



**DILLA UNIVERSTY**  
**SCHOOL OF GRADUATE STUDIES COLLEGE OF AGRICULTURE AND NATURAL**  
**RESOURCE DEPARTMENT OF ANIMAL SCIENCE**

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**ASSESSMENT OF MILK PRODUCTION, MILK HANDLING PRACTICES, AND**  
**EVALUATING BACTERIOLOGICAL QUALITY OF RAW COW MILK PRODUCED**  
**AND MARKETED IN DILLA TOWN AND DILLA ZURIA DISTRICT OF GEDEO**  
**ZONE, SOUTHERN, ETHIOPIA**

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**BY: WOGENE ABEBE ROBA**

**DILLA, ETHIOPIA**  
**January, 2023**



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**M.SC. THESIS RESEARCH SUBMITTED IN PARTIAL FULFILLMENT OF THE  
REQUIREMENT FOR THE DEGREE OF MASTERS OF SCIENCE IN ANIMAL  
PRODUCTION**

**DILLA, ETHIOPIA  
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**COLLEGE OF AGRICULTURE AND NATURAL RESOURCES**

**DEPARTMENT OF ANIMAL SCIENCE**

**APPROVAL SHEET**

As thesis Research advisor, I hereby certify that I have read and evaluated this thesis prepared, under my guidance, entitled, “Assessment of Milk Production, Milk Handling Practices, and Evaluating Bacteriological Quality of Raw Cow Milk produced and marketed in Dilla Town and Dilla Zuria District of Gedeo Zone Southern, Ethiopia”. I recommend that it be submitted as fulfilling the thesis requirement.

Major Advisor Name

Samson Hailerariam (PhD)

Signature-----

Date -----

## Statement of the Author

First, I declare that this thesis is my work and that all sources of material used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for MSc degree at Dilla University, College of Agriculture and Animal production science department and deposited at the University/College library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution any where for the award of any academic degree, diploma, or certificate. Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgement of source is made. Requests for permission for extended quotation from or multiplication of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, However permission must be obtained from the author.

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## **BIOGRAPHICAL SKETCH**

Mr. Wogene was born in Yirgachefe woreda, Gedeo Zone, SNNPRS, from his father Abebe Roba and his mother Birike Haru in September, 1978 E.C. He attended his elementary school education at Aramo Catholic primary school and he attended his primary and secondary school education at Yirgachefe primary and secondary high school. After completing his secondary high school education in 1996.E.C, he joined Alage Agricultural and vocational training collage and graduated with Animal health assistant (AHA) Diploma. Soon after graduation, he was employed in Dilla zuria district as Animal health assistant professional for 7 years. Then after started summer up grade class in Haramaya University and completed his bachelor of veterinary science (BVSC) degree in 2006. After completing his BVSC Degree he employed as DillaZuria District agricultural office coordinator of Animal health processing unit for 1 year and also he lead Dilla Zuria district livestock and fishery resource development office for 2 years. Then before he joined Dilla University for post graduate study in Animal production in September 2012 E.C, he was working as Sector Head of Gedeo zone Livestock and fishery resource development sector.

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## **List of Abbreviations**

AI	Artificial insemination
APC	Aerobic plate count
CSA	Central Statistics Agency
CFU	Coliform forming unit
DUP	Dairy Processing Unit
EAS	East Africa Standard
EUS	European union standard
FAO	Food and Agricultural Organization
FGDFS	Free grazing dairy farming system
IDFS	Intensive dairy farming system
INDF	International dairy federation
LPC	Laboratory pasteurization count
MCC	Milk Collection Centre
MOARD	Minister of Agriculture and rural development
NGO	Non-Governmental Organization
RTC	Rural transformation center
SAS	Statistical Analysis System
SCC	Somatic Cell count
SNF	Solid not fat
SNNPR	Southern nation nationalities and peoples region
SNV	Netherland Development organization
SPC	Standard plate count
SPSS	Statistical Package for Social Science
TVCC	Total viable Coli formi Count
TLU	Tropical livestock unit
TVBC	Total Viable Bacterial count
WHO	World Health Organization

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***Assessment Of Milk Production, Milk Handling Practices, And Evaluating Bacteriological Quality Of Raw Cow Milk Produced And Marketed In Dilla Town And Dilla Zuria District Of Gedeo Zone, Southern, Ethiopia***

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**Abstract**

*The objectives of the study was to asses milk production, hygienic milk handling practices and Bacteriological quality of raw cow milk produced and marketed in the study districts. A total of 208 respondents were involved as respondent dairy cattle owned house hold and milk seller respondents from different milk selling points (restaurant , vendor and milk shop was involved and data were collected through structured questionnaires and 88 raw cow milk sample were collected. Laboratory analysis for total viable bacterial counts and total viable coliform counts were done for different milk samples collected from the two selected districts. Survey works includes: Barn and floor type, cleaning practices, hygienic condition of the milker and cows during milking, source of water used for cleaning purpose( hand, udder and, milk utensils), type of milking container, and major milk quality constraints. Laboratory analysis was carried out to determine the Bacteriological quality of raw cow milk. Among the districts there was strong significant ( $P < 0.05$ ) different in cleaning dairy cattle's barn. In this study about 40% and 5% respondents were clean their dairy cattle barn floor in Dilla town and Dilla Zuria districts, respectively. Over all mean of total viable bacterial count of milk sample from farm gate and milk sample from restaurant and vendor milk selling shop was strong significantly different ( $P < 0.05$ ) and over all mean of total viable coliform counts result was significantly different ( $P < 0.05$ ) the milk sample taken from farm gate and the milk sample from restaurant, vendor and milk shop/tea house. The highest total viable bacterial count ( $4.0 \times 10^6$  CFU) and total viable coli form counts ( $7.8 \times 10^5$  cfu/ml) were observed at restaurant, vendor milk selling shop level respectively. The milk sample from restaurant, vendor, milk selling shop and tea house was subjected high bacterial contamination and does not meet the East Africa community (EAC) maximum acceptable milk quality standard of ( $5.0 \times 10^5$  CFU/ml) for total viable bacterial count and ( $2.0 \times 10^5$  CFU /ml) for total viable coliform count which indicated poor animal husbandry and hygiene practices. Therefore, adequate sanitary measures should be taken at all stages from milk production to consumption.*

**Key Words:** - *Bacteriological quality. Coliform count, Hygienic practices, Raw cow milk, Total bacterial count*

# 1. INTRODUCTION

Dairy production is one of the sustenance factors for economy of Ethiopia. Ethiopia holds large potential for dairy development due to large livestock populations, which comprises 65 million cattle, 40 million sheep, and 51 million goat populations (CSA,2020a). Given considerable potential for small holder income and employment generation from high value dairy products, development of the dairy sector in Ethiopia can contribute significantly to poverty alleviation and nutrition in the country.

The Ethiopian livestock population is almost entirely composed of indigenous animals. Recent estimates showed that 97.8%, 1.9%, and 0.3% of cattle are indigenous, hybrid, and exotic breeds, respectively (CSA, 2020a). Different classifications have been used to characterize the dairy production system. It is classified into three broad categories, namely rural household, peri-urban or small scale and urban or commercial dairy production system (Ayalew,2017). According to CSA (2020b), of the total annual milk production, 50% milk was used for household consumption. In Ethiopia milk and milk products are mainly used in home consumption as they have high nutritional value. In addition, it is a source of cash income to purchase farm inputs like feed, fertilizers and improved crop varieties as well as food and non-food items, like educational materials for their children (Melese and Tesfaye, 2015).

However, the quality of milk produced in Ethiopia is poor and below the standard, due to poor pre-milking and post-harvest handling practices and highly perishable characteristics of the milk (Tsadkan and Gurja, 2018). Milk is a compulsory part of daily diet especially for the expectant mothers as well as growing children (Adil, and Iman, 2011).

Milk is virtually a sterile fluid when secreted into alveoli of udder. However, beyond this stage of production, microbial contamination might generally occur from three main sources; within the udder, exterior to the udder; and from the surface of milk handling and storage equipment, but the surrounding air, feed, soil, feces and grass are also possible sources of contamination (Ali and Abdelgadir, 2011).

Further more, milk is a highly nutritious food which serves as an ideal medium for the growth and multiplication of various microorganisms (Parekh and Subhash,2008). Microbial contamination in milk may cause milk-borne diseases to consumers while others are known to cause spoilage. Sources of microbial contamination in milk include primary microbial contamination from the infected or sick lactating animal. The secondary causes of microbial contamination occur along the milk value chains from milk handlers, unsanitary utensils and/or milking equipment and water supplies used (Parekh and Subhash,2008).

Because of the specific production and handling practices of milk, it is not possible to fully avoid contamination of milk with micro-organisms; therefore the microbial contamination of milk is an important tool in determining its quality.

The problem in study areas dairy production is not exception since it is rural setting without adequate introduction of modern facilities. Generally, raw cow milk and dairy product contamination control is not done on daily basis in Ethiopia (Alehegn,2004). This situation increases the contamination of raw cow milk contamination in country (Worku et al, 2012).

Like wise, in study areas raw cow milk was supplied directly to consumers with out taking appropriate measures. The handling of milk is unsanitary which needs investigation.

Therefore efforts are needed to establish the possible solutions towards the improvement of the qualities of milk and milk products which need identify the possible sources of milk quality deterioration. Several studies need to be carried out in order to provide reliable information for the improvement of the industry. Therefore, the objective of this study was to assess the milk production, milk handling practice, and evaluating bacteriological quality of raw cow milk produced and marketed in Dilla town and Dilla zuria district of Gedeo zone. .

## 1.1 Statement of the problem

Milk is a highly diversified and complex biological fluid that contains a complete and balanced nutrient supply of proteins, carbohydrates, fats, minerals, vitamins and other minor components essential for the growth and development of newborns and young mammals (Patrice, 2007). Furthermore, it is defined as the secretion of the mammary gland of mammals, its primary natural function being nutrition for the young (Walstra *et al*, 2006).

Raw milk is an ideal environment for micro-organisms like bacteria to multiply and major means for transmission of milk-borne pathogens to humans and the prevalence of zoonotic diseases (Perin et al.2018). The milk market in the study area is mainly informal and most of it is operated by individual smallholder producers. The market faces a number of constraints among them being high risks of microbial contamination due to lack of knowledge on microbial risks related to milk handling and consumption. The presence of microbial pathogens and other hazards in informal market in the study area is high, yet the risk to human health is mostly unknown and current food safety management is ineffective and inequitable. Information on the milk handling, quality assessment and marketing linkages is also inadequate.

As many research indicated the hygienic conditions are differing according to the production system, adapted practices, level of awareness, and availability of resources (Gwand et al. 2018; Dinkale 2019; Mikru et al .2021). Due to the play vital role that milk to infant growth as well as the enhancement of the nutritional status of the individuals, assessment of hygienic milk production is crucial (Mikru et al. 2021).

The study areas have potential for dairy cattle production, little was known about the existing milk production, milk hygienic handling practices and milk quality. Therefore, this study was carried out to explore the possible sources of bacterial contamination and the risks associated with milk quality in Dilla Town and Dilla zuria district of Gedeo Zone, Southern Ethiopia. Specifically, the study explored the presence of microbial contamination in the milk through the bacteriological plating. The study will also serve as baseline data for Livestock office, researcher and non-governmental organization (NGO).

## **1.2 Objectives of the study**

### **1.2.1. General objective**

The general objective of this study was:-

- ✓ To assess milk production and handling practice; and evaluating bacteriological quality of raw cow milk produced and marketed in Dilla town and Dilla Zuria District of Gedeo Zone of Southern Ethiopia.

### **1.2.2. The specific objectives**

- ✓ To assess milk production practices in the study areas.
- ✓ To evaluate bacterial quality of raw cow milk produced and marketed in the study areas.

