SCHOOL OF GRADUATE STUDIES

ASSESSMENT OF DAIRY CATTLE MANAGEMENT PRACTICES AND EVALUATION OF THEIR MILK MICROBIAL QUALITY AND CHEMICAL COMPOSITION IN GURAGE ZONE, CENTRAL ETHIOPIA

MSc. THESIS

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Assessment of Dairy Cattle Management Practices and Evaluation of their Milk Microbial Quality and Chemical Composition in Gurage Zone, Central Ethiopia

A Thesis Submitted to School of Graduate Studies, in Partial Fulfillment of the Requirements for the Degree of the Master of Science in Animal Production

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APPROVAL SHEET

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We hereby certify that we have read and evaluated this Thesis entitled "**Assessment o Dairy Cattle Management Practices and Evaluation of their Milk Microbial Quality and Chemical Composition in Gurage Zone, Central Ethiopia**" prepared under our guidance by Alemitu Simachew. Therefore, we recommended that the Thesis shall be submitted to the Department of Animal Science, graduate study programs fulfilling the requirements for the awards of MSc. Degree in **Animal Production**.

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As members of the board of examiners of the master of science Thesis open defense examination, we have read and evaluated this thesis prepared by **Alemitu Simachew** and examined the candidate. We hereby certify that the thesis is accepted for fulfilling the requirements for the award of the degree of Masters of Science in Animal Production.

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STATEMENT OF THE AUTHOR

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
APHA	American Public Health Association
CC	Coliform Count
CFU	Colony Forming Units
CSA	Central Statistics Agency
EACS	East African Community Standard
FMD	Foot and Mouth Disease
GLM	General Linear Model
MWARDO	Meskan Woreda Agricultural and Rural Development Office
PIC	Preliminary Incubation Count
RPM	Rotations Per- minute
SAS	Statistical Analysis Software
SE	Standard Error
SNF	Solid Nonfat
SNNPRS	Southern Nations Nationalities and Peoples Regional State
SPC	Standard Plate Count
SPSS	Statistical Package for Social Science
TBC	Total Bacteria Count

TABLE OF CONTENTS

Contents **Page**

LIST OF TABLES

Table **Page**

LIST OF TABLES IN THE APPENDIX

ABSTRACT

Milk provides essential nutrients and is an important source of dietary energy, high quality proteins and fats, but it is an excellent medium for growth of many kinds of microorganisms under suitable conditions. A cross sectional study was conducted to assess dairy cattle management practice and evaluate chemical composition and microbial quality of raw cow milk in a selected district of Gurage zone, Central Ethiopia region. Two districts were purposely selected based on their dairy cattle potential. Then the districts were stratified in to highland and midland agro-ecologies. For the survey part, data were collected using semi-structured questionnaires from a total of 373 respondents that were randomly selected based on proportionality from each kebele of the two study districts. Beside, a total of 80 milk samples were collected from the udder of the animal and storage container for microbial quality and chemical composition analysis. The current study showed that, 35.4% of the respondent in the study area were practicing natural pasture as feed source and common house with humans (91.2%). The study also revealed that, the majority of the respondents milking their cows in a barn, Washing their hands before milking, but, they are not Washing the udder before milking which was 63.5%, 83.1%, and 72.1% respectively. In addition, the majority of respondents were not practicing cleaning milk equipment, milking near the barn area and udders washing. The overall mean value of fat, protein and ash content of the milk in the study area were 4.12 ± 0.14, 3.35 ± 0.06 and 0.62 ± 0.01% respectively. Significant difference ($P<0.05$) were noted the fat and ash percentage in the milk collected from highland and midland agro ecology. The overall mean of total bacterial counts and coliform counts were 6.48 ± 0.15 and 4.98 ± 0.10 log cfu/ml respectively. Both total bacterial counts and coliform counts showed significant differences between milk collected from udder and storage containers ($P<0.05$). However, significant differences were not observed on coliform count among the different agro ecology. In general,- the result indicated that milk collected from the two districts were poor in bacteriological quality and did not meet the international milk quality standard, whereas the chemical composition was adequate about depend on Ethiopia standared level. Therefore, adequate sanitary measures and hygienic practice should be taken at all stages from washing hands before milking to storage containers of the producer.

Keywords: *Chemical Composition, Dairy Management, Microbial Quality, Raw Milk*

1. INTRODUCTION

1.1. Back Ground

Ethiopia has the largest livestock population in Africa with an estimated 70 million cattle. Female cattle make up 56% of the total population, while the remaining 44% are male. From the total population, local breed accounts about 97.4% while the remaining are hybrid and exotic breeds, which consists 2.3% and 0.3% of the total, and there are around 15.04 million heads of milking cows (CSA, 2021). Given the considerable potential for increasing smallholder income and employment generation from high value milk products, development of the milk sector in Ethiopia can contribute significantly to poverty alleviation and improved nutrition in the country (Nigus *et al*., 2017). Cattle milk is a nationally larger proportion of milk produced. But, this potential has been hampered by different challenges such as lack of improved breed, shortage of feed, shortage of quantity feed and poor performance of local breed (Yirda *et al*., 2020).

Under poor management conditions dairy cattle milk yield is generally low in Ethiopia due to lack of proper supplementary feed for the dairy cattle, poor nutritive value of pastures and forages offered to the cattle's (Bereda *et al*., 2012). The management practices such as feeding, watering, housing and health management practice of dairy animals are different from one environment to another which mainly depend on the availability of feed, water and knowledge of producers of dairy animals (Adugna and Ayalew, 2019).

Hygienic practices are the most important factor in minimizing microbial contamination to produce safe and high quality consumer products of milk. This reduces product losses and improves the position of smallholder milk producers in the sale of high quality milk and dairy products (Amistu *et al*., 2015; Zelalem, 2010). Pre-milking udder cleaning is one of the most important hygiene measures required for clean milk production. This is important because the udder of dairy cows can be in direct contact with soil, urine, manure, and feed refusal (Zelalem, 2010). In addition, as different researcher indicated hygienic practice are reduce milk quality loss due to microbial contamination. A dry milking area has significantly reduced the number of bacteria. It is because no surplus water remains on the surface of the udder to drip into the milk and due to less chance of leaching dirt and bacteria from udder, teats and hands into milk (Islam *et al*., 2009). Milk

is also highly perishable and can be easily adulterated while the quality of the milk is highly depend on farm management (Ayalew and Abatenhe, 2018).

The quality of milk is determined by hygiene and chemical composition (Parekh and Subhash, 2008). Milk is a very nutritious food that is high in vitamins, minerals, proteins, carbohydrates, lipids and active compounds having a role in health protection (Merwan *et al*., 2018; Reta *et al*., 2016). Milk protein, fat, and lactose are an important source of energy. One gram of milk fat gives 9.3 Calvin and one gram of protein and lactose gives 4.1 Calvin (Zewdu, 2015; Asefa and Teshome, 2019).

Milk yield has been emphasized for increasing the productivity of dairy animals however, milk constituents such as fat, protein, solid non-fat, lactose and lactose percentages have so far received little attention (Sudhakar *et al*., 2013). Milk composition is influenced by factors which are specific to a cow and its environment. These factors are disease (mastitis), stage of lactation, diet, the intensity of management, and ambient environmental temperature (Tassew and Seifu, 2011; Mohamed *et al*., 2023). Milk composition and production are the interaction of many elements within the cow and externals (Mohamed *et al*., 2023).

To ensure that raw milk remains fresh for a longer time, good hygiene practices are required during milking and when handling the milk afterwards (Haile, 2015). Therefore, provision of milk and milk products of good hygienic quality is desirable from a consumer health point of view. Poor hygiene of raw milk has greatly worried public health about the transmission of zoonotic disease from cow's milk to humans (Keba *et al*., 2020). To retard microbial contamination in milk and to maintain milk quality for human consumption uses cooling, boiling and pasteurization mechanisms of milk (Haile, 2015). Due to the lack of food safety regulation, and the existing limited analytical capabilities at national and regional levels, Ethiopia has yet to develop a food borne diseases surveillance system coordinated at a national level (Birke and Zawide, 2019). Therefore; this research was focused on dairy cattle management practices and evaluation of raw milk quality in selected woreda of Gurage zone Ethiopia.

1.2. Statement of the Problem

Milk plays an important role in the nutrition of consumers and high mineral content is an added value for supplying the elements necessary for the building of strong bones and

good teeth (Kebede, 2018). However, the consumption of raw milk and milk products is common in Ethiopia which is not safe from a consumer health point of view as it is good media for the growth of microorganisms. Milk is known to be an efficient vehicle for transmission of disease causing agents to humans (Garedew *et al*., 2012).

People continue to consume raw milk even though numerous epidemiological studies have shown clearly that raw milk can be contaminated by a variety of pathogens, some of which are associated with human illness and disease. In the majority of these outbreaks, the organism associated with the milk borne outbreak was isolated from the implicated products or from subsequent products made at the suspected milk or source (Oliver, 2009). The presence of food borne pathogens in milk is due to direct contact with contaminated sources in the hygienic practice and to excretion from the udder of an infected animal. Consumption of raw milk without pasteurization were results in an increased risk for exposure to bacterial food borne pathogens, such as Campylobacteriosis, salmonellosis, yersiniosis, listeriosis, tuberculosis, brucellosis, staphylococcal enterotoxin poisoning, streptococcal, and Escherichia coli (Walstra *et al*., 2006).

Poor management practice and poor hygiene practices of milkers has led to the introduction of pathogenic microorganisms into the milks and milk products. Feeding practice affects the level of chemical composition of milk. Different studies conducted so far in different part of Ethiopia shows differences in hygienic practice, microbial quality and physio-chemical properties of cow milk depending on the different factors such as; types of feed, ecology, management practice, awareness of milk handlers and others and the milk produced is out of standard limit qualities (Oumer *et al*., 2017; Saba, 2015; Alganesh, 2016; Bereda *et al*., 2012). Information about microbial level and chemical composition of milk was essential to understand the quality of produced milk (Haile, 2015).

