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Hygienic Practices of Milk Collecting and Processing: Dairy Farms of Injil District-Herat Province

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ABSTRACT

Milk is recognized as an essential component of the human diet, particularly for infants and young children, due to its comprehensive nutritional profile. Maintaining proper milk hygiene is vital for protecting public health and preserving milk quality throughout the production and supply chain. This study examined hygienic practices in milk collection and processing across dairy farms in the Injil District of Herat Province, Afghanistan. Using a cross-sectional study design, it aimed to assess the sanitary measures implemented in milk handling and production within the region's dairy sector. A systematic sampling approach was employed to select 150 farms, each with a minimum of 10 dairy cows, as the study population, which was conducted between March and May 2023. Data were collected through face-to-face interviews with farm managers, who responded to a pre-prepared questionnaire based on prior research, which focused on four main areas: farm hygiene, milk collection methods, milk storage and transportation, and farmers' knowledge of milk hygienic practices. The questionnaire was translated into the local language to ensure precise and clear responses. It covered topics such as cleaning protocols for milking equipment and facilities, udder washing and milking techniques, types of containers used for milk storage, temperature control during storage, transportation methods, and farmers' knowledge of hygiene regulations. Collected data was entered into SPSS version 27, coded, and analyzed using descriptive statistics such as frequencies, percentages, tables, and graphs. The findings revealed that 97% of respondents were male and only 3% were female. Regarding educational levels, 37% were illiterate, 35% had completed secondary education, and 15% held a bachelor's degree. In terms of hygienic practices, only 25% of farmers washed cows' udders before and after milking, while 56% used warm water and soap for handwashing. Furthermore, 45% of farms stored milk at the recommended temperature of 4°C, whereas 38% stored milk at room temperature, increasing the risk of contamination. Concerning equipment, 43.3% of farmers used plastic containers, and 39.3% used aluminum containers for milk storage. In terms of transportation, 84% transported milk using motorcycles, which posed challenges for maintaining temperature control and hygiene. The study highlights significant gaps in milk collection, storage, and transportation practices despite a general awareness of health risks. Training farmers, improving infrastructure, and promoting the use of standard equipment are essential to enhance milk quality and safety.

Keywords: Dairy Farm, Milking, Milk Collection, Processing, Hygiene, Herat

INTRODUCTION

Milk is considered as a vital part of the diet and offers multitudes of advantages especially for babies and small children (Duguma, 2022). For the microbial contamination to be reduced to the minimum level, certain sanitary practices should be observed. Such practices help minimize product losses while improving the market competitiveness of smallholder milk producers (Amistu, 2015 & Babege, 2020). The majority of farmers possess limited education or formal qualifications, which hinders their ability to effectively manage cattle and consequently increases their exposure to zoonotic risk factors (Nyokabi, 2018). Consequently, the recent reports show that a lot of these dairy farmers do know the health hazards of using low grade, untested milk. The lack of set standards for the hygiene of milk, however, create inconsistencies among producers. For example, some farmers are known to wash their hands before milking, but the methods used range significantly and most without detergent or sanitizer. Moreover, while dwelling in the countryside, people mainly use older tools for both milking and storing milk. Instead, even in the city, there is a lower usage of plastic or stainless steel containers. Poor hygiene practices result in milk being heavily contaminated with various microorganisms, primarily due to a considerable number of smallholder farmers failing to adequately sanitize their milking equipment (Teshome, 2023). On the other hand, many farmers tend to keep separate sheds for housing their cows along with other sanitary practices including washing hands and the udder of the cow before milking. While many farmers have access to pipes for water, which makes cleaning easier, they also tend to use plastic containers for milking. Moreover, while the study indicates a preference for boiled raw milk, it also states rabies and bovine tuberculosis are the two most frequently cited zoonotic diseases (Senay et al., 2020). There is considerable potential for microbial contamination in dairy processing plants. Given that milk is considered a nutrient-rich liquid, it creates optimal conditions for microbial development. Moreover, the movement of employees can bring in microorganisms to several parts of the dairy processing plant (Shasho, 2023). For proper monitoring of a milk hygiene and safety index, the following four indicators were developed: i. Cleaning the udder pre-milking, ii. Hand washing pre-milking, iii. Cleaning the milking area, and iv. Type of containers for milking and storing the milk (whether it constitutes plastic or aluminum/metal) (Andrew *et al*., 2021). Zoonoses such as brucellosis may be avoided with the help of certain animal health practices like vaccination. Farmers' adherence to the withdrawal period is a measure to monitor the quantity of antibiotics which can be found in the milk of sick or treated cows (Kumar *et al*., 2020). In the dairy industry, raw milk is kept in the refrigerator for two to five days prior to processing to slow down the reproduction of deleterious mesophilic and thermophilic bacteria. Nevertheless, this practice promotes the development of psychrophilic and psychrotrophic bacteria which can grow and prevail at temperatures of 7°C (Yalew *et al*., 2024). This study examines hygienic issues in the dairy sector and the problems faced by smallholder farmers with limited infrastructure, knowledge, and resources which directly affect milk. Our study aims to understand the milk production processes as well as the possible sources of contamination in an effort to enhance the safety of milk for consumption.