## **2. LITERATURE REVIEW**

### **2.1 Dairy Cattle Production systems in Ethiopia**

Dairy production systems in Ethiopia can also categorize to rural, peri-urban, and urban dairy production systems from which rural dairy small-holder system supply includes pastoralists, agro-pastoralists, and mixed crop–livestock producers share largest total milk produced and contributing 98% of the milk (Mata work Milkias G ,2016). Per capita consumption of milk is approximately 19 kg per year in Ethiopia (FAO,2018). The quality of milk produced in Ethiopia is poor and below the standard due to poor pre-milking and post-harvest handling practices and highly characteristics of the milk perish ability( Tsadkan Z, Gurja B,2018) . Neglecting hygienic condition of the milking condition environment and milk containers, absence of udder and teats cleaning practices, failure to use towel for udder washing and drying, and poor personal hygiene of the milkers are the factors contribute for poor and substandard microbial quality of milk in Ethiopia dairy production Gebeyew et,al ,2016)].

#### **2.1.1 Rural Dairy cattle production system**

The highest source of milk in Ethiopia is traditional dairy cattle production, while cattle are kept for drought power without giving any focus to improve the milk production potential of dairy cattle and focuses on butter production rather than fluid milk (Alemayehu et al., 2012).

From the total national milk production, 97% comes from rural milk production system which produced by small holders. The rural milk production system is highly reliant on the low productivity of the indigenous zebu cattle breeds that can produces 400-680 liters of milk per cow per lactation period (Zelalem et al., 2011).

#### **2.1.2. Per-urban dairy cattle production system**

The per-urban dairy cattle production systems are mainly located at the edge of the town areas which have comparatively better access to urban centers in which dairy cattle products are extremely wanted (Azage et. al., l2013). This production system is categorized as semi-intensive crop-livestock farming system. Most of the dairy cattle producers depend on hybrid cows and

they practiced supplementary concentrate feeding. As related to the rural dairy cattle production system, per-urban dairy cattle production systems is typically located along roads within reasonable distance to urban centers and keepers are involved in fluid milk market (Nigatu, Dirk and Azage, 2012).

### **2.1.3 Urban dairy cattle production system**

In most towns of Ethiopia, the urban dairy cattle production systems are practiced with little or no land resources for the production and sale of milk (Azage et al. 2013). It is the most market oriented dairy cattle production system compared to other production systems (Asrat et al. 2016). Urban areas producers use crossbred, as well as high grade, dairy animals. However, only 1% of the dairy cattle from the total population of dairy cattle of the country are kept under urban dairy cattle production system (Gezu et al, 2018). Furthermore, cattle are housed in improved shelters made of locally available materials (Bekele et. al.2015). Concentrates, roughages and non-conventional feeds are the main feed resources which are used in urban dairy cattle production system. Road side consumable forages, fruits of plants and wastes are also used in urban dairy cattle production system (Asrat et al.,2016). Similarly, the study conducted by Gebeyew et al.(2016) showed the main feed resources in urban areas of Dawa chefa districts were grazing land; sun dried hay, agro-industrial oil seed cakes, crop residues and concentrates. On the other similar research findings grass hay, crop residues and concentrates were regularly used dairy cattle feeds in both urban and per-urban areas (Kiros et. al. 2018). Under the use of intensive management system urban dairy cattle production systems has better access to inputs and services providing by the public and private sectors as compared to other dairy cattle production systems (Azage et al. 2018).

Milk is sold to consumers and processing plants through informal market. But milk supply is low due small number of dairy cattle population kept under this system (Gezu and Zelalem, 2018).

Generally, the urban and per-urban dairy cattle production systems use improved dairy cattle or hybrid cows with relatively better management, purchased and conserved feed and stall-feeding. As a result cows shows the better performance and highly profitable as compared to other systems (Alemayehu et al.,2012). According to Assaminew and Ashenafi, (2015) the average

number of hybrid dairy cattle were greater in urban than that of per-urban dairy cattle production system (Gillah et al.,2012).

It is known that in big towns there is high demand for dairy cattle products consumption and the urban and per-urban dairy cattle production systems have their own role in filling demand-supply gap for milk and milk products in towns (Zelalem et al., 2011). Butter milk, butter and cottage cheese are dairy products which are produced and used as source of income to buy farm inputs (Asrat et al, 2015).

## **2.2 Dairy animal population in Ethiopia**

Ethiopia has the largest livestock population in Africa, with 65 million cattle, 40 million sheep, 51 million goats, and 8 million camels in 2020 (Central Statistics Agency, CSA, 2020a). Between 2000 and 2016, the average stock of livestock, measured in tropical livestock units (TLU) per 100 people, stood at 51 TLU, which is more than double the continental median of 23 TLU. The gross production value average growth rate during the same period was 4.5% also twice the continental median of 2.2% (FAO, 2019). The national herd supports, at least in part, the livelihoods of more than 11.3 million rural households, including 27– 35% of the highland livestock keepers, and a large proportion of the lowland herders, who live below the Government of Ethiopia established poverty line (Shapiro et al., 2017).The Ethiopian livestock population is almost entirely composed of indigenous animals. Recent estimates showed that 97.8%, 1.9%, and 0.3% of cattle are indigenous, hybrid, and exotic breeds, respectively. The estimates for sheep are 99.6% and 0.3% for local breeds and hybrids, respectively; nearly all goats 99.9% are indigenous breeds (CSA, 2020a).

### **2.2 .Dairy cattle population in southern nation nationalities and peoples region and Gedeo zone**

Farmers in the Southern nation nationality and peoples Region had an estimated total 12,404,963 head of cattle (representing 20.5% of Ethiopia's total cattle), 4,735,604 sheep (representing 18.8% Ethiopia's total sheep, and4,819,573 goats (representing 17.6%, Ethiopia's total goat ( CSA,2020a). Gedeo zone is one zone were Founded in the Southern nation nationality and

peoples Region and Gedeo zone had 327,807 cattle , 265,268 sheep and 50,449 goat (Gedeo zone livestock and fishery resource development department 2012 E.C annually report).

### **2.2.2 Milk production in Ethiopia**

The estimate of total cow milk production for rural sedentary areas of the country in 2019/2020 was about 3.89 billion liters on average of 1.54 liters per cow per day over lactation period of 180 days (CSA,2020a). The farm level value of the milk is an estimated birr 16 billion. The values of other important animal products and services include blood, traction, transport and manure for organic fertilizers and fuel. Estimated calf consumption and wastage of milk 32% of the milk produced (Getachew, and Gada, 2001). During peak production in the wet seasons, rural farmers, not part of formal cooperatives, face challenges marketing their milk as most regions experience a surplus .More surplus milk may be processed at the home in to local cheese butter. For most subsistence farmers in all culture in Ethiopia, the daily decision on how to allocate milk is decided by head female in the household and is dependent up on season, number of children in the house hold, presence of sick family members, and daily financial needs.

Depending on the altitude difference, temperature ranges from less than 10°C in alpine areas to 35°C and more in lowland areas. Moreover, rain fall in most of the country is adequate for crop and pasture land production. The favorable climate throughout the country supports use of improved, high yielding animal breeds and offers a relatively disease free environment for livestock development.

### **2.2.3 Milk marketing system in Ethiopia**

In Ethiopia milk and milk products formally and informal marketed. The informal milk and milk product marketing system is dominant, accounting for 95% of the milk and milk product marketed in the country. Producers directly sell their products to consumers or unlicensed traders or retailers through mutual price negotiation (Antenehet al., 2010).

There is no license to operate and no checks on quality in the informal system (Tegen *et al.*, 2013). The formal marketing system prevails in per-urban and urban areas. Milk is collected from producers by cooperatives and private collecting and processing plants, which channel the

products to consumers, caterers, supermarket and retailers (Yilma et al., 2011). Under the formal marketing system the quality of the milk is tested on delivery (Tegen et al., 2013).

#### **2.2.4 Milk Utilization in Ethiopia**

Cows are the main source of milk, and it is cows' milk that is the focus of processing in Ethiopia (Layne et al., 1990). Dairy processing in Ethiopia is generally based on ergo (fermented milk in Ethiopia), without any defined starter culture, with natural starter culture. Raw milk is either kept at ambient temperature or kept in a warm place to ferment prior to processing (Mogessie 2002).

Dairy processing in the country is basically limited to smallholder level and hygienic qualities of products are generally poor (Zelalem and Faye 2006). According to Zelalem and Faye (2006), about 52% of smallholder producers and 58% of large-scale producers used common towel to clean the udder or they did not at all. Above all they do not use clean water to clean the udder and other milk utensils. Of the interviewed small-scale producers, 45% did not treat milk before consumption, and organoleptic properties of dairy products are the commonly used quality tests. The storage stability of butter, while not comparable to ghee, is still in the order of four to six weeks. This gives butter a distinct advantage over fresh milk in terms of more temporal flexibility for household use and marketing (Layne et al., 1990).

#### **2.2.5. Constraints of milk production in Ethiopia**

The constraints of dairy cattle production differ within the three production systems and among different locations (Kassa, 2019).

As indicated by (Gillah, Kifaro, Madsen, 2012), high feed cost, land shortage and space limitation, feed quality, availability and cost problems as well as inadequate extension and veterinary services were the major dairy production system constraints in the Urban and Peri-Urban areas of central high land of Ethiopia. This result was consistent with the finding of (Yetera et al., 2018) and (Bereda et al., 2014) who found out feed shortage perceived as the first constraints to dairy farming followed by diseases. They are reported that land shortage, feed shortage, water shortage and poor artificial insemination efficiency (AI) service as the most important dairy production constraints. Similarly, feed shortage and land scarcity, diseases, poor

access to market place, restricted market information, lack of improved breed, inadequate artificial insemination (AI) and infrastructure were reported as the primary constraints of dairy cattle production by Gemechu and Amene 2017).

The major production problems listed by Misganaw et.al.,2017)includes absence of milk processing plants and equipment's, lack of skills, inadequate manufacture space, changeable marketing scheme, shortage of water, poor genetic potential of dairy cows for milk production. Comparable to this, feed shortage, inappropriate heat detection activity, poor management of animals, high service charge for artificial insemination and long distance from artificial insemination center are mentioned as main problems of artificial insemination services (Engidawork,2018).Feed and water scarcity, shortage of land, high feed cost, contamination and waste disposal are listed as the most challenges for dairy production in and around Wolaita Sodo town, southern Ethiopia (Asrat et. al. 2016).

According to Desalegn (2017)high cost of shortage of cattle feed, inadequate water supply, space limitations and diseases were identified as the main constraints of dairy cattle production in Bishoftu and Akaki. Moreover, Kassa (2019) identified lack of market-oriented production, non-existence of transport, insufficient infrastructure facility and institutional arrangements, disease; illegal trade and poor market data were the major reasons for the poor performance of dairy sector.

#### **2.2.6 Milk marketing chain in urban and Peri-urban areas**

In Ethiopia milk and milk products formally and informal marketed. The informal milk and milk product marketing system is dominant, accounting for 95% of the milk and milk product marketed in the country. Producers directly sell their products to consumers or unlicensed traders or retailers through mutual price negotiation (Anteneh et al., 2010).

There is no license to operate and no checks on quality in the informal system (Tegen *et al.*, 2013). The formal marketing system prevails in per-urban and urban areas. Milk is collected from producers by cooperatives and private collecting and processing plants, which channel the

products to consumers, caterers, supermarket and retailers (Yilma et al., 2011). Under the formal marketing system the quality of the milk is tested on delivery (Tegen et al., 2013).

Ethiopia has no market for dairy, with the exception of few major urban areas. Lack of markets affects the overall dairy production and consumption in the country (SNV, 2008). Generally dairy marketing systems are traditional; during milk marketing, in majority of household whole milk and butter are used for sale (Asaminewet al., 2008; Gatwech, 2012).

### **2.2.7. Opportunities of milk production in Ethiopia**

The large population of milk cows, diverse genetic resource of dairy cattle adapted to the varied environment, and different agro-ecological zone, presence of potential land for manufacturing of quality feeds under rain season and irrigated environments are opportunities for milk producers to increase milk production (Azage et al ,2013) and (Kassa2019).The existence of fast growing population and urbanization with an extended utilization of milk and its products are the main opportunities of milk production in Ethiopia (Kassa, 2019).

