housing provides opportunities to protect animals from predators and theft and to keep them safe. All of the respondents in the study area housed their goat in a separate open *kraal* which is enclosed of thorned acacia trees. The finding is in agreement with the report of Fikru and Omer [22] in which all of the farmers in Awbare district housed their goat in an open *kraal*. Similarly, Legese *et al.* [23] reported that farmers in Shinile district used open-top fences for housing all animals. The purposes of goat housing in the study area were to protect them from predators, extreme climate at night, theft and ease the husbandry practices.

Majority of the respondents (55.8%) in the study area were cleaning goat house (*kraal*) once in two days; while, the remaining 24.2% and 20% of the respondents clean the *kraal* once in three days and daily, respectively (Table 3). The study indicated that, all of the observed *kraals* have no roof and constructed on earth floor, with poor drainage condition and difficult to clean and often were contaminated with mud, and urine especially during the rainy seasons. This undoubtedly results in soiling of teats, udders, flank and other body part of

Table 2. Purposes of keeping goats in the study area.

Purpose(s)	Priority choices					Index
	R1	R2	R3	R4	R5	
Income	86	12	18	0	0	0.35
Milk	9	23	13	10	2	0.17
Meat	37	24	32	10	0	0.31
Ritual	0	0	9	6	7	0.07
Social and cultural	0	0	10	9	11	0.09

milking goats while they are lying in muddykraals, and cause the microbial contamination of milk during milking especially when udder and teats were poorly cleaned before milking.

3.4. Milking and Hygienic Practices during Milking

All respondents in the study area milk their goats in the open *kraals* which have no roof and walls (Table 4). This indicates that sometimes milk can be contaminated with muck and animal dung mainly the rainy season which could raise the possibility of milk contamination & spoilage.

None of the respondents practiced udder washing prior to milking (Table 4). This could be due to lack of awareness and may become possible source for the contamination of milk with harmful microorganisms. Lack of udder cleaning practices before start milking will allow entry of spoilage and pathogenic microorganisms into milk while milking and failure to wash udder before milking undoubtedly expose milk for microbial contamination [24]. Provision of milk of good hygienic quality is desirable from consumer's health point of view.

Furthermore, the result showed that about 88.3% and 83.33% of pastoralists and agro-pastoralists, respectively, did not wash their hands prior to milking (Table 4). This is comparable with the study of Hassen *et al.* [17] who reported that majority of pastoralists (93.3%) and agro-pastoralists (75%) Degahbur area did not wash their hands before milking. FSA [25] indicated that milk producers should properly wash udders and their hand before start milking as such practices

Table 3. Cleaning practices of goat house (%) in the study area.

Frequency of cleaning house	Pastoral	Agro-pastoral	Overall	<i>P-value</i>
Daily	16.7	23.3	20	
Once in two days	53.3	58.3	55.8	0.2
Once in three days	30	18.3	24.2	

Table 4. Milking frequency and hygienic practices during milking in the study area.

Variables	Pastoral	Agro-pastoral	Overall	<i>P-value</i>
Milking frequency				
Once a day	0	0	0	
Twice a day	100	100	100	
Udder washing				
Udder washing before milking	0	0	0	
No washing at all	100	100	100	
Hand washing before milking				
Yes	11.7	16.67	14.17	0.4
No	88.3	83.33	85.83	

highly minimizes milk contamination with harmful microorganisms. According to Kurwijila [26], using un-cleaned hands while milking highly increases the microbial content of milk. This is because such practices help pushing of visible and non-visible dirt found on improperly cleaned hand into the milking container while milking.

The study further noted that goats were milked inside their open *kraals* of no roofs and wall and don't have milking barn. As a result, farmers in the study area were milked their animals in undesignated poorly maintained barn which predisposing milk to contamination and spoilage. Milking in open area may allow contaminants entry in to the milk and can be cause for high spoilage rate [27]. The milking area must minimize the risk of contamination from any source, including dust, flies, birds or other animals.

3.5. Milking Equipment, Smoking and Cleaning Practices

All of the respondents in the study area were using plastic equipment for milking and milk handling which are not appropriate and can contribute milk contaminate and spoilage (Table 5). In addition, the information generated through key informants interview and focus group discussion revealed that the recommended and appropriate milk equipment were not used in the area due to accessibility and affordability. Similar to this Omoro [19] indicated since stainless steel milk containers are expensive, milk producers in Kenya use plastic containers

Table 5. Milking equipment, smoking and cleaning practices in the study area (%).

