African Journal of Inter/Multidisciplinary Studies 2023 | *5(1): 1-13* | *DOI: https://doi.org/10.51415/ajims.v5i1.1127*

RESEARCH ARTICLE:

Traditional Milking Hygiene Practices and their Effect on Raw Milk Quality of Rural Small-Scale Dairy Farmers in Kwa-Hlabisa, KwaZulu-Natal, South Africa

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Received: 07 December 2022 | **Revised:** 26 June 2023 | **Published:** 02 July 2023

Reviewing Editor: Dr. Francis Akpa-Inyang, Durban University of Technology

Abstract

This study examines the impact of traditional hygienic milking practices employed by rural small-scale dairy farmers on the quality of raw milk. While advancements in technology have revolutionized hygienic milk production methods for both small- and large-scale farmers, rural small-scale milk producers, particularly in countries like Zimbabwe, continue to rely heavily on hand milking as their primary method of milk harvesting. To investigate this issue, a convergent parallel mixed research approach was utilized, involving face-to-face interviews with 53 selected rural small-scale dairy farmers using a structured questionnaire. The collected data were analyzed using descriptive, frequency, chi-square, and cross-tabulation analyses. The findings revealed that participants aged 50 and above constituted the majority (58.5%) and were more likely to report low income. Additionally, households with 8 to 11 members (38%) and those with no formal education (18.9%) were also more likely to report low income. Several parameters were identified as significantly affecting milk quality ($p < 0.05$), including hand washing after milking, back leg tying, washing of milking utensils, use of towels, teat dipping, milking when sick, covering of milk, mixing of fresh and old milk, and lack of milk pasteurization before consumption. The study concludes that traditional hygiene practices contribute to milk contamination by rural small-scale dairy farmers, compromising the quality of raw milk. To support these farmers, interventions such as the provision of a dairy extension officer, practical workshops, incentives, entrepreneurial skills training, and farmer-to-farmer visits are recommended.

Keywords: *hygienic practices; milk quality; small-scale dairy farmers; traditional practice*

Introduction

Milk plays a vital role in Sub-Saharan Africa, providing employment, food security, and sustainable income for millions of people (Olofsson, 2013; Vorster *et al*., 2013). The consumption of milk and milk products is steadily increasing due to factors such as population growth, economic development, urbanization, and growing health consciousness (Al-Atiyat, 2014; Vorster *et al*., 2013). Developing countries, in particular, have seen a significant rise in milk consumption, with an annual increase of approximately 4%, as well as a 5% increase in animal meat consumption (Stoll-Kleemann and O'Riordan, 2015). In many developing nations, milk plays a crucial role in ensuring household food security by serving as a valuable source of essential nutrients and a regular income (Chitiga-Mabugu *et al*., 2013; Duguma and Geert, 2015). In many African countries, with the exception of South Africa, milk stands out as one of the most readily available food sources for small-scale rural dairy farmers (Scholtz and Grobler, 2009; Bereda *et al*., 2012). Studies conducted by Grobler in the emerging and communal sectors of South Africa have supported this finding. Market-oriented small-scale dairy farming in rural areas has been shown to contribute to increased domestic income, help offset the impact of job losses, and generate employment opportunities in processing and marketing (Chagunda *et al*., 2016; IFC, 2016). Rural small-scale dairy farming holds the potential to stimulate economic growth and alleviate poverty. Given the long-standing tradition of milk consumption in African societies, no doubt promoting rural milk production would have a significant positive impact on improving the well-being of women, children, and the overall population of the nation (Bereda *et al*., 2012).

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Milk serves as an excellent source of essential nutrients, including calcium, vitamin D, vitamin B12, and protein, all of which are crucial for maintaining a healthy body and immune system. These nutrients play vital roles in disease control and resistance to infections (Barbosa *et al*., 2015). In communities with a high prevalence of HIV, individuals may have compromised immune systems, making them more susceptible to malnutrition and infections. Consumption of dairy products can help boost their immune system and provide the necessary nutrients for maintaining overall health. Similarly, as individuals age, their nutrient requirements may increase due to changes in metabolism and digestive system functioning. Dairy products can help fulfil these heightened nutrient needs and contribute to bone health, which is essential for preventing conditions like osteoporosis (Ellis *et al*., 2019). Dairy farming, particularly in rural areas where regular income may be lacking, offers benefits beyond nutritional value. It can provide consistent returns, benefiting not only the family directly but also fostering an appreciation for and gradual adoption of savings and loan approaches (Rischkowsky and Pilling, 2007). Moreover, rural small-scale dairy farming can be successfully carried out even with limited land availability, as long as there is access to water, fodder, and basic animal health facilities and services (Bingi and Tondel, 2015).