In addition the findings of Solomon (2014) indicated that fast urbanization, increase population number and modification in economic standard of the individuals, dairying gives an opportunity to the dairy producers to generate income as it is highly demanded product. The growing demand for milk and its products like fermented milk (Yogurt), butter, cottage cheese, butter milk, ghee and whey offers a good opportunity for dairy producers (Asrat et al 2016). Hence a potentially large domestic market is the main opportunities of milk production in Ethiopia (Kassa, 2019). There are plenty of opportunities for dairy development as listed by Asrat et al., (2013) and Kiros et al (2018). On the other hand, development of infrastructural sector, such road access or road construction to connect towns with rural kebeles, water supply, electrification, communication activities would favor modern dairying (Gemechu and Amene, 2017)

## **2.3 Milk and milk products handling practices**

Milk and milk products are major food for human consumption all over the world. Milk is virtually sterile when it is synthesized in healthy cow's udder. However, as soon as it leaves despite milk is highly nutritious food it can be easily contaminated with physical, chemical, microbiological hazards.

Milk quality refers to a blend of characteristics such as chemical, physical, bacteriological and aesthetic that boost up the acceptability of milk product and milk safety is free from pathogenic organisms and other contaminants that may constitute health hazards (Merwan et al, 2018). Specific gravity, chemical composition and bacteriological quality of milk are important to determine milk quality and safety. While milk for milk products microbial quality and safety (Merwan et al, 2018)

### **2.3.1 Related milk quality problem**

In Ethiopia milk produced at smallholder farm is marketed without quality control measures. Hygienic control of milk and milk products is not usually conducted on routine bases. Apart from this, door-to-door raw milk delivery in the urban and peri-urban areas is commonly practiced with virtually no quality control at all levels (Godefay and Molla, 2000). Although, properly operational formal marketing and grading system targeted towards relating quality of products to market price is not well established, provision of milk and milk products of good hygienic quality is desirable from consumer's health point of view (Zelalem, 2012).

On the other hand, the Chemical composition, particularly milk fat content is used as quality test (Zelalem, 2010). The nutritional as well as the economic value of milk is directly associated with its solids content. The higher the solids content better its nutritional value and more of a milk product can be made (Pandy and Voskull, 2011). Protein content being one of main quality determining criteria applied to milk payment to producers in many countries where others are priced according to fat and solids-non-fat composition (FAO, 2004).

Since raw milk quality is very important for the quality is very important for the quality milk and milk product made of it therefore, quality of raw milk should be under control. So, safety of

dairy products with respect to food-borne diseases is a great concern around the world. This is especially true in developing countries where production of milk and various dairy products take place under rather unsanitary conditions and poor production practices (Zelalem and Faye, 2006; Alganesh et al., 2007; Asaminew and Eyassu, 2011). Therefore, every milk delivery should be inspected with regard to certain quality parameters in the country.

### **2.3.2. Milk Hygienic Handling Practices**

The hygienic handling of milk from milking to the time it reaches a consumer has a greater influence on safety and quality of the milk and its products. When unhygienically handled, milk can easily be contaminated. Possible practices that can lead to milk contamination include, milking, transportation and delivery of milk. Infected personnel involved in milking are also a potential source of milk contamination. Moreover, containers that are used to put milk during milking, storage and delivery may be possible sources of milk contamination. Under poor sanitary conditions, milk can easily be contaminated by several bacteria (Prajapat, 1995; Chatterjee et al., 2006). To avoid cross contamination, proper separation of the activities, thorough cleaning and disinfection of containers is important (Kivaria et al., 2006). The hygienic measures taken by milk handlers before, during and after milking play a vital role on milk hygiene and safety.

### **2.3.3 Milk quality and safety in Ethiopia**

Specific gravity and chemical constitutes the specific gravity of milk among others is commonly used for quality test mainly to check for the addition of water to removal of cream increase it.

Mekonen and Menigistu (2017) report broken paraed that the mean specific gravity of raw milk obtained from farmers and dairy cooperatives was 1.029g/ml. For normal whole cow milk specific gravity ranges from 1.028g/ml-1.036g/ml based on the East Africa community (EAS) (2006) standard. The milk which having specific gravity below recommended level implies that there was adulteration of mil with water which contributes to production of poor quality milk (Ali et al, 2010). The solid constitutes of milk make an important food items from nutritional as

well as processing point of view. Milk fat and protein are most important components of different varieties of most shelf stable milk products (Mekonen and Menigistu, 2017).

## **2.4 Milk Composition and Milk Quality**

Milk and dairy products have become a major part of the human diet in many countries over many years; hence considerable attention has been paid to improve the yield, the compositional and hygienic quality in order to minimize the level of contamination (Adesium, 1994).

In general, milk has a high nutritional value and it is a good diet for children (FAO, 2005). It provides nourishment and immunological protection (Bauman, 2004). However if not handled properly, milk can be easily destroyed through contamination and bacterial growth and becomes unfit for human consumption. Some of microbial contaminants are responsible for milk spoilage while others are pathogenic with potential health effects to cause milk borne diseases (Kivaria *et al.*, 2006). Bacterial count in milk is influenced by the temperature at which milk is stored and the time that elapses since milking.

The quality of milk intended for consumption and processing varies subject to cattle breed (Barłowska *et al.*, 2009). However, new breeding goals have recently been identified, especially on milk composition, following the demands of a healthier human diet (Boichard *et al.*, 2012). The chemical composition of milk can be influenced by several factors such as animal species and genetics, environmental conditions, lactation stage, and animal nutritional status (Kalac and Samkova, 2010). Generally, milk is composed of 87.7 % water, 3.3% protein, 3.4% fats, 4.9% lactose and 0.7% mineral (Poulsen *et al.*, 2012). Fat, protein and casein content are important traits for the milk and cheese industry while the fraction of milk used for cheese making is growing worldwide (International Dairy Federation, 2012). Milk contains a natural inhibitory system, which prevents a significant rise in the bacteria count during the first 2 - 3 hours. If milk is cooled within this period to 4°C, it maintains nearly its original quality. Timely cooling ensures that the quality of the milk remains good for processing and consumption (Omore *et al.*, 2005). East African countries (EAC) have harmonized standards for some products including milk. Standards are reference points and tools for ensuring quality and safety. East African Standard (EAS 67) prescribes quality requirements for raw, normal cow's milk standard at their

level of operation to protect the consumer (EAS, 2006). The quality it covers bacteriological quality.

Hygienic milk only originates from mastitis free and healthy animals. Cows suffering from a disease may secrete the pathogenic bacteria, which cause the disease, in the milk they produce. In addition, unclean equipment also will allow microorganisms to grow rapidly. However, milk is a perishable product. It is an ideal medium for microorganisms to contaminate and invade with microorganisms easily.

## **2.5 Physical properties of milk**

### **2.5.1 pH value**

Milk pH gives an indication of milk hygienic and it should not be  $\leq 6.6$  or  $\geq 6.8$  when milk temperature is  $-20^{\circ}\text{C}$ , because cooling of milk reduces the risk of growth of bacteria while high milk temperature must be considered as favorable to the growth of bacteria in milk (Walstra et al., 1999). The pH values higher than 6.8 indicates mastitis milk and pH values below 6.6 indicates increased acidity of milk due to bacterial multiplication (O'Connor, 1995).

### **2.5.2 Specific gravity**

Specific gravity is the ratio of density of the substance to the density of standard substance (water). The density of a substance varies with temperature, it is necessary to specify the temperature when reporting specific gravities or densities. The specific gravity of milk is influenced by the proportion of its constituents (e.g. Composition), each of which has different specific gravity approximately as follows; Water (1.000), Fat (0.930), Protein (1.346), Lactose (1.666), Salts (4.12) and SNF (1.616). The specific gravity of milk is decreased by addition of water, addition of cream (fat), while removal of fat and reduction of temperature increase specific gravity of milk. Generally, normally milk has a specific gravity between 1.027 and 1.035 with an average value of 1.032 at  $16^{\circ}\text{C}$  (O'Connor, 1994, Morris, 1999).

### 2.5.3 Titratable acidity

Titrateable acidity is a measure of freshness and bacterial activity in milk. The natural acidity of individual milk varies considerably, depending on species, breed, individuality, stage of lactation, physiological condition of the udder, etc. The higher the solid not fat contents of milk the higher the natural acidity and vice versa. When the milk is kept for some time, the bacteria will multiply and utilizes lactose and converts in to lactic acid, thereby increasing the acidity and decreasing the pH value. This acidity is known as developed or real acidity. The sum of natural acidity and developed acidity is known as titrateable acidity (Krishnaiah, 2005).

Titrateable acidity of milk has long been recognized and employed as an indicator of quality (Jay, 2003). It is expressed in terms of percentage lactic acid since lactic acid is the principal acid produced by fermentation after milk is drawn from the udder. Fresh milk, however, does not contain any appreciable amount of lactic acid and therefore an increase in acidity is a rough measure of its age and bacterial activity (O'Mahony, 1998; Lampart, 2005). Within a short time after milking, the acidity increases perceptibly due to bacterial activity. The degree of bacterial contamination and the temperature at which the milk is kept are the chief factors influencing acid formation.

Therefore, the amount of acid depends on the cleanliness of production and the temperature at which milk is kept. For this reason, determination of acid in milk is an important factor in judging milk quality. Acidity affects taste as well. When it reaches about 0.3%, the sour taste of milk becomes sensible. At 0.4% acidity, milk is clearly sour, and at 0.6% it precipitates at normal temperature. At acidity over 0.9%, it moulds (Heineman, 2001). Campbell and Robert (1995) reported that the off-flavour and odours of milk and milk products can be placed in categories based on their causative factors. The sour flavor (acid) is developed when microorganisms ferment lactose and other carbohydrates. Lactic acid is the primary acid in milk and milk products that is responsible for the lower PH.

## **2.6. Control of Contamination in milk**

The sources of entry of microorganisms in milk are interior of udder, exterior of udder, atmosphere, utensils and milking person. Therefore, in order to obtain milk free from microbes, the hands of milking persons and the teats should be washed by antiseptic solutions. The utensils in which milking is carried on should be sterilized before use, the milking should be done in a clean atmosphere and the *utensil* should be plugged with cotton wool after milking. The exterior of the udder can be a major source of bacterial contamination to milk. Cleaning and removal of soil, bedding material and manure from the udder and flanks of the cow before milking is necessary to prevent the entry of many types of bacteria into the milk. The degree of cleanliness of the milking system probably influences the total bulk milk bacteria count. The key words in controlling bacteria in milk are cleanliness, sanitation and cooling. Cleanliness applies to the cow, cow environment, milking area, personnel involved in milk and the milk storage area. Sanitation applies to the milking system and bulk tank. Cooling refers to temperature of milk after it leaves the cow and how quickly it is cooled.

According to Coia et al. (2001), to produce clean milk from healthy cows the cow udder should be washed with clean water before milking to produce clean milk and to minimize bacterial contamination in milk. The body of the cow should be free of soil, dirt and manure and contamination of milk from external sources. Although milking persons and milk handlers should be in good health and their hands should be clean, and milking barn should have a good floor that is easy to clean and drain, there should be good ventilation and lighting.

### **2.6.1 Control Measures of microbial contamination in raw milk**

**Cooling;** to prevent or retard growth of bacteria in milk and to maintain its quality for domestic consumption or during transport to the processing plant, it is essential to cool the fresh milk as quickly as possible (O'Connor, 1995). Although cooling and chilling of milk at temperature of 5°C or below is necessary to minimize microbial growth and prevent milk quality deterioration during handling storing and transporting before the raw milk being processed.

In order to facilitate bulking of raw milk supply and transport the incoming milk refrigeration facilities are provide at points of cooled and transport means to maintain the temperature as such

as possible (Getachew et al, 2008).in the tropical countries of Africa with high ambient temperature, lack of refrigeration facilities at farm and house hold level imply that raw milk will acidify very fast (Godefay and Molla, 2000).

There for the collection systems must be designed to move the cooling and /or processing center in shortest possible time. In addition every effort should be made to use available systems such as water cooling, air circulation or shaded areas to reduce milk temperature (Dello Castillo).