According to the information gathered from Gurage zone Livestock and Fishery office (GZLFO, 2022), the zone has high dairy potential especially Meskan district which is the major milk producer area of the zone and distributes milk to different cities. However, there is scarcity of information about the management practice, hygienic production and chemical compositional level of milk in the district. Previous report by Bereda *et al*. (2012) showed that the quality of whole milk produced in Ezha districts of the Gurage

zone were found to be below the standard. Such hygienic problems might be also common in Meskan, Mihur Aklil and other districts of the zone. Besides, there is inadequate information about chemical composition and microbial levels of raw milk in the study areas. Hence, there is a need for information that gives a clear picture on chemical compositional level and contamination level of milk which is helpful for stakeholders to take prevention measures. Therefore, this study was undertaken in an attempt to achieve the following objectives:

1.3. Objective of the Study

1.3.1. General objective

To assess dairy cattle management practices and to evaluate raw cow milk chemical composition and microbial quality in Gurage Zone, Centeral Ethiopia.

1.3.2. Specific objectives

- To assess the management practice of dairy cattle in study area
- To evaluate microbial status of milk in study area
- To analyze the chemical composition of raw cow milk in study area

1.4. Research Questions

1. What are the management practices of dairy cattle in the study area?
2. Is the milk producer in the study area follows hygienic milk production?
3. Does milk produced from the study area meet the microbiological quality standard?
4. What does the chemical composition of raw milks look like in the study area?

1.5. Significance of the Study

Identifying and understanding major management practices may have an influence on quality on milk production or opposite to that at household level, will give important information for policy makers orany developmental interventions. It is imperative to describe and diagnose the existing hygienic practice to provide policy related information that helps to prioritize among the many possibilities depending on the relative extent of influence of milk quality determinants. More specifically, the result of the study helps concerned bodies keep hygienic practice and to raise awareness of hygienic practices of milk producer households to add milk quality in the study areas.

2. LITERATURE REVIEW

2.1. Dairy Production System in Ethiopia

Dairy production is practiced almost all over Ethiopia. Most classifications of dairy cattle production systems in Ethiopia are based on the degree of integration of livestock production with crop production, level of inputs and intensity of production, agro ecology and market orientation. Dairy production systems in Ethiopia have been classified into five; pastoral, agro-pastoral, mixed crop-livestock farming, peri-urban and urban dairying (Mengistu, 2021). Based on climate, land holdings and integration with crop production as criterion, the dairy production system classified as rural (pastoralism, agro-pastoralism and highland mixed smallholder), peri-urban and urban (Tsehay, 2001; Sintayehu *et al*., 2008). The three systems of (pastoral, agro-pastoral and highland mixed smallholder production system) are contributing about 98%, while the urban and peri-urban dairy farms produce only 2% of the total milk production of the country (Mebrate *et al*., 2019).

2.1.1. Rural dairy production system

The rural milk production system is part of a subsistence farming system that contributes for up to 98% of Ethiopia's total milk production and includes pastoralists, agro-pastoralists and mixed-culture livestock producers (Gobena, 2016; Tadesse and Yilma, 2018). The system is not market oriented and most of the milk produced in this system is only for home consumption (Tamiru and Amza, 2017). In this system dairy products are perishable and can carry zoonotic and other pathogens and toxins, making it difficult for dairy farmers to exchange in urban markets (Bekuma *et al*., 2018). In this farming system, feed requirements of cattle come from native pasture, crop residues, stubble grazing and agricultural by-products (Adebabay, 2009). Rural milk production systems rely heavily on the low productivity of indigenous Zebu cows, which can produce 400-680 liters of milk per cow per lactation period (Ararsa, 2022).

2.1.2. Per-urban dairy production system

Peri-urban dairy production systems are primarily located on the edge of urban areas, with relatively good access to city centers where demand for dairy products is extremely wanted (Alemu, 2019). In this system, milk productions are little and no market orientation depending. This sector has most of the domestic improved dairy. The main source of feed is both home grown and purchased hay, and the main goal is to generate additional cash income from the sale of milk (Mebrate *et al*., 2019).

2.1.3. Urban dairy production system

Commercial or urban dairy farming is more specialized farming practiced in the government sector and operated on a commercial basis by very few individuals. This production system is the most market-oriented production system compared to other production systems (Bekele *et al*., 2015; Asrat *et al*., 2016). These farming systems with peri-urban and urban small scale dairy farmers produce 2% of the total milk production of the country (Mebrate *et al*., 2019). Farmers use part or all of their land to grow fodder for their dairy cattle. The herd is dominated by improved/hybrid cows, the production system is market driven and milk production is for sale. According to Tsegaye *et al*. (2022), the average number of hybrid dairy cows was higher in urban than peri-urban dairy systems. It has relatively good access to inputs (such as feed) and services (such as artificial insemination) provided by the public and private sectors compared to other systems and use a centralized control system (Gobena, 2016). Concentrated feed, dietary fiber and non-conventional feed are the main feed sources used in urban dairy cattle production systems (Asrat *et al*., 2016).

2.2. Milk Production in Ethiopia

Ethiopian dairy production experienced a remarkable growth between 2000 and 2010, and has stabilized at 3,100,000 tons of milk per year (FAO, 2019). A daily milk yield of 11.6 and 10.8 liters were recorded from Bishoftu and Akaki towns, respectively, for crossbred cows (Dessalegn *et al*., 2016). Over the past ten years, milk production has typically increased in the nation. The majority of this upward tendency is related to an increase in cow populations (Zelalem *et al*.,2011). The majority of dairy processing in the nation is done by small farmers, and the hygienic standards of the products are typically poor (Zelalem and Faye, 2006). Due to its high nutritional content, milk and milk products play a significant role in consuming Ethiopia's rural and urban populations. Milk and milk products are essential for family consumption in Ethiopia, as well as serving as a source of money from the sale of goods (Bereda *et al*., 2012). Dairy hygiene is given less attention. They reported that exogenous sources of milk contamination with bacteria are very common (Shiferaw *et al*., 2015).

2.3. Dairy Cattle Management Practices

2.3.1. Feed source and feeding practice

Most urban and peri-urban farms have limited land and are situated in or near significant towns and cities. The creation of urban and peri-urban dairy farms has been prompted by the increased demand for milk among urban residents (Habib *et al*., 2007). More than two thirds of the operating expenses of commercial dairy farms in urban and peri-urban areas are related to feed. This is due to the fact that feed and fodder are constantly bought and used to stall-feed animals. In Ethiopia, natural pasture (grazing) and browsing fallow lands, Enset and stubble grazing following the crop harvest were the major feed resources (Bereda *et al*., 2014). The main feed resources to dairy cattle in the Gurage zone were natural pasture, crop residues, crop aftermath grazing, concentrate, Atela and hay. The utilization practices of dairy animals were different from one agroecology to another which mainly depended on the availability of feed resources and the purpose of keeping dairy animals (Adugna and Ayalew,2019). According to Ayeneshet *et al*. (2017); the majority of the feed system for dairy cows was free grazing with a cut and carry system in Alefa district.

2.3.2. Water source and watering practice

A dairy cow's overall water requirements are met to an extent of 80 to 90% by drinking water or ingesting free water. Different production strategies provide different amounts of water to the dairy cow (Njarui *et al*., 2014; Gebrekidan *et al*., 2012). The amount of water, additional to that from feed, a lactating cow needs depends on body size (Looper and Waldner, 2007).

Various factors, including the season, accessibility (ability to obtain), performance and/or breed of the animals (that describes the amount of water), type of major feed (dry or wet), and feeding systems, determine how frequently dairy animals need to be watered (indoor or outdoor where some water is available (Adugna, and Ayalew,2019).

2.3.3. Housing management

In our country almost all farmers in urban areas keep their cows in a separate improved housing, whereas only about half of the farmers do so in peri-urban areas of West Gojam and West Shoa zones with 40.0 % and 81.0% of the farmers in peri-urban and urban areas provide feeding and watering troughs in the barns, respectively (Gizaw *et al*., 2016).

Low bacterial counts are made possible by good management procedures, which also lower the possibility of pathogens in raw milk and lower the risk of high milk output. The protection of animals from harmful environmental effects such as excessive wind, sunlight, predators, airborne infections, and other hazards can boost milk production by lowering environmental stress (Nigus *et al*., 2017; Brourek *et al*., 2017). Cattle are kept with the family to protect them from robbers, to shield them from severe environmental threats, and to make husbandry tasks like feeding, watering, milking, and waste management easier. Unless exercise is required, dairy animals are frequently kept inside at all times. The development of different housing systems in previous decades has been driven primarily by technical innovations required by changes in cow requirements, farmer demands and environmental impact (Dekebo and Kebede, 2023).

2.3.4. Health management

One of the management aspects of dairy cattle production is health care. Unhealthy cows will take less feed and produce less milk of poor quality and sick animals can transmit diseases like; tuberculosis and brucellosis to milk consumers. Maintaining the health of dairy animals will improve production, increase profitability, and reduce harmful microorganisms (Adugna, and Ayalew, 2019). One of the main issues with dairy production or the milk production system is disease. Both cows and calves might die from disease, which also reduces milk output. Dairy farmers face significant financial difficulties as a result of several animal diseases like mastitis, ketosis, hypocalcaemia, anthrax, diarrhea, trypanosomiasis, dystocia and milk fever. Losses result from lowered milk output, calf deaths, and even dairy cows when mastitis, which affects a large portion of the dairy herd, is present (Nigus *et al*., 2017).

2.4. Milk Handling Practices

Hygienic quality of milk and milk products are necessary in all production systems to ensure good health conditions of the consumers, reduces the amount of milk products loss and will enable to compete in the international market. Any improvement in the handling and quality of milk could contribute to the insurance of public health safety while at the same time having positive economic consequences (Grimaud *et al*., 2007). Washing the udder before milking, washing the hand after milking, washing the milking utensil with hot water, source of water for cleaning milk utensils, milk utensils used for milking and milk utensils used for storages are very critical issues during milking handling practices.

According to, Bereda *et al*. (2012); proper sanitary milking practices were not followed by the majority of the respondents in Ezha and most are to wash their hands and milk vessels before milking their cows, washing of udders was not reported, majority had uses to river water (57.2%), tap water (28%) and hand dug well water (7.2%).

2.5. Measures of Milk Quality

The microbial level and chemical composition was essential to understand the quality of milk supply (Haile, 2015). Milk is a complex mixture of fat, carbohydrate, protein, minerals, vitamins and other constituents (Kumar *et al*., 2018). Nutritional as well as the economics values of milk is directly associated with solid content. The higher solid content is better for nutritional values and more milk products made (Pandy and Voskull, 2011). Milk quality implies it is free from harmful toxic substances, free from pathogenic bacteria, free from sediment, good flavor, with normal composition, low in bacterial counts, smell and adequate in keeping quality (Haile, 2015; Kumar *et al*., 2018).