In Bangladesh, small-scale dairy farming is a widespread practice, and many landless farmers actively engage in this sector. These farmers typically own a small number of cows or buffaloes and depend on them for milk production. However, even those without animal ownership can still participate in milk production through various means, such as renting or leasing animals or participating in cooperative dairy farming (Bennett *et al*., 2006). To achieve good milk quality, several factors come into play, including sufficient feeding, proper environmental sanitation, and hygienic milking procedures. Maintaining strict hygiene practices when handling animals is crucial for enhancing milk quality. It is recommended to thoroughly scrub the teats and teat ends using a paper towel or by applying a sanitizing solution directly onto the teats (Suranindyah *et al*., 2015). Maintaining good hygiene practices is crucial for ensuring the production of clean milk. One of the key aspects is the milker's adherence to proper handwashing using clean, warm water and soap before milking (Mora, 2012). Additionally, using disinfectants and ensuring that each animal is provided with a separate towel can further enhance milk quality. It is important to avoid coughing or sneezing over the milk container or milk itself to prevent contamination (Kazanga, 2012). Another practice to be strictly avoided is the milker dipping their hands in the milking bucket during the process to lubricate the teats. This can compromise the cleanliness of the milk. Proper sanitation and design of the milking shed also play a vital role in producing clean milk.

The cleanliness of the shed is crucial to prevent the proliferation of bacteria that can contaminate the milk during milking or cause udder infections. It is essential to have a durable and easily cleanable shed floor, preferably made of concrete, which should be regularly cleaned using disinfectants. Adequate ventilation and proper lighting are also important aspects of a well-designed shed (Bahanullah *et al*., 2013). Another significant source of milk contamination arises from the use of inappropriate or unclean milking utensils (Eromo *et al*., 2016:). Non-food-grade plastic jerry cans and buckets are particularly problematic as they can harbour microbes in cracks and crevices that develop with regular use. It is recommended to use metal containers like aluminium or stainless-steel cans, following the hygiene practices code (Deshwal and Panjagari, 2020). Basic cleaning procedures for milking utensils should be followed, including washing them after each use. Rinsing with clean, cold water helps remove milk residues from the surface, followed by cleaning with fragrance-free soap and heated water. Proper drying and storage of utensils upside down, off the ground, when not in use, are also important (Bekuma and Galmessa, 2018; Mdluli *et al*., 2014).

The lack of comprehensive documentation presents a challenge in identifying the key obstacles to successfully commercializing small-scale dairy farmers. However, it is widely believed that these obstacles encompass insufficient knowledge and skills, limited access to credit, inadequate market opportunities, land scarcity, and a lack of effective extension services. Strydom (2016) asserts that these challenges are widespread. In the Thabo Mofutsanyane district of QwaQwa, Matlou (2018) emphasizes the difficulties faced by small-scale dairy farmers in reconciling traditional cultural knowledge with the demands of a technologically advanced industry. Khapayi and Celliers (2016) argue that the South African agricultural economy offers limited prospects for the commercialization of small-scale dairy farmers, as the absence of a robust support system hinders previously disadvantaged farmers from capitalizing on government initiatives. According to Chikazunga and Paradza (2012), dedicated government support can reverse this situation. Historically, the South African government has fostered agricultural growth through consistent subsidies and support programs for commercial farmers. Therefore, this research aims to address the existing knowledge gap. The objectives of this study are twofold: (1) to describe the milking hygiene

practices of rural small-scale dairy farmers and (2) to evaluate the impact of these practices on the quality of raw milk in Kwa-Hlabisa, KwaZulu-Natal, South Africa.

Methodology

The study was conducted in Kwa-Hlabisa, located in the KwaZulu-Natal Province of South Africa. Kwa-Hlabisa falls under the Hlabisa Local Municipality, which is situated in the uMkhanyakude District Municipality in the northeastern region of KwaZulu-Natal (James and Palmer, 2015). The uMkhanyakude District Municipality includes the local municipality of Hlabisa. The location benefits from good road access, facilitating convenient transportation (James and Palmer, 2015). Hlabisa comprises the former Hlabisa and uThungulu councils and is situated at coordinates 27°7'60" north and 31°49'0" east, with an elevation of 451 meters above sea level. The population of Hlabisa is approximately 71,925 residents, residing in 13,184 households (Hlabisa municipal housing sector plan, 2009). The municipality is characterized by isolated rural communities facing significant levels of poverty. The primary land use activity in the area is subsistence agriculture, which includes limited cattle rearing and milking activities. Additionally, scattered settlements can be found throughout the municipality, alongside plantations (James and Palmer, 2015).