**Boiling;** it is easiest and most practicable method of milk safe in every home. As soon as raw milk is produced or delivered, it should be boiled. Boiling involves raising the temperature to the boiling point and maintaining at this temperature for a few minutes. Then the milk should be cooled immediately. the temperature should be maintained below 10°c since this may be impracticable at home, preferably the milk must be consumed as soon as possible after cooling not an extended period of time after it has been boiled and cooled(Gebra-Emanuel,1997and Linton 1982).

**Pasteurization;** It is the main safe guard against Pathogenic organisms in milk. The combination of pasteurization, care in production and improved storage has resulted in relatively safe milk supply. Milk borne like tuberculosis, diphtheria and scarlet, fever has been practically eradicated. Also the shelf-life of milk has been increase from a few days to a few weeks (Vasavaoa and smith1987).

**Sterilization** involves heating sealed bottles or metal containers of homogenized milk for up to 120°c for 20–30minutes usually using saturated steam under pressure. In sterilization milk is subjected to severe heat treatment that ensures almost complete destruction of the microbial population. The product is then said to be commercially sterile. The milk is subjected to above 100°c for 15–40minutes. The product has a much longer keeps for several months without refrigeration if unopened (Collins, 1967).

## 2.7. Measures of Milk quality

### 2.7.1 Bacteriological quality

Milk is sterile it is synthesized in the healthy cow udder (Linzell and Peaker, 1971) but due to its complex biochemical composition and high water activities, it serve as an excellent media for growth and multiplication of many kinds of microorganisms. Thus it can be contaminated while it is within the udder, if the cow gets infected by bacterial agents as in the case of milk from a Mastitis cows (Quinn et al., 1994; Fernandes et al., 2004). It usually contaminated by organisms free living environment or that are found on surface that come in contact to it during the process of milking (Fernand et al.,2004 and Courtenany et al., 2005), processing (Elmagli and Ibtism, 2006), storing and transporting (Abdel Moneim et al.,2006).

Milk may contain both pathogenic and non-pathogenic organisms. Pathogenic organisms, which may come from directly the cow's udder, are species of *Staphylococcus*, *Myobacterium*, *Brucella*, *Escherichia*, *Corynebacterium*, and other which are known to cause disease to animal and man. Generally bacteria in milk classified into three groups based on the temperature for optimal replication namely: psychrophilic, mesotrophilic and thermophilic bacteria (Dogan and Boor, 2003). Psychrophilic organisms can grow at refrigeration temperatures and responsible to spoilage of milk under cold storage. The psychotropic bacteria are killed by pasteurization, however, the enzymes they produce can survive and their importance in dairy sector is due to economic loss from their spoiling action on milk stored at lower temperature there by reducing its shelf life. Thermophilic organisms are less harmful to health, but can cause change in the organoleptic qualities of milk. They can endure heat and survive pasteurization. Mesophilic bacteria are those, which grow best temperatures ranging from about 20-40°C. These groups of bacteria include the pathogenic genera and are also capable of deteriorating the quality of milk (Hagstad and Hubber, 1986).These group of bacteria responsible for milk born infection of human beings. Owing to the wide spread occurrence of bacterial agent in milk, this item of food is subjected to various standards and quality tests that can be indicates how safe and nutritionally valuable a given dairy product is. These quality indicator includes the standard plate count (SPC), coliform count (CC), laboratory pasteurization count (LPC), and somatic cell count (SCC). In addition to these general bacteriological tests, milk is often subjected to more detailed

laboratory analysis to isolate and identify specific pathogens to man and cow itself (Donald, 1996; Rice and Bodman, 1997; Jay, 2000; Loir et al., 2003; Kavariaet al., 2004; Kesselet al., 2004). But routinely applied method for investigation of bulk milk quality is standard plate count and the somatic cell count (IDF, 1991).

### **2.7.2. Somatic cell count (SCC)**

The somatic cell count (SCC) is internationally recognized as a parameter for assessing milk quality and udder health (Degraaf et al., 1997). (EUS) European union standard requires that the milk should not contain more than 400,000 somatic cell/ml. Milk market routinely rely on somatic cell count to ensure a quality product. Somatic cell count levels are mentioned to ensure compliance with set quality product. Today most markets in developed countries pay a premium for low SCC, good quality milk. One can appreciate the reasons, for paying a bonus for quality milk when the relationship between mastitis (high SCC) and milk composition is understood. Chemical change in milk composition due to mastitis reduced milk quality (Rice and Bodman, 1997).

Raw milk contains three type of cells; epithelial cell, macrophages and polymorpho nuclear cells. The first two cells can be found in uninfected udder while polymorpho nuclear cells and macrophages are found in high numbers only in affected udder (Radostits et al., 1994; Quinn *et al.*, 2002). Due to this, the somatic cell count is internationally recognized as a parameter for assessing both milk quality and udder health .The so-called premium milk or grade 'A' milk should have a SCC of less than  $4.0 \times 10^5$  cells/ml of milk (Degraaf et al., 1997).

### **2.7.3 Coliform count (CC)**

Coliform is not biological classification, but a working definition given to a group of bacteria, which inhabit the intestinal tracts of humans and animals (Jay, 2000). *E.coli* is the most numerous coliform in human and animal intestines and derived almost exclusively from these sources being excreted in large number with human excreted and animal droppings (Quinn et al., 2002). They may be found in the soil, on vegetables and untreated water (Dogan and Boor, 2003; Kessel et al., 2004). It does not survive long in water and therefore, it is the best indicator of

recent human and animal fecal pollution. Its presence in milk indicates a potentially dangerous pollution; high counts a heavy or recent pollution and low counts a light or more remote one (Jay, 2000).

#### **2.7.4 Standard plate count (SPC)**

The standard plate count (SPC), which is also called aerobic plate count (APC) of raw milk gives an indication of the total number of aerobic bacterial present in milk at the time culturing the samples. Analysis of total bacterial count (TBC) may be performed using the bacterial count equipment that applies the flow cytometry technique (Holm *et al.*, 2004). In the SPC method, milk sample are plated on the standard plate count agar media and then incubated for 48hrs at 37°C to encourage bacterial growth. Single bacteria or cluster grow to become visible colonies that are then counted. All plate count is expressed as the number of colony forming unit (cfu) per milliliter of milk (Murphy, 1996).

A negative aspect of the standard plate count is the possible underestimation of the total bacteria quality because a colony does not always originated from a single bacterium (Quinn *et al.*, 1996) and it does not indicate the type of bacterial species involved in the milk contamination. It is sensitive but also labor intensive and is inaccurate for high-count milk samples (Slaughuis, 1996). It required the samples be processed immediately after collection or within 24 hrs of collection, if appropriate cooling facility is in place. However, the SPC is generally accepted as the most accurate and informative method of testing bacteriological quality of milk.

**Table 1. Grading of raw milk based on standard plate count.**

<b>Bacterial count/ml</b>	<b>Grade</b>
Not exceeding 200,000	Very Good
200,000-1000,000	Good
1000,000-5,000,000	Fair

**Source:** (kurwijilaet *al.*, 1992)

### **2.7.5. Dye Reduction Test**

The principle of these tests is based on the effect of the bacteria on some reagents added to milk sample serving as an indication of the bacteriological quality. These include methylen blue reduction test, resazurine test, alcohol test and clot on boiling test (Teka, 1997). In this test, a known dilution of methylen blue solution is added to milk sample and observation is made at fixed intervals until the blue color of the solution disappears (Teka, 1997). Normally, if the number of bacterial organisms is greater, the times required to decolorize the blue color is shorter.

Another test, whose procedure as well as the principle is similar to that for the methylene blue reduction test, is resazurin test. The only expectation is that this test is quicker and the result is obtained in much less time (Teka, 1997). The resazurin dye imparts blue color to milk which when reduced for complete decolonization, reduction of resazurine and the degree of color change is directly related to the number of bacteria organisms in milk (Ombui et al., 1995; Teka, 1997). A disc reading value of 4 and above 10 minutes resazurin test indicates good quality but while reading value of less than 4 and 10 minutes poor quality milk (Ombui et al., 1995).

### **2.7.6 Alcohol test**

Alcohol test can be performed on milk to check its freshness particularly at milk collection centers and other field conditions (Kirwijila et al., 1992). When milk contains more acids, calcium or magnesium compounds greater than normal concentration, it coagulates on the addition of alcohol. This fact based is the basis of alcohol test, which furnish a means of judging the quality of milk.

### **2.7.7 Clot on boiling test**

Acidity decreases the stability of milk if concentration of hydrogen ion is more than the normal amount (O'mahony, 1988), then casein will get precipitated on heating immediately. The clot on boiling test is used to determine whether milk is suitable for processing. As indicates whether the milk is likely to coagulate during processing (usually pasteurization). It performed when milk is brought to the processing plant if the milk fails the test, it is rejected (O'mahony, 1988).

### **2.7.8. Sources of Microbial Hazards in the Milk**

Microbial contamination of milk can originate from a diseased cow, unhygienic milking practice, poor personal hygiene, unsanitary utensils and/or milking equipment and water supplied in sanitary activities (Parekh and Subhash, 2008; Kilango, 2011; Lubote et al., 2014). A cow with an infectious disease can shed pathogens from its blood into the milk. Findings by Streeter et al. (1995) indicate that infected cows with clinical disease and subclinical infections shed *Mycobacterium avium* sub species *Paratuberculosis* in both milk and feces. Detectable levels of the organism were observed in milk from both clinically infected and asymptomatic carrier animals. Also, infected mammary quarters or cows and the environment, in which animals are kept, are known to be chief sources of bacteria that cause udder infections in a herd. Transmission of infectious bacteria to teats of uninfected mammary quarters or cows occurs mostly at milking (Kilango, 2011). Appropriate milking hygiene practices reduces the rate of new infections during milking (Robert, 1996). The use of pre- and post-milking teat disinfectants is an effective measure in reducing the risk of new infections. Pre-dipping reduces the resident teat skin bacterial population, which is the main source of infection for the mammary gland. It can reduce new environmental streptococcal infections and *E. coli* by 50%. Post-dipping prevents the transmission of contagious bacteria such as *S. aureus* (NADIS, 2013). All individuals involved in the milk value chain should maintain hygiene and must be in sound health because microbes may drop from hands, clothing, nose and mouth, and from sneezing and coughing. It is important for them to be in good health to avoid becoming a source of infectious diseases (Kurwijila, 1998). Other bacterial sources are from air, drugs or chemicals used during treatment of animal and from contaminated water used for adulteration by unscrupulous and unfaithful workers/sellers may cause additional health problems (Karimuribo et al., 2005).

## **2.8 Factors influencing food safety in dairy value chain**

Milk is one among the well nutritionally balanced food and hence its safety is vital. However, Debuyser et al., (2001) reported that milk and milk-based food products are highly susceptible to microbial contamination because of their rich composition, which provides a favorable medium for growth of spoilage agents. The pathogens in milk are derived from several sources

including dairy animal, the handler and the environment with the most common external source is contaminated water supply (Kaplan *et al.*, 1990). It should be known that human can be the most critical source of infection.

### **2.8.1. Environmental factors**

A number of environmental factors are associated with the hygiene of milk along the dairy value chain for example water sources, and soil. Bacteria are ubiquitous in air and can easily be introduced into milk. Torkar and Tegar, (2008) have reported that bacterial contamination of milk can originate from different sources such as air, feeds, milking equipment, soil, feces and grass. Furthermore, Kivaria *et al.* (2006) found that elevated levels of enteric organisms in milk reflect a probable source of contamination via water or soil where fecal-oral transmission appears to be of epidemiological significance. On the other hand, cow housing system and the environment from which milking activities are done have a greater impact on the safety of milk. Dirty environment with cow dung is one of the many factors that can lead to microbial contamination of the milk during milking. Donkoret al. (2007) found that important source of microbial contamination of milk is fecal pollution most probably coming from the cow dung.