2.6. Microbial Quality of Raw Cow Milk

A healthy cow's udder secretes milk with extremely little bacterial growth. Poor milking techniques, inadequate cleaning of milking equipment, inadequate cooling, and in some cases, mastitis can cause an increase in bacteria in raw milk (Yeserah *et al*., 2020). The number of bacteria and fungi in raw cow milk samples was counted using the total bacterial count, total coliform counts, spore-forming bacteria, yeast, and mold using the right media (Yeserah *et al*., 2020). Sources of microbial contamination in milk include primary microbial contamination from the infected or sick lactating animal. The secondary causes of microbial contamination occur along the milk value chain which may include contamination during milking by milkers, milk handlers, unsanitary utensils and/or milking equipment, transportation, storage of milk and water supplies used in sanitary activities. The change and contamination of milk and milk products is largely due to microorganisms. Due to microbial growth, temperature management is crucial to preventing milk modification. Since the quantity of microorganisms varies with temperature (season), it can be deduced that there are considerable differences between summer and winter in the overall number of coliforms and *E. coli* (Adugna and Eshetu, 2021).

Table1 . Microbial load of cow milk in different area

No.	TBC (log10 cfu/ml)	TCC (log10 cfu/ml)	Source	Study area
1	7.58	4.49	Asaminew and Eyassu, 2010	BahrDar zuria
2	5.67	4.67	Babege *et al.*, 2020	Cheha district
3	7.09	5.1	Teshome and Tesfaye, 2016	Benchi Maji
4		5.48	Zewdu, 2015	Sidama
5	6.98	4.49	Haile, 2015	West Shoa Zone
6		4.18	Birhanu *et al.*, 2022	North Shewa
7	9.8	4.03	Bereda *et al.*, 2012	Ezha district

TBC: Total Bacteria Count, TCC: Total Coliform Count, cfu: colony forming unit, ml: milliliter

2.7. Sources of Microbial Contamination of Raw Milk

2.7.1. Microbial contamination from interior of the udder

Raw milk typically includes extremely few germs when it leaves the udder of healthy cows, and typically has less than 1000 total bacteria per milliliter (Gülzari *et al*., 2020). The teat cistern, teat canal, and teat apex of healthy cows may be colonized by a variety of microorganisms, but the total number of microorganisms in bulk milk and the potential increase in bacterial numbers during refrigeration are not thought to be significantly influenced by microbial contamination from within the udder of healthy animals (Gülzari *et al*., 2020). In general, the cow's natural flora has no effect on bacteria. A cow with mastitis has the potential to shed significant amounts of germs into the milk supply, despite the fact that a healthy udder should contribute very little to the overall bacteria count of bulk milk. The type of microorganisms that cause mastitis, the stage of the infection, and the proportion of the herd that is sick all affect the overall number of germs in bulk milk (Zewdu, 2015).

2.7.2. Microbial contamination from exterior of the udder

Both bacteria produced from the environment in which the cow is housed and milked as well as those linked naturally with the animal's skin can be found on the outside of the udder and teats of cows (Ebissa and Aki, 2017). The majority of these microorganisms do not grow competitively in milk; therefore, the direct impact of natural inhabitants as

contaminants on the overall mass milk count is generally regarded as being small. The contribution of germs from teats contaminated with dung, mud, feeds, or bedding is more significant (Haile, 2015). When cows are left in muddy barnyards or lay in stalls, their teats and udders naturally get dirty.

Used bedding has been found to contain a significant amount of germs. Frequently, total counts per gram reach 108-1010 (Velázquez *et al*., 2019). Staphylococci, streptococci, spore-formers, coliforms, and other Gram-negative bacteria are among the organisms connected to bedding materials that contaminate the surface of teats and udders (Teresa *et al*., 2019).

According to Fusco *et al*. (2020), bacteria from the exterior of the udder can contaminate from the teat surfaces by producing both thermoduric and psychotropic strains. The amount of soiling on the teat surface and the washing techniques utilized right before milking determine the impact of unclean cows on total bacterial counts. In general, the amount of germs in milk that are provided by unclean teats can be reduced by thoroughly washing the teat with a sanitizing solution (spray, wet towel or dip) followed by thoroughly drying with a clean towel.

2.7.2.1. Influence of handling and equipment cleaning

The cleanliness of the milking apparatus likely has an equal or greater impact on the overall number of bacteria in bulk milk than any other aspect (Gülzari*et al*., 2020). Various germs can grow on milk found in the epidermis and teat canal do not considerably multiply when milk is stored in a refrigerator or on contaminated milk contact surfaces. Poor quality water used on the farm may potentially be a source of microorganisms, particularly psychrotrophs that could contaminate milk or contaminated equipment (Kailasapathy, 2015). By leaving behind milk residues that encourage development and by creating conditions that may favor particular microbial groups, cleaning and sanitizing techniques can affect the level and type of microbial growth on milk contact surfaces (Zewdu, 2015).

2.7.2.2. Milk storage temperature and time

While preventing non-psychotropic bacteria from growing, refrigeration storage will favor psychotropic microbes that enter milk through unclean cows, dirty equipment, and the environment (Kailasapathy, 2015). In order to avoid psychrotrophs in the bulk tank

during storage on the farm or at the dairy plant, it is important to reduce the amount of milk contamination from these sources. Psychrotrophs multiply the longer raw milk is stored before processing (potentially up to 5 days; 2 days on the farm, 3 days in the plant). Milk held at 7.2°C, the legal limit, can grow much more quickly than milk stored at 4.4°C (Gehringer, 1980). The milk is stored at high temperatures for a long time, the bacteria will grow and divide very fast and the milk will have a very high number of bacteria and milk will spoil quickly (Lore *et al*., 2006).

2.7.2.3. Water source for cleaning purpose

Types of water for cleaning milk equipment were very important for milk quality treatment. Cleaning with water from non-tap sources might result in milk and milk products of lower quality. The minimum farmers should be required to prepare water for usage is filter and heat treatment (Zelalem, 2010) since the quality of water affects many germs present in milk. Producers should at the very least filter and heat treat non-tap water before using it for cleaning purposes (Zelalem, 2009).

2.8. Chemical Composition of Raw Cow Milk

The nutritional values of milk for consumers are very important for health and economic importance of milk composition for milk producers and processors. Milk's solid components make it a significant food item from a processing and nutritional standpoint. The two most crucial elements of the various types of shelf-stable milk products are milk fat and protein. Determining the primary chemical components of milk is essential because it forms the foundation for additional processing to create products that are more shelf stable. Moreover, knowledge of the total solids and solids-not-fat content of milk is necessary when it is sold for liquid consumption. Normal cow’s milk contains approximately 87.4% water and 12.6% milk solids (Goff, 2010). The solids consist of 3.9% fat, 3.2% protein, 4.6% lactose and 0.9% others like minerals and vitamins (FAO, 1986).

The average percentages of the components of milk change depending on the species and breeds of the animals, the season, the meals, the party, the lactation stage, and the physiological condition of a specific animal. Depending on diet and climate, the composition can sometimes even change day to day, however during milking; the initial milk and the last milk drop have different compositions. Milk is a great source of

vitamins, minerals including calcium and phosphorus, and high-quality protein (Pandey and Voskuil, 2011).

Table 2. Nutrient composition percentage (g/100g) of raw cow milk

No.	Fat (%)	Protein (%)	Ash (%)	Source	Area
1	6.05	3.3	0.7	Nwanneka and Fekadu, 2007	East Wollega
2	6.3	4	0.8	Gemechu and Amene, 2016	Bench Maji
3	4.2	3.5	0.78	Abdissa *et. al*., 2020	Abuna Gundeberet
4	3.76	3.1	0.6	Gemechu, 2016	Central Highlands of Ethiopia
5	4.5	3.3		Mitku *et. al*., 2020	Haramaya

3. MATERIALS AND METHODS

3.1. Description of the Study Areas

The study was conducted in two districts of Gurage zone, namely; Mihur Aklil and Meskan district. Gurage zone is found in the Central Ethiopia Region. The zone is located between from South to North 7.76^{o} -8.45^{o} latitude and from West to East 37.46^{o} -38.71^{o} longitude. The altitudes range from 1,001 to 3,500 meters above sea level.

Meskan district is the first study located 130 kilometers south of Addis Ababa. Buta Jira town is the capital city of the district. About 80% of the Meskan woreda lies under mid land and the remaining 20% is characterized by highland agro climates having the altitude range of 1501m-3500m elevation above sea level. The average annual temperature of the woreda ranges from 10.5 to 17.5°C and its average annual rainfall ranges from 1000 to 1200mm (MWARDO, 2014). The district consists of 30 peasant associations, 65 private herders and two agro-industries. The total milking cows of the district is estimated to be 34,198 (Asayehegn *et al*., 2021).

Mihur-Aklil is the second study site located at 193 km south west from Addis Ababa. Hawariat is the capital city of the district with a latitude and longitude of 370 52 00'to 380 1800 East and 807 00' to 8020 North's, elevation ranges from 1712 - 3467 meter above sea level (Sahle *et al.,* 2018).

The total land area of the Mihur-Aklil district is estimated to be 473km^2 and it constitutes 32 kebeles (the lowest administrative unit) of which 29 are rural and 3 rural town kebeles. The agro-ecology of the district is 53%- Woina-dega, 40%-Dega and 7%-Wurch. The mean annual temperature is 11ºC- 22ºC and annual rainfall ranges between 1000-1400 mm (MADDPCO, 2020).

3.2. Study Period

The study was conducted from December 2022 to June 2023 to assess dairy cattle management practices and evaluate raw cow milk chemical composition and microbial quality in the study area. Farmers involved in the study were those owing at list one lactating cow.

3.3. Study Design

A cross sectional study was conducted by way of questionnaire survey focusing on the dairy cattle management practices and hygienic practices (housing and cleaning of barn, frequency of cleaning milk containers, washing of udder and milking equipment, water source). Furthermore, the management practices were assessed through observation of the incorporation of recommended husbandry packages applied for each household and chemical composition and microbial quality laboratory analysis of milk sample.

3.4. Study Population

The study animals were indigenous lactating cows that were found in both study districts in different agro ecology. Households having own at least one dairy cow were included for survey data collection on dairy cattle management practice and milk hygiene handling practice.