MATERIALS AND METHODS

Study Design and Sample Selection

The study utilized a cross-sectional survey approach to examine milk collection and processing practices on dairy farms in the Injil district of Herat province, Afghanistan, with data collected in 2023. The target population included all dairy farms in the Injil district, registered and unregistered by the Association of Cattle Farmers. We partnered with the Directorate of Agriculture, Irrigation, and Livestock, and the Association of Cattle Farmers of Herat Province to ensure a representative sample. Using the data and herd size statistics were provided by these organizations, we determined the appropriate sample size, focusing on farms with ten or more cows, regardless of registration status.

Data Collection

This study employed a systematic sampling methodology. Initially, the farmers46' union was approached to obtain a comprehensive list of farmers. Farms with more than five dairy cows were selected from this list as eligible participants. Subsequently, a random sample of 150 farms was drawn from the eligible population for data collection. A structured questionnaire was prepared, and data were gathered through direct, face-to-face interviews with farm managers. The questionnaire

was designed based on prior research (Tishome *et al*., 2017 & Duguma, 2022) and was translated into the local language to ensure clear communication and accurate responses. The questionnaire covered four main areas; (1) Farm Hygiene: Questions in this section assessed the cleanliness practices of storage facilities and milking areas. (2) Milk Collection Procedures: This section examined the methods used to collect milk from cows, including the cleaning standards for equipment and milking techniques. (3) Equipment Maintenance: This part explored the cleaning methods and frequency of maintenance for milking equipment. (4) Farmer Knowledge: This section evaluated the farm managers' understanding of milk cleanliness principles and best practices for milk collection and processing.

Each question in this survey is provided with four choice options, which were designed from the findings of similar studies and combined with the local context. The interviews were carried out in person at farm locations within the Injil district between March and May 2023. Most interviews were conducted during morning hours, typically between 8:00 AM and 4:00 PM, with each session lasting approximately fifteen minutes.

Data Analysis

All collected data was coded and analyzed using SPSS version 27. Descriptive statistical methods were utilized to summarize the collected data, including the use of frequencies and percentages for the various response categories within each variable.

RESULTS

This analysis is based on the data obtained from the dairy farms in Herat Province. The data set paints a picture of how the industry is performing at the moment. Several farms have modernized their practices, but a larger proportion of them still adhere to the old ways of doing things. It is quite easily perceptible that the industry is male-dominated. Out of the 150 respondents, 97% were male, whereas only 3% identified as female. As far as the level of education is concerned, the range of proportions suggests that 37% had no formal education and around 9% had completed primary school, 35% completed secondary education, 15% obtained a bachelor's degree and nearly 5% managed to obtain a diploma. When it comes to participants' work experience, there was a wide range of distribution. Around 44% claimed that they possess five years of work experience, 33% have ten years, 14% have fifteen years and 9% have more than fifteen years. The entire study did create some insight into problems faced by the farmers. As noted previously, 59% of the farms do not have any aerators. Hygiene is also a problematic issue considering that 6% of the farms do not have a separate room for milking. The plan and procedure of waste management is different from farm to farm. 57% of farms reported that they carry out waste clean-up daily while 22% claimed that only do so once in two weeks or more. Only 47% of milking areas have cement floors which could have implications for hygienic practices. Handwashing practices among milkmaids are not uniform – there are 29% only use hot water for handwashing while more than half use hot water and detergent. In addition, only 25% of dairy farmers attempt to control hygienic conditions by washing the udder of the cows before and after milking.