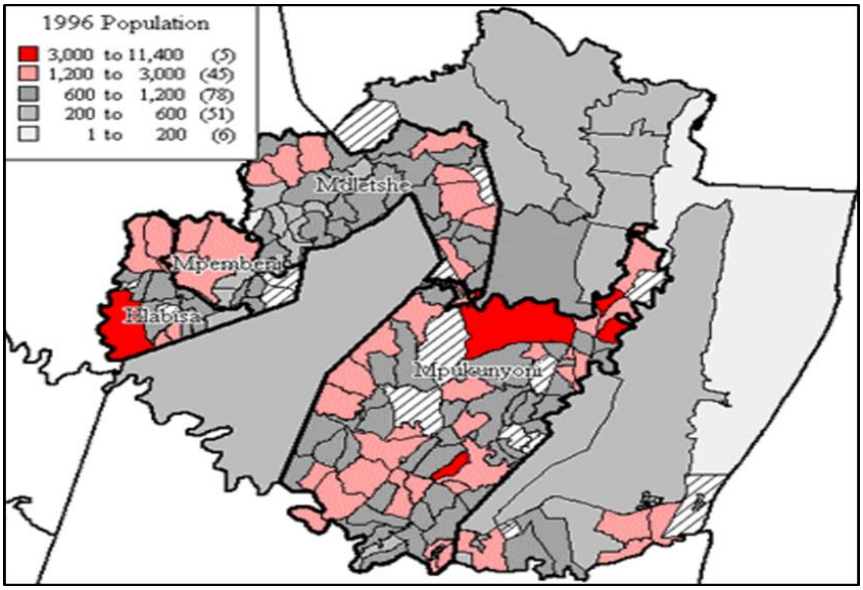

Figure 1: The Map indicating Hlabisa's traditional authority areas and wards, Hlabisa wards are indicated in red within the traditional areas.

For this study, a convergent parallel mixed research design was employed. This design enables the collection of qualitative and quantitative data simultaneously, with separate analyses conducted for each type of data, followed by an interpretation that considers the relationship between them (Yigrem *et al*., 2008). By using a convergent, parallel, mixed research design, the researcher gains a comprehensive understanding of the concepts, characteristics, descriptions, and measures related to the study issue, which may not have been achieved through a single approach (Yigrem *et al*., 2008; Msalya, 2017). The utilization of mixed research methods offers several advantages. It allows for the comparison of qualitative and quantitative findings, facilitating the identification of similarities and differences. Additionally, it ensures that participants' perspectives on the subject of study are captured. Furthermore, it provides greater flexibility in research design, enabling the collection of more comprehensive data compared to using a single approach. It is worth noting that implementing mixed research methods requires careful planning and execution, a collaborative and multidisciplinary research team committed to the success of the study, and ample time due to the labour-intensive nature of the approach (Wisdom and Creswell, 2013).

For this study, a probability random sampling technique was utilized to select households, specifically targeting 53 rural small-scale dairy farmers actively involved in dairy production. To compile a list of households engaged in dairy farming with lactating cattle, information was obtained from the local municipality of Kwa-Hlabisa. The sample size was determined by including all Kwa-Hlabisa village small-scale dairy farmers who had lactating dairy cattle at the time of data collection. Consequently, the study encompassed a total of 53 rural small-scale dairy farmers

in the village. Prior research has demonstrated that collecting a larger number of samples from small-scale, rural dairy farmers yields findings that better represent the specific region under investigation. To ensure a comprehensive understanding, a preliminary visit was conducted before the formal interviews. The purpose of this visit was to locate the farms, provide a concise overview of the research objectives, and obtain the farmers' consent.

For this study, a probability random sampling technique was employed to select households, resulting in a sample of 53 rural small-scale dairy farmers actively engaged in dairy production. The local municipality of Kwa-Hlabisa provided a list of households involved in dairy farming with lactating cattle. Prior to the formal interview process, a preliminary visit was conducted to locate the farms, provide a concise description of the research objectives, and secure the farmers' consent. Data was collected through interviews conducted in the local language by the researcher and two enumerators. A pre-tested structured and unstructured questionnaire was utilized for data collection. All interviews took place during a single visit, allowing for multiple subjects to be interviewed. The interviews encompassed various aspects, including socioeconomic and demographic characteristics, milking system details (such as frequency and hygiene practices such as hand washing of milkers, cleaning of milk utensils, and udder sanitation prior to milking), farmers' awareness of cattle and milk-borne zoonoses and transmission routes, sources of water on the farm, and housing management.