3.5. Sampling Technique and Sample Size Determination

3.5.1. Sampling Technique

A multi-stage sampling technique was used for this study. According to the un- published reported document of Gurage zone livestock and fishery office (2022); Meskan and Mihur-Aklil district are the highest dairy cattle potential and milk producer areas of Gurage zone. Hence, in the First stage, the two study districts were selected purposely based on higher dairy cattle availability. In the second stage, the two districts were stratified as highland and midland based on agro-ecologies and 2 kebeles were selected purposively based on higher dairy cattle availability from each agro-ecology of the two districts, in Meskan highland area (Goyban and Yetebon) in Meskan midland area (Mekich and Wolinsho two) and in Mihur Aklil highland area (Yekote and Furcha) in Mihur Aklil midland area (Ginab and Wukiye). In the last stage, a total number of 373 respondent households were selected using simple random sampling techniques.

3.5.2. Sample size determination

To determine the appropriate sample size, the basic factors to be considered and the level of precision required by users, the confidence level desired and degree of variability. Thus, it was determining the sample size of household population from the sample districts. They require the respondent sample size number to apply a simplified scientific formula provided by Yemane (1967) with 95% confidence level with degree of variability of 0.05 level of precision. The total number of household in the study area in the sum of

household in each kebele (Mekich= 709, Wolinsho two= 578, Goyban= 1050, Yetebon= 951, Yekote= 582, Furcha= 337, Ginab= 695 and Wukiye= 763) giving a total number of 5665. Thus, the sample size for survey data is calculated below according to the Yemane (1967) formula.

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

$$n = \frac{5665}{1 + 5665 * 0.05^2} = 373$$

Where; n = sample size,

N = total number of household in study area (5665),

e = level of precision (0.05 %)

For using proportional allocation, the respondent sample size for different kebele was using a formula by Kothari (2004):

$$ni = n(pi/N)$$

Where, N= total household in eight study kebeles,
n= total sample size,
n_i= sample size for individual kebele and
Pi= number of household in individual kebele
Total household= 5665, total sample size =373,
For example, sample sizes for Meqich (n_1) =$373\left(\frac{709}{5665}\right) = 47$, similarly, the sample size for the rest kebeles are Wolinsho two = 38, Goyban = 69, Yetebon = 63, Yekote = 38, Furcha = 22, Ginab = 46 and Wukiye = 50

3.6. Methods of Data Collection

This study had two parts: Questionnaire survey and Milk sampling for laboratory analysis.

3.6.1. Questionnaire survey

For this study, both primary and secondary data sources were used. The primary data was collected from respondents through semi-structured questionnaires to get comprehensive and reliable information on hygienic practice of milk and management of dairy cattle in the study area. Secondary data were gathered from various sources such as; records, zone

agriculture office, internet sources, reports of both governmental and non-governmental organizations.

3.6.2. Milk sampling

Milk samples were collected from directs the udder of the cow and milk containers of the producer based on the result of the preliminary survey.

For chemical composition and microbial level of milk analysis; the total 80 milk samples were collected. In the past different studies were condacted in different areas by taking different sample sizes for microbial level and chemical composition level analysis. For example; Teshome and Tesfaye (2016) used for 45 milk samples, Yirda *et al*. (2020) and Tola *et al*. (2007) used for 60 milk samples, Gemechu (2016) used for 108 milk samples and other reporters used different samples. So, in this study believe that 80 milk samples give the precise information for microbial level of milk test. For chemical composition analysis 40 milk samples were collected from the udders of the cow. All the milk samples were collected using sterile sampling bottles and properly labeled with all the necessary information. The samples were stored in an icebox containing ice packs during transportation and kept 4^{o}C in the refrigerator until the time of analysis.

Table 3. Number of milk sample collected from two study districts

District	Agro-ecology	Kebele	Udder	Storage container	Total
Meskan	Mid land	Wolinshow2	5	5	10
		Meqich	5	5	10
	High land	Goyban	5	5	10
		Yetebon	5	5	10
	Sub total		**20**	**20**	**40**
Mihur-Aklil	Mid land	Ginab	5	5	10
		Wukiye	5	5	10
	High land	Yekote	5	5	10
		Furcha	5	5	10
	Sub total		**20**	**20**	**40**
Total			**40**	**40**	**80**

3.7. Laboratory Analysis of Milk

Laboratory analyses were carried out at Holetta dairy microbiology laboratory for microbial and chemical composition analysis. For bacterial quantities of raw milk total bacteria count (TBC) and coliform count (CC) tests were conducted and chemical composition of the milk was also tested fat, protein and ash contents.

3.7.1. Microbial quality of milk

Coliform count: One ml of the milk sample was poured into 9 ml peptone water for initial dilution and by transferring 1 ml of the previous dilution into 9 ml of peptone water. After surface plating the appropriate dilution in duplicates on Violet Red-Bile Agar, Petri dishes were incubated at 32°C for 24 hours and counts were made on typical dark red colonies normally measuring at least 0.5 mm in diameter on uncrowned plates (Richardson, 1985). All plate counts were expressed as the number of colony forming units (CFU) per milliliter.

$$N = \frac{\Sigma C}{(1 \times n1) + (0.1 \times n2)} \times d$$

Where, N = Number of colonies per ml of milk sample,

ΣC = Sum of all colonies on plates counted,

n1 = Number of plates used in lowest dilution counted,

n2 = Number of plates used in highest dilution counted and

d = dilution factor of the lowest dilution used.

Total bacterial count: For total bacterial count (TBC) was expressed as the number of organisms of colony forming units per ml (CFU/ml) of samples; appropriate decimal dilutions that would give the expected total number of colonies between 30 and 300 colonies was selected. The molten standard plate count (SPC) agar was cool to 45˚C after sterilization before pouring into the Petri dish. 1 ml of milk sample was added into a sterile test tube containing 9 ml of peptone water up to serial dilution of 10^{-6} and mixed thoroughly. Total bacterial count was made after incubating surface plated duplicate decimal dilutions of milk samples at 37˚C for 48 hours. Finally, colony count was made using the colony counter (Richardson, 1985).

3.7.2. Chemical compositions of milk

Physio-chemical properties of milk samples fat content, protein content and ash content were determined with calibrated milk analyzer (lactoscan) method. The milk samples were put in a test tube, and the Lactoscan was inserted into the milk for one minute, and it displayed the result on the reading plate.

3.8. Inclusion and Exclusion Criteria

Inclusion criteria: for the survey household has the following: the households that own at least one milking cow during the study time, willing to require information through questionnaires and availability of milk during the survey.

Exclusion criterion: for households has: those households were not around during the study, unwilling to give required milk, unable to give the required information and absence of milk during the survey.

3.9. Data Analysis

The qualitative and quantitative data were summarized in to Microsoft excel spread sheets and analysis using SPSS (statistical package for social science, version 25). Descriptive statistics were employed to describe frequency, mean value and percentages of respondents. Data from microbial level were first transformed to logarithmic values (log 10) before statistical analysis. Then, the data on chemical composition and the transformed microbial count values were analyzed using the General Linear Model (GLM) procedure of SAS (Statistical Analysis Software, version 9.4). Mean comparison was carried out using the Least Significant Difference technique when analysis of variance shows significance differences between means and differences were considered significant at $p < 0.05$.

The following model was used for the analysis of the chemical composition and microbial quality of milk:

$$Yij = \mu + \alpha i + bj + eij$$

Where, Yij = individual observation for each test,

μ = the overall mean,

α_i= the effect of agro-ecology,

bj= the effect of milk sources, and

e_{ij} = the error term.

4. RESULTS

4.1. Household Characteristics

The respondents' demographic characteristics are presented in Table 4. The majority of respondents (90.3%) were males while the remaining (9.7 %) respondents were female. The highest age proportions of the respondents ranged from 40-60 years (39.7%). However, the age category 31 to 45, more than 60 and age category 18 to 30 years were 25.7%, 25.5% and 9.1% respectively. The marital status in the current study indicated that the majority of the respondents were married (89.0 %) while the rest were single (7.8%), divorced (1.9 %) and widowed (1.3%). The educational status of the study showed the majority of the respondents were illiterate which covers 40.5% of the respondents and only 4.3% of the respondents attended high school education.

Table 4. Household characteristics of the respondents in the study area

Variable	**High land (N=192)**					**Mid land (N=181)**					**Overall**	
	Meskan(n=132)		**MihurAkli l (n=60)**		**Total (192)**	**Meskan (n=85)**		**MihurAkl il (n=96)**		**Total (181)**	**Mean (N=373)**	
Sex	N	%	N	%	%	N	%	N	%	%	N	%
Male	117	88.6	54	90.0	89.1	78	91.8	88	91.7	91.7	337	90.3
Female	15	11.4	6	10.0	10.9	7	8.2	8	8.3	8.3	36	9.7
Age category												
18-30	15	11.4	6	10.0	10.9	9	10.6	4	4.2	7.2	34	9.1
31-45	40	30.3	15	25.0	28.6	22	25.9	19	19.8	22.7	96	25.7
46-60	53	40.2	23	38.3	39.6	34	40.0	38	39.6	39.8	148	39.7
>60	24	18.2	16	26.7	20.8	20	23.5	35	36.5	30.4	95	25.5
Marital status												
Single	11	8.3	2	3.3	6.8	7	8.2	9	9.4	8.8	29	7.8
Married	117	88.6	56	93.3	90.1	77	90.6	82	85.4	87.8	332	89.0
Divorced	3	2.3	1	1.7	2.1	1	1.2	2	2.1	1.7	7	1.9
Widowed	1	0.8	1	1.7	1.0	0	-	3	3.1	1.7	5	1.3
Education												
Illiterate	49	37.1	25	41.7	38.5	37	43.5	40	41.7	42.3	151	40.5
Read and write	38	28.8	15	25.0	27.6	19	22.4	22	22.9	22.7	94	25.2
Primary school	30	22.7	13	21.7	22.4	17	20.0	15	15.6	17.7	75	20.1
Junior	10	7.6	6	10.0	8.3	9	10.6	12	12.5	11.6	37	9.9
High school	5	3.8	1	1.7	3.1	3	3.5	7	7.3	5.5	16	4.3

4.2. Feeding and Watering Practice

The results of dairy cattle feed resources, water source and frequency of watering of cows in the study areas are presented in Table 5. According to this study, the feed sources for dairy cattle in the study area were natural pasture (35.7%). The remaining feed sources were crop residue (19.8%), hay (10.7%), enset leaves and stems (30.8 %) and concentrated feed (2.7%). However, there is variation in the use of natural pasture as feed source in the different agro ecology as indicated in Table 5. The majority of the respondents (78.0%) in the current study area had access to river water followed by Pond (16.9%) and tap water (5.1%). According to the survey most of the respondents (44.5%) delivering water for their dairy cattle twice a day.