Several issues present themselves regarding the handling and preservation of the milk. A significant proportion of milk is kept at room temperature which increases the risk of contamination, not to mention that only 45% of farmers seem to follow the recommended storage temperature of 4°C. Even more worrying is the fact that 25% of the farmers do not bother to preserve milk after it has been obtained from the cows. The majority of milk shippers, 84% use motorcycles as a transport vehicle, which makes it difficult to ensure good hygiene and temperature control during transportation. On the positive side, a substantial number of farmers, about 67% of them, are breeding Holstein hybrid cattle which are high milk yielders. However, breeding practices appear to be suboptimal, as natural service is employed more frequently (68%) than artificial insemination (31%), indicating potential issues with the efficiency and management of reproductive strategies.

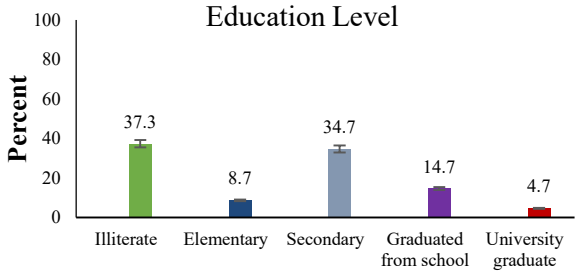

Figure 1. This graph shows the educational level of the respondents (N=150). The largest proportion of respondents, 56 individuals (37.3%), were illiterate, followed by 52 respondents (34.7%) who had

Table 1. The Infrastructure and Practices of Dairy Cows Farms

Characteristic	No. Of Responded (N=150)	Percentage
Aerator in the Farm		
High	20	13.3
Moderate	25	16.7
Low	17	11.3
Minimal	88	58.7
Special Place for Milking		
No	9	6.0
Among the cows	52	34.7
Outside the farm	6	4.0
Special place	83	55.3
Discharging Waste Material		
1-2 Times/week	33	22.0
3-5 Times/week	13	8.7
Daily	86	57.3
Rarely	18	12.0
Number of Dairy cows		
10-20 Cows	114	76.0
20-30 Cows	26	17.3
30-50 Cows	8	5.3
More than 50	2	1.3

completed secondary education. Additionally, 22 individuals (14.7%) held a bachelor's degree, 13 (8.7%) had completed elementary education, and 7 (4.7%) possessed a diploma. This distribution reflects the varied educational backgrounds of the participants.
Source: Author's calculation

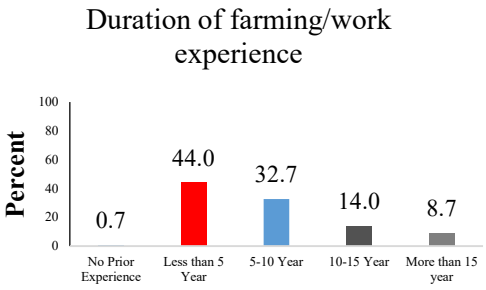

Figure 2. This graph shows the respondents' years of experience in farming or related work. Among the (N=150) respondents, only 1 individual (0.7%) reported having no experience. The largest segment, comprising 66 respondents (44%), had 5 years of experience. Additionally, 49 individuals (32.7%) reported 10 years of experience, 21 (14%) had 15 years, and 13 (8.7%) had over 15 years of experience. This distribution illustrates the diverse range of experience levels among the respondents.
Source: Author's calculation

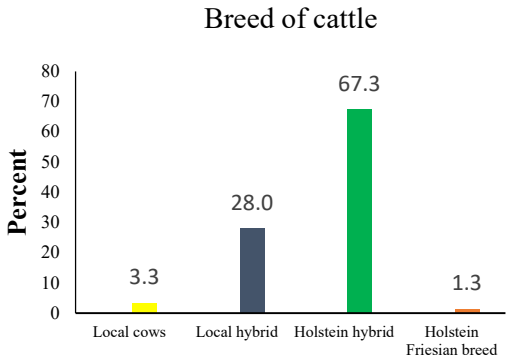

Figure 3. This graph shows the percentage of different cow breeds. Holstein hybrid cows are the most prevalent breed, accounting for 67.3% of the total, reflecting a marked preference among farmers. Local hybrid cows represent 28%, while local breeds constitute only 3.3%, and Holstein Friesian cows are the least common at 1.3%. This distribution provides important insights into breeding patterns that may inform decision-making in dairy farm management.
Source: Author's calculation

