FEDERAL TECHNICAL AND VOCATIONAL TRAINING INSTITUTE (TVTI)

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EVALUATION OF HANDLING PRACTICES, MICROBIAL AND PHYSICOCHEMICAL QUALITY OF RAW AND BOILED MILK MARKETING IN SELECTED AREAS OF SHEGER CITY,OROMIA, ETHIOPIA

BY

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FEBRUARY, 2025

ADDIS ABABA, ETHIOPIA

EVALUATION OF HANDLING PRACTICES, MICROBIAL AND PHYSICOCHEMICAL QUALITY OF RAW AND BOILED MILK MARKETING IN SELECTED AREAS OF SHEGER CITY,OROMIA, ETHIOPIA

A THESIS SUBMITTED TO FEDERAL TECNICAL AND VOCATIONAL TRAINING INSTITUTE (TVTI), FACULTY OF AGRO-PROCESSING TECHNOLOGY

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DECLARATION

I hereby declare that the thesis *entitled* "Evaluation of handling practice the Microbial and physicochemical Quality of Raw and Boiled Milk Selling in Selected areas of Sheger City" is my own work and that all sources of materials used for this thesis work have been accordingly acknowledged. This thesis was submitted in partial fulfillment of the M.Sc. degree requirements at the Federal Technical and Vocational Training Institute (TVTI) and has been placed at the Library in order to be accessible to borrowers according to the library's regulations. I hereby declare that this thesis has not been submitted to any other Universities or institution for the award of any academic degree. I hereby grant the Copyright to the Federal Technical and Vocational Training Institute (TVTI).

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FEDERAL TECNICAL AND VOCATIONAL TRAINING INSTITUTE

FACULTY OF AGRO-PROCESSING TECHNOLOGY

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BY ROBERA DAGAFA ADABA

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DEDICATION

This thesis is dedicated to my beloved daughter, Wada Robera, my shining light. Your strength and resilience during your early days in the hospital inspired me to persevere through the challenges of pursuing my second degree. Though the journey was difficult, your presence filled my heart with hope and determination. May you always know how deeply you are loved and how proud I am to be your father.

BIOGRAPHICAL SKETCH

The author Robera Dagafa Adaba was born on June 6, 1994, from his father Mr. Dagafa Adaba and his mother Ms. Lielt Dereje. Robera attended his early education at Babich Primary and Secondary School. His passion for Animal Science led him to Bako ATVET College, where he pursued Animal Production and Marketing Management at Level IV, graduating in 2013 G.C. He began his professional career as an assistant trainer at Bore TVET College serving for two years before transferring to Bako ATVET College. His dedication to furthering his education took him to FTI Holleta Satellite Campus, where he earned his first degree in Dairy Processing Technology with very great distinction in 2017 G.C. Afterward, he spent another two years as an assistant instructor at Bako ATVET College before joining the School of Graduate Studies at the Federal TVT Institute in 2023 to pursue a Master of Science in Dairy processing Technology.

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ABBREVIATIONS

AMBC	Aerobic Mesophilic Bacterial Count
CC	Coliform Count
DPS	Dairy Product Shop
FAO	Food and Agriculture Organization of the United Nations
SNF	Solid Not Fat
VRBA	Violet Red Bile Agar
YMC	Yeast and Mould Count

ABSTRACT

The study was conducted in the selected areas of Sheger cities, Oromia regional state, Ethiopia to assess the milk handling and hygienic practice as well as to evaluate handling practice, physicochemical and microbial quality of raw and boiled milk collected from dairy product shops and cafeterias. A cross sectional study was used with three sub-cities namely Burayu, Gefersa Guje and Melka Nono were randomly selected for the study. A total of 205 (95 dairy product shops and 110 cafeterias) were assessed in the study and employing survey study. After the sample size were determined using Yemane formula (1967) dairy product shop and cafeterias in each sub cities were selected randomly. From previously surveyed respondents, a total of 60 milk samples (30 raw milk from dairy product shop and 30 boiled milk samples from cafeteria) were collected aseptically from dairy product shops and cafeteria's for microbial analysis (Aerobic Mesophilic bacterial count, coliform count and yeast and mould count) and physico chemical quality test and hygienic handling practice of raw and boiled milk wered conducted through survey studies. The data was coded and analyzed using SPSS version 29. A t-test was applied to microbial counts following log transformation, and descriptive statistics namely frequencies and mean were used to summarize the survey study results. According to key informant interviews, consumer's preference for raw milk's lower price over boiled milk is the main factor driving the higher percentage of raw milk sales. The result of the study revealed that the majority (88.24%) of the dairy product shops and 96.4% of sampled cafeterias used temperature-controlled refrigerator for milk storage. The majority (98.94%) of the respondents used tap water to clean milk utensils. Plastic containers were the primary milk storage and storage vessels reported in the current study. About 92.3% of respondents in study areas were using raw milk to serve their customers while 7.7 % were using milk powder as raw material. The majority (82.9%) of dairy product shop are selling raw milk, Irgo, Ayib and butter, while 17.1% of them were selling raw and boiled milk. The microbial analysis revealed that the overall Aerobic Mesophilic Bacterial count for raw and boiled milk was 6.14 and 3.21 Log10 cfu/ml, respectively. The corresponding mean coliform counts were 4.78 and 2.31 Log10 cfu/ml, while the mean yeast and mold counts were 3.71 and 0.71 Log10 cfu/ml, respectively. Significant differences ($p<0.05$) were observed in total plate count, total coliform count and yeast and mould between the milk sources in dairy product shops. However, no significant variation was reported in the yeast and mould count of boiled milk samples from cafeteria. The physicochemical analysis of raw milk from dairy product shops revealed that overall mean for fat, protein, lactose, and solid-not-fat were 3.67±0.37, 3.13±0.17, 4.44±0.39, 8.15 ± 0.51, 1.025±0.001, 6.23±0.16, -0.50± 0.02, 4.85 ± 1.78 respectively. On the other hand, specific gravity, pH, freezing point, and water added to be 1.025±0.001, 6.23±0.16, -0.50±0.02, and 4.85±1.78, respectively. The cleaning practices however differed across in the study area, and quality checks were rare. However hygiene standards and temperature monitoring were commonly practice in the study area, there were problems with training and regulatory enforcement. *Therefore, to ensure milk quality and protect public health it is recommended that hygienic practices be enforced during milk collection, handling and storage.*

***Key phrases**: Physicochemical quality, Microbial quality, and hygienic practice*

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1. INTRODUCTION

1.1. Background

The agricultural sector in Ethiopia plays a critical role, closely intertwined with the lives and livelihoods of its people. Around 12 million smallholder farming households contribute approximately 95% of the country's agricultural production and provide 85% of its employment (FAO, 2024). Ethiopia is home to the largest livestock population in Africa, which contributes 16.5 % to the national Gross Domestic Product (GDP) and 35.6 % to agricultural GDP with dairying represents half of the livestock output (Leggesse *et al.,* 2023). The country possesses over 70 million head of cattle with cows producing over 70% of the total milk production. The total annual milk production from cattle is estimated at 4.96 billion liters from 7.5 million milking cows (CSA, 2020/21). As a result, cows' milk is exhaustively utilized in Ethiopia to convert into a lot of home and industrial based milk products.

Milk is one of the most widely consumed nutritious foods globally. However, it is also highly perishable and easily prone to microbial contamination and spoilage (Farrell, 2017). The quality, safety, and organoleptic qualities of milk are crucial in determining the physicochemical and microbiological qualities of the subsequent milk products (Rouhi *et al.,* 2017). In developing countries in general and in Ethiopia in particular the quality and safety of milk and milk products are frequently reported to be substandard and thereby a potential posing health risks to consumers (Abate and Hailu, 2015). Milk is a favorable environment for the growth and multiplication of microorganisms including spoiling and foodborne pathogens, which could compromise the safety and quality of the product (Musema and Mussa, 2022). Therefore, monitoring the microbiological and physicochemical characteristics of milk throughout the entire supply chain is paramount. In this regard, pasteurization and boiling are two examples of milk treatment techniques that can lower the microbial load and extend milk's shelf life without much change in its milk physicochemical properties (Rouhi *et al*., 2017).

The physicochemical quality of milk is influenced by several factors, which can be broadly categorized into compositional, environmental, and processing factors (Nivedita *et al.,* 2018).

Milk composition is affected by various factors, including stage of lactation, breed differences, number of calving (parity), seasonal variations, age and health of animal, feed and management effects including number of milking per day and herd size (Lujerdean *et al.,* 2007). At farm level, this may be due to problems with feeding, udder health or incomplete milking. Unbalanced diets and mastitis are also known to decrease and lactose contents in severe cases fat. The lactose content of milk is moderately constant between dairy breeds, protein varies to some degree but fat varies widely. The age of the cow is closely related to the number of lactations, as an increase in number of lactations is associated with decrease in fat and solid not fat (SNF) content of milk (Almaz, 2014). Environmental factors such as the diet of dairy cows, seasonal variations, climate, and breed and lactation stage of the cows also impact milk quality. Additionally, processing factors like temperature treatments (e.g., pasteurization), storage conditions, and mechanical handling (e.g., homogenization) can alter the milk's physicochemical properties (Lewis, 2022). Conversely, it is generally believed that the dairy farmer can alter many of these factors to achieve milk production and increase profit (Desaleng, 2017). The gross milk composition of cows contains 87.2% water, 3.7% fat, 3.5% proteins, 4.9% lactose and 0.7% ash (Park, 2009). Dehinenet *et al.* (2013) reported that the protein content of crossbred milk was 3.12%. According to Negash (2012b), the raw milk in the Mid-Rift Valley of Ethiopia contained 5.48±0.19% fat, 9.10±0.09% solids-not-fat (SNF), and 3.46±0.04% protein. Farm management has a significant role in determining the quality of milk. The quality and safety of dairy products connected to food-borne diseases is a major concern worldwide, implementing strict and comprehensive regulations pertaining to dairy products are necessary (Banda, 2010). This problem is particularly prevalent in underdeveloped country, where milk and dairy products are frequently produced under unsanitary conditions and with inadequate production practices (Bardhan & Sharma, 2023) The dairy industry is essential to income generation, nutrition, and food security worldwide (Hui Yan, 2022). However, the quality of raw milk directly affects the shelf life of the dairy products and poses risks to consumers when the milk and its products are unsafe milk and dairy products (Gebretsadik *et al*., 2020).

Ethiopia's dairy industry is changing from a traditional subsistence to a market-oriented system, but the sub-sector is constrained by poor hygiene practices, inadequate infrastructure, lack of quality standards, and limited awareness among producers and consumers. To revert the above-mentioned constraints, it is essential to understand the current state of Ethiopia's dairy industry particularly in terms of milk and dairy product quality to enable effective interventions (Gebreyohanes *et al*., 2021). Raw milk had higher microbial counts compared to pasteurized milk. Pasteurization can reduce the number of harmful bacteria, making the milk safer for consumption. Pasteurized milk had slightly higher levels of certain nutrients compared to raw milk, likely due to the heating process which can affect the milk's composition. Poor hygienic practices during milk collection and processing contribute to the high microbial load in raw milk (Belay *et al.,* 2023).

The study aimed to evaluate the physicochemical and microbiological quality of raw and boiled milk sold in the selected areas of Sheger City. By analyzing the microbiological and physicochemical quality of milk samples from different sources, the study seeks to provide valuable insights into the safety and quality of milk available to consumers in Sheger City.

1.2. Statement of the Problems

The quality of milk is an important factor to maintain the safety and nutritional value of dairy products (Burke *et al*., 2018). In Ethiopia raw and boiled milk are the two most commonly consumed dairy products. However, their microbial and physicochemical quality can vary greatly due to factors such as milk source, processing methods, and storage conditions (Rouhi *et al*., 2017).

Many people assume that boiling of milk is sufficient to make it safe for consumption. However, this process can degrade essential nutrients like vitamins B1, B2, B12, and C. While milk has a boiling point of about 212°F, it is never brought to a complete boil during the boiling process, so not all pathogens like *Bacillus cereus*, which can withstand high temperatures will be destroyed by this method. Moreover, it can change milk's flavor and texture, which makes it less appealing (Kathleen, 2024). In Sheger City, where the demand for milk products is high, consumers rely on both raw and processed milk for their nutritional needs. Therefore, it is crucial to determine the microbial and physicochemical quality of the milk sold in the area to ensure its safety and high quality. This study seeks to compare the microbial and physicochemical quality of raw and boiled milk to identify the factors that affect their quality. The results of this study provided valuable insights into the safety and quality of milk and help in the development of effective strategies to improve the quality of dairy products.

1.3. Objectives of the Study

General objective

- To evaluate the handling practices, microbial and physicochemical qualities of raw and boiled milk sold in selected areas of Sheger city.

Specific objectives

- To assess the handling practices of raw and boiled milk; and
- To evaluate the quality of raw and boiled milk samples in selected areas of Sheger city

1.4. Research Questions

- What are the handling practices of raw milk and boiled milk in selected areas of Sheger city?
- What are the distinctive physicochemical qualities of raw and boiled milk in the selected areas of Sheger City?
- How does the microbial quality of raw and boiled milk compare in the selected areas of Sheger City?

1.5. Significance of the Study

The study aims to provide insights into the quality of milk sold in the selected areas of Sheger city, which is crucial for ensuring public health and safety. The results can be utilized to develop policies and regulations that guarantee the quality of milk offered for sale in the market place. The study provides information on the physicochemical and microbiological quality of milk sold in the selected areas of Sheger city. The result of findings can also be used to compare the quality of milk sold in other cities and countries and determining areas in need of improvement. Furthermore, the study adds to the body of knowledge already in existence by offering details on the quality of boiled milk, which are not commonly found in the literature. The study's recommendations and intervention strategies can help to mitigate the key challenges of microbial quality, physicochemical properties of raw and boiled milk, and promote best practices in the study area. Overall, this study represents a valuable contribution to the dairy industry and has the potential to enhance the quality of milk available in the market.

1.6. Scope of the Study

This study aimed to evaluate the hygienic handling practices, microbial, and physicochemical qualities of both raw and boiled milk in selected areas of Sheger City, Oromia Regional State, Ethiopia. This research was completed within nine months and provided insights into the quality and safety of raw and boiled milk in these study areas.

1.7. Limitation of the Study

The study encountered several limitations. First, budget constraints restricted the scope of the data collection, analysis, and sample size. Second, due to the high cost of reagents and unwillingness of some organization to permit their laboratory, only a subset of microbial quality parameters such as Aerobic Mesophilic Bacterial Count, coliform count and yeast and mould were analyzed. Finally, as the study areas were newly structured cities obtaining accurate population data from the study area trade office was very challenging

2. LITERATURE REVIEW

2.1. Milk and Milk Products Handling Practices in Ethiopia

Milk is almost sterile when produced in a healthy cow's udder. However, it becomes contaminated with microorganisms once it is exposed to the environment, leading to spoilage before consumption or further processing (Tolessa, 2016). As a liquid and nutritious medium, milk is particularly susceptible to bacterial contamination. Therefore, maintaining hygienic milk handling practices is crucial, including the sanitation of the milking environment, the hygiene of the milker, and the cleanliness of the utensils used for collection and storage (Tsedey and Asrat, 2015).

In Ethiopia, milk hygiene practices fall below standard levels due to inadequate pre-milking procedures such as washing the udder with clean water, cleaning the milking barn, drying the udder with an individual towel, washing the milkers' hands and milking utensils, and using poor-quality or non-boiled water for udder cleaning. Furthermore, insufficient post-milking practices, such as poor hygiene of milk equipment and storage containers, prolonged storage, and improper transportation and retailing, contribute to microbial contamination (Fufa *et al.,* 2019).