Table 5. Feed sources and watering practice in the study area

Variables	High land(N=192)					Mid land(N=181)					Overall Mean (N=373)	
	Meskan (n=132)		MihurAkl il (n=60)		Total (192)	Meskan (n=85)		MihurAkl il (n=96)		Total (181)		
Major Feed Source	N	%	N	%	%	N	%	N	%	%	N	%
Natural pasture	39	29.5	19	31.7	30.2	38	44.7	37	38.5	41.4	133	35.7
Crop residue	26	19.7	13	21.7	20.3	15	17.6	20	20.8	19.3	74	19.8
Concentrate feed	4	3.0	3	5.0	3.6	1	1.2	2	2.1	1.7	10	2.7
Hay	16	12.1	11	18.3	14.1	5	5.9	9	9.4	7.7	41	11.0
Enset leaves and steams	47	35.6	14	23.3	31.8	26	30.6	28	29.2	29.8	115	30.8
Sources of Water												
River	104	78.8	52	86.7	81.3	64	75.3	71	74.0	74.6	291	78.0
Pond	21	15.9	5	8.3	13.5	19	22.4	18	18.8	20.4	63	16.9
Pipe water	7	5.3	3	5.0	5.2	2	2.4	7	7.3	5.0	19	5.1
Frequency of Watering												
Roam freely	23	17.4	11	18.3	17.7	10	11.8	15	15.6	15.8	59	15.8
Once a day	35	26.5	9	15.0	22.9	28	32.9	24	25.0	25.7	96	25.7
Twice a day	57	43.2	31	51.7	45.8	36	42.4	42	43.8	44.5	166	44.5
Three/day	17	12.9	9	15.0	13.5	11	12.9	15	15.6	13.9	52	13.9

4.3. Types of housing and cleaning practices

In the present study, 91.2% of the respondents share a house with humans (Table 6). About 36.5 % of the respondent's clean their dairy barns every day, while 26.3% clean two times per a week. The remaining 19.6 % of the respondents clean the dairy barn one time per a week and 17.7% greater than two times per a week.

Table 6. Types of dairy barn and barn cleaning frequency in the study area

Variables	**High land (N=192)**					**Mid land (N=181)**					**Overall**	
	Meskan(n=132)		**MihurAkli l (n=60)**		**Total (192)**	**Meskan (n=85)**		**MihurAkl il (n=96)**		**Total (181)**	**Mean (N=373)**	
	N	%	N	%	%	N	%	N	%	%	N	%
Types of dairy barn												
Separate / fenced	9	6.8	3	5.0	6.3	12	14.1	9	9.4	11.6	33	8.8
Common house with humans	123	93.2	57	95.0	93.8	73	85.9	87	89.6	88.4	340	91.2
Frequency of cleaning barn												
Every day	54	40.9	21	35.0	39.1	33	38.8	28	29.2	33.7	133	36.5
One time/week	28	21.2	12	20.0	20.8	15	17.6	18	18.8	18.3	73	19.6
Two times per a week	21	15.9	19	31.7	20.8	25	29.4	33	34.4	32.0	98	26.3
>Two times/week	29	22.0	8	13.3	19.3	12	14.1	17	17.7	16.0	66	17.7

4.4. Dairy Cattle Disease and Health Care

According to this study, the respondent indicated the most predominant dairy cattle disease in the study area were FMD (32.7%), while about 21.7%, 14.2%, 13.4%, 11.8% and 6.2% of the respondents reported that diarrhea, anthrax, tick, mastitis and Liver fluke

disease, respectively. The study also showed that the majority of the respondents (83.1%) treat cattle health problems with veterinary drugs, while the rest 16.9 of the respondents' manage the health problem with traditional medicine available in the locality. About 51.5% of the respondents reported to vaccinate their animals (Table 7)

Table 7. Disease and health management in the study area

Variables	**High land(N=192)**					**Mid land(N=181)**					**Overall**	
	Meskan (n=132)		**MihurAkil (n=60)**		**Total (192)**	**Meskan (n=85)**		**MihurAkil (n=96)**		**Total (181)**	**Mean (N=373)**	
	N	%	N	%	%	N	%	N	%	%	N	%
Treatment of sick animal												
Veterinary drug	126	95.5	45	75.0	89.1	75	88.2	64	66.7	76.8	310	83.1
Traditional method	6	4.5	15	25.0	10.9	10	11.8	32	33.3	23.2	63	16.9
Types of disease												
FMD	45	34.1	16	26.7	31.8	32	37.6	29	30.2	33.7	122	32.7
Anthrax	23	17.4	4	6.7	14.1	17	20.0	9	9.4	14.4	53	14.2
Diarrhea	29	22.0	15	25.0	22.9	16	18.8	21	21.9	20.4	81	21.7
Mastitis	9	6.8	11	18.3	10.3	8	9.4	16	16.7	13.3	44	11.8
Tick	17	12.9	10	16.7	14.1	7	8.2	16	16.7	12.7	50	13.4
Liver fluke	9	6.8	4	6.7	6.8	5	5.9	5	5.2	5.5	23	6.2
Vaccination status												
Yes	75	56.8	34	56.7	56.8	47	55.3	36	37.5	45.9	192	51.5
No	57	43.2	26	43.3	43.2	38	44.7	60	62.5	54.1	181	48.5

4.5. Hygienic Practices During Milking

4.5.1. Milking and milk handling practice

In this study, about 47.5% of the total respondents used river/ stream water for cleaning purposes (udder, milk equipment and hand), while 30% and 22.5% of them used hand dug wells and piped/ tap water respectively (Table 8). The majority (86.1%) of the respondents wash hands before milking, while the rest 13.9% did not wash their hands. In the current study about 72.1% of the respondents did not wash udder before milking and the rest 27.9% of the respondents washed udder before milking.

According to the survey, most of the respondents milk their animals in a barn (63.5%), while the rest practice milking outside in the open air and in a separate milking barn. In this finding 41.2%, 29.0% and 29.8% of the respondents had washed utensils used for milking practice daily, two times a day and two day intervals respectively (Table 8)

Table 8. Milk hygienic practices of households in the study area

Variables	High land(N=192)					Mid land(N=181)					Overall	
	Meskan (n=132)		MihurAkl il (n=60)		total 192	Meskan (n=85)		MihurAkl il (n=96)		total 181	Mean (N=373)	
Source of water used for cleaning	N	%	N	%	%	N	%	N	%	%	N	%
Piped/ tap	33	25.0	16	26.7	25.5	20	23.5	15	15.6	19.3	84	22.5
River/ stream	54	40.9	23	38.3	40.1	38	44.7	62	64.6	55.2	177	47.5
Hand dug well	45	34.1	21	35.0	34.4	27	31.8	19	19.8	25.4	112	30.0
Milked area												
In barn	79	59.8	45	75.0	64.6	52	61.2	61	63.5	62.4	237	63.5
Open air	38	28.8	12	20.0	26.0	15	17.6	20	20.8	19.3	85	22.8
Separate milking barn	15	11.4	3	5.0	9.4	18	21.2	15	15.6	18.2	51	13.7
Wash hands before milking												
Yes	120	90.9	51	85.0	89.1	71	83.5	79	82.3	82.9	321	86.1
No	12	9.1	9	15.0	10.9	14	16.5	17	17.7	17.1	52	13.9
Udder wash before milking												
Yes	33	25.0	10	16.7	22.4	26	30.6	35	36.5	33.7	104	27.9
No	99	75.0	50	83.3	77.6	59	69.4	61	63.5	66.3	269	72.1
Wash utensils												
Daily	57	43.2	24	40.0	42.2	39	45.9	34	35.4	40.3	154	41.2
Twice a day	42	31.8	22	36.7	33.3	16	18.8	28	29.2	24.3	108	29.0
Two day interval	33	25.0	14	23.3	24.5	30	35.3	34	35.4	35.4	111	29.8

4.5.2. Sanitary practice and milking containers

The results of type of milk bucket and type of water for cleaning of utensils in the study area presented in Table 9. The present study indicated that 39.6% of the respondents use warm water for cleaning of utensils. In addition, 22.9%, 22.9% and 14.6% of the respondents used cold water, water and soap and both alternatives respectively whereas

the 39.6% of respondents used warm water in high land and 31.5% in midland areas. According to the survey, the respondents that use water and soap were 22.9% and 29.8% in highland and midland areas, respectively. Most of the respondents (56.6%) used a plastic jar as a milk bucket, while the rest 28.7% used a traditional pot and 14.7% used an aluminum/ steel milk bucket.

Table 9. Types of water for cleaning utensils and types of milking container

	High land(N=192)					**Mid land(N=181)**					**Overall**	
Variables	**Meskan (n=132)**		**MihurAkl il (n=60)**		**total 192**	**Meskan (n=85)**		**MihurAkl il (n=96)**		**total 181**	**Mean (N=373)**	
Types of water	N	%	N	%	%	N	%	N	%	%	N	%
Warm water	50	37.9	26	43.3	39.6	24	28.2	33	34.4	31.5	133	35.7
Cold water	31	23.5	13	21.7	22.9	23	27.1	15	15.6	21.0	82	22.0
Water and soap	32	24.2	12	20.0	22.9	23	27.1	31	32.3	29.8	98	26.3
Both alternative	19	14.4	9	15.0	14.6	15	17.6	17	17.7	17.7	60	16.1
Milk bucket												
Plastic	66	50.0	37	61.7	53.6	52	61.2	56	58.3	59.7	211	56.6
Aluminum /steel	24	18.2	7	11.7	16.1	13	15.3	11	11.5	13.3	55	14.7
Traditional pot	42	31.8	16	26.7	30.2	20	23.5	29	30.2	27.1	107	28.7

4.6. Chemical Composition of Raw Cow Milk

The composition of fat content, ash content and protein content of raw cow milk in the study area is presented in Table 10. Average total mean value of fat content in the milk sample was 4.12 ± 0.14%. Statistically significant differences ($P < 0.05$) were noted among the fat content of raw cow milk from highland and midland agro ecology. In this study, the mean value of ash content of milk was 0.62 ± 0.01%. Significance differences ($P < 0.05$) were observed on the ash content of the milk collected from highland and

midland areas. The overall mean of protein contents of raw cow milk samples was 3.35 ± 0.06 %. The average protein contentof milk samples obtained from highland and midland areas were 3.45 ± 0.10 and 3.24 ± 0.06 %, respectively. Statistical analysis showed that there was no significance difference (P > 0.05) within the protein content of highland and midland agro-ecology.