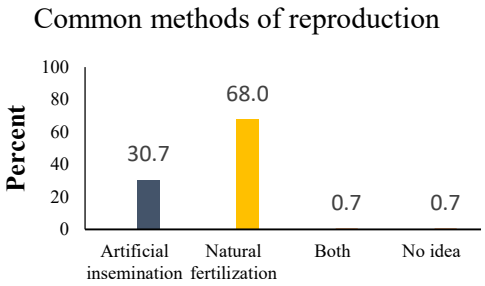

Figure 4. This graph shows the fertilization method preferred by respondents. The majority of respondents (70%) indicated a preference for natural fertilization, demonstrating a clear inclination over artificial insemination. The low percentages for both methods being used simultaneously and the "I don't know" responses suggest limited awareness or interest in alternative reproductive technologies. This distribution highlights a strong tendency toward natural fertilization, which may have implications for agricultural practices and extension efforts.

Source: Author's calculation

Table 2. Milk Production and Processing Practices.

Characteristic	No. of Responded (N=150)	Percentage
Milk Quality Tests		
pH	72	48
Temperature	49	32.7
Mastitis	29	19.3
Milking Time per day		
Non	4	2.7
Evening	4	2.7
Both	142	94.7
Milk Storage period in the Farm		
1-3 Hour	37	24.7
3-5 Hour	14	9.3
5-8 Hour	61	40.7
Not stored	38	25.3
How is milk sold		
Raw milk	118	78.7
Other production	14	9.3
All of them	18	12
Breast drying method		
Cotton pieces	92	61.3
Special towels	16	10.7
Disposable napkins	9	6
Do not dry	33	22

Source: Author's calculation

Table 3. Equipment and Hygiene Practices in Cows Dairy Farms

Characteristic	No. of Responded(N=150)	Percentage
Cleaning milkmaid hands		
Cold Water With Detergent	15	10
Hot Water With Detergent	84	56
Cold Water	7	4.7
Hot Water	44	29.3
Washing the breast before and after milking		
Yes, very much	38	25.3
Yes, little	64	42.7
Very little	40	26.7
Never	8	5.3
Type of water to wash the breast		
Hot water	142	94.7
Cold water	8	5.3
Method of milking		
With Hand	55	36.7
Milking machine	47	31.3
Both	48	32
Temperature for milk store		
4 C0	68	45
Cold water container	25	16
Room temperature	57	38
Freezer	1	0.7
Washing method for milking equipment		
Cold water	3	2
Hot water	67	44.7
Cold water with detergent	59	39.3
Hot water with detergent	21	14
Vehicle for milk transport		
Truck without roof	11	7.3
Truck with roof	11	7.3
Motorcycle	126	84
Special tanker	2	1.3

Source: Author's calculation

Type of milk storage containers

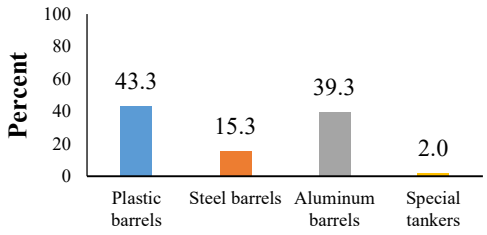

Figure 5. This graph shows the percentage distribution of different types of barrels. Plastic barrels are the most commonly used for milk storage, accounting for 43.3%, followed closely by aluminum barrels at 39.3%. In contrast, steel barrels represent 15.3%, while special tankers are used by only 2% of respondents. These findings indicate a clear preference for plastic and aluminum barrels over steel barrels and specialized tankers.