### **2.8.2. Cow udder**

Cleaning the udder of the cow's before milking is one the most important hygiene practices required to ensure clean milk production (Zelalem, 2010). This is important since the udder of the milking cows could have direct contact with the ground urine, dung and feed refusals. Cleaning and removing of soil particles, bedding material and manure from the udder and flanks is necessary to prevent the entry of many types of bacteria in to the milk (O'Connor, 1995). Udder washing with clean water and drying by using hand towels reduces milk contamination by transient bacteria located on udder (Robbert,1996).special care must be given to the cloths used for cleaning and sanitizing may result in re-contamination of udder. It is there for recommended that separate cloths be used for cleaning and sanitizing, and if possible, each cloth should be used for one cow only (O'connor, 1995). Not washing the udder before milking can impart possible contamination in to the milk.

Maximum reduction of teat contamination of 90% can be achieved with good udder preparation before milking. This depends on initial level of contamination and the way of udder preparation. So with initial contamination level this 90% reduction might not be reached (Murphy, 1996).

### **2.8.3 Milking person**

Milk handling personnel (milking person) may contribute various organisms including pathogens especially when they are careless, uniformed, or willfully negligent, directly to milk (Ashenafi, 1994). Organisms may drop from hands, clothing, nose and mouth and from sneezing and coughing. It is important for milk men to good health so that can be source of infectious diseases such as, tuberculosis (Kurwijila, 1998).

### **2.8.4 Milking Equipment**

Poorly cleaned and sanitized milking utensils may be source of many microorganisms (Banwat, 1989). Milk drops left on the surface of milking equipment act as excellent media for the growth of variety of bacteria (Bramley and Mckinnon, 1990). Milk equipment not properly cleaned and sanitized after use milk residue left on equipment and utensils surface provide nutrients to support the growth of many microorganisms, including pathogens (Brayan, 1983). In case cracked milking equipment large number of bacteria enter and grow in the cracks, are difficult to clean (Thomas et al, 1966). The bacterial load of milk increases during transportation and if the transportation equipment the bacteria counts increase causing spoilage before milk reaches its destination (Grillet et al., 2010). Milking equipment should be easy to clean Aluminum and stain lees steel equipment are mostly preferred (Zelalem, 2010).

### **2.8.5. Water**

Water serves as primary source microorganisms contamination (Mbabazi, 2005), if water obtained from an open water supply care should be taken to prevent drainage that may contain human stool and other contaminants gaining entry in to the source (Jay, 1992).

## **2.9 Health and Economic impact of Unsafe Milk**

Food safety is an area of great concern in terms of public health management especially from an economic point of view (Mangwayana et al., 2000). Food-borne diseases due to microbial pathogens in milk are a serious threat to the health of millions of people (FAO, 2006). Raw milk continues to be a staple in the epidemiological literature linked to campylo- Bacteriosis, salmonellosis, tuberculosis, brucellosis, hemorrhagic colitis, Brainerd diarrhea, Q fever, listeriosis, yersiniosis, and toxoplasmosis to name a few (Plotter, 2002).

These impose a substantial burden on health care systems and reduce economic productivity (FAO, 2006). Seventy percent of deaths among children fewer than five years are linked to biologically contaminated food and water (Unnevehr and Hirschhorn, 2000). Also, unsafe milk and milk borne illnesses cause producers, vendors and wholesalers to earn a poor reputation, which may take time to overcome and consequential loss of income. These important players may also become prey of milk borne illness thus perpetuating the cycle of poverty (Nhachi and Kasilo, 1996; FAO, 2006). The sources of contamination are variable and can take place at any point in the milk production and marketing chain.

The major milk borne pathogens of concern are zoonosis and environmental coliforms of fecal origin. The latter are commonly introduced in milk due to poor handling at farm and along the value chain. Contamination of fecal bacteria in milk usually occurs through the use of contaminated water and unsanitary equipment (Kilango, 2011). Currently, there is limited scientific data to quantify the magnitude of the problem and to provide baseline data from which informed decisions can be made. More information is needed that will help improved regulatory policy decisions to be made. Scientific data will also help ensure more effective control when outbreaks occur (Mangwayana et al., 2000). There is evidence of many harmful bacteria being potentially linked with bovine milk contaminations (Table 2).

**Table 2. Bacterial types commonly associated with bovine milk**

<b>Bacteria group and species</b>	<b>Outcome</b>
Lactococci: <i>L. lactis</i> -diacetylactis, <i>L. lactis</i> , <i>L. Cremoris</i>	Flavour production and fermentation
Lactobacillus: <i>L. lactis</i> , <i>L. bulgarica</i> , <i>L. acidophilus</i> , Leuconostoc lactis, Propionibacterium	Acid production/fermentation
Pseudomonas, Bacillus cereus	Spoilage
Enterobacteriaceae	Pathogenic and Spoilage
Staphylococci: Staphylococcus aureus ( <i>S. aureus</i> ).	Pathogenic
<b>Streptococcus:</b> Strep. Agalactiae	Pathogenic
Zoonotic Brucella abortus	Pathogenic
Zoonotic Mycobacterium bovis	Pathogenic
<b>Coliforms:</b> Escherichia coli ( <i>E. coli</i> )	Some are zoonotic and pathogenic
<b>Listeria:</b> Listeria monocytogenes ( <i>L. monocytogenes</i> )	Pathogenic; mainly in unpasteurised cheese

Source: O'Connor (1995)

### **2.9.1 Concepts of food safety and risk analysis**

Food-borne disease is still an alarming problem in developing countries leading to severe human suffering and major economic loss as reported by WHO and FAO, (2005). Risk analysis is based on approach to improve food safety decision making process hence contributing to reduction in the incidence of food-borne disease and continuous improvement in food safety. This approach makes it possible for the information on hazards in food to be linked directly to the available data on the risk to human health. Risk analysis comprises risk assessment, risk management and risk communication.

This study is believed to be timely and crucial to identify and document important information on the milk production, milk handling practices, and bacteriological quality of raw cow milk produced and marketed, which will answer many consumers, have complaints regarding quality of milk and addressing this issue needs research. Therefore, the objective of this study was to assessing the milk production, milk handling practice, and evaluating bacteriological quality of raw cow milk produced and marketed in Dilla town and Dilla Zuria District.

## **3. MATERIALS AND METHODS**

### **3.1. Description of the study areas**

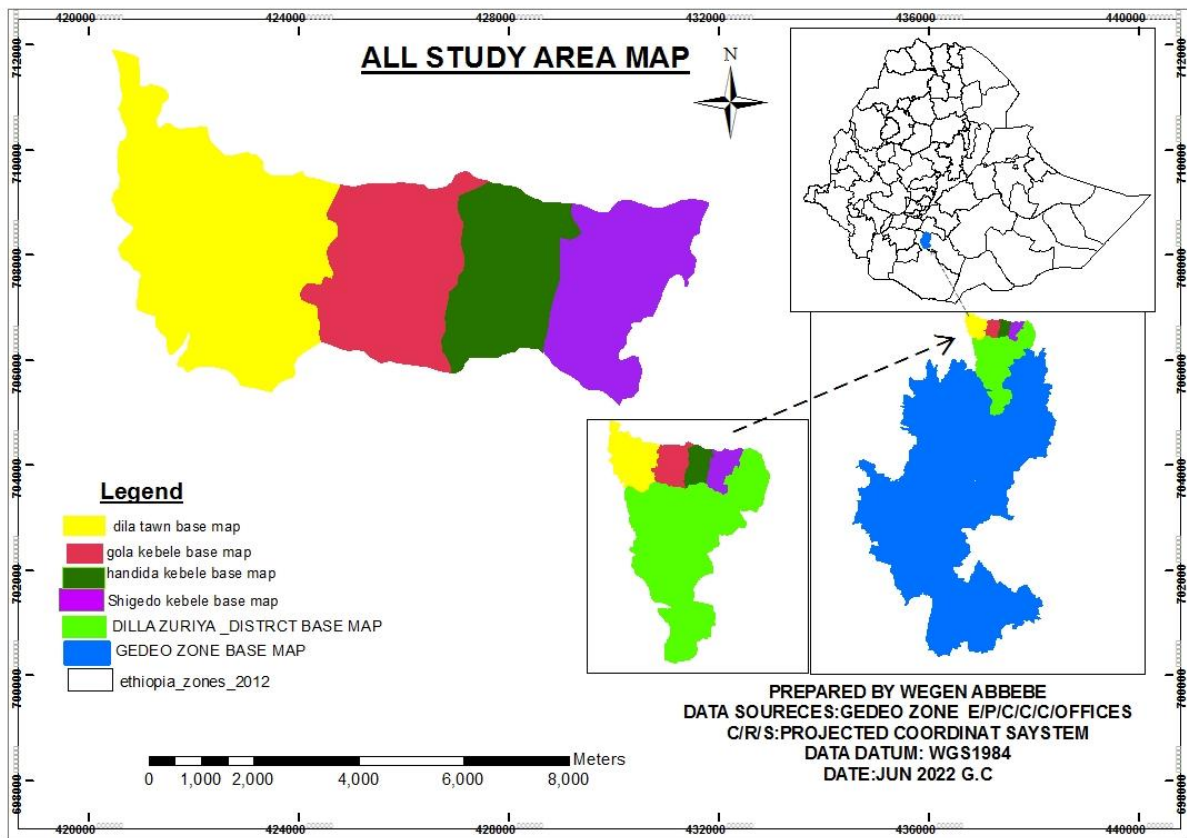
The present study was conducted in two districts of Gedeo Zone of Southern Nations, Nationalities, and Peoples Region (SNNPR). Those districts were Dilla town and Dilla zuria. Dilla town is the administrative center of Gedeo zone which is located 369 km away from the capital city of Ethiopia, Addis Ababa on the main road from Addis Ababa to Nairobi. Dilla town has longitude and latitude  $6^{\circ}24'30''\text{N}$   $38^{\circ}18'30''\text{E}$ , with an elevation of 1570 meters above sea level. According to the Dilla town Administration office information developed in 2022 Dilla town has an estimated area of 1200 hectare that comprises of 5 (five) urban kebeles.

According to Dilla town Agricultural and livestock production office data in 2018, the livestock population of the Dilla town estimated to be 5,042 cattle out of which 2,052 dairy cows, sheep 6,006 and goats 4,514. The major feed sources for those livestock in the Dilla town are natural pasture, crop residues, hay and local brewery by-product (Briniti and Atella), agro-industrial by-products and others (Gedeo zone livestock and fishery development department 2011 E.C report). Cows in the study areas largely depend on agro industrial by-products throughout the year and crop residues late in the dry season (Gedeo zone livestock and fishery development department 2011 E.C report). All farms found in Dilla town have no access to grazing land. Hence, mainly they depend on agro industrial by product, hay and crop residue others. Agro industrial by product purchased daily along with crop residue which was purchased immediately after the end of harvesting season and stored in straw shed.

Dilla Zuria District is situated in Gedeo zone which is named after its main administrative town. Dilla zuria, which is located 6 km far from Dilla town and 371 km away from the capital city of Ethiopia, Addis Ababa. The District has an estimated area of 12044 hectare that comprises of 17 rural kebeles. The District is bordered on the west by the Oromiya Region and on the south and Oromia region and Wonago District, on the east by Bule, on the north Dilla town and Sidama Region.

The altitude of the Dilla Zuria District is 1550-2850 a.s.l and has the average rain fall range 900-1400mm, the average temperature range 16<sup>0</sup>C to 24 <sup>0</sup>C and the soil type is clay loam.

The livestock population of the DillaZuria District accounts 25,654 cattle, sheep 22,294 and goats 1,335 according to Dilla Zuria livestock and fishery Resource office data on 2018.The major feed sources for livestock in the DillaZuria District are natural pasture, crop residues, hay and agro-industrial by-products and others. All farmers found in Dilla Zuria District have Low access to grazing land. Hence, mainly they depend on Cut and carry feeding strategy.



**Figure 1. A map of Gedeo Zone showing its districts including Dilla Town and Dilla Zuria districts that were selected in this study: The map showing the position of the zone in Ethiopia.**

## **3.2. Research Design and Sampling Techniques**

### **3.2.1 Research Design**

In this study a cross sectional study design was employed. The study involved different actors and different parts along the dairy value chain of the study areas (Figure 2) who were farmers, milk collection centers, milk vendors, milk retailers and milk selling restaurants in Dilla town and Dilla Zuria districts. The selection criteria of the study participants included availability of milk during the time of sample collection and willingness to participate in the research.