The data management and entry process utilized the Statistical Package for Social Sciences (SPSS). All collected data were coded and entered into SPSS. The analysis was conducted using version 25.0 of the SPSS computer programme. Prior to analysis, the data underwent a thorough cleaning and verification process. For the qualitative data obtained from key informant interviews, a descriptive analysis approach was employed to provide an overview and description of the data collected from the sample of rural small-scale dairy farmers. To determine the significance of relationships between the different socioeconomic characteristics of rural small-scale dairy farmers and their milking hygiene practices, the Pearson Chi-Square test was employed. A significance level of $p < 0.05$ was considered statistically significant.

Before starting the research, the study design was submitted to the Humanities and Social Science Research Ethics Committee at the University of KwaZulu-Natal (Protocol Reference No. HSS/1072/016M) for their permission and support. The nature of the study was fully explained to participants to obtain consent. Information was collected after securing consent from the study participant. Data obtained from each study participant was kept confidential, and all people who participated in the study were acknowledged. Further, no false promises such as remuneration, food, or financial aid were given.

This study answers four sub-questions: what are the socio-economic and demographic characteristics of the participants; under what conditions are their cattle housed; What hygiene practices are undertaken in relation to milking; and how do these practices affect the quality of the milk produced?

Socio-economic and demographic characteristics of the participants

Table 1 presents the socio-economic and demographic characteristics of the participants in KwaHlabisa. The findings reveal that 58.5% of the rural small-scale dairy farmers were aged 50 years and above, while only 7.9% were younger than 30. Among those interviewed, 66% were male. The participants exhibited low levels of formal education, as 18.9% had no formal education, 47.2% had only completed primary school, 32.1% had finished secondary school, and less than 2% had obtained tertiary education. Household sizes tended to be larger, with 51% of respondents indicating that their households consisted of eight or more people. In contrast, only 8% reported household sizes of four people or fewer. Regarding sources of income, the majority of participants relied on a state pension (38%), followed closely by off-farm employment (34%). Notably, 81% of the participants had more than 10 years of farming experience. In terms of land ownership, more than half of the participants (54.7%) owned between 0.5 to 1.5 hectares of land, while 5.7% possessed more than 3.5 hectares.

Table 1: Socio-economic demographic characteristics of the participants

Parameter	Category	No. of participants	Percentage (%)
Age	15-20 years	1	1.9
	21-30 years	3	5.7
	31-40 years	3	5.7
	41-50 years	15	28.3

	>50 years	31	58.5
Gender	Female	18	34
	Male	35	66
Education	No formal education	10	18.9
	Primary education	25	47.2
	Secondary education	17	32.1
	Tertiary education	1	1.9
Household size	1-3 members	4	8
	4-7 members	22	42
	8-11 members	20	38
	≥12 members	7	13
Source of income	Dairy farming	1	2
	Other agricultural duty	12	23
	Off-farm employment	18	34
	Remittance	2	4
	Pension	20	38
Farm experience	1-5 years	3	5.7
	6-10 years	7	13.2
	>10 years	43	81.1

Dairy cattle housing characteristics

The dairy cattle housing characteristics of the participants in Kwa-Hlabisa are shown in Table 2. In the study, all participants kept their cattle in the open (without roofing). The results showed that 94.3% of the floor of the milking area was covered with dung. No floors were made of concrete. Barn cleaning was not a regular practice. 51% of the participants clean their barns annually; 34% report never cleaning their barns. A small number of participants reported cleaning their barns twice a year.

Table 2: Housing characteristics of the farm

Parameter	Categories	Frequency	Percentage (%)
Floor-type	Earthen surface	3	5.7
	Cow dung surface	50	94.3
	Concrete surface	0	0
Shed cleaning	Once a year	27	50.9
	Twice a year	4	7.5
	Sometimes	4	7.5
	Never cleaned	18	34.0
Housing system	Permanently closed	0	0
	Open house	54	100

Milkers, milking and hygiene

Table 3 displays the milking methods and milking hygiene practices followed by the participants in this study. The findings reveal that the majority of farmers (79.2%) did not receive any dairy training. Among the 11 participants who did receive training, seven underwent general farm management training, two received pasture establishment training, and two received training on proper milk handling. Regarding milking responsibilities, in 50.9% of cases, family members were responsible for milking, while in 35.8% of cases, the owners themselves undertook the task. In the remaining instances, a worker or, rarely, a neighbour was assigned milking responsibilities. All milking was performed manually daily, with the majority of milkers (90.6%) tying the back legs of the animal. However, milker hygiene practices varied.