Variables	Pastoral	Agro-pastoral	Overall	P-value
Milking equipment				
Plastic materials	100	100	100	
Cleaning milk vessels regularly				
Yes	43.3	76.67	60	<0.0001
No	56.67	23.33	40	
Smoking milk containers				
Yes	85	88.33	86.67	0.5
No	15	11.67	13.33	
Purpose of smoking containers				
Give flavour & aroma	23.52	18.87	21.15	0.7
Increase shelf life	19.60	15.10	17.30	
Both	56.86	66.03	61.53	
Plants used for smoking				
Sogsog (<i>Acacia ethaica</i>)	49.02	41.51	45.19	0.3
Kadi (<i>Blanite sgalabra</i>)	23.53	35.85	29.81	
Kariir (<i>Solanum Carense</i>)	27.45	22.64	25	

which are difficult to clean and disinfect and thus it might contribute to poor quality of milk. The leftover of milk and other dirt particles within the container may result in the contamination of milk. Omore *et al.* [19] also reported that lack of formal training and use of plastic containers are the main factors that contribute to the low quality of raw milk sold by producers and informal milk traders.

The use of plastic equipment is not advisable as the surface is easily scratched by the common cleaning systems, which makes it difficult to clean and provide hiding places for microorganisms. This allows the multiplication of microorganisms during the intervals between milk handling, and become potential source for microbial contamination of milk during milking and handling [19]. Aluminum cans and stainless steel equipment are the preferred milking utensils [19] [28].

All respondents in the study area were fumigating milking equipment with smoke from burning stems of specific plant species such as Sogsog (*Acacia ethiopia*), Kadi (*Blanites galabra*), Kariir (*Solanum carense*), Wigir (*Olea Africana*) (Table 5). It has been indicated that smoking of milk equipment is done to develop desirable flavour in the milk (Table 5). Similarly, Hassen *et al.* [17] reported that majority of the respondents in Degahbur district were using smoking to improve taste and flavor as well as to increase shelf life of milk. The current finding also agrees with the finding of Abebe *et al.* [29] who reported that the purpose of smoking was to improve the taste and flavor of milk products, as well as to increase the shelf life of the product in Ezha district of Guragezone. Moreover, the finding also in line with the finding of Negash *et al.* [30] who reported that about 93.3% of respondents smoked their milk handling equipment to improve flavor and aroma of milk and milk products in mid rift valley of Ethiopia. Smoking of milking equipment with herbs is used in pastoral communities of Kenya to disinfect milking equipment, to improve the flavor of milk, and to extend their shelf life [31].

Moreover, smoking inhibits growth of microorganisms in milk as it has anti-microbial activity, and thus, increases the shelf life of the milk [32]. Similarly, Fita *et al.* [33] indicated that, smoking milk vessels by using burning wood chips of specific trees and shrubs has advantage of imparting a special taste and odour to the product, and disinfect the vessels, thus reducing the numbers of microorganisms and thereby extending the shelf life of the product.

3.6. Major Constraints of Hygienic Goat Milk Production

Comparably, limited awareness on barn hygienic, poor hygienic production, source of washing water, and disease and parasites were the major constraints of milk hygienic in study area. The result is in agreement with the report of Ruegg [34], who reported that practices that expose teat end to wet and muddy pens increase the risk of occurrence of mastitis and hence milk contamination with micro-organisms.

Barn hygiene, poor hygienic production practices,, source of udder washing, disease & parasites, and lack of extension service were ranked as the main goat milk hygienic constraints in the study area, respectively (**Table 6**). Barn hygiene (with an index value of 0.35) was ranked as the first most important problem contributing for contamination of milk in the study area.

Poor hygienic production of milk (unclean udder due to lack of washing the udder before milking, unclean hands, poor personal hygiene and health status, unclean milking containers due to lack of clean water, unclean milking sites) is more likely to cause milk-borne diseases and the natural antimicrobial factors can only provide a limited protection against specific pathogens for a short period. This is in line with Mohammed *et al.* [24] who reported milk-borne disease is higher when the milk is consumed in its raw state as commonly practiced by the local producers. Tollossa *et al.* [35] noted poor handling practices for instance unclean milking equipment as one of the major constraints of milk commercialization in Ethiopia. In addition, Yeserah *et al.* [36], who reported poor hygienic condition for instance unclean milking equipment as one of the major constraints of milk in Ethiopia.

4. Conclusion and Recommendations

According to the study, the majority of respondents in both production systems in the study area were illiterate, which indicates that they had a limited awareness and knowledge of hygienic milk production procedures. The goats were milked inside open *kraals* which could raise the possibility of milk contamination and spoilage. Majority of the respondents didn't wash their hands and the udder of the animal prior to milking, indicating low community awareness and knowledge of hygienic milk production and handling practices. Plastic equipment which is difficult to clean and can increase milk contamination and spoilage was used for milking and handling. The main obstacles to producing hygienic goat milk in the area were poor barn hygiene and poor production procedures. In general, it can be concluded that the goat milk production and handling

Table 6. Ranking of major goat milk hygienic constraints in the study area.