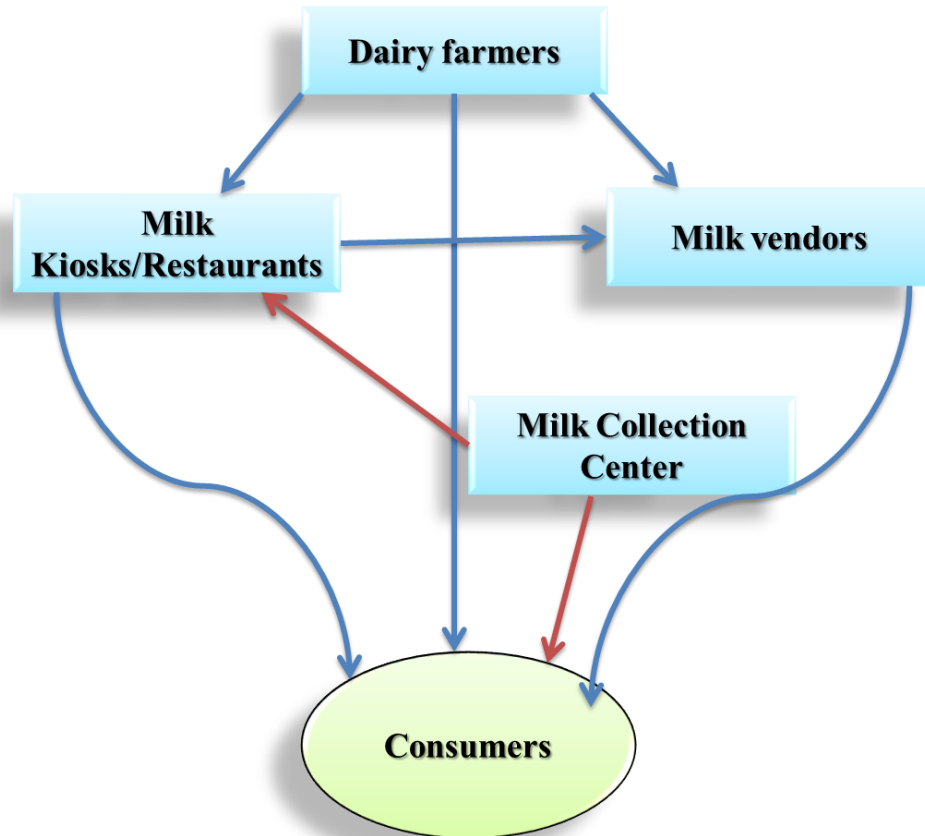
### **3.2.2 Study site selection, Sample size and sampling technique**

For this study a total of two (2) districts Dilla town and Dilla zuria districts were selected randomly. From Dilla Town 3 urban kebeles and three kebeles from Dilla zuria District were selected based on the potential of dairy cattle farming.

Dairy cattle owned house hold data in study districts were 121 house hold was in Dilla Town, 142 house hold was in Dilla Zuria District and 88 respondents was in different milk selling points( restaurant, vendor milk selling shop/kiosks . A list of dairy cattle owned house hold was obtained from Dilla town Agricultural Development Office and Dilla zuria district Livestock and fishery development department (2014 E.C).Number of households sampled in the study Districts was determined by  $N = 0.25/SE^2$ , where N = number of sampled households, SE = standard error (Arsham, 2005).

Considering standard error of 0.05 with 95 % coefficient interval as follows,  $N = 0.25/ (0.0346)^2 = 208$ . Then 120 household dairy farmers and 88 respondents from different milk selling points (restaurant, vendor milk selling shop/kiosks were selected those who are willing to provide raw milk for analysis. in total 208 dairy cattle owner households and milk seller interviewed from different milk selling points restaurant, vendor milk selling kiosks and tea shop (59.26 % total of 351 respondents from dairy farm and different milk selling points) were selected for the study.

The other part included in this study was the representative respondent who engaged on milk selling activities. A purposive sampling technique was done for dairy farmers who sell milk for different consumers, milk selling restaurants and kiosks/shop or different milk selling points. Prior to sampling in Dilla town and Dilla zuria district dairy farmers who sell milk, milk selling restaurants and kiosks/shop or milk selling points were identified. A total of 88 milk selling representative respondents were selected for this study.



**Figure 2. Raw cow milk value chain in the study districts**

### 3.2.3. Sampling and handling of milk samples

All of the samples were collected using proportional random sampling method . Milk samples were collected from different actors such as dairy farms, restaurants /milk selling points (kiosks/shop) along the production, Tea shops and selling line. At farm level, milk samples were obtained directly from farm gate under 30 minute after milking from the collection containers during milking; distribution and storage, and milk sample taken from restaurant/milk selling points (kiosks/shop) immediately as the milk reach the restaurants before boiling. About 50 ml of milk sample was collected and put in a sterile falcon tubes and placed in a cool box with ice packs. Within 30 minutes up to 1 hour samples was transported from the field and stored at - 20°C at Dilla university Animal Science Department Dairy technology laboratory until analysis.

**Table 3. Raw cow milk sample collected for laboratory analysis**

Sources of raw milk	Number of samples
Farm	22
Vendor	22
Restaurant/kiosks	22
Farm shop/tea house	22

## 3.3 Data Source and Collection Methods

In this study two different data sources and methods of collection was employed. Those include survey data and laboratory based data.

### 3.3.1. Survey (Socio-economic) data collection

Structured questionnaires was used which focused on all selected farmers with lactating cattle to obtain information regarding animal management, milk production, milking and milk handling, marketing/selling, transportation and common problems associated with milk production and management. In addition, selected milk selling kiosks/shop, vendors and owners of milk restaurants were interviewed on the quality of milk handle, about predisposing factors which is possible sources of microbial contamination and problems associated with trading milk. The

questionnaires were made of pre-coded closed ended questions with very few open ended questions.

Prior to starting of data collection, the questionnaire was pretested for clarity and time. After testing it was revised and re-written in a better order. The questionnaire was administered through face to face conversation. While administering questionnaires, direct observation on general cleanliness and hygienic practices with regard to milk was also done and noted. Upon finishing of the administration of questionnaires, and raw cow milk samples was collected for laboratory analysis.

### **3.4. Laboratory analysis**

#### **3.4.1. Microbiological Assessment of Raw Cow Milk**

Microbiological quality of the raw milk was performed by spreading aliquots of serially diluted milk aliquot onto agar plates. By this study total viable bacteria count and total coliform counts was conducted and compared with existing microbial count standard. For this purpose different media has been prepared based on the instruction provided by the manufacturers.

#### **3.4.2 Used Media**

##### **3.4.2.1 Plate count agar**

Plate count agar made in India (verna industrial estate) was used. The medium composed of Tryptone 5.0g, Yeast Extract 2.5g, Dextrose 1.0g, Agar 15.0g Final pH  $7.4 \pm 0.2$  at  $25^{\circ}\text{C}$ . The media was prepared according to the manufacturer's instructions where by 23.5 g of the powdered medium was suspended in to 1litre of distilled water. The medium was mix thoroughly to avoid solid particles and boiled to dissolve completely followed by sterilization by autoclaving at  $121^{\circ}\text{C}$  for 15 minutes and cooled to below  $45^{\circ}\text{C}$  and poured onto sterile petri dishes. The plates were inverted and left at room temperature for two hours for the media to solidify then put upside down in the incubator for 24 hours at  $37^{\circ}\text{C}$  to check for sterility and to dry the condensed vapors on the plate cover.

### **3.4.2.2 MacConkey Agar**

MacConkey Agar which was made in India (B/4-6, M.I.D.C,Dindhori, Nashik India) used for this study. The medium was composed of 20g/l Peptone, 10g/l Lactose, 5g/l Bile salts, 5g/l Sodium chloride, 0.075g/l Neutral red, 12g/l Agar and final of pH 7.4 ± 0.2 at 25°C. The medium was prepared according to the manufacturer's instructions where by 49.53g of the powdered medium was suspended into 1litre of distilled water. The medium was mix thoroughly to avoid solid parities and boiled to dissolve completely followed by sterilization by autoclaving at 121°C for 15minutes and cooled to below 45°C up to 50°C up and poured onto sterile Petri dishes. The plates were inverted and left at room temperature for two hours for the media to solidify then put upside down in the incubator for 24 hours at 40°C to check for sterility and to dry the condensed vapors on the plate cover according to the standard method (Anonymous, 2006).

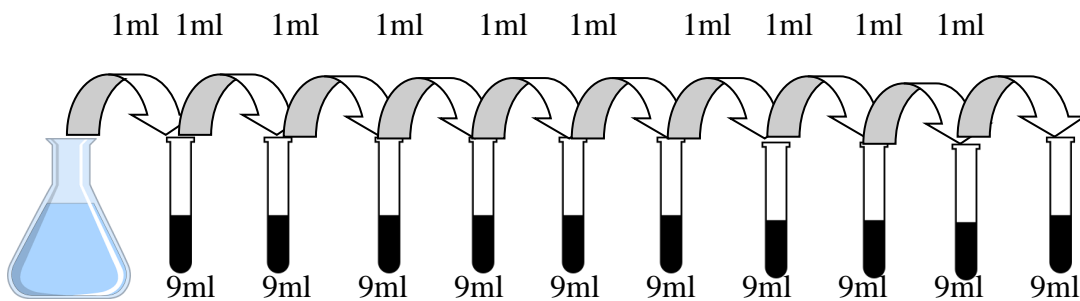
### **3.4.3 Preparation of media and milk samples for laboratory analysis**

All laboratory analysis was done in Dilla University, College of Agriculture and Natural resource, Animal science department of dairy technology laboratory for milk bacteriological quality analysis. For this study milk sample collection materials preparation was the first steps, so sample collection materials was sterilized by autoclave in 121°C for 15 minutes properly and all collected milk sample was reached in 30 minutes p to 1 hour in laboratory and refrigerated in refrigerator rapidly. In this study two laboratory analysis tests was implemented total plate count and coliform count test both tests was implemented to isolate bacterial load in raw milk in study districts. For both laboratory analysis tests to prepare media used agar was plate count agar for total plate count and MacConkey agar for coliform count in raw cow milk. Both agars were prepared for media preparation as their manufacturer instruction. Total plate count (TPC) was determined according to the procedure of ISO4833-2 standard protocol. The protocol detects all viable microorganisms that can grow aerobically on plate count agar at an appropriate incubation condition of 37 °C for 24 hours.

For total plate count, plate count agar prepared to prepare media as followed,28 g of powder agar measured on sensitive balance, dissolved in 1 liter distilled water, mix properly to avoid any

solid parts of powder agar, boiling it on magnetic hot plate by shaking well to remove any residue solid under the bottle, boiled media was sterilized in autoclave by 121 °C for 15 minutes, autoclaved media was cooled on water bath by 45 °C and bring in biological safety cabinet to drop in prepared sterilized petri-dishes and wait media dried and invert petri-dishes, then placed in refrigerator until culturing. During serial preparation all used materials was sterilized, disinfected and burned by flame to control bacterial contamination. Dilution was done by ten folds prepared test tube, then add 9ml distilled water in test tube and take 1 ml from first sample properly mixed 1ml in was transfer to second test tube and repeated this procedure up to last test tube while serial dilution preparation was finished dispersing 0.1ml milk sample on prepared media in petri-dishes and was milk sample was dispersed in all area of petri-dishes by burned loop by flame or sterilized cotton swab by autoclave and finally, all prepared plate was incubated in incubator by 37 °C for 24 hours. After 24 hours cultured milk bacterial colony was counted by colony counter and recoded data was properly. And all counted plate was again sterilized by autoclave by 121°C for 15 minutes to kill bacteria to control bacterial contamination.

For total viable coliform count laboratory analysis used agar was Macconkey agar all procedures was implemented was similar with plate count agar but the only difference was incubation degree Celsius plate count agar was incubated in incubator by 37 °C for 24 hours and MacConkey agar was incubated in incubator in incubator by 40 °C for 24 hours and all counted plate was again sterilized by autoclave by 121°C for 15 minutes to kill bacteria to control bacterial contamination. The procedure was repeated for further serial dilutions up to 10<sup>10</sup> dilution. As shown in Fig.3.