Table 10. Chemical composition of raw cow milk in the study area (mean ± SE)

Variables	**Agro Ecology**		**Overall mean**	**P-value**
	High land (n=20)	**Mid land (n=20)**	**(n=40)**	
Fat	3.76 ± 0.21^{a}	4.51 ± 0.16^{b}	4.12 ± 0.14	0.007
Protein	3.45 ± 0.10	3.24 ± 0.06	3.35 ± 0.06	0.077
Ash	0.60 ± 0.01^{a}	0.63 ± 0.01^{b}	0.62 ± 0.01	0.015

Means followed by different superscript letters within a row are significantly different (P < 0.05), n= number of samples

4.7. Microbial Quality of Raw Cow Milk

The total bacteria count (TBC) of milk samples collected from different milk sources in two agro ecologies is presented in Table 10. In this study, the mean value for total bacteria count was 6.48 ± 0.15 log 10 cfu/ml. On the other hand, the mean of total bacteria count of milk from highland and midland agro ecology were 6.77 ± 0.28 log 10 cfu/ml and 6.18 ± 0.20 log 10 cfu/ml respectively. There was a significant difference (P < 0.05) on the total bacterial count of the milk collected from the midland and highland areas. According to the result obtained, total bacteria counts were significantly different (P < 0.05) betwen two different milk sample sources. The mean total bacteria count of milk collected from storage containers and directly from the udder of the cow was 7.34 ± 0.19 log 10 cfu/ml and 5.61 ± 0.14 log 10 cfu/ml, respectively.

In the current study from a total of 80 milk samples tested for total coliform count, the overall mean count was 4.98 ± 0.10log 10 cfu/ml. The mean of total coliform count of milk from highland and midland study areas was 4.91 ± 0.21 log10 cfu/ml and 5.05 ± 0.12 log10 cfu/ml respectively. Significant variation was not observed (P > 0.05) in total coliform count among the different agro ecology. Total coliform count were significantly different (P < 0.05) betwen different milk sample sources. The mean total bacteria count

of milk collected from storage containers and directly from the udder of the cow was 5.55 ± 0.09 log 10 cfu/ml and 4.41 ± 0.01 log 10 cfu/ml, respectively (Table 11).

Table 11. Microbial level of raw cow milk in the study area (mean ± SE)

Variables (Milk source)	**Agro Ecology**		
	High land (n=40)	**Mid land (n=40)**	**Mean**
TBC (log 10 cfu/ml)			
Storage container	7.83 ± 0.23	6.85 ± 0.26	**7.34 ± 0.19[a]**
Udder	5.71 ± 0.20	5.51 ± 0.1	**5.61 ± 0.14[b]**
Mean	**6.77 ± 0.28[a]**	**6.18 ± 0.20[b]**	**6.48 ± 0.15**
CC (log 10 cfu/ml)			
Storage container	5.44 ± 0.21	5.65 ± 0.15	**5.55 ± 0.09[a]**
Udder	4.37 ± 0.13	4.45 ± 0.14	**4.41 ± 0.01[b]**
Mean	**4.91 ± 0.21**	**5.05 ± 0.12**	**4.98 ± 0.10**

Means followed by different superscript letters within the last row and the last column are significantly different ($P < 0.05$), n= number of samples, TBC= total bacteria count, TCC= total coliform count.

5. DISCUSSION

5.1. Household Characteristics

The present study shows that the majority of the respondents were male headed households and the highest age proportions of the respondents ranged 46-60 years. The field observation and the survey result shows that the age between 18-45 years old of household heads in the study area was more educated, working age, which is important to cattle hygienic and managing activities and they were productive. The respondents in the study area had different educational status. The result indicates that the majority of households in the current study area were illiterate (40.5%). As the field observation showed that they have weak understanding and knowledge of dairy cattle management practice and milk handling practice. Education is an important entry point for empowerment for technology and an instrument of sustainable development. The household educational status in this study is less as compared to the reports by Yeserah *et al*. (2020) from around Bahir Dar city, in which elementary to higher education accounts for 45.7%. In the present study, 34.3 % of respondents were completed elementary to higher education levels. In contrast with this result Tolosa *et al*. (2016) from Jimma, reported, 71% of the respondents completed secondary school or higher education. In the current study most of the respondents had married. These results agree with reports by Yirda *et al*. (2020) who indicated that 6.7% single, 80.8% married, 10.8% divorced and 1.7% widowed in Girar Jarso District of Oromia Region.

5.2. Feeding and Watering Practice

According to the current study, household fed their dairy cattle with different feed resources based on availability. This study indicated tha,t 35.7% feed sources in the study area were natural pasture. This result disagrees with the report of Hailemariam *et al*. (2022) who indicated that the major feed resources in Dilla Zuriya of Gedeo zone was banana and enset leaves and streams. According to the current respondent in this study, they use different sources of water for their dairy cattle. As observed in the current study in both districts of Gurage Zone River water was most available. The majority 78.0% of the respondents in the study areas obtain water from rivers. This result is in line with the finding of Babege *et al*. (2020) who reported the majority of respondents (69.4 %) in Cheha district of Gurage Zone used river water for their animals. In the current result the majority also showed that the watering frequency of dairy cattle in the study area was

twice a day. This result is disagree with report by Adugna and Ayalew (2019) who indicated that water frequency of dairy cattle once a day for dry season (63.9%) and wet season (70.6%) in Wolkite, Enmore, Geta and Mareko district of Gurage zone.

5.3. Types of housing and cleaning practices

According to the current study almost all of the households (91.2 %) kept their cattle within the family house. This result is consistent with study by Babege *et al*. (2020) who reported 96.7% share with family houses from Cheha district of Gurage Zone. In contrast, the finding of Birhanu *et al*. (2022) reported 84.5% separate house, 14.9% fenced barn and 0.7% common house with human from North Shewa Oromia region. Common house with humans is the cause of disease transmission between humans and animals to humans, and it affects milk quality (Babege *et al*., 2020). The majority of the respondents (36.5%) clean the barn feces every day. But, in a current study 19.6% households clean the barn once a week. This means the udder of the cow should be in direct contact with the dung that can definitely contribute to the poor quality of milk. This result is disagree with the finding of Saba (2015) who reported 65% of respondent practice daily barn cleaning in Berga and Ejerie districts of West Shoa zone and Bereda *et al*. (2012) who reported that barn cleaning practice on daily 11.7%, twice per a week 39.1%, three times per a week 46.7% and four times per week 2.5% of respondents from Ezha district of Gurage Zone. Housing conditions and Barn cleaning practice are the major methods of keeping milk hygienic. The barn is not sufficiently clean, the cow udder and teat direct contact with dung, urine, feed wastage and inserts with the teat and this contributes to the possible contamination of milk.

5.4. Dairy Cattle Disease and Health Care

The high incidence of foot and mouth disease (FMD) 32.7% observed in the study area. This result disagrees with the finding of Ayeneshet *et al*. (2017) who reported lumpy skin disease was identified as the major disease affecting dairy cattle in Alefa and Quara districts of North Gonder zone. On the other hand, the current result is line with the finding of Dessalegn (2017) from Bishoftu and Akaki towns in Oromia region. About 83.1% of the total respondents' were to treat cattle health problems in veterinary drugs. Whereas highland areas (89.1%) treat cattle health problems using veterinary drugs than midland areas (76.8%). About 48.5% of the total respondents dairy cattle not vaccinate.

Therefor, dairy cattle affected disease and milk quality also poor and transmission zoonotic disease for humans.

5.5. Hygienic Practices of Milk

5.5.1. Milking and milk handling practice

Hygienic practices are a major pathway to produce safety and quality product for the consumers reducing microbial contamination. Factors that could contribute to the contamination of milk include; insufficient pre-milking udder preparation, insufficient cleaning of milkers hand and milking utensils, use of poor quality and non-boiled water for cleaning of milk equipment (Worku *et al*., 2012). In this study, the majority (47.5%) of the respondent's used water for cleaning purposes was obtained from unprotected river/ stream water.Waters used for cleaning purposes may have a variety of microorganisms which have the ability to grow on the surface of milking equipment. The results in this study disagree with the study reported by Bereda *et al*. (2012) from Ezha district of Gurage Zone and Saba (2015) from Adea Berga and Ejerie Districts of West Shoa Zone. When water from non-tap sources is used for cleaning purposes, it is important that producers should at least boil and heat treat it before use (Zelalem, 2010). Milkers are to keep personal hygiene during milk operation; the milk should be in good quality.

In this study, about 86.1% of the respondents reported to wash their hands before milking while the rest 13.9% did not wash their hands before milking. This result disagrees with the finding of Saba (2015) who reported 69.4% of the respondents hand washing before milking and no hand washing 30.6% of the respondents from Adea Berga and Ejerie Districts of West Shoa Zone. In this result was similar to Tolessa and Asmamaw (2017) study who reported 83% of the respondents' practice hand washing before milking in the Asossa area. Milkers do not wash hands; probably increase microbial contamination of milk. The majority of the respondents 72.1% did not wash the udders before milking. So, there may be the possibility of contaminations in the milk. This might be due to lack of awareness related to hygienic production of milk. Pathogenic microorganisms present in the dust, urine, dung and feed refusals entered in teat can easily multiply and deteriorate the quality of milk (Zelalem, 2010). The bacteria which are naturally present on the skin of animals and enter into the milk from the surface of the teat; this also includes bacteria present in milk (Afzal *et al.,* 2011; Ruegg and Reinemann 2002). The present studies

agree with Zewdu (2015) reported from Sidama High Lands of Southern Ethiopia. But, disagree with Mohamed *et al*. (2023) reported from Kebribeyah District of Fafan Zone, Somali Regional State Ethiopia. According to Tassew and Seifu (2011) all of the respondents do not wash the udder of the cows during milking.