Constraint(s)	Priority choices					Index
	R1	R2	R3	R4	R5	
Barn hygiene	58	31	18	6	0	0.35
Poor hygienic production	29	24	32	10	0	0.29
Source of washing water	12	19	10	8	6	0.17
Disease and parasites	0	5	9	7	11	0.10
Lack of extension service	0	2	10	8	9	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 constraints of camel production mentioned by the farmers, R = Rank.

practices used in the study area were unsanitary, which might be primarily due to the community's lack of awareness and knowledge as well as a lack of supporting infrastructure. Therefore, the concerned governmental and non-governmental organizations should place a high priority on the improvement of hygienic practices by carrying out various relevant development interventions, such as increasing milk producers' awareness and capacity on hygienic milk production practices, improving the health of goats, and providing the necessities for milk handling.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Javaid, S.B., Gadahi, J.A., Khaskeli, M., Bhutto, M.B., Kumbher, S. and Panhwar, A.H. (2009) Physical and Chemical Quality of Market Milk Sold at Tandojam, Pakistan. *Pakistan Veterinary Journal*, **29**, 27-31.
- [2] Pandey, G.S. and Voskuil, G.C.S. (2011) Manual on milk safety, quality and hygiene. Golden Valley Agricultural Research Trust, Chibombo, 52.
- [3] Lore, T.A., Kurwijila, L.R. and Omoro, A. (2006) Hygienic Milk Production: A Training Guide for Farm-Level Workers and Milk Handlers in Eastern Africa. ILRI (International Livestock Research Institute), Nairobi, 1-12.
- [4] Bereda, A., Yilma, Z. and Nurfeta, A. (2012) Hygienic and Microbial Quality of Raw Whole Cow's Milk Produced in Ezha District of the Gurage Zone, Southern Ethiopia. *Wudpecker Journal of Agricultural Research*, **1**, 459-465.
- [5] Yilma, Z. (2012) Microbial Properties of Ethiopian Marketed Milk and Milk Products and Associated Critical Points of Contamination: An Epidemiological Perspective. In: Cunha, M.L.R.S., Ed., *Epidemiology Insights*, IntechOpen, London, Chapter.15, 298-322.
- [6] Kuma, A., Abdisa, M. and Tolossa, D. (2015) Evaluation of Hygienic Status and Marketing System of Raw Cow Milk in Different Critical Points of Oromia Special Zone. *Global Journal of Science Frontier Research: C Biological Science*, **15**, 21-30.
- [7] Chatterjee, S., Bhattacharjee, I., Chatterjee, S. and Chandra, G. (2006) Microbiological Examination of Milk in Tarakeswar, India with Special Reference to Coliforms. *African Journal of Biotechnology*, **5**, 1383-1385.
- [8] Kivaria, F.M., Noordhuizen, J.P.T.M. and Kapanga, A.M. (2006) Evaluation of the Hygienic Quality and Associated Public Health Hazards of Raw Milk Marketed by Smallholder Dairy Producers in the Dar es Salaam Region, Tanzania. *Tropical Animal Health and Production*, **38**, 185-194.
<https://doi.org/10.1007/s11250-006-4339-y>
- [9] Lumadede, A.K., Owuor, G., Laqua, H. and Gluecks, I.V. (2010) Pastoral Milk Production and Market Chain Analysis in Dollo ado and Dollo Bay. Somali Region of Ethiopia for Save the Children/US-Version 1, Save the Children, Ethiopia, 4-34.