Furthermore, using plastic containers for milk handling and transportation increases the risk of contamination. As the number of plastic containers increases, so does the chance of contamination, and many plastic containers have characteristics that make them unsuitable for milk handling (Tsedey and Asrat, 2015). Moreover, using clay pots for milk storage is another factor. These containers are difficult to clean hygienically and can harbor bacteria, leading to milk spoilage and quality deterioration (Tsedey and Asrat, 2015). Dairy producers employ various methods to clean their milking utensils, such as washing with or without hot water, followed by smoking with aroma-producing plants.

2.2. Microbial Quality of Raw and Boiled Milk in Ethiopia

2.2.1. Microbial quality of raw milk

Microbial diversity in raw milk is the variety and abundance of microorganisms that are present in raw milk, which can originate from different sources, such as the animal’s udder, the milking equipment, the environment, and the handling practices. Microbial diversity in raw milk can affect the quality, safety, and health benefits of milk and dairy products. Therefore, it is important to monitor and control the microbial composition of raw milk throughout the production chain (Quigley *et al.*, 2013). Raw milk can contain a variety of microorganisms, some of which are beneficial and some of which are harmful.

Raw milk can have a complex microbiota of bacteria, including lactic acid bacteria (LAB) such as *Lactococcus, Lactobacillus, Streptococcus, and Enterococcus*. These bacteria are important for dairy fermentations and can also promote health. However, raw milk can also be contaminated with pathogenic bacteria such as *Campylobacter, Cryptosporidium, E. coli, Listeria, Brucella,* and *Salmonella*. These bacteria can cause serious illnesses, such as diarrhea, vomiting, fever, paralysis, kidney failure, and death (Koski *et al.*, 2018). It contains yeasts, which are single-celled fungi. Yeasts can contribute to the flavor and aroma of fermented dairy products, such as cheese and yogurt. However, some yeast can also cause spoilage of raw milk, such as *Candida, Kluyveromyces, and Geotrichum* (Machado *et al.*, 2017).

Molds are multicellular fungi that can grow on the surface of raw milk or dairy products. Some molds are used to produce cheese varieties, such as Penicillium for blue cheese and Brevibacterium for Limburger cheese. However, other molds can produce toxins, such as aflatoxins and ochratoxins that can be harmful to humans and animals. Some examples of mold genera that can contaminate raw milk are *Aspergillus, Fusarium, and Alternaria* (Machado *et al.*, 2017). To prevent the risks associated with raw milk consumption, it is recommended to pasteurize milk before drinking or using it for dairy products (Quigley *et al.*, 2013).

2.2.1.1. Factors influencing the microbial composition of raw milk

The microbial composition of raw milk is influenced by many factors, such as animal health, milking practices, and environmental conditions. The health status of dairy animals can affect the type and number of microorganisms in their milk. For example, mastitis, an inflammation of the mammary gland, can increase the somatic cell count and the presence of pathogens, such as *Staphylococcus, Streptococcus, and Escherichia coli*, in the milk (Singha *et al.*, 2023). The hygiene and cleanliness of the milking equipment and personnel can also influence the microbial contamination of raw milk. Poor sanitation can introduce undesirable microorganisms, such as *Pseudomonas, Acinetobacter, and Bacillus,* into the milk (Quigley *et al*., 2013).

The surrounding air, water, feed, and housing conditions of the dairy animals can also affect the microbial composition of raw milk. For example, the air can carry dust, spores, and aerosols that can contaminate the milk with molds, such as *Aspergillus, Fusarium, and Alternaria*, which can produce toxins (Velázquez-Ordoñez *et al.,* 2019). The water can also introduce pathogens, such as *Campylobacter, Cryptosporidium, and Salmonella*, into the milk (Quigley *et al*., 2013).

The microbial load can affect the quality, safety, and functionality of raw milk and dairy products. The microbial load of raw milk is influenced by many factors, such as Animal health and welfare, milking hygiene and equipment, environmental conditions, and management (Deddefo *et al*., 2023) These factors can have significant impacts on the quality, safety, and functionality of raw milk and dairy products, as well as the health of consumers and animals (Yuan *et al*., 2022).

2.2.1.2. Bacterial profiles in raw milk

Bacterial profiles in raw milk refers to the types, numbers, and diversity of bacteria that are present in milk that has not been pasteurized or processed. Bacterial profiles can vary depending on many factors, such as animal health, milking practices, and environmental conditions. Bacterial profiles can affect the quality, safety, and functionality of raw milk and dairy products (Quigley *et al.,* 2013). Some of the common methods to analyze bacterial profiles in raw milk are culture-based and molecular methods. Culture-based methods involve growing bacteria on selective or differential media, such as agar plates, and counting the colonies or measuring the turbidity (Yuan *et al*., 2022). Molecular methods can provide information on the total bacterial diversity and the relative abundance of different taxa, as well as the detection and quantification of specific genes or markers, such as antibiotic resistance or virulence genes (Quigley *et al.,* 2013).

2.2.1.3. Specific bacterial groups commonly present in raw milk

The specific bacterial groups that are commonly present in raw milk are lactic acid bacteria (LAB), coliforms, and psychotropic bacteria (Yuan *et al.*, 2019). They can have various impacts on the quality and safety of milk and dairy products. Some of these impacts are sensory properties, nutritional properties, technological properties, and health properties (Lauchlin *et al.*, 2020). These impacts can vary depending on the type, number, and activity of the bacteria in raw milk, as well as the processing and storage conditions of milk and dairy products (Du *et al*., 2022).

2.2.1.4. Pathogenic microorganisms in raw milk

Pathogenic microorganisms are microorganisms that can cause diseases in humans or animals (Koski *et al.*, 2018). Raw milk may harbor various pathogenic microorganisms capable of causing human diseases. Among these, *Escherichia coli (E. coli) strains, Salmonella spp., Listeria monocytogenes, Campylobacter spp., Brucella spp., Mycobacterium bovis, Staphylococcus aureus, and Clostridium botulinum* pose risks (Thoen *et al.,* 2009). These pathogens can contaminate raw milk through fecal contamination, environmental sources (soil, air), udder infections, feed, water, humans or infected animals (Jamali *et al.,* 2015).

Pathogenic microorganisms can pose serious health risks to consumers of raw milk, especially to vulnerable groups, such as children, the elderly, pregnant women, and immuno compromised individuals (Koski *et al.*, 2018). Pasteurization and proper hygiene are essential to reduce the risk of transmitting these harmful microorganisms to consumers (Jayarao *et al.,* 2006).

2.2.2. Microbial quality of boiled milk

Certainly, the research on the microbiology and physicochemical quality of boiled milk in Ethiopia is limited. There is not enough research work on this topic in Ethiopia, which makes it difficult to draw conclusions about the microbial and physicochemical quality of boiled milk sold in the market. This research might help to identify areas for improvement and ensure the quality of boiled milk sold in the market.

Boiling is a common method of heating raw milk to kill harmful bacteria and extend its shelf life. However, boiling can affect the microbial load and diversity of raw milk in various ways. Some of the effects are a reduction of microbial load and a reduction of microbial diversity (*Metwally et al.*, 2011). Boiling can effectively eliminate most of the pathogens such as *Salmonella, Escherichia coli,* and *Listeria monocytogens* that can cause serious illnesses in humans and animals and can also reduce the number of spoilage bacteria, such as *Pseudomonas, Acinetobacter, and Bacillus,* that can cause off-flavors, slime, and heat-stable enzymes in milk. However, boiling may not be able to completely sterilize raw milk, as some microorganisms, such as spore-forming bacteria and thermophilic bacteria, can survive or grow at high temperatures (Vithanage *et al.*, 2017).

Boiling for 0.5, 1.0 and 2 min reduce total bacterial count from 7.8×10^9 to 2.26×10^3, 1.3×10^3, 3.9×10^2 in buffaloes´ milk and from 3.6×10^9 to 6.3×10^2 and 3.2×10^2 to 3.5×10^2 in cows` milk. Increasing the holding period beyond the 0.5 min progressively reduce the numbers, but insignificantly. Lethality values of buffaloes´ and cow's milk is greater than 67 when milk is boiled for 1 and 2 min. Boiling periods beyond 2 min did not show any increase in the lethality rate. Therefore, boiling milk need not to exceed than more 2 min period (Ahmed M.M. *et al.,* 2014)

According to (Metwally *et al.*, 2011), on cold storage, the microbial content of boiled milk, not only increases but also declines on the first week. Boiling destroys bacterial vegetative cells leaving behind spores of the spore former which are dominated by *Bacillus cereus* and *Micrococcus leteus.* (Metwally *et al.,* 2011) concluded that, boiling is a useful method to prevent the growth of harmful bacteria in raw milk, but it can also reduce the number and variety of beneficial bacteria in raw milk.

2.3. Physico-chemical Qualities of Raw and Boiled Milk

2.3.1. Physicochemical quality of raw milk

Milk is a complex biological fluid that consists of various components, each with its own chemical and physical qualities. The major components of milk are water, lactose, fat, protein, minerals, vitamins, and enzymes. Water is the most abundant component, accounting for about 87% of the total weight of milk. Lactose is the main carbohydrate in milk, providing about 40% of the total energy. Fat is the most variable component in milk, ranging from 2.5% to 6.5% depending on the breed and diet of the animal (McSweeney *et al.*, 2022).

Protein is the most important component in milk, as it determines the functionality and quality of many dairy products. Milk proteins can be divided into two groups: caseins and whey proteins. Caseins are the dominant proteins in milk, forming spherical aggregates called micelles that are stabilized by calcium and phosphate. Whey proteins are the soluble proteins in milk, comprising about 20% of the total protein (Roy *et al.*, 2020). They have high nutritional and biological value and can exhibit various functional properties. Minerals are the inorganic components in milk, such as calcium, phosphorus, magnesium, sodium, potassium, chloride, and iron. They play important roles in the structure, stability, and metabolism of milk. Vitamins are the organic components in milk, such as A, D, E, K, B1, B2, B6, B12, C, niacin, folic acid, and biotin. They are essential for the growth and health of the animal and the consumer. Enzymes are the biological catalysts in milk, such as lipases, proteases, lactases, and peroxidases. They can affect the flavor, texture, and shelf life of milk and dairy products (Park *et al.*, 2017).

2.3.1.1 Analysis of physicochemical quality of milk

Milk and dairy products are analyzed and measured for their physicochemical quality to ensure their quality, safety, and functionality. Various methods and instruments are used to determine the composition, acidity, pH, density, freezing point, specific gravity, viscosity, and heat stability of milk and dairy products. The composition of milk and dairy products can be determined by different methods, such as titration, refractometry, infrared spectroscopy, chromatography, electrophoresis, Lactoscan milk analyzer and immunoassay (McCarthy *et al.*, 2009). The fat content of milk can be measured by the Gerber method, which involves adding sulfuric acid and amyl alcohol to milk and centrifuging the mixture to separate the fat layer (Prasad *et al.*, 2018). The protein content of milk can be measured by the Kjeldahl method, which involves digesting milk with sulfuric acid and catalysts, distilling the ammonia, and titrating the ammonia with a standard acid solution (Goyal *et al.*, 2023).

The acidity of milk and dairy products can be measured by different methods, such as titration, pH meter, and colorimetric indicator (Lewis *et al.*, 2022). The titratable acidity of milk can be measured by the Soxhlet-Henkel method, which involves adding a phenolphthalein indicator to milk and titrating it with a standard sodium hydroxide solution until a pink color appears. The pH of milk can be measured by a pH meter, which involves dipping a glass electrode into milk and reading the electric potential difference between the electrode and a reference electrode (Prasad *et al.*, 2018).

2.3.2. Physicochemical Properties of Boiled Milk

2.3.2.1. Effects of boiling on milk components

Boiling is a process that involves heating milk to a high temperature, usually above 100 °C, for some time. Boiling can affect the composition, structure, and functionality of milk components, such as fat, protein, lactose, and minerals, in various ways. Boiling can cause the fat globules in milk to coalesce and form a layer of cream on the surface. This can reduce the fat content and the emulsion stability of the remaining milk (Sing *et al.*, 2009). Boiling can cause the denaturation and aggregation of both casein and whey proteins in milk. This can affect the solubility, viscosity, and gelation of milk proteins. It can also cause the Maillard reaction between lactose and protein, resulting in the browning and caramelization of milk (Kumar *et al.*, 2022).

2.3.2.2. Effects of boiling on physicochemical properties of milk

Boiling can affect the physicochemical properties of milk, such as acidity, pH, density, specific gravity, viscosity, freezing point, and heat stability, in various ways. The acidity of milk refers to the concentration of hydrogen ions (H+) in milk, which is related to the presence of organic acids, such as lactic acid, citric acid, and phosphoric acid (McCarthy *et al.*, 2009). Boiling can increase the acidity of milk by causing the hydrolysis of lactose into glucose and galactose, which can be fermented by bacteria into lactic acid. Boiling can also increase the acidity of milk by causing the denaturation and aggregation of whey proteins, which can release more phosphoric acid into the milk. The acidity of milk affects the coagulation, flavor, and shelf life of milk and dairy products (Kumar *et al.*, 2022).

The pH of milk is inversely related to the acidity of milk and ranges from 6.5 to 6.8 for fresh milk. Boiling can decrease the pH of milk by increasing the acidity of milk, as explained above. The pH of milk affects the growth of microorganisms, the activity of enzymes, and the stability of milk components (Lewis *et al.*, 2022).

3. MATERIAL AND METHODS

3.1. Description of the Study Area

The study was carried out in Sheger city, Oromia regional state, Ethiopia (Fig.1). The Sheger city has 12 Sub-cities namely Burayu, Eka Tafo, Sululta, Furi, Gelan Guda, Gelan, Koye, Mana Abichu, Malka Nono, Sebeta, Kura Jida, and Gefersa Guje. It is situated at an altitude of 1700 - 3600 meters above sea level. The average minimum and maximum annual temperatures are 23^{0}C and 36^{0}C, respectively, and the mean annual rainfall is 800 - 226 mm. The pattern of rainfall is bimodal, in which the long and heavy rainfall is received from June to September, while the short and lower rainfall is received from February to April. The livestock population including cattle 1,114,498, sheep 37, 4798, goats 79,052, horse 54,161 donkey 120,198, mule 8,575 and poultry 491,185 (CSA, 2016).