Source: Author's calculation

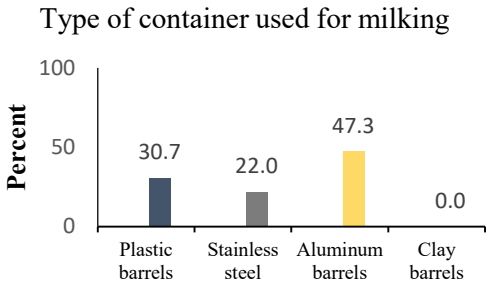

Figure 6. This graph shows the percentage distribution of different barrel types. Aluminum barrels are the most frequently used, comprising 47.3%, followed by plastic barrels at 30.7%. Stainless steel barrels account for only 2.5%, and no respondents reported the use of clay containers. This data reflects a significant preference for aluminum and plastic barrels over stainless steel or clay alternatives.
Source: Author's calculation

DISCUSSION

The survey focused exclusively on the Injil District of Herat Province. Still, the participants' distribution and some other research portray a pattern concerning gender and schooling level as it relates to dairy farming in the area. In this particular case study, the ratio of males to females was heavily unbalanced as 97.3 % of the respondents were men, while 2.7% were women. This accompanies the general observation in dairy farming where men have more control over this profession. Educationally, the group was heterogeneous with 37.3% had no formal education, while 19.4% held higher education such as a bachelor's and diploma. The previously cited papers by Teshome *et al*. (2017), Azage *et al*. (2013), and Edge *et al*. (2020) also exhibit that male farmers among the dairy farming population of rural Ethiopia have minimal formal education. This suggests that more actions are required to promote and facilitate equal opportunity in capacity building and equal gender representation in the dairy farming sector to enhance the corresponding productive and managerial practices. Of note, a concern specific to Tadele *et al*. (2016) is that milk production is mainly carried out by women, which represents a locational difference in gender participation. Along with these researchers, the pattern of few people being willing to adopt new technology for dairy farming activities due to low literacy could provide a rationale for effective educational campaigns to boost dairy farm productivity and sustainability.

This study, along with Edget *et al*. (2020) and Senay *et al*. (2020) discussed the waste disposal and hygiene practices of dairy farming people in Ethiopia. For this survey, 57.30% reported daily waste disposal while 22% did weekly. This demonstrates the commitment to sanitation among dairy farmers which impacts overall farm hygiene. The type of flooring used was also indicative of hygiene practices. "Earthen" floors, which "Edget" *et al*. (2020) noted 58.82% of respondents from their study used in their barns, were the most common (47.3%). Barn cleaning is also performed differently. 41.9% of respondents from Seney *et al*. (2020) indicated barn cleaning at least twice a day which shows a strong commitment to cleanliness. However, a significant proportion still reported simple weekly (3.1%) or bi-weekly (1.3%) cleaning practices. These changes indicate that there is a conscious effort to manage hygiene in dairy farming. While some farmers have introduced proactive approaches to waste disposal and barn cleanliness, further improvement is needed to enhance animal health and productivity. Ethiopia has unique trends and patterns relating to milking hygiene, a detail this study and past research help aim to capture.

In this research, 94.7% of farmers claimed to have milked their cows twice a day, whereas 95.8% reported cleaning their milking utensils before using them, indicating dedication towards regular milking practices as well as sanitation of equipment. However, there was an important lapse in the hygiene practices of the farmers such that only 82.4 percent cleaned the udder and teats before milking, which highlights the gaps in proper milk quality management. These trends are consistent with the findings of Teshome *et al*. (2017) in which 97.8 percent of respondents practiced milking twice a day, however, a large number of them (85.6%) did not wash the udder and the teats which poses chances for infection. In some of Deginet *et al*. (2020) and Mitiku *et al*. (2019), the respondents exhibited varying behavior and some claimed to wash their hands and the milking vessels but did not do adequate udder scrubbing or use towels or soap for the cleaning. All these studies reiterated the need to clean containers used for milking before and after, which was done by all participants of every group. While the general practice of cleaning the barn was high in this case (39.5% of daily cleaning said), other studies had more variation, some of the respondents claimed to do so once a week or less.