- [10] Terfa, G. (2015) Microbiological Quality and Impact of Hygienic Practices on Raw Cow's Milk Obtained from Pastoralists and Market. The Case of Yabello District, Borana Zone, Ethiopia. *Global Journal of Food Science and Technology*, **3**, 153-158.
- [11] Hayes, M.C., Ralyea, R.D., Murphy, S.C., Carecy, N.R., Scarlett, J.M. and Boor, K.J. (2001) Identification and Characterization of Elevated Microbial Counts in Bulk Tank Raw Milk. *Journal of Dairy Science*, **84**, 292-298. [https://doi.org/10.3168/jds.S0022-0302\(01\)74479-7](https://doi.org/10.3168/jds.S0022-0302(01)74479-7)
- [12] Nanu, E., Latha, C., Sunil, B., Prejit, M.T. and Menon, K.V. (2007) Quality Assurance and Public Health Safety of Raw Milk at the Production Point. *American Journal of Food Technology*, **2**, 145-152. <https://doi.org/10.3923/ajft.2007.145.152>
- [13] Felleke, G. (2003) Milk and Dairy Products, Post-Harvest Losses and Food Safety in Sub-Saharan Africa and the Near East. A Review of the Small Scale Dairy Sector-Ethiopia. FAO Prevention of Food Losses Programme, Food and Agriculture Organization of the United Nations, Rome.
- [14] 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**, 276-279. <https://doi.org/10.1016/j.anaerobe.2011.03.011>
- [15] Gurmessa, T. (2015) Microbiological Quality and Impact of Hygienic Practices on Raw Cow's Milk Obtained from Pastoralists and Market. The Case of Yabello District, Borana Zone, Ethiopia. *Global Journal of Food Science and Technology*, **3**, 153-158.
- [16] CSA (Central Statistical Agency) (2007) National Statistics Archived November 14, 2012, at the Wayback Machine, Table 2.2.
- [17] 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**, 303-316. <https://doi.org/10.4236/ojas.2022.122023>
- [18] Kerealem, E. (2005) Honeybee Production System, Opportunities and Challenges in Enebe Sar Midir Woreda (Amhara Region) and Amaro Special Wereda (Southern Nations, Nationalities and Peoples Regional State), Ethiopia. MSc. Thesis, Alemaya University, Alemaya, 133 p.
- [19] Omore, A., Lore, T., Staal, S., Kutwa, J., Ouma, R., Arimi, S. and Kang'ethe, E. (2005) Addressing the Public Health and Quality Concerns towards Marketed Milk in Kenya. Smallholder Dairy Project, Nairobi, 42 p.
- [20] Kocho, T.K. (2007) Production and Marketing Systems of Sheep and Goats in Alaba, Southern Ethiopia. MSc Thesis (Animal Production), Hawassa University, Awassa, 159 p.
- [21] Zereu, G., Meshka, M., Shanka, M. and Sodo, E. (2016) Assessment of Goat Production Systems and Factors Affecting Production and Utilization of Goat's Milk in Humbo District of Wolaita Zone, Southern Ethiopia. *Journal of Biology, Agriculture and Healthcare*, **6**, 46-51.
- [22] Fikru, S. and Omer, A.A. (2015) Traditional Small Ruminant Production and Management Practices in Awbare District of Ethiopian Somali Regional State. *Animal Production Science*, **5**, 697-704.
- [23] 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 Project Report, International Livestock Research Institute, Nairobi.

- [24] 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. *Food Science and Quality Management*, **49**, 80-88.
- [25] FSA (Food Standards Agency) (2006) Milk Hygiene on the Dairy Farm—A Practical Guide for Milk Producers. Food Standards Agency, London, 1-10.
- [26] Kurwijila, L.R., Omore, A., Staal, S. and Mdoe, N.S.Y. (2006) Investigation of the Risk of Exposure to Antimicrobial Residues Present in Marketed Milk in Tanzania. *Journal of Food Protection*, **69**, 2487-2492.
<https://doi.org/10.4315/0362-028X-69.10.2487>
<https://meridian.allenpress.com/jfp/article-abstract/69/10/2487/171961>
- [27] Kahuta, G. (2013) Milk Quality and On-Farm Factors Leading to Milk Spoilage in Bugaaki Sub County, Kyenjojo District. MSc Thesis, Makerere University, Kampala, 72 p.
- [28] Zelalem, Y., Yohannes, G., Gizachew, B., Alemu, G.W. 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. *Proceedings of the 11th Annual Conference of the Ethiopian Society of Animal Production (ESAP)*, Addis Ababa, 28-30 August 2003, 397-402.
- [29] Abebe, B., Zelalem, Y. and Ajebu, N. (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**, 91-98.
<https://doi.org/10.5897/JABSD2013.0206>
<https://academicjournals.org/journal/JABSD/article-full-text-pdf/3DFB18642495>
- [30] 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**, 1-12.
- [31] 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**, Article No. 9. <https://doi.org/10.1186/s40550-016-0032-8>
- [32] Mogessie, A. and Fekadu, B. (1993) Effect of Container Smoking and Cleaning on the Microflora and Keeping Quality of Raw Milk from a Dairy Farm in Awassa, Ethiopia. *Tropical Science*, **33**, 368-376.
- [33] Fita, L., Beyene, F. and Hegde, P.B. (2004) Rural Smallholders Milk and Dairy Products Production, Utilization and Marketing Systems in East Shoa Zone of Oromia. *Proceedings of the 12th Annual Conference of the Ethiopian Society of Animal Production*, Addis Ababa, 12-14 August 2004, 13.
- [34] Ruegg, L. (2006) Role of Hygienic in Efficient Milking. *WCDS Advances in Dairy Technology*, **18**, 285-293.
- [35] Tollossa, W., Edessa, N., Ajebu, N. and Haile, W. (2014) Milk Handling Practices and Its Challenges in Borana Pastoral Community, Ethiopia. *African Journal of Agricultural Research*, **9**, 1192-1199. <https://doi.org/10.5897/AJAR2013.8247>
<https://academicjournals.org/journal/AJAR/article-full-text-pdf/200670C43834>
- [36] 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. *Advances in Dairy Research*, **8**, Article No. 234.