Although all participants reported handwashing, the majority (79.2%) indicated that they washed their hands with cold water only. Only 13.2% of respondents reported washing with warm water and detergent. Furthermore, while most participants claimed to wash before and after milking (83%), only 5.7% reported washing between cows. Additionally, although the majority of participants (81.1%) stated that they refrained from milking activities when they were ill, some indicated that they continued milking despite being unwell. Regarding washing teats and udders, 69.8% of participants reported doing so. However, the source of the water used for washing varied, with 62.3% using stream water, 17% using tank water, 13.2% using tap water, and 7.5% using well water.

Consequently, the quality of the water used for washing in most cases remained undetermined. Furthermore, when it came to drying teats and udders after washing, the majority of participants (86.8%) reported not using a towel at all. Only 9.4% used a common towel, while a mere 3.8% used an individual towel.

Table 3: Milking methods and hygienic milking practices followed by rural small-scale dairy farmers

Parameter	Categories	Frequency	Percentage (%)
Dairy training	Yes	11	20.8
	No	42	79.2
Type of training	General farm management	7	13.2
	Pasture establishment	2	3.8
	Proper milk handling	2	3.8
Milk responsibilities	Owner	19	35.8
	Family member	27	50.9
	Neighbour	1	1.9
	Worker	6	11.3
Milking clothes	Yes	13	24.5
	No	40	75.5
Tying of back legs	Yes	48	90.6
	No	5	9.4
Milking system	Manual system	53	100
Milking frequency per day	Once	53	100
Use of towel	Common towel	5	9.4
	Individual towel	2	3.8
	No use of a towel	46	86.8
Sources of water	Tap	7	13.2
	Well	4	7.5
	Tank	9	17.0
	Stream water	33	62.3
Udder and teat washing	Yes	37	69.8
	No	16	30.2
Washing of hands	Yes	53	100
Hand wash during milking	Before the onset of milking	6	11.3
	During milking of each cow	3	5.7
	Before the onset of milking and after the last milking	44	83
Washing hands with water/detergent	Coldwater only	42	79.2
	Warm water only	2	3.8
	Coldwater with detergent	2	3.8
	Warm water with detergent	7	13.2
Milking when milker is sick	Yes	10	18.9
	No	43	81.1

Milk storage and hygiene

Table 4 presents the milking utensils and milk-handling practices employed by the participants. The findings indicate that a majority of the participants, 79.2%, use plastic containers for collecting milk, while only 1.9% utilize stainless steel and the remaining 18.9% use wooden containers. Although 90.6% of participants wash their milk handling containers, a significant proportion (64.2%) wash them with cold water. Only 5.7% wash their containers with detergent and cold water, and merely 3.8% wash them with warm water. None of the participants reported removing or discarding the foremilk during milking. While all participants engage in milk sieving, up to 24.5% of them do not cover their milk after milking. As for milk preservation, it is accomplished through fermentation by 50.9% of participants, storage on a cool floor by 43.4%, and occasionally through smoking by 5.7%.

Table 4: Milking Utensils and milk handling practice

Parameter	Categories	Frequency	Percentage (%)
The material of milking container	Stainless-steel container	1	1.9
	Plastic container	42	79.2
	Wooden container	10	18.9
Washing of milking container	Yes	5	90.6
	No	48	9.4

Washing of milking container with water/detergent	Coldwater only	34	64.2
	Warm water only	2	3.8
	Coldwater with detergent	3	5.7
Covering of milk after milking	Yes	40	75.5
	No	13	24.5
Method of preservation	Smoking milk vessel	3	5.7
	Cooler place	23	43.4
	Ferment	27	50.9

Correlation of socioeconomic and hygiene

Table 5 below shows the overall relationships between variable socio-economic characteristics of rural small-scale dairy farmers and hygienic milking practices. The relationship indicated that socio-economic characteristics such as age, level of education, dairy herd size, family household size, source of income, and experience in milking were significant ($p < 0.05$) in improving and reducing milk quality at different levels of the milking process.

Table 5: Relationship between socio-economic variables with hygienic milking practices.