The majority of the respondents (63.5%) in the study area milked their animal in a barn, 22.8% milked in open air and the rest 13.7% milked in a separate milking barn. This is due to lack of knowledge about pathogenic microorganisms present in unprotected enviro nmens and produced poor quality of milk. Microorganisms present in the air or environments and also milking in open air exposure microorganism and themilk should be contaminated. Generally, proper sanitary milking practices were not followed by the majority of the respondents in the study area. The present studies disagree with the finding of Tesfaye (2019) reported from central Ethiopia. On the other hand, this result is line with the finding of Abdissa *et al*. (2020) who recorded 62.6% of the respondents milked in barn, 18.1% of the respondents milked open land and 19.4% of the respondents milked in separate houses from Abuna Gindeberet district.

5.5.2. Sanitary practices and milking containers

About 35.8% of the respondents were washing their container with warm water. The current study disagrees with the result of Abdissa *et al*. (2020) who reported 68.4% of the respondents were using warm water from Abuna Gindeberet and the result of Yeserah *et al*. (2020) who reported 10.3% of the respondents uses warm water for cleaning purpose from around Bahir Dar city. The use of warm water and soap cleaning for utensils could be preferred to remove microorganisms and remove milk remains, which decrease milk contamination. About 56.6% of the respondents used plastic jars equipment respectively, while 28.7% and 14.7% of them used traditional pots and aluminum/steel, respectively. This study types of milk storage utensils disagree with the finding of Abdissa *et al*. (2020) who reported 14.2% of the respondent were using plastic jar, 51.6% of the respondent use clay pot and 32.2% of the respondent's calabash 32.2% from Abuna Gundeberet district and the finding of Bereda *et al*. (2012) who reported all of the respondents milk store in plastic jar from Ezha district of Gurage zone. Milking equipment determines the quality of milk and milk products. Milk producers need particular attention for the type as well as cleanliness of milk equipment. Aluminum equipment and Plastic jar are mostly preferred

because they are easy to clean. Traditional pot is very difficult to clean and can contribute to milk spoilage.

5.6. Chemical Composition or (Nutreint Content) of Raw Cows Milk

5.6.1. Fat content

Fat is the most important constituent of milk and to be considered economics of milk and milk products (Cheung and Mehta, 2015). It is the most valuable constituent of milk and having a fair amount of fat is more valuable as food than milk (Mohamed *et al*., 2023). Most price plans for milk depend on higher milk fat content. The mean value of fat content in milk collected from high land (3.76± 0.21%) was lower than milk collected from midland (4.51 ± 0.16%). The difference was also statistically significant. This variation may be due to stage of lactation, diet, age, milking interval and milk yield. The overall mean of fat content of cow milk in the study area was 4.12%. The result of fat content of this study is similar with the finding of Abdissa *et al*. (2020) who reported 4.2% of fat content from Abuna Gundeberet district. However, it is lower than with reports of Nwanneka and Fekadu (2007) who reported 6.05% of fat content from Horro Cattle in East Wollega, Gemechu and Amene (2016) who reported 5.867±0.586 % of fat content from Bench Maji-Zone; Mitku *et al*. (2020) who reported 4.5% of fat content from Haramaya. The fat content in the current result is greater than the finding of Gemechu (2016) who reported that 3.76% of raw milk from Central Highlands of Ethiopia and Dessalegn *et al*. (2016) who reported 3.60% fat content of raw milk from Different Value Chain in Central Ethiopia. Milk composition has a dynamic nature and the composition varies depending on age, stage of lactation, breed, diet, milk yield, energy balance and health status of the udder (Haug *et al*., 2007). According to the Ethiopian standard, the minimum fat percent of whole milk should not be less than 3.5% (ES, 2009). Hence, the fat content for the current result fulfilled the recommended standards.

5.6.2. Ash content

The average ash content of raw cow milk samples collected from highland and midland areas were 0.60 ± 0.01% and 0.63 ± 0.01%, respectively. Statistical analysis showed that there is a significant difference within the ash content of milk collected from highland and midland areas. The overall mean of ash content found in the raw milk during this study is 0.62 ± 0.01% which is equal with the findings of Dessalegn *et al*. (2016) who reported

0.62% of ash content in raw milk collected from different value chain points of Central Ethiopia. On the other hand, the current study result of ash content is lower than the finding of Gemechu and Amene (2016) who reported 0.8% of ash content from Bench Maji, Abdissa *et al*. (2020) who reported 0.78% of ash content from Abuna Gundeberet and Nwanneka and Fekadu (2007) who reported 0.7% of ash content from East Wollega. But, the value in the current study is greater than the result of Gemechu (2016) who reported 0.6% of ash content from Central Highlands of Ethiopia. The ash content of cow milk remains relatively constant 0.7% to 0.8% and ash content is influenced by breed, stage of lactation, interval between milking, completeness of milking, feed type and age and health status of the milking cows (O'Connor, 1995).

5.6.3. Protein content

Proteins in milk are a great quality and important to remember that are the building blocks of all living tissue (Guetouache *et al*., 2014). The mean value of protein content in milk collected from high land (3.45 ± 0.10%) was higher than milk samples collected from midland (3.24 ± 0.06%), even though there was no significant difference between agro ecologies. Protein content of milk gradually decreases with increased cow age (Guetouache *et al*., 2014). The overall mean of the protein percentage in the study areas was 3.35%. The result of this study is slightly similar with the finding of Nwanneka and Fekadu, (2007) who reported 3.3% of protein content from East Wollega and Mitku *et al*. (2020) who reported 3.3% of protein content from Harmaya. On the other hand the current result is lower than the finding of Abdissa *et al*. (2020) who reported 3.5% from Abuna Gundeberet and Gemechu and Amene (2016) who reported 4% from Bench Maji. But, the current study result is greater than the finding of Gemechu (2016) who reported 3.1% from Central Highlands of Ethiopia. A deficiency of crude protein in the feed may depress milk protein due to low forage intake, under feeding concentrates, poor quality forage and inadequate grounded grain (Bailey *et al*., 2005). According to the Ethiopian standard agency, the minimum protein percent of whole milk should not be less than 3.2 % (ES, 2009). Hence, the average protein content for the current result fulfilled the recommended standards.

5.7. Microbial Status of Raw Cow Milk

5.7.1. Total bacterial count

Total bacteria count is an estimating total number of microorganisms for products commonly used by dairy manufacturers for determining the microbiological quality of milk (Lim *et al*., 2023). Milk from a healthy cow udder contains very few bacteria and poor hygienic practice introduces additional bacteria that cause the milk to spoilage very quickly (Lore *et al.,* 2006). All the raw milks had a high number of bacterial loads which averaged from 5.51 ± 0.1 to 7.83 ± 0.23 log 10 cfu/ml during the study period. The overall mean total bacteria count of milk produced in the study area was 6.48 log 10 cfu/ml (Table 10). The mean of TBC showed significant difference among the milk samples collected from midland (6.18 log 10 cfu/ml) and highland (6.77 log 10 cfu/ml) areas. This variation in this factor should be due to the milking area, hygienic practice of the udder and hygienic condition of the person during milking. Good hygiene will ensure that the milk handle is clean and has low levels of bacteria.

In the current study; total bacteria count of milk collected from storage containers is higher than milk collected from the udder of the cow (7.34log 10 cfu/ml and 5.61 log 10 cfu/ml) respectively. Milk collected directly from the udder and storage container samples were the same person and all hygienic practices are the same, this difference might be due to the use of poorly cleaned milk containers. Cleanliness of milking equipment influences the total population of milk bacterial count more than any other factors (Afzal *et al*., 2011). The total bacteria count obtained in the current study is lower than reported by Worku *et al*. (2012) who found total bacteria count from storage containers 8.15 log 10 cfu/ml and total bacteria isolate from udders of cow milk 7.18 log 10 cfu/ml from Borana pastoral community of Oromia Region. In addition, Asaminew and Eyassu, (2010) reported total bacteria isolation 7.58 log 10 cfu/ml from Bahir Dar zuria; Teshome and Tesfaye, (2016) reported 7.09 log 10 cfu/ml from Benchi Maji and Bereda *et al*. (2012) reported 9.8 log 10 cfu/ml from Ezha district and Oumer *et al*. (2017) reported for milking bucket 8.02 log 10 cfu/ml from North Wollo smallholder dairy farms. But, the total bacteria count in the current study is higher than the finding of Babege *et al*. (2020) who reported 5.67 log 10 cfu/ml from Cheha district; Tadese *et al*. (2023) who reported 2.63 log 10 cfu/ml from Mukaturi town in Oromia Region and the finding of Birhanu *et al*. (2022) who reported 4.51 log 10 cfu/ml from North Shewa Zone. The higher level of total bacteria count observed in the present study was attributed to low level of

educational status, lack of good hygienic practice, lack of personal hygiene, lack of good hygienic practice of milking utensils and poor hygiene around milking environments. Overall the current result was higher than the upper acceptable limits given for raw milk bacterial population 5.3 log 10 cfu/ml East African community standards (EACS, 2007).

5.7.2. Total coliform count

The average mean value of coliform count in milk collected from high land (4.91 log10 cfu/ml) was lower than milk collected from midland (5.05 log10 cfu/ml), even though there was no significant difference ($P > 0.05$) between agro ecology. However, statistically significant differences were observed on the mean of total coliform count in milk collected from the udder of the cow and storage containers. The mean value of total coliform count in milk collected from the udder of the cow (4.41 log10 cfu/ml) was lower than milk samples collected from milk storage containers (5.55 log10 cfu/ml). These results were higher than the reports of Oumer *et al*. (2017) who reported 3.71 log10 cfu/ml and 5.15 log10 cfu/ml milk collected from direct the udder of the cows and milking bucket, respectively. In the current study overall mean of coliform counts of raw milk were 4.98 log 10 cfu/ml. Compared to this study; higher than the reports of Bereda *et al*. (2012) who reported 4.03 log 10 cfu/ml, Birhanu *et al*. (2022) who reported 4.18 log10 cfu/ml and Tadese *et al.* (2023) who reported 4.78 log10 cfu/ml. But, the coliform count in this study is lower than the finding of Zewdu (2015) who reported 5.48 log 10 cfu/ml. On the other hand, the value in line with the finding of Teshome and Tesfaye (2016) who reported 5.1 log10 cfu/ml from Benchi Maji and Babege *et al*. (2020) who reported 4.67 log10 cfu/ml from Cheha district. The high coliform count in the milk is associated with manure, used in bedding materials and barnyard mud's (Afzal *et al*., 2011). The incidence of coliforms in raw milk had received considerable attention due to their association with contamination of manure origin and the consequent risk of more pathogenic manure organisms being present.