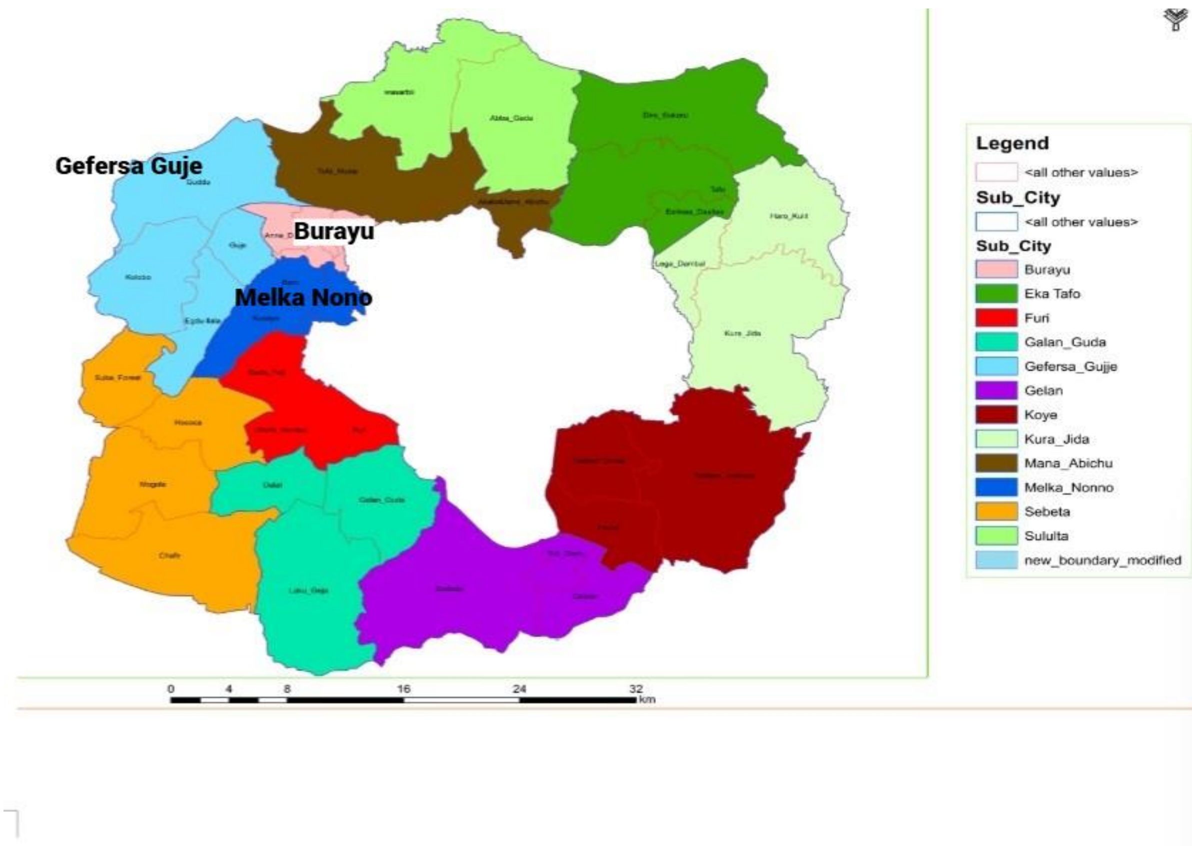

Figure 1. The map of Study area

3.2. Study Population

The study population of this research was dairy product shops and Cafeteria.

3.3. Study Design

A cross-sectional study aimed to evaluate the hygienic handling practice, microbial and physicochemical quality of raw and boiled cow's milk produced and marketed in selected areas of Sheger city was conducted from March to October 2024 using survey questionnaires, key informant interviews, focus group discussions combined with laboratory analysis of raw and boiled milk to evaluate the microbiological and physicochemical quality.

3.3.1. Sampling procedure and sample size determination

The Dairy Product Shop (DPS) and cafeterias in selected study area were the study population. Out of 12 Sub-cities from Sheger City, three Sub-city namely Burayyu, Malka Nono, and Gefersa Guje sub city were selected purposively on the basis of milk production potential, presence of different dairy marketing actors in the areas. DPS and cafeterias were selected via proportional sampling techniques using the data list available at the respective sub-cities trade office. The number of DPS and cafeteria in Burayu, Malka Nono, and Gefersa Guje Sub-cities were 125, 160 and 137, respectively. First the sample were determined by using Yemane (1967) for survey studies, then proportional sampling were used based on the data available at respective trade office of selected study area. Thus through proportional sampling 60, 78, and 67 respondents were selected from Burayu, Malka Nono, and Gefersa Guje Sub-cities r the survey respectively. Moreover, from previously surveyed respondents at both the DPS and cafeteria 19, 21, and 20 were randomly selected for laboratory analysis from three "Sub-cities' respectively. Generally, 95 and 110 respondents from DPS and cafeterias respectively were included in the study with a total of 205 respondents. Additionally, for the physicochemical and microbial quality analysis, 60 milk samples (30 raw milk samples from DPS and 30 boiled milk samples from cafeterias of the selected study areas) were randomly collected. Sample size was determined based on the formula recommended by Yemane (1967) for survey studies.

$$n = \frac{N}{1+N(e)2} \quad = \frac{422}{(1+(422*0.05)2} = 205$$

Where, n= designates the sample size the researcher uses;

N= designates total number of dairy product shop and cafeterias.

e= designates maximum variability or margin of error;

1= designates the probability of the event occurring.

3.4. Data Collection Methods

Data were collected by using questionnaire survey, key informant interview, focus group discussion and laboratory analysis of raw and boiled milk samples. A semi-structured questionnaire consisting of both open ended and closed questions was prepared to administer individual interviews. Prior to full administration the questionnaire was pretested and adjusted based on feedback from data collectors who encountered issues during the pre-test. The questionnaire focused on several key areas including socio-economics characteristics of the respondents, common sources of contamination or spoilage in milk production and distribution, storage conditions, important considerations for ensuring safe and high-quality milk for consumers, key factors that influence the microbial quality of raw and boiled milk.

Key informant interviews were conducted in each sub cities with dairy product shop and cafeteria owner, worker, and government senior expert were purposively included to get reliable data. The total numbers of key informants participated in this study were 15 (five from each sub-cities). The interview was mainly focused on milk microbial and physicochemical quality, consumer preference, health aspects of using raw and boiled milk, customer milk consumption pattern, milk hygienic and handling practice in the study area.

Nine persons from each sub cities which includes DPS owners, cafeteria managers or owners, and experts from the agricultural office participated in focus group discussions covering various topics including milk handling practices, consumer behavior and perception, regulatory framework, milk storage and transportation, milk consumption patterns, impact of milk quality on human health, quality control measures, impact of milk quality on the local economy, consumer education and awareness, microbial quality of milk, physicochemical properties of milk. From a total of 27 participants 15 were from DPS and 12 were from cafeterias of the selected study areas.

3.4.4. Milk sampling

Sixty milk samples were taken for physicochemical and microbial quality tests from dairy product shop and cafeterias. 10 raw and 10 boiled milk samples were collected from each "Sub cities" dairy product shop and cafeteria respectively. Altogether, 60 milk samples were collected separately and aseptically. Before sampling from bulk milk tank the milk was thoroughly mixed after which approximately 250 ml of milk was transferred into sterile sampling bottles. 250 ml of boiled milk sample were taken from cafeteria at the time it is ready for serving and transferred to sterile sampling bottles and immediately packed to ice box. All milk sample bottles were capped, labeled with a permanent marker and stored in an ice packed cool box and transported to Lame Dairy PLC, Dairy Microbiology Laboratory for microbiological analysis and Federal TVT Institute for physicochemical analysis. Samples from the dairy product shop were collected during the early morning. Then, the milk samples were analyzed for physicochemical quality and microbiological quality parameters. Boiled milk samples from cafeterias were collected during mid-day. The media used for laboratory analysis were prepared following the manufacturers guidelines. All the analyses were performed within 24 hours of sampling.

3.4.5. Physicochemical Quality Analysis of Milk

The milk quality evaluation including preliminary quality tests, determination of major milk chemical composition, and microbial quality of milk were conducted.

Preliminary quality test: In order to evaluate the quality of milk, preliminary quality tests were undertaken. These include: Specific gravity, pH, freezing point and added water

Chemical composition test: The major chemical composition of milk and milk products determined include: percent of protein content, lactose content, fat content, and solids nonfat (SNF). Preliminary quality and milk compositions tests were determined using Ultrasonic milk analyzer: Lactoscan (Model: SAP-CB-011068, Bulgaria) reliable, automated multi-parameter milk analyzer providing rapid test results for chemical composition of milk (fat, protein, lactose and solid not fat) and physical characteristics (specific gravity, freezing point and added water). The Lactoscan was cleaned and rinsed three times with distilled water before analysis of each samples. Results of added water, specific gravity, freezing point, protein content, lactose content, fat content, and solids nonfat (SNF) were displayed on the screen of the ultrasonic milk analyzer: Lactoscan.

Determination of pH: For determination of pH in raw and boiled milk the method of AOAC (2000) was used and digital pH meter was used. Digital pH meter was calibrated with standard buffer 4 and 7 before measuring the samples. Sample solution was taken in the beaker and directly introduced the electrode into the solution. When the first reading was completed, the electrode was wiped with distilled water and dried-up with tissue paper. Similarly, all other samples were determined consequently.

3.4.6. Milk Microbial Quality Analysis

Aerobic Mesophilic Bacterial Count (AMBC)

One mL of milk sample was added to a sterile test tube with 9 mL of peptone water. After thorough mixing, the sample was diluted up to $1:10^{-6}$ and using 15-20 mL standard plate agar (Brand: Accumix, India), a duplicate sample (1mL) was poured and mixed thoroughly. The plate sample was allowed to solidify and then incubated at 30°C for 48 hours. For AMBC, appropriate decimal dilutions that would give the expected total number of colonies on a plate between 30 and 300 colonies were selected (Melese and Adisu, 2015). Colonies were counted using a colony counter (Marth, 1978). The standard plate agar media were prepared following the standard procedure provided by manufacturers.

Coliform count

One ml of milk sample was added to a sterile test tube containing 9 mL of peptone water. After mixing, the sample was serially diluted to $1:10^{-5}$ and duplicate samples (mL) were plated using 12-15 mL of violet red bile agar solution (VRBA) (Brand: HiMedia, India) After thorough mixing, the coated sample was allowed to solidify and then incubated for 24 hours at 30 °C. Finally, colonies were counted using a colony counter (Marth, 1978). Typical dark red colonies on uncrowned plates were considered as coliforms and counted. The CC was counted from duplicate plates containing 25 to 250 colonies. The violet red bile agar media were prepared following the standard procedure provided by manufacturers

Yeast and Mould Count (YMC)

The yeast and mould count was performed by plating a sample on Malt extract agar (Himedia) according to ISO 661. Malt extract Agar (Brand: Himedia, USA) is prepared following the standard procedure for media preparation. Samples of raw and boiled milk were diluted following similar methods as for Aerobic Mesophilic Bacterial Count (AMBC) but dilutions were surface plated on Malt extract Agar (Brand: Himedia, USA).The dried plates were incubated at 25°C for 3-5 days. Colonies with a yellow-white and slightly dark color were counted as yeasts and molds.

Reading and interpretation results:

The number of organisms (CFU) per milliliter of milk was calculated using the following mathematical formula (IDF, 1987).

$N=\Sigma C / (1\times n_1+0.1\times n_2)\ d$

Where, ΣC = Sum of all colonies on all plates counted

n_1 = Number of plates in the first dilution counted

n_2 = Number of plates in the second dilution counted

d = Dilution factor of the lowest dilution used

The results of microbial counts were transformed to logarithmic values (log 10)

3.4.6. Data analysis

The data was gathered and entered to Microsoft Excel spread sheet (2010) and analyzed by the statistical package for social science (SPSS, version 29). To display the result, descriptive statistics like mean, percentage, and standard error were employed. The least significant different (LSD) was used for the mean comparison. Laboratory data was examined using t-test data analyses. The data microbial data were first transformed into natural log 10 to normalize them before analysis for statistical difference of means using analysis of variance (ANOVA). The physicochemical and microbial qualities of raw and boiled milk were expressed as the mean ± standard deviation. At the ($P<0.05$) level, means were considered significantly different, and the least squares significant difference was used to separate them.

4. RESULTS AND DISCUSSION

4.1. Characteristics of the Respondents

The gender, age group and educational status of the respondents in the study area for dairy product shops and cafeteria are presented in Table 1. About 44.83% of the respondents in dairy product shops (DPS) and 48% of respondent in Cafeteria were male, while the corresponding values of female were 55.17 % and 52 %, respectively. This finding indicates that women play a larger role in business operation both in DPS and cafeterias. These results in contrast with previous reports, where males were the predominantly involved in the business with values ranging from 65 to 97% in different parts of Ethiopia, for instance, Haile (2015), who reported that in Adea Berga in the West Shewa Zone, the overall mean of male dairy producer were 97%, and Wondatir (2010), who reported that 86.7% of respondents were male dairy farmers in the Highland. Males conduct the majority of dairy farming (65%) according to a study on dairy farmers in Maharashtra conducted by Mohammed and Yancy (2023) and Samuel (2020) also reported the dominance of male (71.25%) in dairy production at Sebeta town of Oromia regional state, Ethiopia.

About 37% respondents in DPS and 41% of the respondents in cafeteria their average age were between 26–35 years and 36-45 years, respectively. This indicates that most dairy product sellers within a productive age range and created job opportunity for others. The current result is consistent with Alganesh *et al.,* (2019), who found that the productive age group dominated the dairy production in Jimma's central highlands. With regard to educational status, the majority of the respondents from DPS and cafeteria had completed high school 39.1% and 31.8%, respectively, while the corresponding values who attended above college were 37.5% and 34.7%, respectively. There were no illiterate respondent registered, this result indicates that there was higher literacy in both dairy product shop and Cafeterias. This indicates that a significant portion of the respondents were educated, which could help drive further the advancement of dairy product utilization and processing of the Sheger cities in particular and the country at large. Education facilitates the adoption of new technologies, improves milk production quality and strengthens food safety practices.

Higher education levels in milk product marketing lead to better quality control, addressing consumer demands, and promoting innovation. Additionally, education is helpful in improving dairy practices, ensuring quality control, and promoting sustainable development in the dairy sector (Demelash *et al.,* 2024)

Among the respondents from DPS and cafeterias, 23 % had got training on milk handling practice and the microbial properties of milk, while the majority (77%) of them did not receive any training. However, notable difference in the percentage of respondents who had undergone training on these topics. The significant training gap, particularly among cafeteria respondents, may negatively impact the microbiological quality and safety of milk products, which is evident as 62.8% of respondents from DPS and 91.3% of from cafeterias did not receive any training related to milk handling practices. These findings consistent with Deddefo *et al.* (2023) who reported that inadequate training and poor hygienic milking practices were dominant among dairy farmers. The lack of training could lead to higher bacterial counts in milk posing serious food safety risks.

Table 1: Socio-economic characteristics of respondents in the study area

Variables	**Dairy product shops (N=95)**	**Cafeteria (N=110)**	**Overall mean**
Age (yrs)			
18-25	6.83	5.26	6
26-35	36	39.13	37
36-45	46.4	44.3	45
More than 55 years	13.8	11.43	12.5
Gender (%)			
Male	44.83	48	46.4
Female	55.17	52	53.6
Educational level (%)			
Primary school	15.8	1.83	8.8
Junior school	7.6	31.6	19.6
High school	39.1	31.8	35.45
College or University	37.5	34.7	36

Training received (%)			
Yes	37.2	8.7	23
No	62.8	91.3	77

4.2. Types of Milk Product Selling in Dairy Product Shops

The types of milk product sold in dairy product shops are presented in Figure 2. The majority (82.9%) of these shops sell raw milk, Irgo, Ayib and butter, while 17.1% of them offer both raw and boiled milk. Based on key informant interviews in the study areas, the primary reason for the higher sales of raw milk is consumers' preference for its lower price compared to boiled milk. To satisfy their children's milk needs, many consumers choose to purchase raw milk and boil it at home (Adrienne, 2024). But when raw milk is handled incorrectly, it can become contaminated with pathogenic bacteria like *Salmonella, E.coli*, and *Listeria monocytogens*, which poses serious health risks. These pathogens have the potential to cause severe foodborne illnesses, especially in susceptible groups like pregnant women, the elderly, and children. To reduce these health hazards and safeguard consumers, it is essential to ensure that milk is handled, stored, and processed properly (CDC, 2024). This highlights the significance of receiving proper training in milk handling techniques to guarantee the safety of milk and milk products (Fagnani *et al.,* 2021).