Milking Practice	P-values					
	Age	Education	Herd size	Household size	Source of income	Dairy experience
Use of PPE	0.432	0.209	0.327	0.332	0.150	0.588
Back legs tying	0.634	0.964	0.766	0.051*	0.815	0.526
Hand wash after milking	0.634	0.607	0.821	0.069	0.154	0.641
Hand wash before milking	0.000*	0.107	0.965	0.199	0.026*	0.355
Utensils material	0.594	0780	0.039	0.949	0.629	0.946
Washing of container	0.556	0.447	0.456	0.658	0.756	0.526
Washing utensils	0.001*	0.595	0.702	0.439	0.293	0.480
Source of water	0.932	0.788	0.836	0.707	0.092	0.827
Multi-use of container	0.094	0.514	0.821	0.121	0.085	0.747
Washing teat, udder	0.962	0.237	0.651	0.545	0.055	0.989
Use of towel	0.318	0.988	0.841	0.041*	0.000*	0.459
Teat dipping	0.716	0.681	0.016*	0.062	0.080	0.228
Milking when sick	0.233	0.893	0.188	0.418	0.003*	0.156
Covering of milk	0.262	0.232	0.277	0.297	0.853	0.007*
Milk storage	0.294	0.892	0.650	0.619	0.132	0.737
Transferring milk	0.510	0.888	0.223	0.580	0.168	0.747
Fresh and old mix	0.667	0.114	0.310	0.073	0.037*	0.848
Pasteurized before consumption	0.465	0.826	0.319	0.117	0.041*	0.916

*significant at p-value <=0.05

Discussion

In this study, Table 1 reveals that 58.5% of the participants engaged in dairy farming were over 50 years old. This finding aligns with a scientific report by Hu and Gill (2021:401). The literature also supports the notion that an ageing rural small-scale dairy farmer population is commonly observed in rural dairy farming (Heide-Ottosen and Vorbohle 2014; Ogola *et al*., 2015). Various factors, such as the availability of alternative professions and opportunities in higher-paying sectors, contribute to the decreased participation of the younger population (below 50 years) in rural dairy farming (Leavy and Smith 2010:7). The primary reason for low participation in full-time dairy farming among rural small-scale farmers is the absence of a commercialization plan. Most farmers produce milk solely for personal consumption, resulting in a limited engagement in income-generating opportunities (Al Sidawi *et al*., 2021). Based on the survey findings, 33% of milk producers were female, while 66% were male. This gender distribution may be attributed to the physical demands of milking duties, which are better suited for elderly male farmers who can handle large milk containers. Bereda *et al*. (2012) discovered that dairy farming offers more opportunities for women to be involved in day-to-day management compared to men. However, for optimal efficiency, dairy farming necessitates a well-coordinated division of labour, which tends to favour male farmers.

Men often undertake weekly or seasonal farming tasks such as forage planting, coordinating animal health services, and cattle feeding. Additionally, men are generally considered the owners of livestock (refer to Table 1). In traditional African societies, men hold authority over women in household matters, which restricts women's access to resources. Men inherit more substantial resources than women in rural areas, including land and livestock.

The educational background of the participants in this study varied, with a significant proportion having either no formal education (18.9%) or secondary education (32.1%), while the majority (47.2%) had completed primary education. A study conducted in Illu Aba Bora Zone, Southwest Ethiopia, also found that most household heads had received non-formal or elementary school education (Bereda *et al*., 2014). Insufficient knowledge among rural farmers, particularly regarding milking practices, can have negative effects on milk quantity and quality. Tsegaye (2016) emphasized that low levels of education within households can hinder the development of the rural dairy industry. This is evident in the low adoption rates of dairy innovations such as artificial insemination and improved pasture crops. Small-scale rural dairy farmers require additional support to improve their production and husbandry practices, with a particular focus on hygiene. The results of the study also revealed that a large majority of participants (79.2%) had not received any training in dairy farming. Only a small percentage (3.8%) reported receiving training specifically related to proper milking and clean milk handling. Seblewengel *et al*. (2017) highlighted the importance of improving husbandry practices through farmer training as a strategy to enhance competence among rural small-scale dairy farmers and promote technology adoption. Similarly, it has been documented that providing appropriate training can enhance dairy farming practices and increase the adoption of technology in resource-poor households. Ledo *et al*. (2021) stated that regular training is necessary to develop the desired level of knowledge and skills in scientific dairy farming for dairy farmers.