The accumulated results demonstrate the importance of hygiene in dairy farming, especially about udder sanitation and the general hygiene of which milk is produced to lower contamination chances. The current study and other major studies conducted in Ethiopia reveal the differences in milking and hygiene practices in various locales and cultures. In this research, most of the respondents 56% cited hot water and soap as the primary means of handwashing and recognized hygiene's importance in the milking process. While this was the case, compliance with practices about udder cleanliness was not harmonious as only 25.3% of respondents said that they regularly wash their udders before milking, and an astonishing 5.3% reported that they do not wash them at all. In the same fashion, the study showed that most people (94.7%) clean their udders and use hot water to do so. A smaller proportion of the population used adequate procedures of hygiene and drying, though, 75.5% used their hands instead of towels. There was a variety of types of containers used in milking, the most predominant type was plastic barrels, which were used by 80.7% of the respondents in mining and 43.3% in storage. This agrees with the findings by Teshome *et al*. (2017) who reported that plastic buckets were the most preferred milking containers in all regions. In addition, studies by Daginete *et al*. (2020) and Mitiku *et al*.

Various sources, including Mitiku *et al*. (2019), confirm that having different sources of water such as groundwater and spring water greatly aided the washing of milk containers in numerous dairy farming communities. Furthermore, clarifying, Mitiku *et al*. (2019) accentuated the integration of plastic containers among many dairy farming communities which significantly replaces clay and metal. While a significant number of communities have opted to clean milking tools with hot water, communities investigated by Senay *et al*. (2020) still heavily rely on plastic containers for the transportation and storage of milk. These peculiar practices shed light on the absent incorporation of the more hygienic options such as stainless steel. Little by little, these conclusions shed light on the gaps in cleansing practices such as udder washing and container cleansing that need to be bridged in Ethiopia region dairy farming communities to improve the standard of milk. Relatively, this adds to the collection of studies investigating the regions straddling Ethiopia focusing on the old and current norms of the sale, usage constructs, and the source of water needed for dairy farming practices. The Herat province's Injil district showcases a crystal clear example where an astounding 78.7% shifted to raw milk, leaving processed dairy products to be the greatly unused segment of the market.

Unlike other studies, a 2020 study by Deginet *et al*. within the Kembata Tembaro Zone revealed that while manufactured dairy products were most popular, 22.62% of households still consumed raw milk. With this study located in the Injil district, there was also a significant difference between the districts, with 60% of farms relying on deep-hole water, 31.3% using urban water sources, and 6.7% using hand wells. Just like Tadele *et al*, 2016, other scholars like Tadele *et al* also observed significant sectional differences with a greater dependence on hand pipes in certain regions of Eastern Ethiopia such as Harar. Together with Tadele *et al*., Senay *et al*. noticed that 97.5% of the water used to clean milking equipment and structures came from pipe water. Having varying resource practices and relying heavily on water pipes to complete hygiene measures for dairy products emphasizes the need for region-specific hygiene and quality improvements for the products.

CONCLUSION

This study provides a comprehensive evaluation of milk collection and processing practices in the Injil District of Herat Province, highlighting the region's reliance on traditional farming techniques and the need for improvements in hygiene and education. While many farmers demonstrate awareness of zoonotic risks, there is a clear gap in understanding the health implications of milk handling, particularly concerning cows with illnesses. The study also reveals considerable variability in storage and milking equipment practices, raising concerns about milk safety and quality. Inconsistent adherence to hygienic practices, such as washing equipment and udder cleaning, further underscores the need for standardized protocols. To enhance the quality and safety of milk production, it is essential to implement comprehensive training programs, promote adherence to best practices, and increase awareness of zoonotic diseases. By addressing these challenges, the dairy sector in Injil District can be improved, leading to better public health outcomes and enhanced livelihoods for farmers.

AUTHORS CONTRIBUTIONS: Afghan R. prepared the study plan, collected the data, entered the data into SPSS version 27, and performed the

statistical analysis and prepared the first manuscript. Mohammadi Abdulhamid, Mohammadi Aminullah and Wasim W. A., contributed to enter the data into SPSS version 27, and performed the statistical analysis. Haqmal M. A., and Mohmand N. A., contributed to edit and review the final draft of the paper, and all authors read and approved the final version of the article.

REFERENCES

Abayneh, E., Seyoum, W., Getachew, M., & Tora, E. (2020). Knowledge and hygienic practices among milk and cottage cheese handlers in districts of Gamo and Gofa Zone, Southern Ethiopia. *Acta Scientific Veterinary Sciences*, 2(4). Retrieved from https://www.researchgate.net/publication/343163332

Amentie, T., Eshetu, M., Mekasha, Y., & Kebede, A. (2016). Milk postharvest handling practices across the supply chain in Eastern Ethiopia. *Journal of Advanced Veterinary and Animal Research*, 3(2), 112–126. https://doi.org/10.5455/javar.2016.c139

Amistu, K., Melese, A., & Degefa, T. (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: Biological Science,* 15(1), 21–30.