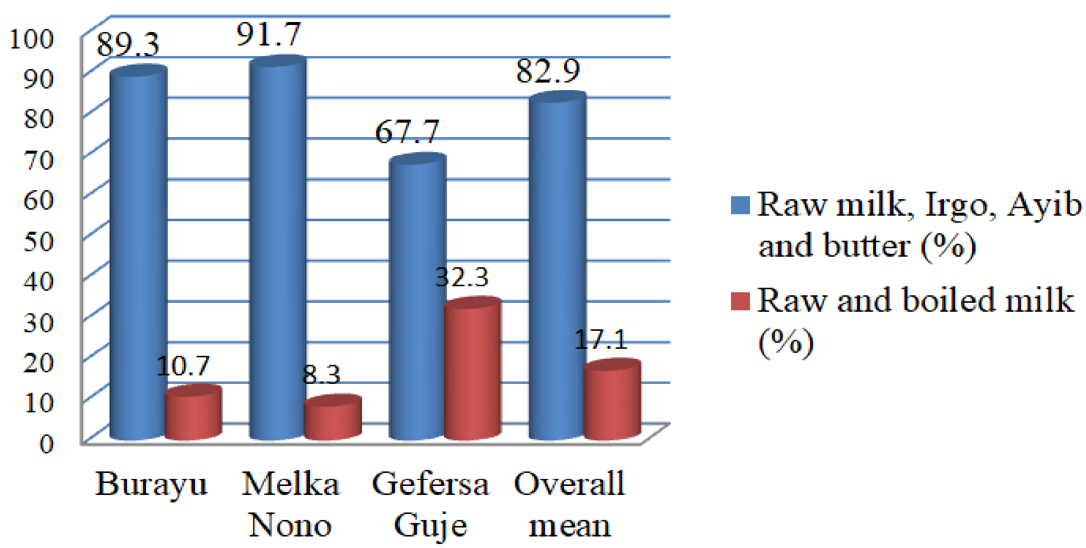

Figure 2. Types of milk products in dairy product shop

4.3. Source of Milk Products in Dairy Product Shop and Cafeteria

The source of milk in dairy product shop and cafeteria are shown in Table 2. A large portion of the raw milk supply for dairy product shops (42%) and cafeterias (53.8%) comes from surrounding small-scale farmers, while 34% and 46.2%, respectively are supplied by commercial farms. The results of the current study revealed that 48% of the raw milk used in DPS and cafeteria is sourced from surrounding small-scale farmers, which might be due to proximity and cheaper transportation costs. Considering their proximity and lower transportation costs, sourcing raw milk from local farmer is often the preferred choice for dairy product sellers (Zhang *et al.,* 2021). Commercial farms also play a substantial role contributing 40% likely due to their reliable supply chains and higher production capacities. Furthermore, a significant portion of DPS and cafeteria (11%) supply raw milk from their own farms, which helps ensure better quality control and reduces reliance on external vendors. The current study shows a significant reliance on surrounding small scale farms for milk supply and it aligns with a previous study conducted by Minten *et al.,* (2020) in Addis Ababa, which found that 85% of milk consumed was raw milk from local farms and 15% from commercial farms.

According to the respondents in the study areas, the overall mean times for selling milk after reception in DPS and cafeteria were 44% within 6 hrs and 46% within 12 hours. This indicates either high customer demand or efficient inventory management as the majority of the milk is sold within the first 12 hours. Alemneh *et al.* (2019) who reported that smallholder farmers struggle to sell milk due to limited market access and poor infrastructure, which can result in longer times and potentially affect milk quality.

Table 2: Source of milk products in dairy product shop and cafeteria

Variables	Dairy product shops (n=95)	Cafeteria (n=110)	Overall mean (n= 205)
Source of milk			
Surrounding small-scale farmers	42	53.8	48
Dairy cooperatives	2.3	-	1.15
Commercial farms	34	46.2	40
Own farms	21.8	-	11
Time required to complete milk sales after reception			
Less than 6 hours	50.8	37.3	44
Less than 12 hours	38.4	53.6	46
Less than 24 hours	10.7	9.1	10

4.4. Types of Milk and Source of Raw Milk in Cafeteria

The types of milk, source of raw milk and the ratio of water to milk powder used in cafeteria are shown in Table 3. Almost all (92.3%) of the respondents in study areas reported raw milk to serve their customers, while only 7.7 % used milk powder, which is mixed in a ratio of one cup of water to two table spoons of milk powder. This preference for raw milk is likely due to its perceived freshness and superior taste. The result of the current study is in agreement with previous studies. For instance, raw milk is often more preferred than boiled milk because it contains higher levels of nutrients including vitamin B2, B12, D and minerals such as Calcium and Phosphorus (Yacoubian, 2023). Raw milk is better than milk powder for its creamier taste, richer and perceived freshness (Shirvell, 2020). Raw milk were sourced from dairy product shop of study areas.

Table 3: Types of milk, source of raw milk and ratio of water to milk powder used in cafeteria

	Study site (N=110)			
Variables	Burayu	Melka Nono	Gefersa Guje	**Overall mean**
Types of milk in use				
Raw milk	96.9	97.6	83.3	92.3
Milk Powder	3.1	2.4	16.7	7.7
Ratio of water to milk powder				
One cup water with 2 tablespoon of milk powder	3.1	2.4	16.7	7.7
Didn't use it at all	96.9	97.6	83.3	92.3

4.5. Handling Practices of Boiled Milk

The handling practices of boiled milk during storage, boiling time and temperature is summarized in Table 4. The current study found that 70.64% of the respondents store raw milk in the refrigerator immediately after receiving it and boil only it when necessary. In contrast, 29.36% of respondents boil raw milk upon receipt, then cool it and refrigerate it until use. This pattern is consistent with finding from Amenu *et al,* (2019) who reported as there is a strong unwillingness to boil milk before consumption due to misconceptions that boiling destroys nutrients.

The study result also revealed that only 18.8% of the respondents used a thermometer to control the temperature and the duration of boiling, while the majority (81.2%) of them depends solely on observation. Regarding boiling time, 45.63% of the respondents boil milk for longer than two minutes followed by 38.16 and 15.9%, for about two minutes and one minute, respectively. Furthermore, only 14.1% of the respondents maintain a boiling temperature of 100.5°C, whereas 85.9% did not check the temperature at all.

These practices may be influenced by various factors including lack of awareness or training on proper milk handling practices, cultural preferences for traditional methods, and a perceived lack of necessity for precise measurements. A study conducted by Abunna *et al.,* (2019) in Addis Ababa revealed significant bacterial contamination in milk due to poor handling practices and inadequate temperature control during boiling. There can be serious consequences if the temperature and time at which milk boils are not properly controlled. Insufficient boiling may not completely fully eliminate the harmful bacteria, which could result in foodborne illness and other health hazards. On the other hand, over boiling can reduce the nutritional value of milk, alter its flavor, and lessen its valuable qualities. The possible cause for these practices might be lack of knowledge or training regarding safe milk handling practices. The result highlights the need for enhanced training and resources to encourage better milk handling practices, ensuring both safety and quality.

Table 4: Handling practices of boiled milk in the study areas

	Study site (N=110)			
Variables	Burayu	Melka Nono	Gefersa Guje	**Overall mean**
Storage condition				
Boiling followed cooling	31.3	26.2	30.6	29.36
Keep in refrigerator without boiling it	68.8	73.8	69.4	70.64
Methods of temperature control				
Using thermometer	18.8	23.8	13.9	18.8
Observation	81.3	76.2	86.1	81.2
Milk boiling time				
One minutes	9.4	19	19.4	15.9
Approximately 2 minutes	40.6	35	38.9	38.16
More than 2 minutes	50	45.2	41.7	45.63
Milk boiling temperature				
At 100.5^0C	9.4	19	13.9	14.1
I didn’t check the temperature	90.6	81	86.1	85.9

4.6. Hygienic milk Handling Practices during Transportation and Storage

Hygienic milk handling practices during transportation and storage are presented in Table 5. Overall mean of DPS and cafeteria’s respondents were 63%, 35% and 2% were using narrow neck plastics (Jerycan), aluminum and bucket respectively for milk storage during transportation. The study result revealed that majority of DPS and cafeterias of the study areas were utilizing narrow neck plastics (Jerycan) for storing and transporting raw milk from farm to DPS and cafeterias. About 88.24 % of dairy product shop of study areas were using temperature adjustable refrigerator while only 11.76% of respondents was using the normal home refrigerator. Majority (96.4 %) of respondents of study areas cafeteria were using temperature adjustable refrigerator while only 3.6 % was storing in normal home refrigerator. Most of the respondents from both DPS and cafeterias were using temperature adjustable refrigerator for storing raw milk until selling to customers. This result is disagree with finding of Abebe *et al.,* (2018) who reported 82.5% of respondents in selected areas of Ethiopian central highlands stored evening milk at room temperature until sold the following morning. This result reflects better access to technology and infrastructure in current study areas as it is urban while the compared result was from dairy farmer of the rural or peri-urban.

From respondents of DPS and cafeteria of study areas 37.6%, 35.4%, 23.4% and 3.5% were using not food grade detergent with warm water, cold water with detergent, food grade detergent with warm water and warm water only respectively as milk container washing materials. This suggests that while a considerable percentage of respondents prioritize using food-grade detergents, a remarkable still use warm water only or non-food-grade detergents, which may not be as safe or effective for cleaning milk storage equipment. The practice of using cold water without detergent results in to inadequate cleaning of containers which assist as source of milk contamination (Pandey and Voscuil, 2011). The result of current study relatively align with Abebe *et al.,(*2018) which reported that 53.8% of respondents using cold water and soap while 46.2% using warm water with soap for cleaning milk utensils.

As a source of water for cleaning equipment 96.94% and 61.13% of respondent of DPS and cafeterias of the study areas using municipal supplied water while only 1.06% and 38.8% respectively were using ground water for cleaning equipment. The overall mean of study results indicate that 80% of participants relied on municipally supplied water as their primary source for cleaning milk storage equipment, while only 20% utilized groundwater for this purpose. Similar finding was reported by Bruktawit (2016) the majority (98.9%) of respondents use municipally supplied water for cleaning of milk equipment's. When water from non-tap sources is employed for cleaning, it is crucial for producers to filter and heat treat it beforehand, as the quality of the water significantly affects bacterial counts (Zelalem, 2009).

The overall mean frequency of container cleaning among respondents from DPS and cafeteria in the study areas were 49% twice a day, 37.63% once a day, and 13.28% three times or more per day. The study revealed that the most common frequency of container cleaning among respondents is twice a day, with overall mean of 49%. This suggests that closely half of the respondents prioritize maintaining cleanliness by cleaning their containers twice daily, reflecting a strong awareness of hygienic practices. Additionally, 37.63% of respondents clean their containers once a day. This shows a strong commitment to routine cleaning even though it is less often than twice a day. A smaller group, comprising 13.28% of respondents, cleans their containers three or more times daily. This could indicate either a higher level of concern for cleanliness or specific requirements that necessitate more frequent cleaning. Overall, the study suggests that the majority of respondents (86.63%) clean their containers at least once a day, reflecting a general awareness and hygienic practice. A study conducted in the Borana pastoral community by Amdhun, (2019) found that 77.8% of households did not properly clean their milk handling equipment. This result is significantly lower than the current study, indicating a better awareness and hygienic practice in current study area than Borana pastoral community.

About 76.17% of respondents of dairy product shop of study areas were cleaning milk material immediately after using it while 23.83% cleaning milk material prior to use it. 91.2% of cafeterias of study areas respondents were responded as they are cleaning milk material immediately after using it while 8.8% were cleaning prior to use it. The overall mean milk storage equipment cleaning of DPS and cafeteria were 83.7% immediately after using it 16.7% prior to use it. The studies result is relatively in line with the result of Dejene *et al.,* (2021), Nyokabi *et al*., (2023), Feyisa *et al.,* (2024) who reported that 70% of respondents cleaned their milk storage equipment immediately after use, and 30% cleaned it prior to use, 75% of respondents cleaned their milk storage equipment immediately after use, while 25% cleaned it prior to use, and 80% of dairy farmers cleaned their milk containers immediately after use, and 20% cleaned them before use respectively. These comparisons show that, despite some regional differences, cleaning milk storage equipment immediately after use is a common practice throughout Ethiopia. Previous studies have demonstrated generally poor hygienic practices in Ethiopia's dairy industry. For instance, a study conducted by Yeserah, (2018) revealed that large number of dairy producers do not adhere to recommended cleaning procedures and frequently use primitive techniques like smoking and fumigation in place of adequate washing and sterilization. Small holder dairy producers more often lack knowledge and training regarding basic hygiene, which results in inconsistent practices (Teshome, 2023). There are several benefits to cleaning milk materials immediately after use, such as avoiding bacterial growth, preserving product quality, and making cleaning simpler. It also aids in establishing consumer trust and adhering to food safety regulations. However, using cleaning products just before using them can result in a higher risk of contamination, spoiling, and harder cleaning because of dried residues. This approach may lead to uneven product quality and possible legal problems. All things considered, prompt cleaning is essential to preserving hygiene and guaranteeing the safety. According to Abebe *et al.,* (2018), delay in cleaning milk containers gives microorganism's adequate time to multiply and increase in number to the level that may be difficult to reduce to acceptable amount during cleaning. This could result into high microbial counts in milk kept in these containers and hence accelerated microbial spoilage leading to post harvest losses of the milk. The result of current findings were also in line with Abebe *et al.,* (2018).

According to current study, the overall mean smoking of milk storage material of DPS and cafeterias of study areas, 35.8% of respondents were conducting smoking of milk storage equipment while the majority (64.2%) of respondents did not. Smoking milk storage equipment is a common practice that helps sanitize milk containers and improve the flavor and shelf life of milk. The usage of this practice could be contributing to the poor microbial quality of milk observed in the study, as smoking can help in reducing microbial contamination. Smoking by using deferent types of plant materials were means for extending the shelf life of milk and milk products (Azeze *et al.,* (2016). It is proved that this practice extends the flavor, aroma, and shelf life of dairy product (Tsadkan and Amaniel, (2016) and Abebe *et al.,* (2018). Apart from these, Gonfa *et al.,* (2001) showed that smoking slowed souring, improved flavour and slowed the growth of coliforms. Deferent studies have provided ample evidence of the practice of smoking milk storage materials with Olea Africana (Woira). The above respondents were used Olea Africana (Woira) as a means of smoking milk storage materials, demonstrating the material's common use and cultural importance. The result of this study is consistent with the study conducted by Shambel *et al.,* (2021) in the Haramaya district discovered that Olea Africana is commonly used to smoke milk utensils, in addition to other plants such as Catha edulis.

Table 5: Hygienic milk handling practices during transportation and storage (% of respondents)

Variables	**DPS (N=95)**	**Cafeteria (N=110)**	**Overall mean**
Types of milk transportations containers			
Aluminium	36.3	33.5	35
Narrow neck plastic (Jerycan)	59.5	66.5	63
Bucket	4.2	-	2
Milk storage before selling			
Less than 4^0c	88.24	96.4	92.32
Normal home refrigerator	11.76	3.6	7.68
Milk container washing materials			
Food grade detergent with warm water	25.2	21.6	23.4
Warm water only	7	-	3.5
Not food grade detergent with warm water	27	48.23	37.6
Cold water with food grade detergent	40.8	30	35.4
Source of water for cleaning			
Municipal supplied water	98.94	61.13	80
Ground water	1.06	38.87	20

Milk containers cleaning frequency per day			
Once	5.46	69.8	37.63
Twice	67.96	30.2	49
Three and above	26.56	-	13.28
Time of cleaning milk storage containers			
Prior to use it	23.83	8.8	16.3
Immediately after using it	76.17	91.2	83.7
Smoking of storage material			
Yes	71.6	-	35.8
Not at all	28.4	100	64.2
Types of smoking plant			
Woira (Olea Africana)	71.6	-	35.8
Do not use smoking at all	28.4	100	64.2

4.7. Quality Checks during Milk Receiving

Quality checking during milk receiving is summarized in Table 6. Study result of milk quality checks during receiving in DPS and cafeteria shows that organoleptic tests are performed by 11.3% of respondents in DPS and 8.3% in cafeterias with an overall mean of 9.8%. Lactometer readings are slightly used more than organoleptic test with 10.52% in DPS and 11.8% in cafeterias, resulting in an overall mean of 11.2%. However, a significant majority 78.07% in DPS and 80% in cafeterias do not perform any quality checks, with an overall mean of 80%. The result align closely with the finding of Merema, (2020), Girma and Mekonnen, (2023), and Minten *et al.*,(2023) who reported 15% of respondents used organoleptic tests, 10% used lactometer readings, and 75% did not perform any quality checks during milk receiving at Kombolcha district, South Wollo, Ethiopia, 12% of respondents are using organoleptic tests, 8% using lactometer readings, and 80% did not conduct any quality checks at Kombolcha, Ethiopia and 10% of respondents used organoleptic tests, 12% used lactometer readings, and 78% did not perform any quality checks respectively. The result revealed that common need for improved quality control practices in milk handling in current study area.