In addition to the aforementioned findings, it was observed that a significant proportion (75.5%) of participants in the current study engaged in milking without proper milking clothes, which can potentially have an adverse effect on the quality of the milk produced. This aligns with the research conducted by Kazanga (2012), who emphasized that dirty milking clothes or shoes can serve as a source of bacteria that can contaminate the milk. Another noteworthy observation in this study is the prevalence of daily hand milking. The method of hand milking employed can also influence the quality of the milk. This finding is consistent with the research by Olofsson (2013), who documented that rural small-scale dairy farmers in Mapepe, Choma, and Batoka districts in Zambia exclusively practice whole-hand milking without the use of lubricants. Bacteria and pathogens can potentially originate from the milker's hands, underscoring the importance of hand hygiene during the milking process. Similarly, ensuring the overall cleanliness of the cow and the immediate milking environment is crucial, as it can have implications for udder health and milk hygiene. In contrast to the findings of the current study, which revealed that dairy farmers in Hlabisa engage in once-a-day milking (ODM) due to the limited availability of family members during the day, previous research conducted by Yilma (2012) and Ayenew *et al*. (2009) reported that in Ethiopia, dairy cattle are typically milked twice daily. Yigrem *et al*. (2012) also documented a higher frequency of milking in Ethiopian urban dairy farms. The practice of ODM among rural small-scale dairy farmers in Hlabisa is influenced by factors such as low milk yield and variations in the rearing traditions of local and exotic crossbreeds. It is important to highlight the potential implications of ODM on household nutrition. As ODM does not yield sufficient milk for households with larger family sizes, it can significantly impact the availability of milk for consumption within the household. Moreover, this practice can hinder the ability of poor households to improve their livelihoods by obtaining more milk, which could contribute to better nutrition, food security, and income generation.

Milk production necessitates adherence to certain practices such as utilizing clean milking equipment, ensuring milkers wash their hands, cleaning the udder, and using separate towels to dry the udder during milking and handling (Azeze and Tera 2015). According to Kebede and Mergerrsa (2018), the majority of farmers in Jimma, Ethiopia, follow similar hygiene measures, including cleansing their hands, milk containers, udders, and teats of their livestock before milking. However, in this study, it was observed that 79.2% of participants used only cold water for cleaning, while 13.2% used warm water with detergent. Although participants reported washing their hands before and after milking, they did not wash their hands between milking different cattle. Notably, no medical evaluations of farm staff, particularly milkers, were practised in this study. However, it was found that participants refrained from milking when they were ill to prevent the transmission of diseases such as typhoid, typhus, and tuberculosis. It is crucial to emphasize the significance of implementing comprehensive hygiene practices in milk production to ensure the safety and quality of the milk.

According to best practices, it is recommended to wipe udders and teats with a single-use towel after washing. However, Yilma (2010) found that both small and large-scale dairy producers in the Ethiopian central highlands used a common towel for drying udders. Similarly, in a related study by Duguma and Geert (2015) in Jimma City, Southwestern Ethiopia, only 13% of farmers used an individual towel, which is higher than the findings of the current study. Contrary to best practices, the present study reveals that 86.8% of dairy farmers do not wipe the teats and udders or use individual towels for drying after washing (Table 5). The high percentage of farmers not practising udder wiping may be attributed to their use of dripping water on the teat as a lubricant during the milking process. It was observed that none of the farmers in the study used a lubricant during milking. It is important to note that the use of dripping water as a lubricant may be necessary for these farmers, given their practices. However, it is crucial to emphasize the importance of implementing proper udder hygiene practices to ensure milk quality and cow health.

The failure to wipe udders and teats with a single-use towel can lead to the transmission of diseases, particularly mastitis and zoonosis, to individuals who consume the milk. According to Zelalem (2012), when non-tap water is used for cleaning, it is important for producers to at least filter and heat treat the water to mitigate its impact on milk bacterial load. Kebede and Megerrsa (2018) reported that 98.9% of participants in Addis Ababa use piped water, while the remaining 1.1% use well water. However, in the current study, 62.3% of participants relied on untreated stream water as their primary source for cleaning udders, teats, hands, and milking utensils. Additionally, 7.5% used well water, 17% used tank water, and 13.2% used tap water for cleaning and washing purposes. The high percentage of farmers using stream water in this study is detrimental to milk production quality in the area. In terms of milk collection containers, the code of hygiene practices recommends using metal containers such as aluminium and stainless-steel cans, as plastic containers can harbour microbes in cracks and crevices that develop over time. Kebede and Mergerrsa (2018) reported that approximately 92.6% of farmers in Jimma collected milk using plastic buckets, while only 3.7% used stainless-steel cans. Similarly, in this study, 79.2% of participants used plastic containers for milk collection, while only 1.9% used stainless steel. Furthermore, 64.2% of participants cleaned their milk collection containers with cold water and no detergent. These findings highlight the need for improved water sources and proper container hygiene practices in milk production to ensure the safety and quality of the milk consumed.