**Figure 3. Serial dilution procedure for culturing**

### **3.4.4.1. Microbiological tests**

For evaluation of milk quality, microbial contamination was assessed through estimating total plate count (TPC), and coliform count (CC) in milk where produced and marketed in study districts to isolate microbial load in raw milk.

#### **3.4.4.1.1. Total viable Bacterial Count (TVBC)**

For aerobic plate count, 1 ml of each dilution of a sample was transferred to separate sterile Petri dishes and 15 ml of standard plate count agar medium cooled to 45 °C was added to each plate followed by immediate mixing of the sample dilutions and agar medium by pour plate technique (BAM, 2001). The plates were incubated at 37 °C for 24 h immediately after solidification of agar.

#### **3.4.4.1.2. Total Coliform Count (TCC)**

For counting of coliform, 1 ml of each dilution of a sample was mixed with crystal violet neutral red bile lactose agar using pour plate technique. The plates were incubated at 40 °C according to the standard method (Anonymous, 2006).

### **3.5. Statistical analysis**

All data will be entered, cleaned and managed using MS Excel© worksheet. Preliminary data analysis like homogeneity test, normality test and screening of outliers will be employed before conducting the main data analysis. SPSS statistical software (SPSS for windows, release 20.0, 2011) will be used to analyze the data. Index will be calculated to provide ranking for purpose of assessing milk handling practices, and milk bacteriological quality load isolation of raw milk in study areas. Milk bacteriological quality load isolation of milk will be analyzed using Statistical Analysis System (SAS, version 9.4, release 2013). Experimental study will be analyzed using the Generalized Linear Model (GLM) procedures of the Statistical Analysis System (SAS, release 9.1, 2003). Statistical significance will be established at 95% confidence and critical p value of 0.05.

The following model was used to analyse the microbiological quality of milk:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + \epsilon_{ijk}$$

where  $\mu$  is the overall mean;  $\alpha_i$  is the effect  $i^{\text{th}}$  districts (Districts,  $i = 1, 2, 3$ );  $\beta_j$  is the  $j^{\text{th}}$  effect of milk sources ( $j = 1, 2$ );  $\alpha\beta_{ij}$  is the  $ij^{\text{th}}$  interaction effect of milk sources and districts; and  $\epsilon_{ijk}$  is random error.

## 4. Result and discussion

### 4.1. Characteristics and Distribution of Respondents

Demographic characteristics of the selected household in Dilla town and Dilla zuria district is presented in (table 4). A total of (208) respondents from dairy farmer and different milk selling points was interviewed in both study areas. According to the survey result among the interviewed respondents interviewed (76.7%) households were male and (23.3%) was female in Dilla town and (81.7%) respondents was male and 11(18.3%) female in Dilla zuria district. This finding is similar as reported in Ade Berga and Ejerie districts of West Shoa Oromia, Ethiopia (Saba Haile, 2015).

Regarding their educational level of interviewed respondents in town (36.7%) was completed primary school where as it was (18.3%) for Dilla Zuria district. However, around (61.7%) of the respondents were secondary school and above completed in Dilla town whereas only (41.7%) of the respondents in Dilla zuria district. As it is well known educational background has immense impact on the productivity of animal and handling of the produced products (Oduro-ofori et al. 2014).

**Table 4. Demographic characteristics of the respondents**

Demographic Information	Category	Number (%) of the respondent		P – Value
		Dilla Town	DillaZuria District	
Sex	Female	14 (23.3)	11 (18.3)	0.500
	Male	46 (76.7)	49 (81.7)	
Education	Primary school	22 (36.7 )	33 (55)	0.078
	Secondary school	23 (38.3)	20 (33.3)	
	Vocational/college	10 (16.7)	5 (8.3)	
	University	4 (6.7)	0 (0)	
	Illiterate	1(1.7)	2 (3.3)	

#### **4.2. Dairy production system, breed type and purpose of milk production**

Dairy Animal production system, trend of production and breeds of dairy cattle in the study area are shown in (table 5). As per the results of the interview there were three farming systems namely free grazing /Extensive dairy farming system, semi-intensive dairy farming system (SIDFS) and mixed dairy farming system observed in the study areas time of this study.

Majority of respondents (78.3%) respondents was manage their dairy cattle by free grazing/ extensive dairy farming system whereas (15 %) respondents was manage their dairy cattle by semi-intensive dairy farming system. The remaining (6.7%) respondents was manage their dairy cattle by mixed dairy farming system in Dilla Zuria District and (21.7%) respondents was manage their dairy cattle by free gazing/ extensive dairy farming system, were most (75%) respondents in Dilla town was manage their dairy cattle by semi- intensive dairy farming system and the rest (3.3%) respondents was manage their dairy cattle by mixed dairy farming system (Table 5).

The results, as seen in (Table 5), indicate that the trend of dairy cattle production and relative dairy cattle number was significantly ( $P < 0.05$ ) different among the two districts. The dairy cattle production is showing decreasing in Dilla town (81.7%) based on the response obtained from interviewed respondents. Where as in Dilla Zuria district the trend was increasing as indicated by 60% of the respondents' information.. Here the reason for difference was Dilla zuriya District supported Livestock and fishery sector development project (LFSDP) Data source Dilla zuria district livestock and fishery development department office 2014 E.C). in Dilla zuriya District Livestock and fishery sector development project (LFSDP) was supply dairy cattle, feed, animals vaccine and drugs as cooperative level organized dairy cattle farmers.

The type of dairy cattle breed in the study area was significantly different ( $P < 0.05$ ) between the two districts. In study areas, respondents owned (65%) cross breed in Dilla town and (35%) respondents was owned local breed in Dilla town. However the value in Dilla Zuria districts showed that the reverse which was (33.3%) the respondent household owned cross breeds and (66.7%) respondents was owned local breed. the result showed that interviewed respondents response during survey.

As indicated in result obtained from the interviewed households; the dairy farmers were produce milk for selling, for home consumption and both. Further more, the result showed that there was significant difference ( $P < 0.05$ ) among the districts in terms of the purpose of milk production. It was observed in this study that most of respondents produce the milk for selling was (51.7%,) while (28.3%) respondents produce the milk for home consumption in Dilla town and (65%) produced milk was consumed in respondents home and (28.3%) produced milk for selling purposes and (6.7%) produced milk was for both purposes. In Comparison two study areas Dilla town and Dilla zuria District, most produced milk in Dilla town (51.7%) was respondents produced milk for selling, (28.3%) was produced milk in Dilla Zuria District for selling purposes, and also (65%) produced milk in Dilla zuria District was for home consumption and the remaining (25) milk produced in Dilla town was for home consumption (Table5).

### **4.3. Milk production level and lactation length in study district**

The daily average milk yield of local dairy breeds was significantly different ( $p < 0.05$ ) between districts where as the average yield was not significantly different among districts. This is may be due to dairy cattle management system and feeding system difference in the two districts. In Dilla town most respondents was managed their local and cross dairy cattle breed at home and by feeding grasses and additionally supplementary feed such as agro industrial by-products. Whereas, Dilla zuria district dairy cattle owned respondents were managed their dairy cattle in a free grazing system and only feed grass and agricultural by-products. As indicated in (table 5) the average of daily milk yield by local dairy cattle breed was (2.2L/day) and (1.7 L/day) in Dilla town and Dilla zuria district, respectively. The average of daily milk yield by cross dairy cattle breed was (9.3 L/day) and (8.0±1.137L/day) in Dilla town and Dilla zuria districts, respectively. The finding of the present study result was lower than from the reported result that the average daily milk yield of the indigenous local dairy cattle in central zone of Tigray was 2.56 liters/day. by Gebre, Kidan and Tesfay (2010). However, the average daily milk yield for local dairy breed of the present study result was greater than 1.4L/day from local dairy cattle in Ade Berga and Ejerie districts of West Shoa Oromia, Ethiopia (Saba Haile, 2015).

The current result of daily produced milk yield from cross dairy cattle was lower than that reported result 11 L/day in Ade Berga and Ejerie districts of West Shoa Oromia, Ethiopia (Saba Haile, 2015) and (Getu et al, 2009) from cross dairy cattle breed.

The lactation length of both local and cross breed dairy cattle was not significantly different among districts (Table 5). The average lactation length for local breed was 6.95 and 7.02 months for Dilla town and Dilla zuria districts, respectively where as for cross breeds was 8.98 and 8.92 months for Dilla town and Dilla zuria districts, respectively. The findings of the present study were lower than that reported result by Gebre, Kidanand Tesfay (2010).

Table 5. Dairy Animal production system, Trend of production, Breeds of dairy cattle, milk production level and lactation length in the study area

Variable	Category	Number (%) of respondent		P-Value
		Dilla Town	DillaZuria District	
Production system	Free grazing/Extensive	<b>13 (21.7)</b>	<b>47(78.3)</b>	0.000
	Semi intensive farming	45 (75)	9 (15 )	
	Mixed	2 (3.3)	4 (6.7)	
Dairy production trends	Increasing	10 (16.7)	36 (60)	0.000
	Decreasing	49 (81.7)	23 (38.3)	
	Unchanged	1 (1.7)	1 (1.7)	
Purpose of milk production	For home consumption	17(28.3)	39(65)	0.000
	For selling	31(51.7)	17(28.3)	
	For both	12 (20)	4 (6.7)	
Owned Breeds of dairy cattle	Owned local breed	21(35)	40(66.7)	0.001
	Owned Cross breed	39 (65)	20 (33.7)	
Milk production (Lt/day)*	Local breeds	2.2±0.421	1.7±0.356	0.000
	Cross breeds	9.3±2.525	8.0±1.137	0.103
Lactation length(in Months)*	Local breeds	6.95±0.524	7.02±0.325	0.115
	Cross breeds	8.98±0.612	8.92±0.289	

\*The value indicated in Mean ± Standard deviation

#### 4.4. Dairy cattle management practices

Dairy cattle handling and management practices in the study area are presented in (table 6). The use of separate housing for dairy animal was significantly different ( $P < 0.05$ ) among the districts. Most of the interviewed respondents in study areas were used separate house for their dairy cows. The result of the interview indicated that (100% ) of the farmer in Dilla town and (85%) of the farmer in Dilla zuria district were used separate house for the dairy animal. However, (15%)

of respondents in Dilla Zuria district family member were lives together in the same house with dairy cows. This could probably cause the transmission of disease from animal to human beings and also from human to animal (Virlogeux et al. 2018) The research findings by Saba, (2015) reported similar result (100%) of the respondents were used housed type barn in Ade Berga and Ejerie district of West Shoa, Ethiopia. Where as, this study result was opposed reported by Yonad et al., (2009) were most interviewed house hold was used fenced barn type for overnight cattle holding in Borena zone of southern, Ethiopia.

The present survey result showed that the type of floor material for dairy cattle house used by the farmers were significantly different ( $P < 0.05$ ) between the two districts. Around (48.3%) the dairy cattle producing farmers in Dilla town construct the floor for their dairy cow's house by using concrete/cement. However, most (38.3%) of the dairy cattle producing farmers in Dilla zuria district was constructed the farm house floor by using mud/ earth. This result was agreed with report by Fufa et al., (2019) by the study conducted in Akaky, Bole, Nefassilk, Lafto and Yeka sub city of Addis Ababa, Ethiopia where by 54.3% dairy cattle house floor was constructed by concrete/cement.

According to the result obtained from the survey of both districts there was no significant difference in the use of bedding material in the dairy farm house. According to the result obtained in the study areas (83.3%) and (78.3%) of the respondents were not used bedding material for their dairy animals in Dilla town and Dilla zuria districts, respectively. Whereas, (16.7%) and (21.7%) of the respondent were used bedding material in the dairy farm for Dilla town and Dilla zuria districts, respectively. The dairy farmers who use bedding material for their animal, the common bedding materials according the response obtained from interviewed households (20%) in Dilla town and (13.3%) in Dilla Zuria districts was grass or cereal straw. And only (3.3%) and (1.7%) in Dilla town and Dilla Zuria districts respectively were used saw dust as bedding materials.