Table 6: Quality checks during milk receiving (% of respondents) in the study sampling sources

Variables	**Dairy Product Shop (N=95)**	**Cafeteria (N=110)**	**Overall mean**
Quality checks during milk receiving			
Organoleptic test	11.3	8.3	9.8
Lactometer reading	10.52	11.8	11.2
No use of any test	78.07	80	80

4.8. Quality Control Practices

Quality control measures in place are summarized in Table 7. For monitoring temperature and storage conditions, 98.94% of DPS observed to proper practices, compared to only 60% in cafeterias, resulting in an overall mean of 79.5%. Conversely, 1.06% of DPS and 40% of cafeterias did not monitor temperature and storage conditions, with an overall mean of 20.5%. Regarding the use of clean and sanitized equipment, 95.06% of DPS and 96.4% of cafeterias using clean and sanitized equipment with an overall mean of 95.7%. Additionally, 4.94% in DPS and 3.6% in cafeterias, with overall mean of 4.3% had a problem in using clean and sanitized equipment. Strict hygienic practices during milk handling were observed in 92.9% of DPS and 85.5% of cafeterias respondents with an overall mean of 89%. Strict hygienic practice during milk handling was not applying by 7.1% in DPS and 14.5% in cafeterias with overall mean of 11%. 100% of the respondents were reported that, there is a gap in milk quality control measure in study areas. The study result of quality control measures show that DPS generally maintain higher standards compared to cafeterias. DPS are more attentive in monitoring temperature and storage conditions, which is critical for keeping milk quality and safety. Both DPS and cafeterias are good at using clean and sanitized equipment, though there are still gaps that could lead to contamination. Hygienic practices during milk handling are also better in DPS than in cafeterias, indicating a higher risk of hygiene-related issues in the latter. Overall, while DPS perform better, the gaps in cafeterias' practices could compromise milk quality and increase health risks for consumers.

The results of current study shows higher percentage of respondents are monitoring temperature and storage condition, which is significantly higher than the finding of Teshome *et al.,* (2014) who reported 70%. And the result of cafeterias respondents are closer to the finding of Alemu *et al.,* (2019) who reported 65%. For the use of clean and sanitized equipment, current study results (95.06% in DPS and 96.4% in cafeterias) exceed but relatively align with those of Gebremedhin *et al.* (2021); Bekele *et al.* (2018) who reported that 90% and 85% respectively. Hygienic practices during milk handling in current study (92.9% in DPS and 85.5% in cafeterias) also exceed the finding of Tadesse *et al.,* (2022); Mekonnen *et al.,* (2017) who reported 80% and 75% respectively. Overall, the result of current study indicates better quality control measures, particularly in DPS; however milk sold in cafeterias of the study area need improvement.

Table 7:- Quality control measures in place (% of respondents)

Variables	**Dairy Product Shop (N=95)**	**Cafeteria (N=110)**	**Overall mean**
Monitoring of temperature and storage condition			
Yes	98.94	60	79.5
No	1.06	40	20.5
Use of clean an sanitized equipment			
Yes	95.06	96.4	95.7
No	4.94	3.6	4,3
Strict hygienic practice during milk handling			
Yes	92.9	85.5	89
No	7.1	14.5	11
Gaps in existing quality control measures			
Yes	100	100	100

4.9. Constraints in Milk Quality Control in Dairy Product Shop and Cafeterias

As indicated in table 7 above 100 % of respondents were reported that there is a gap in existing milk quality control. Constraints of milk quality control in dairy product shop and cafeteria is summarized in table 8. The main constraints of milk quality control in dairy product shops include inadequate training of dairy farmers and workers (14.13%), poor communication between stakeholders (20.3%), and insufficient regulatory enforcement (37%). Additionally, there are issues with checks for adulteration (14.9%) and temperature monitoring during transportation and storage (13%). The most critical problems are regulatory enforcement and communication, highlighting the need for better training, improved stakeholder collaboration, and stricter regulations to enhance milk quality control.

The main constraints of milk quality control in cafeterias, based on the data provided by respondents, include a lack of reliable supply chain (11.6%), inadequate refrigeration (18.6%), and failure to regularly test milk for contamination (24.4%). Poor sanitation practices in milk production (17.5%), lack of training and awareness (15.6%), and no clear protocol for addressing quality complaints (11.83%) are also significant issues. The most critical problem is the failure to regularly test milk for contamination, highlighting the need for stringent testing protocols to ensure milk safety and quality. Improving refrigeration and sanitation practices, along with better training and clear protocols for quality issues, can significantly enhance milk quality control in cafeterias.

Table 8: Constraints in Milk Quality Control in Dairy Product Shop and Cafeterias

Study site	**Dairy Product Shop (DPS) (N=110)**				**Cafeteria (N=110)**			
Constraints	Burayu	Melka Nono	Gefersa Guje	**Overall mean for DPS**	Burayu	Melka Nono	Gefers a Guje	**Overall mean for cafeteria**
Inadequate regulatory enforcement of quality control standards in the dairy industry	46	29	36	37	NA	NA	NA	NA
Poor communication between stakeholders in the milk supply chain regarding quality control issues	17	19	25	20.3	NA	NA	NA	NA
Insufficient checks for adulteration	14.6	19	11	14.9	NA	NA	NA	NA
Inadequate training of dairy farmers and workers on quality control measures	7	16	19.4	14.13	NA	NA	NA	NA
Inadequate monitoring of temperature during transportation and storage of milk	15	16	8.3	13	NA	NA	NA	NA
Failure to regularly test milk for contamination	NA	NA	NA	NA	25	22.2	26.1	24.4
In adequate refrigeration	NA	NA	NA	NA	15.6	16.6	23.8	18.6
Poor sanitation practice in milk production	NA	NA	NA	NA	21.8	16.6	14.3	17.5
Lack of training and awareness	NA	NA	NA	NA	15.6	19.4	11.9	15.6
No clear protocol for addressing quality complaint or issues when they arise	NA	NA	NA	NA	12.5	11.1	11.9	11.83
Lack of reliable supply chain	NA	NA	NA	NA	9.3	13.8	11.9	11.6

NA: Not Applicable

4.10. Physicochemical compostion of Raw and Boiled Milk

The result of physicochemical qualities of raw and boiled milk is shown in Table 9.The average mean±SD of added water of raw and boiled milk collected from DPS and cafeterias of study areas were 4.85 ± 1.7 and 3.94 ± 1.8, respectively. Both raw and boiled milk were found to be adulterated with no significant variation ($P>0.05$) between them in terms of added water contents of the milk samples. The mean values of added water lower than those reported by Bruktawit (2016) and Jalel (2021) who reported 5.5 ± 10.1; 5.68 ± 2.19 respectively, but higher than 2.80±3.60 as reported by Dessaleng (2017). Water adulteration not only reduces the nutritional worth of milk but also it poses health risk if the water is contaminated (Pitty, 2011; Kandpal *et al.,* 2012).

Overall mean of specific gravity of the raw milk and boiled milk samples was 1.025 ± 0.001 and 1.026 ± 0.002, respectively. The specific gravity results showed a significant difference between the raw and boiled milk samples. The specific gravity of raw milk source did not meet the Ethiopian Standard range of 1.026 and 1.032, which is an indication of the possible adulterations. The results of current study are lower than the specific gravity values of 1.029, 1.031 and 1.030 as reported by Zerihun and Getenesh, (2019); (Bruktawit, 2016); and Jalel,(2021), respectively. Normal milk has a density ranges between 1.027 and 1.035, with a mean of 1.032 at 16°C (FAO, 1999). The specific gravity of milk is lowered by addition of water and cream and is increased by addition of skim milk or removal of fat (Dessaleng, 2017).

The overall mean ±SD of freezing point of raw and boiled milk samples from DPS and cafeterias were -0.50± 0.02 and -0.55 ± 0.04, respectively with significant differences between the two types of milk ($p < 0.05$). According to Ethiopian standards, fresh cow milk should ideally have a freezing point between -0.547 and -0.590 (ESA, 2009). Dehinenet *et al*.,(2013) in selected areas of Amhara and Oromia National Regional States, Ethiopia and Jalel (2021) in selected areas of Oromia special zone found less freezing point raw milk and higher for boiled milk -0.559 and of -0.514, respectively. The overall mean ±SD of current study of raw milk from DPS and boiled milk from cafeteria were outside the range of normal milk this might be due to milk adulteration and poor handling practices. However, these finding were lower than the finding of (Biruktawit, 2016) who reported milk freezing points of -0.941. The difference in freezing points could be attributed to heat treatment affecting the milk or storage of raw milk at low temperature. Monitoring freezing points is crucial to detect water and amount of water added to milk. The freezing point of milk could be affected by location, breed, and management practices besides season, feed type, and water intake by the animals. However, protein and fat content do not impact milk's freezing point. The pH values of raw milk samples collected from different DPS and boiled were 6.23 ± 0.24 and 6.3 ± 0.19, respectively. However, no significant difference ($p > 0.05$) was observed between the raw and boiled milk. Fresh normal cow milk has a pH of 6.6 to 6.8 when milk temperature is 20°C (FAO, 2009). The pH-values in study were below the normal pH ranges of fresh milk, this might be due to increased acidity of milk from bacterial multiplication. Boiling milk slightly decreased its pH, consistent with the findings of Mihaela *et al.,* (2016) and comparable with the findings of Teklemichael *et al.,* (2015), though different from those of Eshetu *et al.,* (2019) who reported the overall mean pH value of 6.69±0.02.

The overall mean ± SD of fat composition of raw milk sampled from different DPS and boiled milk sampled from various cafeterias of study areas were 3.67 ± 0.29 and 3.6 ± 0.39 respectively. However, no significant different was observed between raw and boiled milk samples. The current finding aligns with Dessaleng (2017), who reported a fat content of 3.60% ± 0.53 in milk from the Bishoftu and Akaki towns in Oromia Regional State, Ethiopia. However, the fat content found in this study lower than those reported by Kunda *et al.,* (2015), Eshetu *et al.,* (2019), and Biruktawit (2016), who noted an overall mean fat content of 3.9% in raw milk from smallholder dairy farmers in Lusaka Province of Zambia, 4.02±0.10 and 4.42 ± 1.16 in raw cow's milk sold in selected sub-city of Addis Ababa, Ethiopia, respectively. Factors such as feed and nutrition, genetics, milking frequency and techniques, and seasonal variation can influence cow milk fat content. According to the Ethiopian Standard Agency (ESA, 2009), raw milk should not have less than 3.5% fat content. Therefore, the average fat content observed in both raw milk and boiled milk samples fulfilled the recommended standards.

The mean ± SD protein content of raw and boiled milk samples from different DPS and cafeteria was 3.13 ± 0.17 and 3.08 ± 0.23 respectively. Similar to milk fat, no significant variation in milk protein was found between raw and boiled milk samples of the current study. This result agreed with previous studies by Teklemichael *et al.* (2015) and Jalel (2021) who reported protein content of 3.42 ± 0.139 and 3.2 ± 0.082 respectively. though it was higher than Mezgeb *et al,* (2012), who reported that the average protein content of 2.73±0.03 and lower than the finding of Girma and Mekonin (2023), who reported that the average protein content of 3.58±0.05. Even if, research on boiled milk is limited, the differences might be due to the physicochemical changes that occur during boiling reduces whey proteins and alterations in other milk protein structure. ESA (2009), recommends a minimum protein content of 3.2% for whole milk. The overall mean protein content in the current study was slightly below in acceptable range of Ethiopian standard (ESA, 2009).

The overall average ± SD of lactose content in raw and boiled milk samples from DPS and cafeterias was 4.4 ± 0.3, and 4.13 ± 0.4, respectively (Table 10) with a statistically significant difference ($p<0.05$) between raw and boiled milk. Lactose content found in this study was higher than the findings of Dessaleng (2017) who reported 3.93±0.25 in raw milk from Bishoftu and Akaki Towns, Oromia Regional State, Ethiopia and Mezgeb *et al.,* (2012) who recorded 4.13±0.05 in raw milk. The lactose content of boiled milk (4.13 ± 0.39) aligned with the result of Mezgeb *et al.,* (2012). According to European Union quality standards for unprocessed whole milk, lactose content should not be below 4.2% (Tamime, 2009). Therefore, the overall mean lactose content observed in this study (4.26 ± 0.4) falls within the recommended range. Generally, variations in milk composition may be influenced by factors such as animal breeds, feeding management, and environmental condition (Pandey and Voskuil, 2011).

The average SNF contents of raw and boiled milk samples collected from DPS and cafeterias were 8.15 ± 0.5 and 8.14 ± 0.45, respectively with no significant differences observed between boiled and raw milk ($p > 0.05$). The slight difference in the average SNF content between raw and boiled milk samples can be attributed to several factors. The SNF content may be slightly impacted by heat treatment during boiling, which can result in small losses of some nutrients, including proteins and minerals. Furthermore, boiling causes some of the water to evaporate, which can concentrate the milk's solids and possibly change the composition of SNF (Mihika, 2021). The FDA recommends a minimum SNF content of 8.25% for whole cow’s milk, which mean the current finding fall slightly below this recommended standard. The SNF content obtained in this study from different DPS and cafeterias of selected areas of Sheger Cities were 8.15 ± 0.46 and 8.14 ± 0.45, respectively. The SNF content of sampled milk was slightly higher than that reported by Estifanos *et al.,* (2015) and Samuel, (2020) who reported the average SNF of 7.98±0.98 and 7.96%, respectively. However, it was lower than the findings of Debebe (2010); Dehinnet *et al.* (2013); Teklemichael (2012); and Fikrineh *et al.* (2012) who reported the SNF content ranging from 8.3±0.30% to 9.05±0.16% in raw milk from various sources in Ethiopia town respectively. Boiling milk can cause structural changes in proteins, leading to reduce a protein digestion and retention, which may explain lower SNF content as observed in boiled milk. Differences between milk sources could also be due to adulteration such as fat removal, genetics variations, dry matter intake and reduced mineral intake (Glenn *et al.,* 2019).