The results of the study revealed that all participants (100%) used separate houses to keep their animals, with 94.3% utilizing cow dung-type floor sheds. This finding contradicts the findings of Kebede and Mergerrsa (2018), who reported that most participants in Addis Ababa used concrete shed floors. Table 5 presents the relationship between socioeconomic characteristics (age, education, household size, and source of income) and hygiene milking practices. Age and source of income emerged as the most significant factors when considering handwashing and utensil washing. This could be attributed to farmers primarily using their income to maintain good milking practices, ensuring high-quality milk production. Rural dairy farmers often have substantial off-farm income. Mdluli *et al*. (2014) stated that good hygiene practices are commonly associated with farmers over the age of 40. Similarly, Mdluli *et al*. (2014) discovered that older farmers exhibited better hygiene practices. Teshager *et al*. (2013) also supported this notion, stating that older participants in their study conducted in Ilu Aba Bora Zone belonged to the productive age group. Furthermore, age demonstrated a positive correlation with handwashing ($p < 0.05$) (Table 5). This could be attributed to the fact that older participants, with extensive experience in dairy farming, recognized the importance of handwashing for maintaining proper milking hygiene and obtaining high-quality raw milk.

The findings of the current study align with the literature report by Maina *et al*. (2019), indicating a large household size. Recent studies conducted in Bahir Dar Zuria revealed an average household size of 8.2 people (Duguma and Janssens 2016) and 7.2 people Mecha Woredas (Ayza *et al*., 2013). Participants in this study expressed that having a large family size was advantageous in terms of labour power for daily farm activities, such as tying the back legs of the cow before milking. There is a strong correlation ($p < 0.05$) between household size and income with towel usage. Larger families, increased involvement in agricultural activities, and division of farm labour can contribute to higher milk production and quality. The size of the herd was found to be associated ($p < 0.05$) with teat dipping. The cost of teat-dipping chemicals increases with the size of a dairy farmer's herd. Farmers may lack awareness of the importance of teat dipping for producing high-quality milk. Moreover, the dairy farming experience was found to influence milk storage practices ($p < 0.05$). Many of the elderly participants likely had more extensive agricultural experience. Table 5 demonstrates the association between income source and the blending of aged

and fresh milk, as well as pasteurization prior to consumption ($p < 0.05$). This highlights the significance of income and milk quality for rural dairy farmers.

Conclusion

This study revealed that the majority of rural small-scale dairy producers made efforts to maintain hygiene by washing milking containers and udders. However, there is a need to establish a milking standard specifically tailored for these farmers. This should be followed by capacity development and training programs aimed at enhancing the skills of farmers and pastoralists in dairy production, processing, and marketing. In future work, it is recommended to organize workshops targeting dairy cow producers to emphasize the importance of adequate udder preparation and a hygienic milking technique. This includes promoting personal hygiene practices, emphasizing the use of clean dairy utensils, and ensuring proper treatment of water to improve the hygienic quality and shelf-life of milk. The availability of clean, potable water is essential to effectively implement these hygiene practices and enhance their impact. Furthermore, interventions addressing infrastructure and enhanced input supply systems should be implemented to support the implementation of these hygiene practices effectively. This will contribute to the overall improvement of milk quality and production in rural small-scale dairy farming. A dairy extension officer is needed to assist rural small-scale dairy farmers. Hands-on practical workshops and standard operating procedures are required to ensure the optimisation of milk hygiene conditions from production to utilisation. Dairy farmers need to adopt good farming practices, including good dairy housing, the use of clean water, and sanitary milking procedures, including the use of suitable equipment, cleaning, disinfection, and post-rinsing. Rural small-scale dairy farmers must be provided with incentives for adopting practices that ensure milk safety in addition to developing a formal milk market. The presentation of this project results in small-scale dairy farmers. The government and non-governmental organisations (NGOs) should consider equipping rural small-scale dairy farmers with entrepreneurial skills to successfully benefit from the enterprise and fully participate in the South African dairy industry. More farmer-to-farmer visits should be encouraged to enable peer motivation in the application of acquired knowledge into practice. This will play a role in bridging the gap between knowledge acquisition and its application.

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