Andrew, R., Chusi, T., & Mwembezi, G. P. (2021). Milking Hygiene and Handling Practices among Smallholder Dairy Farmers in Zanzibar. European Journal of Agriculture and Food Sciences, 3(6), 82–88. https://doi.org/10.24018/ejfood.2021.3.6.422

Babege, K., Eshetu, M., & Kassa, F. (2020). Hygienic Production Practices and Microbial Quality of Cow Milk in Cheha District of Gurage Zone, Southern Ethiopia. Open Journal of Animal Sciences, 10(03), 592–607. https://doi.org/10.4236/ojas.2020.103038

Duguma, B. (2022). Milk composition, traditional processing, marketing, and consumption among smallholder dairy farmers in selected towns of Jimma Zone, Oromia Regional State, Ethiopia. *Food Science and Nutrition*, 10(9), 2879–2895. https://doi.org/10.1002/fsn3.2884

Gebremedhin, S. G., Engdaw Mequnnent, S., & Gichamo, A. A. (2020). Assessment of knowledge, attitudes and practices of people about milk quality and common zoonotic diseases in small holder dairy production chain in selected sites of southern Ethiopia. International Journal of Advanced Research in Biological Sciences Int. J. Adv. Res. Biol. Sci, 7(8), 25–36. https://doi.org/10.22192/ijarbs

Guya, M. E., Adugna, M. M., & Mumed, Y. Y. (2019). Milk production, marketing, and quality in Meta District of Eastern Hararghe Zone, Ethiopia. *Journal of Agricultural Science*, 11(5), 535. https://doi.org/10.5539/jas.v11n5p535

Hailemeskel, D. (2020). Production, handling, traditional processing practices, and quality of milk in Kembata Tembaro Zone Milk Shed Area, Southern Ethiopia. *International Journal of Animal Science and Technology*, 4(2), 33–49. https://doi.org/10.11648/j.ijast.20200402.13

Kumar, A., Mishra, A. K., Saroj, S., Sonkar, V. K., Thapa, G., & Joshi, P. K. (2020). Food safety measures and food security of smallholder dairy farmers: Empirical evidence from Bihar, India. Agribusiness, 36(3), 363–384. https://doi.org/10.1002/agr.21643

Nyokabi, S., Birner, R., Bett, B., Isuyi, L., Grace, D., Güttler, D., & Lindahl, J. (2018). Informal value chain actors' knowledge and perceptions about zoonotic diseases and biosecurity in

Kenya and the importance for food safety and public health. *Tropical Animal Health and Production*, 50(3), 509–518. https://doi.org/10.1007/s11250-017-1460-z

Shasho, B. (2023). KAPs on milk quality and associated factors for milk contamination in selected districts of East Hararghe Zone, Oromia County, Ethiopia: A thesis proposal. Retrieved from http://meddocsonline.org/

Tegegne, A., Gebremedhin, B., Hoekstra, D., Belay, B., & Mekasha, Y. (2013). Smallholder dairy production and marketing systems in Ethiopia: IPMS experiences and opportunities for market-oriented development. *International Livestock Research Institute (ILRI)*.

Teshome, G., & Tesfaye, A. (2017). Dairy cattle milk production, handling, processing, utilization, and marketing system in Bench Maji Zone, Southwest Ethiopia. *International Journal of Livestock Production*, 8(9), 158–167. https://doi.org/10.5897/ijlp2017.0381

Teshome Aleli, A. (2023). Milk handling, hygienic practice, and microbial qualities of milk in Ethiopia. *Journal of Health and Environmental Research*, 9(4), 12. https://doi.org/10.11648/j.jher.20230904.12

Yalew, K., Pang, X., Huang, S., Zhang, S., Yang, X., Xie, N., Wang, Y., Lv, J., & Li, X. (2024). Recent developments in detection and control of psychrotrophic bacteria in dairy production: Ensuring milk quality. *Foods, 13*(18), 2908. https://doi.org/10.3390/foods13182908