Table 9: Mean (± SD) of physicochemical properties of raw and boiled milk

	Types of sample (N=60)			
Measured variable	Raw Milk from DPS (30)	Boiled milk from cafeteria(30)	Overall mean	**P-value**
Added water	4.85 ± 1.7	3.94 ± 1.8	4.39±1.75	0.06
Fat	3.67±0.29	3.6±0.39	3.63±0.34	0.39
Protein	3.13±0.17	3.08±0.23	3.1±0.2	0.36
Lactose	4.4±0.3^{a}	4.13±0.4^{b}	4.26±0.35	0.004
SNF	8.15±0.5	8.14±0.6	8.14±0.55	0.91
pH	6.23±0.24	6.3±0.19	6.26±0.21	0.71
Specific gravity	1.025±0.001^{a}	1.026±0.002^{b}	1.025±0.0015	0.029
Freezing Point	-0.5±0.02^{a}	-0.55±0.04^{b}	-0.525±0.03	0.001

Different superscript in the same row show significant difference at p<0.05

4.11. Microbial Quality of Raw and Boiled Milk

The microbial count results of raw and boiled milk samples collected from DPS and Cafeteria of the study area are presented in Table 10. The overall mean aerobic mesophilic bcterial count (AMBC) for both raw and boiled milk samples was 4.67 ± 0.9 log10 cfu/ml). However, significantly higher average AMBC was observed in raw milk samples (6.14 ± 1.38 log10 cfu/ml) compared with boiled milk samples (3.21 ± 0.47 log10 cfu/ml) with the difference being statistically significant at $p < 0.05$. The current average AMBC results of raw milk are comparable to findings from various studies carried out in the country, for instance Tsedey and Asrat (2015) and Abebe *et al.,* (2018) who reported the TPC result of (6.84 ± 0.07) log10 cfu/ml) in Hawassa and Yirgalem areas, Southern Ethiopia and (6.76 ± 0.12 log10 cfu/ml) in the central highlands of Ethiopia, respectively. In contrast, the current finding is lower than the AMBC reported by Asaminew and Eyassu (2011), Abebe *et al.,* (2023) and Abebe *et al.,* (2012) (7.58 log cfu/ml), (9.0 ± 2.9 log cfu/ml) and (9.82 log cfu/ml), respectively. On the other hand, higher average AMBC result was observed by previous researchers, such as Mussa (2022) who found average AMBC of 4.54 ± 0.67 log cfu/ml. The findings in this study were generally higher than the acceptable bacteria level of 5.0 log10 cfu/ml of raw milk (Lore *et al*., 2005).

The possible causes for this include contamination from the udder surface, farm-level contamination, inadequate cooling methods and transportation, unclean milk containers, poor water quality used for cleaning milking utensils, and delays between production and commercialization (Dessaleng, 2017). The primary causes of high bacterial loads include maintaining unclean housing and milking areas, milking dirty udders, and insufficient cleaning the milking utensils (Hossain *et al.,* 2011).

The overall mean ± SD for boiled milk from cafeterias in the current study area was 3.21 ± 0.47 log10 cfu/ml. This result for boiled milk was lower than the AMBC of pasteurized milk reported by Woldemariam and Asres (2017) who reported (2.6×10^6), but higher than the TPC of boiled milk reported in in the selected sub-cites of Addis Ababa, Ethiopia by Abunna *et al.,* (2019) and Karmaker *et al.,* (2020) who reported the AMBC result of 3.11±0.12. The lower AMBC of boiled milk compared to pasteurized milk might be attributed to the boiling process raises the temperature sufficiently to a wider variety of microorganisms, resulting in a lower AMBC for boiled milk. Pasteurization is effective; it may not eliminate all microorganisms entirely, as it seeks to balance microbial reduction with reduction and nutrient retention.

The CC of raw and boiled milk from various dairy product shops and cafeterias of the three study areas indicated different results. The CC of raw and boiled milk sample were 4.78 ± 0.29 log10 cfu/ml and 2.31 ± 0.36 log10 cfu/ml, respectively with an overall average of 3.54±0.32 log cfu/ml. A significant difference in CC was recorded between raw and boiled milk samples collected from different DPS and cafeterias of the selected areas of Sheger cities ($p < 0.05$).

The current study's CC result was lower than those reported by Biruktawit (2016) and Abebe *et al.,* (2023) who found CC values of 6.18 ± 2.7 log10 cfu/ml in milk samples collected from selected sub-city of Addis Ababa, Ethiopia, and 6.8 ± 2.6 log10 cfu/ml in milk sample collected from Asosa district, Ethiopia. Conversely, this finding was higher than the results of Mussa (2022), Tsedey and Asrat (2015), Abebe *et al.,* (2018), Abebe *et al.,* (2012), and Negash *et al.,* (2012), who reported a coliform count of 2.95 ± 0.44 log10 cfu/ml in milk sample collected from Worabe town, Silte Zone, Southern Ethiopia, 3.48 ± 0.18 log10 cfu/ml in milk sample collected from Hawassa and Yirgalem areas of Southern Ethiopia, 3.50 ± 0.01 log10 cfu/ml in milk sample collected from selected areas of Ethiopian central highlands, 4.03 ± 0.09 in cow milk sample from Ezha district of Gurage zone, Southern Ethiopia, and 4.35 ± 0.06 log10 cfu/ml in milk sample from the Mid-Rift Valley of Ethiopia, respectively.

The average CC of raw milk observed in the current study is slightly higher than the recommended range of Ethiopian Standard Authority. The total CC of fresh cow milk should not exceed ≤ 4.70 log10 cfu/ml for safe human consumption. High levels of coliforms in milk indicates that the milk is contaminated with feces as result of inadequate udder washing before milking, improper hand washing followed by the milkers, and the use of poor and untreated water to clean milking utensils. Grillet *et al.*, (2007), who confirmed that, milk contamination from unclean milk utensils or from milking cows suffering from environmental coliform mastitis could be the cause of elevated coliform counts. Furthermore, coliform bacteria in bulk milk are employed as indicator of handling-related sanitary conditions. The overall mean ± SD of CC for boiled milk from the three selected areas of Sheger cities was 2.31 ± 0.36 log10 cfu/ml. A high CC suggests the presence of harmful bacteria, including potential pathogens like *E. coli*, which can pose serious health risks to consumers. These bacteria can cause foodborne illnesses, leading to symptoms such as diarrhea, vomiting, and abdominal pain (Berhe *et al.,* 2020).

The result of current study was lower than the result of CC in pasteurized milk (6.78 ± 7.72 log10 cfu/ml) (Koushki *et al.*, 2016). Boiling is effective method of eliminating coliform bacteria due to coliform's inability to withstand heat and their inability to survive boiling at high temperatures (Asfidoajani *et al.,* 2018). Both boiling and pasteurization are effective in falling the coliform count in milk, but boiling is more likely to fully eradicate coliforms due to the higher temperature used than pasteurization except possible loses of some nutrients (Metwally and Dabiza, 2011).

The YMC result of the raw and boiled cow milk produced in the study area are presented in Table 12. The overall mean of YMC of raw and boiled milk was 2.25±0.53 log10 cfu /ml with significantly higher YMC was observed in raw milk (3.72 ± 0.6 log10 cfu /ml) than in boiled milk (0.79 ± 0.46 log10 cfu /ml). Yeast and mould are widely distributed in the environment and may be found as part of the normal flora of foods or in adequately sanitized utensils or as an air-born contaminants (Cogliati *et al.,* 2023). These can cause public health problems by the production of toxic metabolites (Nanu and Latha, 2007). The overall mean of YMC found in raw milk of the current finding is higher than 2.63 ± 0.46 log 10 cfu /ml, 3.12 ± 0.06 log 10 cfu /ml and 3.49±0.038 log 10 cfu /ml as reported by Mussa (2022), Nanu and Latha (2007) and Girma and Mekonin (2023) respectively. In contrast, the current YMC result is lower than the result of Abebe *et al.* (2018) and Abebe *et al.* (2023) who reported that the YMC of 5.06 ± 0.01 log cfu /ml and 9.2 ± 2.6 log cfu /ml, respectively. Average mean ±SD of YMC of boiled milk from different cafeterias of the study area was 0.79 ± 0.46. The average value of YMC observed in the current finding was with in the acceptable limit (< 5 log cfu/ml) established for raw milk (ESA, 2009). The overall mean YMC obtained in boiled milk of current study shows lower counts compared to pasteurized milk in other studies have been conducting in different parts of the country. For instance, study conducted by Alemu *et al.* (2023) reported an average YMC of 2.00±0.16 log 10cfu/ml in pasteurized milk in Bishoftu, and Teklegiorgis (2018) who found YMC ranges from 4.4 $\times 10^1$ to 4.43 $\times 10^5$ cfu/ml in pasteurized milk in Addis Ababa and its surrounding, Ethiopia. This revealed that the YMC in boiled milk of the current study is lower, which may be attributed to boiling process efficiency in lowering YMC or enhanced hygienic practices in cafeterias of current study areas. Variations in YMC results across different study areas might be attributed to several factors including environmental conditions, hygienic practices, sampling methods and geographical factors.

Table 10: Mean (±SD) microbial counts (log10cfu/ml) of raw and boiled milk samples

Measured variable	**Types of sample (N=60)**			
	Raw Milk from DPS (30)	Boiled Milk from cafeteria (30)	Overall mean	**P-value**
Aerobic Mesophilic Bacterial Count	6.14 ± 1.38^{a}	3.21 ± 0.47^{b}	4.67±0.9	0 .001
Coliform Count	4.78 ± 0.76^{a}	2.31 ± 0.36^{b}	3.54±0.32	0.001
Yeast and Mould Count	3.72 ± 0.6^{a}	0.79 ± 0.46^{b}	2.25±0.53	0.001

Different superscript in the same row show significant difference at p<0.05

5. CONCLUSION AND RECOMENDATIONS

5.1. Conclusion

Most of the dairy product shops and cafeterias sell raw milk sourced from surrounding small scale and commercial farms. The majority of the respondents reported storing raw milk in refrigerator and only boiling it when needed. The cleaning practices however differed across in the study area, and quality checks were rare. Though hygiene standards and temperature monitoring were commonly practice in the study area, there were problems with training and regulatory enforcement. Efficient supply chain management is crucial for ensuring milk quality and safety.

In the present study, the majority of the physicochemical quality of the raw and boiled milk samples from selected areas of Sheger cities failed not meet quality standards, indicating that the milk samples collected were adulterated. Significant differences were found between boiled milk from cafeteria and raw milk from dairy product shops, which indicates boiling of milk negatively impacts the chemical quality of milk. Microbial analysis revealed that raw milk from dairy product shops had higher levels of aerobic mesophilic bacterial count, total coliform count, and yeast and mould count than the acceptable limits, indicating significant microbial contamination likely due to poor hygienic practices, inadequate cooling, and improper handling of milk. Boiled milk, however, showed considerably lower levels of total plate count, total coliform count, and yeast and mould count demonstrating the effectiveness of boiling in reducing microbial load compared to pasteurization. Ensuring proper quality control, hygiene and handling practices at all stages of milk production, storage, and transportation and distribution is essential in maintaining milk quality and safety.

5.2. Recommendations

Based on the study findings, the following recommendations are forwarded.

- Strict hygienic measures should be enforced during milking, and proper milk handling practices must be followed at dairy product shops and cafeterias. Comprehensive training should be provided to dairy farmers, handlers, and workers on proper hygiene, milk handling, and quality control measures.

- Regular monitoring of milk sold in the Sheger city and consumed by the public should be made as it is mandatory to protect against milk borne diseases caused by unsafe milk. Regulatory oversight must be improved to ensure compliance with quality standards through regular inspections and penalties for non-compliance.

- Mandatory quality checks should be introduced at all stages of milk production, storage, and distribution using reliable methods like lactometer readings and microbial testing. Proper storage containers and temperature-controlled environments should be utilized, and further studies covering larger areas are needed to evaluate the physicochemical and microbial qualities of raw and boiled milk.

6. REFERENCES

Abera Teshome Aleli,(2024). Review on Handling, Hygienic Practices and Microbial Qualities of Raw Milk in Ethiopia. *International Journal of Agriculture and Nutrition*

Abhiram Karmaker, Pabitra Chandra Das, Abdullah Iqbal, (2019). Quality assessment of different commercial and local milk available in the local markets of selected area of Bangladesh. Journal of Advanced Veterinary and Animal Research .pp 2-6

Abunna Kurra, Fufa. (2019). Handling Practices, Quality and Safety of Milk along the Dairy Value Chains in Selected Sub Cites of Addis Ababa, Ethiopia. Biomedical Journal of Scientific & Technical Research. 13. 10.26717/BJSTR.2019.13.002330.

Ahmed M.M. Metwally, N. M.-K. (2011). The Effect of Boiling on Milk Microbial Contents and Quality. Journal of American Science, pp 1-6.

Alemu T, Kebede G, Tadesse Y. (2023). Physicochemical and Microbiological Quality and Safety of Brand Pasteurized Milk Produced and Sold in Bishoftu, Ethiopia. Research Square. DOI: 10.21203/rs.3.rs-3541835/v1.

Alganesh Tola Gemechu. (2017). Status and Challenges in the Safety and Quality of Dairy Products in Ethiopia: A Review. Food Science and Quality Management. ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online) Vol.59, 2017

Alganesh, T., Tesfa K, Yetnayet B, Taye T and Fekadu, 2019. Assessment of butter adulteration practices and associated food safety issues along the supply chain in central highlands and south west mid lands of Ethiopia.

Almaz K. (2014). The quality and safety of raw cow milk produced and marketed by three dairy farms in Mekelle, Northern Ethiopia, M.Sc. Thesis Haramaya University, Haramaya. Ethiopia, 69p.

Amenu, K., Wieland, B., Szonyi, B. et al. (2019) Milk handling practices and consumption behavior among Borana pastoralists in southern Ethiopia. J Health Popul Nutr 38, 6. https://doi.org/10.1186/s41043-019-0163-7

Anjum Rashid, I. J. (2019). Probing the physicochemical and sensorial. International journal of food properties, 2019, Vol. 22, No. 1, pp 825–842.

Asfidoajani, Fatemeh & Mohammadi Sichani, Maryam. (2018). Comparison of Coliform Contamination and Endotoxin Levels in Raw Cow's Milk. Zahedan Journal of Research in Medical Sciences. In Press. 10.5812/zjrms.59333.

Awasti, N., Anand, S. (2020). The Role of Yeast and Molds in Dairy Industry: An Update. In: Minj, J., Sudhakaran V, A., Kumari, A. (eds) Dairy Processing: Advanced Research to Applications. Springer, Singapore. https://doi.org/10.1007/978-981-15-2608-4_12

Azeze, T. and B. Haji, (2016). Assessment of Post-Harvest Loss of Milk and Milk Products and Traditional Mitigation Systems in Southern Ethiopia. Food Science and Quality Management, pp: 48

Bardhan and Sharma: Technical efficiency in milk production in underdeveloped production environment of India*. Springer Plus 2013 2:65

Bereda A., Aboretugn Nigussu & Bulti Nigatu. (2023). Determination of Microbial Hygiene Indicators of Raw Cow Milk in Assosa District, Ethiopia. Journal of Food Quality. 2023. 1-6. 10.1155/2023/6769108.

Bereda, A., Yilma, Z., & Nurfeta, A. (2012). Hygienic and microbial quality of raw whole cow's milk produced in Ezha district of the Gurage zone, Southern Ethiopia. Wudpecker Journal of Agricultural Research, 1(11), 459-465.

Bereda, A., Yilma, Z., Eshetu, M., & Yousuf, M. (2018). Hygienic practices, microbial quality and safety of raw cow's milk and traditional fermented milk (Irgo) in selected areas of Ethiopian Central Highlands. East African Journal of Veterinary and Animal Sciences, 2(1), 17-26.

Berhe, G., Wasihun, A.G., Kassaye, E. *et al* (2020). Milk-borne bacterial health hazards in milk produced for commercial purpose in Tigray, northern Ethiopia. *BMC Public Health* **20**, 894. https://doi.org/10.1186/s12889-020-09016-6

Bingyao Du, L. M. (2022). Single Molecule Real-Time Sequencing and Traditional Cultivation Techniques Reveal Complex Community Structures and Regional Variations of Psychrotrophic Bacteria in Raw Milk. Frontiers in Microbiology, 13, 853263 pp 1-9.