According to the American and European community member states the acceptable limit of coliform count for raw milk was 2.18 log10 cfu/ml (APHA, 1992). Therefore, in a current result milk collected from study sites was 4.98 log 10 cfu/ml does not meet the minimum quality standard as the coliform count is much higher than the limited value indicated and none of the samples in the present study can fit this standard. This may suggest the need to further investigate the presence of human pathogenic bacteria in raw

milk in the study areas. This study result had agreement with this suggestion, the presence of potential risk factors such as; milking area, udder hygiene, proper hand washing and cleanness of milking and storage utensils that might predispose the milk contamination. The higher coliform count is observed due to the initial contamination of the milk samples either from the cows, the milkers, milk containers and the milking environment.

6. CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The top feed resources used for dairy cow in the study area were natural grazing and Enset leaves and stems. Despite this households were not much attention for balanced feed raition. The house were not comfortable for cows with unproper cleaning and share with human houses due to transmission of disease . FMD was the major health problems of dairy cattle in the study area. In general, this study showed that dairy cow management and hygienic practice in the household level was given less attention; like cleaning of dairy barn, udder, milking utensils, milking area and in avalablity of enough and balanced ration. The results obtained in this study showed that milk available from the producers has low quality considering the microbial contamination of the milk. The majority of milk producers are lacking knowledge of hygienic ways of milk prodaction including cleaning milk equipment's, washing udders of animals before milking and cleaning of milking areas which could be a sources of milk contaminations. This was evident from analysis of bacteriological status of milk samples in the study area which had high total bacteria count and coliform counts in the udder of the cow milk and milking storage containers. The microbial test confirmed that milk collected in both districts in the two different agro ecology had poor microbial level and doesn't meet the standard level. This may be a potential source of milk borne infections. Physico Chemical compositions of fat, protein and ash contents of the study met the acceptable limit Ethiopian standard agency. But, fat and ash content of milk are highly different in highland and midland areas.

6.2. Recommendations

According to the above conclusion the following recommendations are forwarded

- Awareness should be created among dairy cow producers on the importance of adequate use of clean milk equipment, washing the udder and the hand before milking, proper cleaning of milking areas and the type of water used for cleaning to improve milk hygienic quality.
- Strict hygienic measures should be applied during milking and milk handling practices which can be, achievable by educating farmers or milk producers on good ways animal husbandry practices.

- Health professionals and Veterinarians should work together to create awareness on the risk consumption of raw milk in order to safeguard the public from milk-borne zoonotic infections.
- Further study is required with wider area coverage to identify the different species of microorganisms that might cause food borne illness.

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8. APPENDICES

8.1. Appendix A

ANOVA Test on Chemical Composition and Microbial Quality

Appendix Table 1. ANOVA Test on Fat Content

Dependent Variable: Fat

Source	DF	Sum of Square	Mean Square	F Value	Pr > F
Model	1	5.67009	5.67009	8.12	0.0070
Error	38	26.53655	0.69833		
Corrected Total	39	32.20664			

R-Square	Coeff Var	Root MSE	Fat Mean
0.176053	20.21925	0.835662	4.133000

Appendix Table 2. ANOVA Test on protien Content

Dependent Variable: Protein

Source	DF	Sum of Square	Mean Square	F Value	Pr > F
Model	1	0.45156	0.45156	3.29	0.0777
Error	38	5.21901	0.13734		
Corrected Total	39	5.67057			

R-Square	Coeff Var	Root MSE	Fat Mean
0.079633	11.08163	0.370597	3.344250

Appendix Table 3. ANOVA Test on Ash Content

Dependent Variable: ash

Source	DF	Sum of Square	Mean Square	F Value	Pr > F
Model	1	0.00930250	0.00930250	6.48	0.0151
Error	38	0.05457500	0.00143618		
Corrected Total	39	0.06387750			

R-Square	Coeff Var	Root MSE	Fat Mean
0.145630	6.119826	0.037897	0.619250

Appendix Table 4. ANOVA Test on TBC

Dependent Variable: Total Bacteria

Source	DF	Sum of Square	Mean Square	F Value	Pr > F
Model	7	73.7671788	10.538168	10.30	<.0001
Error	72	736767600	1.0232883		
Corrected Total	79	147.4439387			

R-Square	Coeff Var	Root MSE	Fat Mean
0.422774	14.67790	0.730629	4.977750

Appendix Table 5. ANOVA Test on CC

Dependent Variable: Total coliform

Source	DF	Sum of Square	Mean Square	F Value	Pr > F
Model	7	28.15064	4.02152	7.53	<.0001
Error	72	38.43494	0.53381		
Corrected Total	79	66.58559			

R-Square	Coeff Var	Root MSE	Fat Mean
0.195482	19.69833	0.931928	4.731000

8.2. Appendix B

Questionnaire survey format

A. General Information

1. Name of respondent_____ _____ Sex _____

2. Age group a. 18–30 years b. 31–45 years

c. 46–60 years d. >60 years

Address: Woreda_____ Kebele _____

3. Marital status of the household a. Single b. Married

c. Divorced d. Widowed

4. Educational level

a. Illiterate b. Read & write c. Primary school d. Junior school

e. High school f. Certificate and diploma level g. Degree and above

5. Number of dairy cows:

Lactating cows _____Dry cows _____Heifers_____

6. Do you have cross cow? a. Yes b. No

7. If yes, how many cows-------

8. Purpose of keeping dairy cattle: -

a. Milk sale b. Milk consumption c. processing d. others

B. Feeding Management of Animals

1. What are the major feed resources available for dairy cattle in your area?

a. Natural pasture b. Crop residue c. Industrial by product

d. Concentrate feed e. Hay f. Enset leaves and steams g. Other

2. Land ownership a. No access to land b. Own c. Lease

3. Do you practice concentrate feed? a. Yes b. No

4. If yes, do you have market opportunity for concentrate feed purchase for your animal?

a. Yes b. No

5. Who provides a technical and other supports regarding to improved feed accessed?

a. Government b. Cooperatives (Union) c. NGO

6. What type of feeding system do you apply in feeding of your dairy animals?

a. Individual feeding system b. Group feeding system

c. Randomly feeding system d.Other specify

7. Do you practice supplementary feeding? a. Yes b. No

8. If yes, which type of supplementary feeds?

a. grain leftover b. House west, atela and common salt c. Mill by products

d. Grain leftover and atela and common salt e. Other

C. Water Management of Animals

1. What are the sources of water to your animals?

a. River b. Pond c. Spring water d. Pipe water

2. What is the average distance travelled cow to the water source?

a. < 1km b. 1-5km c. 6-10km d. no distance

3. How frequently the water is delivered to cows?

a. Roam freely b. Once a day c. Twice a day d. Three times a day

D. Health Management of Animals

1. Do you know any health problem in your dairy cattle? a. Yes b. No

2. If yes, what are the major health problems in your dairy cattle?

a. FMD b. Anthrax c. Diarrhea d. Mastitis

e. Tick f. liver fluke g. other (specify) ----------

3. How do you treat cattle health problems?

a. Taking to veterinary drug

b. Taking to a traditional method c. other (specify) ----------

4. Do you encounter problem of udder infection? a. Yes b. No

4.1. If yes, how frequent per year?

a. Once b. Twice c. Three times d. Others

5. What measure was taken to correct this?

a. Tradition treatment b. Veterinary services c. Both

6. Do you give vaccines to your cow? a. Yes b. No

7. If yes, against which diseases? ----------

8. Do you get veterinary services? a. Yes b. No

9. If yes, what kind of service? ----------

10. If no, explain the reason for the absence of veterinary services----------

11. How is the adequacy of veterinary service in your area?

a. Adequate b. Inadequate

E. House Management of Animals

1. Do you have an experience of housing your dairy animals? a. Yes b. No

2. What types of dairy barn you are using?

a. Separate house b. Fenced house

c. Concrete house d. Common house with humans

3. How often do you clean your dairy house?

a. Every day b. One time/week c. Two times per a week

d. >Two times/week e. Other (specify) _____

4. How many times do you wash your milking cows?

a. Once a week b. twice a week c. once at two weeks interval

d. once a month e. no wash at all

5. Do you use bedding materials for your animals? a. Yes b. No

5.1. If yes, what type of bedding do you use?

a. Straw b. Wood shavings c. Soil d. Grass

f. Other (Specify) _____

5.2. How long do you use it before change? _____

F. Pre-milking Udder Preparation and Hygienic Practices

1. How do you milk your cow? a. By hand b. By machine c. Both

2. Where are cows milked?

a. In barn b. Outside in the open air c. In a separate milking bar

3. Do you wash your hands for milking? a. Yes b. No

4. If yes, when you wash? a. before and after milking b. between milking

c. only before milking d. only after milking

e. not at all

5. Do you wash the teats and udder before milking? a. Yes b. No

6. Do you use towel for teat drying? a. Yes b. No

6.1. If yes how? a. One for one cow b. Communal

6.2. If yes, when? a. Pre-milking b. Post-milking c. Both

8. How often clean the utensils used for milking?

a. Daily b. Two times a day c. Two day interval d. Other

9. How do you keep the hygiene of milking buckets? Washing with:

a. Warm water b. Cold water c. Both alternatively d. Water + soap

10. What is the source of the water used for washing the udder and milk utensils?

a. Piped/ tap b. River/ stream

c. Hand dug well d. Other (specify)……

11. Do you use personal protective clothes while milking cows? a. Yes b. No

12. Do you have knowledge of milk borne disease? a. Yes b. No

G. Milk Conservation/Storage Practices

1. What type of milk bucket used?

a. Plastic b. Aluminum/ steel c. Traditional pot d. Others____

2. Do you test milk contamination when you take from handling practices?

a. Yes b. No

3. Do you practice Plants used for cleaning and smoking of milk utensils?

a. Yes b. No

3. 2. If yes which herbs/ plants/ used for smoking?

a. Abalo b. Cheba c. Tegi d.Yesetkest

e. Nachakitele f. Kessie g. Other (Specify)----------

4. Why do you use these plants?

a. Give good flavor and aroma b. Increase the shelf life of the milk

c. Facilitate fermentation d. It just a tradition e. Other (Specify)