Bruktawit Shimeles (2016). Physicochemical properties and microbial quality of cow milk collected from selected Subcity of Addis Ababa, Ethiopia. International Journal of Agricultural and Food Science. pp 55-67

BS EN ISO 6887-1. Microbiology of the food chain-preparation of test samples, initial suspension and decimal dilutions for microbiological examination. Part 1: General rules for the preparation of the initial suspension and decimal dilutions; 2017.

C. T. Manoj Kumar, O. P. (2022). Advanced dairy cvhemistry. In O. P. C. T. Manoj Kumar, Chemistry of Milk and Milk Products (pp. 471-495). singapore: Springer.

Castellini, G., Barello, S., & Bosio, A. C. (2022). Milk Quality Conceptualization: A Systematic Review of Consumers', Farmers', and Processing Experts' Views. Foods, 12(17), 3215. https://doi.org/10.3390/foods12173215

Centers for Disease Control and Prevention (CDC). (2023). Raw Milk Questions and Answers. https://www.cdc.gov/foodsafety/rawmilk/raw-milk-questions-and-answers.html.

Central Statistical Agency of the Federal Democratic Republic of Ethiopia (CSA, 2020/21), "Agricultural sample survey

Cocolin, L. A. (2002). An application of PCR-DGGE analysis to profile the yeast population in raw milk. International Dairy Journal, 12: pp 407-411.

CSA. (2017). Key findings of the 2016/2017 (2009 e.c) agricultural sample surveys. 1-25.`

Dairy farmers in Ethiopia. Agriculture & Food Security.

Debebe W. (2010). Physicochemical Properties and Safety of Street-vended Milk in and Around Addis Ababa City (Kotebe, Bishoftu and Chancho), MSc. Thesis, Haramaya University, Ethiopia, 83p

Deddefo, A., Mamo, G., Asfaw, M. et al. (2023) Factors affecting the microbiological quality and contamination of farm bulk milk by Staphylococcus aureus in dairy farms in Asella, Ethiopia. BMC Microbiol 23, 65. https://doi.org/10.1186/s12866-022-02746-0

Dehinenet, G. and Hailemariam, M. (2013) Determinants of raw milk quality under a smallholder production system in selected areas of Amhara and Oromia National Regional States, Ethiopia. Agriculture and biology journal of North America, 4(1), 84-90.

Demelash Kefale Tenaw, Tsegaye Metiku, Maradona Birhanu and Li Ruilan (2024). Review on the status of dairy production and processing in Ethiopia: Acta Entomology and Zoology 2024; 5(1): 36-40 pp 1-5

Dessalegn G (2017). PhD dissertation on Characterization of Dairy Cattle Husbandry Practice and Performance under Smallholder Systems and Analysis of Milk Value Chain and Quality in Bishoftu and Akaki Towns, Oromia Regional State, Ethiopia.

Desye, Belay & Bitew, Bikes & Amare, Dagnachew Eyachew & Birhan, Tsegaye & Getaneh, Alem & Gufue, Zenawi. (2023). Quality assessment of raw and pasteurized milk in Gondar city, Northwest Ethiopia: A laboratory-based cross-sectional study. Heliyon. 9. e14202. 10.1016/j.heliyon.2023.e14202.

E.Nanu, C.Latha, B.sunil,Prejit, Magina Thomas and K.Vrinda Menon (2007). Quality Assurance and public health safety of raw milk at the production point. American journal of Technology 2(3): 145 -152. ISSN 1557-4571

Estifanos H., Tarekeg G., Yonas H., Eyassu S., Mengistu K. and Mohammed A. (2015). Physicochemical Properties and Microbial Quality of Raw Cow Milk Collected from Harar Milkshed, Eastern Ethiopia, J. Biol. Chem. Research, 32(2): 606-616.

Esubalew Ayele (2022). Review on Handling Practice and Microbial Quality of Raw whole cow milk produced in Ethiopia. https://www.academia.edu/8318696

Esubalew Ayele (2022). Review on Handling Practice and Microbial Quality of Raw Whole Cow Milk Produced in Ethiopia.

Ethiopian Standard Agency, Unprocessed Whole/Raw Cow Milk Specification, ES. 3460 (2009), 2009.

Fagnani R, Nero LA and Rosolem CP (2021). Why knowledge is the best way to reduce the risks associated with raw milk and raw milk products. Journal of Dairy Research 88, 238–243. https://doi.org/10.1017/ S002202992100039X

FAO (1999). “Extension Services for Quality Milk Production”. Proceedings of an International Workshop in conjunction with the East-West-Forum of the Federal Ministry for Food, Agriculture and Forestry, Germany.

FAO. (2001). The lactoperoxidase system of milk preservation. Regional Lactoperoxidase Workshop in West Africa. Burkina Faso.pp 17-19.

FAO. (2020). The role of milk and dairy products in human nutrition. United State of America: Milk Talk.

FAO. (2024). Ethiopia at a glance. https://www.fao.org/ethiopia/fao-in-ethiopia/ethiopia-at-a-glance/en/.

Farrell, J. (2017). Application of the supply chain analysis for nutrition (scan) Tool . http://www.gainhealth.org/, pp 2-10.

Feyisa, B.W., Haji, J., & Mirzabaev, A. (2024). Adoption of milk safety practices: evidence from

Fikrineh N., Estefanos T. and Tatek W. (2012). Microbial quality and chemical composition of raw milk in the Mid-Rift Valley of Ethiopia, African Journal of Agricultural Research, 7(29): 4167-4170.

FSSI. (2016). Manual for analysis of milk and milk products. Milk and milk products, 25-197.

Fufa A, Nigus T, Fikru R, Dinka A, Kebede A (2019). Handling Practices, Quality and Safety of Milk along the Dairy Value Chains in Selected Sub Cites of Addis Ababa, Ethiopia. Journal of Scientific Techinical Research.13 (1).

Gebretsadik Berhe, A. G. (2020). Milk-borne bacterial health hazards in milk produced for commercial purpose in Tigray, northern Ethiopia. BMC Public Health, pp 1-9.

Gebreyohanes, G. Y. (2021). Dairy industry development in Ethiopia: Current status, major challenges. ILRI. Position Paper (pp. 1-39). Nairobi,Keniya: International Livestock Research Institute (ILRI).

Gemechu, Teshome & Beyene, Fekadu & Guya, Mitiku. (2014). Handling Practices and Microbial Quality of Raw Cow's Milk Produced and Marketed in Shashemene Town, Southern Ethiopia.

Getabalew, Mebrate & Alemneh, Tewodros & Bzuneh, Etagegnehu. (2020). Review on Milk and Milk product Handling Practices, Utilization and Microbial quality in Ethiopia. 4. 218-224.

Girma Birhanu, Mekonnen Yirga. (2023) Assessment of Raw Cow's Milk Quality in Kombolcha, Ethiopia. Animal and Veterinary Sciences. Vol.11, No.5,pp. 128-135.doi: 10.11648/j.avs.20231105.14

Glenn A. A. van Lieshout, Tim T. Lambers, Marjolijn C. E. Bragt & Kasper A. Hettinga (2019): How processing may affect milk protein digestion and overall physiological outcomes: A systematic review, Critical Reviews in Food Science and Nutrition, DOI: 10.1080/10408398.2019.1646703

Gonfa, A., A.F. Howard and H.H. Wilhelm, 2001. Field survey and literature review on traditional fermented milk products of Ethiopia. International Journal of Food Microbiology, 68: 173-186.

Grimaud Patrice, Sserunjogi Mohamed L., Grillet Nelly. 2007. An evaluation of milk quality in Uganda: Value chain assessment and recommendations. African Journal of Food, Agriculture, Nutrition and Development, 7 (5), 16 p.

Hossain T. J., Alam M. K. and Sikdar D. (2011). Chemical and microbiological quality assessment of raw and processed liquid market milks of Bangladesh. Continental Journal Food Science and Technology, 5(2): 6 -17.

http://www.fda.gov/Food/ScienceResearch/LaboratoryMethods/BacteriologicalAnalyticalManual BAM

https://doi.org/10.1093/9780197610145.003.113, accessed 6 Mar. 2024. 0001

https://doi.org/10.18697/ajfand.16.2625https://foodstruct.com/compare/milk-vs-powdered-milk

https://www.cdc.gov/food-safety/foods/raw-milk.html

https://www.cspinet.org/cspi-news/raw-milk-sales-are-and-so-are-public-health-risks

Hui Yan, W. D. (2022). Bacterial Composition and Interactions in Raw Milk and Teat Skin of Dairy Cows. Fermentation, pp 4-9.

Huizhi Yuan, S. H. (2022). Microbial Properties of Raw Milk throughout the Year and Their Relationships to Quality Parameters. Foods 2022, 11, 3077, pp 3-9.

J.McLauchlin1, H. A. (2020). Microbiological quality of raw drinking milk and unpasteurised dairy products: Epidemiology and Infection,pp 1-10.

Jalel Fikadu (2021). Physicochemical Characteristics of Raw Milk from Farm to End User in Urban Area of Oromia Special Zone Surrounding Finfine, Ethiopia. Global Journal of Animal Science, Livestock Production and Animal, 47(1) pp 4-10

Jamali, H., Chaji, M., & Najafi, M. B. H. (2015). Prevalence, characterization, and antimicrobial resistance of Staphylococcus aureus isolated from raw milk and dairy products in Iran. Journal of Food Protection, 78(4), 724-727.

Jayarao, B. M., Donaldson, S. C., Straley, B. A., Sawant, A. A., Hegde, N. V., & Brown, J. L. (2006). A survey of foodborne pathogens in bulk tank milk and raw milk consumption among farm families in Pennsylvania. Journal of Dairy Science, 89(7), 2451-2458

Jill A. Makovec, M. a. (2003). Antimicrobial resistance of bacteria isolated from dairy cow milk samples submitted for bacterial culture. Journal of the American Veterinary Medical Association, pp 1-9.

Kandpal SD, Srivastava AK, Negi KS (2012). Estimation of quality of raw milk (open and branded) by milk adulteration testing kit. Indian Journal of Community Health, 24(3)

Kasech Amdhun. (2019). Milk Container Sanitation Regime Using Wood Smoke: Perceived Roles and Effects on Milk Quality in Borana, Ethiopia. http://etd.aau.edu.et/handle/123456789/25762

KGaA, M. (2019). Dairy Products microbiology testing. Sigm Aidrich.com/dairy, pp 5-20.

Kunda B, Pandey GS, Muma JB (2015). Compositional and sanitary quality of raw milk produced by smallholder dairy farmers in Lusaka Province of Zambia. Livestock Research for Rural Development.

Leggesse, G. U. (2023). Ethiopia National Dairy Development Strategy 2022–2031. Ministry of Agriculture, Feder-al Democratic Republic of Ethiopia.

Lei yuan, f. a. (2019). Insights into Psychrotrophic Bacteria in Raw Milk: A Review. Journal of Food Protection, Vol. 82, No. 7, pp 1-9.

Lewis, M. (2022). Advanced Dairy Chemistry: Physical and Physicochemical Properties of Milk and Milk Products. Switzerland: Springer.

Lisa Quigley, O. O. (2013). The complex microbiota of raw milk. Federation of European Microbiological Societies, pp 664–698.Lore T., Omore A. and Steve S. (2005). FAO action program for the prevention of food losses. Milk and dairy products, post-harvest losses and food safety in Sub Saharan Africa and the near East. Pp: 39.

Lujerdean A., Bunea A. and Mireşan V. (2007). Seasonal Related changes in the major nutrients of Bovine milk (total protein, lactose, casei, total fat and dry matter). Cluj-Napoca: University of Agricultural Science and Veterinary Medicine vol 52.

M Bellal Hossain, S. R. (2013). Physicochemical characteristics of various raw milk sample in samples in a selected dairy plant of Bangladesh. International Journal of Engineering and Applied Sciences,Vol. 1, No.3, pp 1-7.

M.Lia Koski, H. K. (2018). Foodborne illness outbreaks linked to unpasteurised milk and relationship to changes in state laws – United States, 1998–2018. Epidemiology & Infection, 9-21.

Machado, S. G. (2017). The Biodiversity of the Microbiota Producing Heat-Resistant Enzymes Responsible for Spoilage in Processed Bovine Milk and Dairy Products. Frontiers in Microbiology, pp 1-16.

Maturin L. and Peeler J.T. (2001). Aerobic plate count. In: Hammack, T., Feng, P., Jinneman, K., Regan, P.M., Kase, J., Orlandi, P., Burkhardt, W. (Eds.), Bacteriological Analytical Manual. Food and Drug Administration, Washington:

McCarthy O.J. and Singh H. (2009). Physico-chemical Properties of Milk, Advanced Dairy Chemistry, 3:691-758. DOI 10.1007/978-0-387-84865-5.

Mebrate Getabalew, Tewodros Alemneh and Dawit Akeberegn (2019). Dairy Production in Ethiopia - Existing Scenario and Constraints. Journal of scientific and Technical Research. pp 2-6. DOI: 10.26717/BJSTR.2019.16.002903.

Megh R. Goyal, S. R. (2023). The Chemistry of Milk and Milk Products: Physicochemical Properties, Therapeutic Characteristics, and Processing Methods (1st ed.). New York: Apple Academic Press.

Melese, A., Addisu, H. (2015) Microbiological Quality Assessment of Raw and Pasteurized Milk. International Journal of Food Science and Microbiology, Vol, 2(6), 087- 091.

Mezgeb Workiye (2012). Study on milk chemical composition, bacteriological quality and handling practices in Debre Libanose district North Shewa Zone Oromia region, MSc Thesis Addis Ababa University Faculty of Veterinary Medicine, DebreZeit, Ethiopia.

Mihaela Ostan, i. Gogoaşă1, Olga-alina Rada (2015). The effect of boiling on the pH, Electirical conductivity, conductivity and lactose content of cow milk. Research Journal of Agricultural Science vol. 47 (2),pp 1-4

Minten, B., Habte, Y., Baye, K. *et al.,*(2023). Food Safety and Incipient Modern Value Chains: Evidence from Milk in Ethiopia. *Eur J Dev Res* **35**, 1197–1223. https://doi.org/10.1057/s41287-023-00575-z

Minten, B., Habte, Y., Tamru, S., & Tesfaye, A. (2020). The transforming dairy sector in Ethiopia. PLOS ONE, 15(8), e0237456. https://doi.org/10.1371/journal.pone.0237456

Mitiku Eshetu, Alemnesh Yirda, and Firew Kassa. (2015). Microbial Quality and Safety of Raw Cow Milk in Girar Jarso District of Oromia Regional State, Ethiopia. Eth. J. Anim. Prod.vol 19(1).pp 3-9

Mohammad reza Koushki, P. K.-K. (2016). Microbiological quality of pasteurized milk on expiration date in Tehran, Iran. J. Dairy Sci. 99:1796–1801, pp 1-5.

Moosavy, M.-H. a. (2017). Effects of seasonal and geographical variations on the physicochemical properties of commercial pasteurized milk in the northwest of Iran. Nutrition & Food Science, Vol. 47 No. 1,, pp 31-41.

Muleta, Tolessa. (2016). The microbiology of Ethiopian milk and milk product: review. International Journal of Current Research. 08. 34606-34611.

Mussa S. M. (2022). Assessment of Production Practice, Physicochemical Properties and Microbial Quality of Raw Cow Milk in Worabe Town, Silte Zone, Southern Ethiopia. Biology and Medicine, pp 1-9.

Muzahidul Islam, Sadia Afrin, Firoz Ahmed, Barun Kanti Saha and Md. Nur Hossain, 2021. Microbiological Quality Assessment of Raw and Commercial Milk Available in the Local Market and its Acceptability. American Journal of Food Technology, 16: 1-8.

Negash F., Estefanos T., and Woldu T. (2012b). Microbial quality and chemical composition of raw milk in the Mid-Rift Valley of Ethiopia, African Journal of Agricultural Research, 7(29): 4167-4170.Niamh Burke, K. A. (2018). The Dairy Industry: Process, Monitoring, Standards,. http://dx.doi.org/10.5772/intechopen.80398, pp 2-20.

Nick W. Smith.Andrew J. Fletcher, J. P. (2022). Modelling the contribution of Milk to the Global Nutrition. Frontier in Nutrition, pp 1-7.

Nivedita Prasad, S. S. (2018). Physico-chemical Properties of Milk and Dairy Products. International Journal of Current Microbiology and Applied Sciences, pp 1662-1665.

Nyokabi, N.S., Phelan, L., Gemechu, G. *et al.,* (2023). From farm to table: exploring food handling and hygiene practices of meat and milk value chain actors in Ethiopia. BMC Public Health 23, 899. https://doi.org/10.1186/s12889-023-15824-3

O. J. McCarthy & H.Sing. (2009). Physico-chemical Properties of Milk. In O. J. McCarthy & H.Sing, Advanced Dairy Chemistry (pp. 691-758). New York: Springer.

Pandey, G. S. & Voskuil, G. C. (2011). Manual of milk safety, quality and hygiene, Golden Valley Agricultural Research Trust, Lusaka Zambia.

Park, Y. W. (2017). Milk and dairy products in human nutrition: production, composition, and health. springer.

Paul L. H. McSweeney, J. A. (2022). Advanced dairy chemistry. Switzerland: springer.

Pitty (2011). A national survey on milk adulteration. Conducted by Food Safety and Standards Authority of India.

Production Practices in Sebeta Town of Oromia Regional State, Ethiopia. Austin J Vet

Rajesh Ku. Meher, S. s. (2015). Qualitative analaysis and microbial test of pasteurized milk. International Journal of Pharmacy and Biological Sciences (e-ISSN: 2230-7605), pp 215-219.

Roya Rouhi, M. R.-A. (2017). Microbiological and Physicochemical Properties of Raw Milk Produced from Milking to Delivery to Milk Plant. Journal of Pure and Applied Microbiology, pp 1-6.

Samia Mustafa Ahmed Abd Elrahman, A. M. (2013). Effect of storage Temprature on microbiological and physicochemical properties of pasteurized milk. Food Science and Technology, 1-7.

Saminew T. and Eyassu S. (2011). Microbial quality of raw cow's milk collected from farmers and dairy cooperatives in Bahir Dar Zuria and Mecha district, Ethiopia. Am. J. Agric. And Biol., 19: 21-27.

Sci & Anim Husb.; 10(3): 1124)

Shambel Z, Kebede E, Mengistu M, Lamboro T. (2021). Identification and Evaluation of Preservative Plants on Traditionally Fermented Cow Milk. Curr Res Nutr Food Sci; Version 9(1). doi : http://dx.doi.org/10.12944/CRNFSJ.9.1.31

Shewangzaw A, Ahmed M, Nunu H (2016). Handling, Processing and Utilization of Milk and Its Products in Gondar Town, Ethiopia. Journal of Life Science and Biomedicine. 6(6):120-126.

Shuvo Singha, Fabrizio Ceciliani, Md. Mizanur Rahman, Mohammad Abdul mannan, S. C. (2023). Factors influencing somatic cell counts and bacterial contamination. Tropical Animal Health and Production, pp 2-10

Sintayehu, Y., Fekadu, B., Azage, T. and Berhanu, G. (2008): Dairy production, processing and marketing systems of Shashemene, Dilla area, South Ethiopia. IPMS Improving Productivity and Market Success of Ethiopian Farmers Project Working Paper 9. ILRI (International Livestock Research Institute), Nairobi, Kenya, pp 62.

Tadesse, Tesfaye & Gure, Abera & Kedir, Kassim. (2023). Physicochemical properties and microbial load evaluation of raw cow milks of Jimma Town, Ethiopia. Bulletin of the Chemical Society of Ethiopia. 37. 553-563. 10.4314/bcse.v37i3.2.

Tamime, A.Y. (2009) Milk Processing and Quality Management. Society of Dairy Technology, United Kingdom

Tekilegiorgis, T. (2018). Microbiological Quality Analysis of Raw and Pasteurized Milk Samples Collected from Addis Ababa and Its Surrounding in Ethiopia. Approaches in Poultry, Dairy & Veterinary Sciences. 4. 10.31031/APDV.2018.04.000598., pp 3-20.

Teklemichael Tesfay and Eyassu Seifu. (2015). Physico Chemical Properties of Cow Milk Produced and Marketed in Dire Dawa Town, Eastern Ethiopia. Journal of Food Science and Quality Management.vol 49.pp 2-7

Teshome Aleli A.(2023) Milk Handling, Hygienic Practise and Microbial Qualities of Milk in Ethiopia. J Health Environ Res. doi: 10.11648/j.jher.20230904.12

Thoen, C. O., Steele, J. H., & Gilsdorf, M. J. (2009). Mycobacterium bovis infection in animals and humans. John Wiley & Sons

Tournas, Valerie. (2009). Microbial contamination of select dietary supplements. Journal of Food Safety. 29. 430 - 442. 10.1111/j.1745-4565.2009.00167.x.

Tsedey, A. and Asrat, T (2015). Safety and Quality of Raw Cow Milk Collected from Producers and Consumers in Hawassa and Yirgalem areas, Southern Ethiopia. Food Science and Quality Management, 44, 2224-6088

Umer AA, Bongase SA, Tolemariam T, Bulto AO (2023). Assessment of Milk Quality and Dairy

Valente Velázquez-Ordoñez1, B. V.-C.-B.-R.-G.-D. (2019). Microbial Contamination in Milk. Nutrition in Health and Disease,pp 4-20.

Valerie Tournas, (M. (2002). BAM Chapter 18: Yeasts, Molds and Mycotoxins. https://www.fda.gov/food/laboratory-methods-food/bam-chapter-18-yeasts-molds-and-mycotoxins.

Vithanage, N. R. (2017). Microbiological quality of raw milk attributable to prolonged refrigeration conditions. Journal of Dairy Research,, pp 5-20.

Woldemariam HW, A. A. (2017). Microbial and Physicochemical Qualities of Pasteurized Milk. Journal of Food Processing Technology,pp 1-5.

Wondatir, Z., 2010. Livestock production systems in relation with feed availability in the highlands and central rift valley of Ethiopia.

Yeserah, Birhanu (2018) Handling practices and microbiological quality of raw cow's milk in and around bahir dar city, Ethiopia. DSpace Repository, http://hdl.handle.net/123456789/8992.pp 5-95

Z.A. Shojaei and A.Yadollahi. (2008). Physicochemical and Microbiological Quality of Raw, Pasteurized and UHT Milks in Shops. Asian Journal of Scientific Research,, 1: pp 532-538.

Zelalem Yilma, 2009. Microbial Properties of Ethiopian Marketed Milk and Milk Products and Associated Critical Points of Contamination: An Epidemiological Perspective, Addis Ababa, Ethiopia. pp. 298-322

Zerihun Asefa and Getenesh Teshome (2019). Physical Properties and Chemical Compositions of Raw Cow Milk in Milk Shades Around Addis Ababa, Ethiopia. Journal of Natural Sciences Research. vol 9(19).pp 2-6

Zhang, X., Chen, X., Xu, Y. et al. (2021) Milk consumption and multiple health outcomes: umbrella review of systematic reviews and meta-analyses in humans. Nutr Metab (Lond) 18, 7. https://doi.org/10.1186/s12986-020-00527-

APENDIX

Annex 1. Questionnaires

Dear respondents, the following questionnaire prepared to get necessary information about people's knowledge and awareness of factors that could lead to microbial contaminations and poor physicochemical qualities of milk at distribution level. It will take less than thirty minutes to complete this questionnaire. Please note that your answer is completely confidential, and your name will not be included in any reports of these results. Your individual answer will not be shared with anyone. The quality of your response is very important to get good result. Considering this, please give me accurate response for the question written below.

PART 1: RESPONDENT PARTICULARS (I will start asking you some personal questions)

1. How old are you?

   18 – 25 yrs ☐ 26 – 35 yrs ☐ 36-45 yrs ☐ 46-55 yrs ☐ More than 55 yrs ☐

2. What is your gender? Male ☐ Female ☐

3. Level of education of the respondent

   A. Illiterate

   B. Primary school.

   C. Junior school

   D. High school.

   E. College or University level

4. What is your level of awareness about the microbial quality and physicochemical properties of milk?

   A. I am very knowledgeable.

   B. I have a good understanding.

   C. I have some basic knowledge.

D. I am not very familiar with

E. I have no knowledge.

5. Do you received any specific training on physico chemical and microbial quality of milk from government or NGO's

   A. Yes B. Not at all

Part II. Types of milk, source of raw milk in use,

1. What type of milk do you usually sell?

   Raw, yoghurt, cheese and butter ☐ Raw and Boiled milk only ☐

2. Where do you usually obtain milk

   A. Surrounding small scale farm.B. Dairy cooperative C. Commercial farms D. own farms E. other, please specify_______________

3. For how long time raw milk stay at the shop before selling?

   A. Less than 6 hours B. Less than 12 hours C. less than 24 hours D. More than 24 hours

4. How you store raw milk before selling?

   A. Temperature controlled refrigerator C. Normal home refrigerator

   B. In room temperature D. In cold water

5. Milk containers during transportation

   A. Aluminium B. Narrow neck plastic (jerycan)C. Bucket

6. What are the material used for filtration?

   A. Muslin cloth B .Sieve C. Both

Part III milk handling practice

1. What milk handling practices you followed

	Yes/No
Do you follow strict hygiene practices when handling milk to prevent contamination?	
Do you ensure that milk is stored at the appropriate temperature	

to maintain its quality?	
Do you use clean and sanitized equipment when handling milk?	
Do you give priority for cleanliness and sanitation in all aspects of milk handling?	

2. Milk container is washed by____________________

    A. Food grade detergent with warm water

    B. Warm water only

    C. Not food grade detergent with warm water

    D. Cold water with detergent

    E. Cold water only

3. What is your source of water for cleaning of equipment?

    A. Municipal supplied water B. ground water C. treated water

4. Frequency of container cleaning in a day

    A. Once B. Twice C. 3 and above

5. When you clean milk storage material?

A, Prior to use it B. Immediately after using

6. Do you smoke milk storage material?

    A. Yes (Answer next question) B. Not at all

7. What type of smoking material you are using?

    A. Woira (Olea Africana)

    B. Tossign (Tbymus vulgar)

    C. Tid (Juniperous prociera)

    D. Not at all

8. What type of quality checks you are using during milk receiving from supplier?

A. Organoleptic test C. Alcohol test

B. Lactometer reading D. Other, please specify--- E. Not at all

9. What quality control measures do you have in place to ensure the safety and quality of the milk?

Item	Yes/ No
Do you monitor of temperature and storage conditions	
Do you use clean and sanitized equipment	
Do you apply strict hygiene practices during milk handling	
Do you implement proper cooling procedures	
Do you clean your hands after every touching of birr and other materials	

10. Is there gaps or constraint you are facing?

A. Yes (Go to question 11) B. No

11. List the gaps or constraint do you faced according to their priority
1
2.
3.
4.
5.
6.

For Cafeteria

Types of milk

1. You are using raw milk or powder milk for serving your customers?

A. Raw milk

B. Powder milk (go for next question)

2. What ratio of water to milk powder you are using for 1 cup

   A. 1 cup water and 3 table spoon of milk powder

   B. 1 cup water and 2 table spoon of milk powder

   C. 1 cup water and 4 table spoon of milk powder

   D. 1 cup water and 2.5 table spoon of milk powder

   E. I didn't used it

3. In what type of milk storage material you store milk?

   A. Glass containers

   B. Plastic containers

   C. Stainless still /Aluminium container

   D. Other please specify_______________________________

4. Type of refrigerator or coolers you are using

   A. Normal refrigerator

   B. Temperature controlled refrigerator

   C. Cold water

5. Quality checks you are using during milk receiving

   A. Organoleptic test

   B. Temperature check

   C. Alcohol test

   D. Lactometer reading

   E. Clot on boiling test

   F. Not at all

6. Cleaning of milk storage material and serving cup is with------

   A. Food grade detergent with warm water

   B. Warm water only

   C. Not food grade detergent with warm water

   D. Cold water with detergent

   E. Cold water only

7. Source of water for cleaning of equipment

   A. Municipal supplied water B. Ground water C. Treated water

8. How to store milk prior to serving for customers by boiling?
   A. Boiling as it is received, cool to room temperature and refrigerate till utilization
   B. Keep in refrigerator as it is received without boiling it
   C. Keep in room temperature
9. How to control the temperature during boiling of milk?
   A. Use thermometer
   B. Seeing as it boiled by assuming
10. Time at which you boil milk is ________
   A. 0.5 minute
   B. One minutes
   C. Two minutes
   D. More than two minutes
11. At what temperature you boil the milk at your cafeteria?
   A. At less than 50^0C
   B. Approximately at 80^0C
   C. Approximately at 90^0C
   D. At milk boiling temperature (100.5^0C)
   E. I didn't check temperature

Annex 2. Laboratory work pictures

Figure 3. Physicochemical quality testing

Figure 4: Total bacteria colony in milk samples

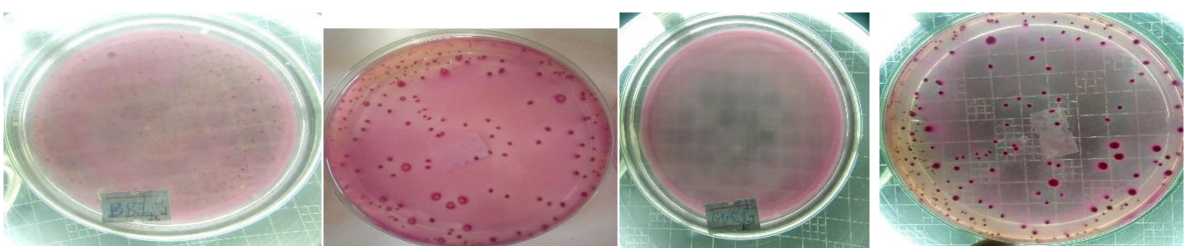

Figure 5: Total Coliform counts colony in the milk sample

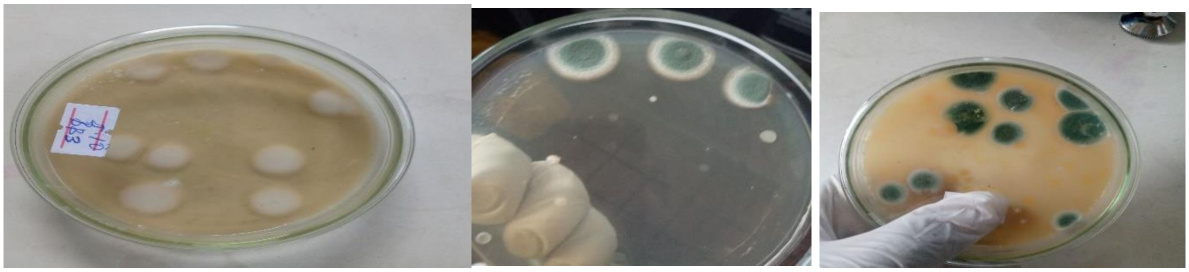

Figure 6: Yeast and mould counts colony in milk samples

Incubated sample   Colony Counter

Figure 7: Equipment used