The waters sources used for dairy cattle was significantly different ( $P < 0.05$ ) between the two districts. The main source of water for drinking by dairy cattle and sanitary activities associated with dairy cattle production was river or stream water (30% and 75%) in Dilla town and Dilla Zuria districts, respectively. Regarding water availability categories in study areas (83.3%) and

(58.3%) respondents said water availability was sufficient in Dilla town and Dilla Zuria respectively (Table 6).

**Table 6. Dairy cattle housing and feeding system as reported by farmer respondents**

Variable	Category	Number (%) of respondent		P-Value
		Dilla Town	Dilla Zuria District	
Types of dairy animal house	Separate house	60 (100)	51 (85)	0.002
	In the living house with human	0(0)	9 (15)	
Animal house wall material	Thatched	14 (23.3)	3 (5)	0.000
	Block house	15 (25)	1(1.7)	
Animal house floor material	Trees wood	31(51.7)	56 (93.3)	0.000
	Concrete/cement	29 (48.3)	2 (3.3)	
	Stones	7 (11.7)	5 (8.3)	
	Mud/Earthen	17 (28.3)	23 (38.3)	
Use of bedding material	Trees wood	7 (11.7)	30 (50)	0.487
	Use bedding	10 (16.7)	13(21.7)	
Type of bedding material	No bedding	50 (83.3)	47 (78.3)	0.542
	Grass or cereal straw	8 (13.3)	12 (20)	
Drinking water source	Saw dust	2 (3.3)	1(1.7)	0.000
	Rivers or streams	18 (30)	45 (75)	
	Dams/pond and bore hole	5 (8.3)	10 (16.7)	
	Spring and river/rainy water	21 (35)	4 (6.7)	
Water availability	Only Spring water	16 (26.7)	1 (1.7)	0.010
	Sufficient	50 (83.3)	35 (58.3)	
	Insufficient	2 (3.3)	7 (11.7)	
	Intermediate	8 (13.3)	18 (30)	

#### 4.5. Hygiene practices in milk production

The hygienic practice in milk production in Dilla town and Dilla Zuria district is presented in (Table 7). Among the districts there was strong significant ( $P < 0.05$ ) different in cleaning dairy cattle's barn. In this study about (40% and 5%) respondents were clean their dairy cattle barn floor in Dilla town and Dilla Zuria districts, respectively. However, majority of the interviewed farmers (60%) and (95%) were not clean dairy cattle barn floor in Dilla town and Dilla zuria districts, respectively. It is clear that keeping the sanitary condition of milking area is important prerequisite for quality milk production (Zelalem, 2010).

For those farmers who clean the barn floor according the response obtained from representative households the majority (60% and 95%) of the respondents were only remove feces from the farm in Dilla town and Dilla Zuria districts, respectively. The frequency of cleaning the barn floor in Dilla town about (23.3%) of the farmer was clean once a day. This might be the cause of variation in milk quality due to udder and teat contamination with unclean barn floor in line this study current finding about (40%) of the respondents in Dilla town related results was wash/clean barn floor and but, also opposed reported in current finding results in Dilla Zuria District with previously reported result Cheha District Gurage Zone Southern, Ethiopia (Kibebewet al.,2020).

Most respondents in Dilla town (93.3%) was milked their dairy cows twice a day which is in morning hours and in afternoon hours rest respondents (6.7%) were milked their cows only (once a day) or only morning hours. Whereas, (43.3%) respondents in Dilla zuria district were milked once a day in morning hours and (56.7%) respondents was milked twice a day or (milking in morning hours and afternoon hours). This study finding result in Dilla town was similar with previously reported result in Cheha district of Gurage Zone Southern, Ethiopia. (Kibebew et al., 2020), and Shashemene town (Teshome, 2013), was reported that all of the respondents were milked their cows two times a day and not similar with Dilla Zuria District (Table 7).Based on the results of the present survey study( 80% and 78.3%) of the respondents in Dilla town and Dilla Zuria districts, respectively were didn't restrain their dairy cows during milking.

Milking person can be an important source for milk contamination. Therefore, keeping personal hygiene and milking person should be in good health condition during milking operation zelalm (2010). As obtained result from survey in both study districts according to hand washing before the milking there was no significant difference. Most of the interviewed respondents (80%) was washed their hands before milking, while the rest (20%) was did not wash their hands before milking in Dilla town and (60%) of respondents was wash hand before milking and (40%) respondents was did not wash hand before milking in Dilla zuria district . From respondents washed his hand before milking (66.7%) was practiced hand washing by only by water and only a few (11.3%) was practiced hand washing by using water with soap (Table 7).

Cleaning of the udder before milking is one of the most important hygienic practices required to ensure quality milk production. This is important since udder of cows could have direct contact with the ground, feces urine, dung and feed refusal (Zelalem, 2010).

The use of soap and quality water for cleaning could be expected to remove milk remains, and microorganisms that affect the microbial quality of milk

As observed in this survey interviewed respondents (55%) of dairy farmers was washed /cleaned their cows udder before milking and (45%) respondents were was did not washed /cleaned their dairy cows udder before milking in Dilla town and (33.3%) respondents was washed or cleaned their dairy cow udder before milking (66.7%) respondents did not wash/clean their cows udder before milking in Dilla zuria district.

According to the result obtained from the survey of both districts there was no significant difference in the practices of cows' udder washing before milking. Finding result in this present study during study time were was less than reported result (Haile, et al. 2012) reported result that (82.5%) small holder dairy farmers was owned households in Hawassa city practiced udder washing before milking, and also this finding result was agreed with reported result that around (72-79%) of households clean udder before milking (Zelalem, and Bernard, 2006). And as opposed reported result all respondents was did not clean udder before milking in Cheha District Gurage Zone Southern, Ethiopia (Kibebew et al., 2020).

The present survey finding showed that the type of equipment for milking and milk handling used by the dairy cattle producing farmers were significantly different ( $P < 0.05$ ) among the districts. Around (55%) and (86.7%) dairy cattle producing farmers were used plastic pail in Dilla town and Dilla Zuria district respectively. Very few (6.7%) farmers in Dilla town were used stainless steel for milk handling (table 7).

Regarding to cleaning condition of milking equipment there was significant difference ( $P < 0.05$ ) among the respondents of the two districts. From interviewed respondents (51.7%) was practicing only wash milking equipment and milk handling equipment and (48.3%) respondents were used both wash and smoke equipment in Dilla Town. On the other hand around (71.7%) respondents practice only wash equipment and (23.3) respondents were used both washing and smoke equipment in Dilla Zuria District. For washing equipment most dairy cattle producing farmers in both study districts were used river and stream water and only a few respondents were used tape water in study districts (Table 7).

**Table 7. Hygienic activities related to milk production in the selected farms' of representative household**

Variable	Category	Number (%) of respondent		P-Value	
		Dilla Town	DillaZuria District		
Cleaning barn floor	Clean the floor	24(40)	3(5)	0.000	
Frequency of cleaning the floor	Once a day	14(23.3)	2(3.3)	0.000	
	Twice a day	4(6.7)	0(0)		
	Once in a week	6 (10)	1(1.7)		
Milking time	Only removal of feces	36(60)	57(95)	0.000	
	Only in the morning	4 (6.7)	2(43.3)		
	In the morning and afternoon	56 (93.3)	34(56.7)		
Milking practices	Tie cow during milking	12 (20)	13 (21.7)	0.822	
	Wash hand before milking	47 (78.3)	37 (61.7)		0.046
	Wash udder during milking	33(55)	20 (33.3)		0.017
	Do not wash udder during milking	27 (45)	40 (66.7)		
	Use towel to dry teat	19 (31.7)	6 (10)		0.003
Do not use towel to dry teat	41 (68.3)	54 (90)			
How wash hand before milking	Only by water	40 (66.7)	34(56.7)	0.088	
	By water and with soap	7 (11.7)	3 (5)		
How wash udder	Using cold water	13 (21.7)	14 (23.3)	0.016	
	Using warm and clean water before	1 (1.7)	0 (0)		

	milking			
	Remove feces from teat	27 (45)	40 (66.7)	
	Use collective towel to clean udder/teats	19 (31.7)	6 (10)	
Milking and milk storage equipment/container	Plastic pail	33 (55%)	54 (86.7%)	0.000
	Stainless steel	4 (6.7%)	0 (0%)	
	Plastic pail and mazz can	12 (20%)	8 (13.3%)	
	Plastic pail and stainless steel	11(18.3%)	0( 0%)	
	Only Wash milking and storing equipment	31(51.7%)	43(71.7)	0.006
	Wash and smoking milking and storing equipment	29(48.3%)	14(23.3)	

In the present study, even if there was no any statistically significant difference among the districts, majority of the interviewed respondents (58.3%) and (63.3%) were reported that there were no observed udder health problems on dairy cows in Dilla town and Dilla zuria districts, respectively (Table 8). The previous finding indicated that around (60%) farmers in Cheha District Gurage Zone Southern , Ethiopia do not observed udder health problems (Kibebew et al.,2020) which comparable with the present findings. In contrast higher proportion respondents (97%) experienced udder health problem among the herds in Nuer Zone Gambella Region, Ethiopia (Yien, 2014).

According to the representative households response (30%) and (21.7%) produced milk from infected udder and treatment with antibiotic was discards in Dilla town and Dilla zuria district, respectively. hose respondents were done the same until the end of drug with draw period as suggested by animal health assistant and veterinarian in the areas (Table 8).

**Table 8. Teat and udder health problem in the selected households' farm**

Variable	Category	Number (%) of respondent		P-Value
		Dilla Town	DillaZuria District	
Occurrence of udder and teat health	Observed heath problem	25 (41.7)	22 (36.7)	0.575
	Do not observed udder healthy problem	35 (58.3)	38 (63.3)	
The fate of the	Discard	18 (30)	13 (21.7)	0.522

milk after treatment	Give to calves	3 (5)	4 (6.7)
	Give to cats or dogs	4 (6.7)	3 (5)
	Mix milk with from healthy cow and sell	0 (0)	2 (3.3)

#### 4.6. Major Milk Quality Related Constraints

The constraint which affects milk quality in the study areas is presented in (Table 9) below. According to the response obtained from representative household shortage of clean water was the first most critical constraint of milk quality related issues in Dilla town where (76.7%) of the respondent choose it as first constraints. Whereas in Dilla Zuria districts lack of milk handling equipment and cooling facility (85%) and lack of awareness in hygienic milk handling (68.3%) were the first important constraints which affects milk quality.

**Table 9. Constraints which deteriorate milk quality in the study areas**

Variable	Category	Number (%) of respondent		P-Value
		Dilla Town	DillaZuria District	
Major milk quality related constraints	Shortage of clean water	46 (76.7) <sup>1st</sup>	38(63.3)	0.020
	Limited awareness on hygienic milk handling	37 (61.7)	41 (68.3) <sup>1st</sup>	0.000
	Lack of quality milk handling equipment and cooling facility	40 (66.7)	51 (85) <sup>1st</sup>	0.05

Milk selling points and type of milk sold in the Dilla town and Dilla Zuria districts is presented in (Table10). According to the survey results milk selling points in both study districts was significance difference ( $P < 0.05$ ). As per the findings of the present study around (64.6%) of the representative households responded that large amount of milk produced in the study areas was sold at the point of Farm gate. In Dilla town (25%) of the farmer was sold the produced milk to restaurant/hotels. However, in Dilla Zuria districts most (87.5%) of the respondent reported that most the produced milk was sold at farm gate for different buyers. Based on the interview results

most the representative households (54.2%) and (87.5%) sold raw cow milk in Dilla town and Dilla zuria district, respectively.

Table 10. Milk selling points and type of milk sold in the Dilla town and Dilla Zuria districts

Selling points and milk type	Categories	Districts			P – Value
		Dilla town	Dilla Zuria	Total	
Milk selling center n (%)	Restaurant/ Hotels	6 (25%)	0	6 (12.5%)	0.000
	Kiosks/Shop	7 (29.2%)	0	7 (14.6%)	
	Farm gate	10 (41.7%)	21 (87.5%)	31(64.6%)	
	Tea house	1 (4.2%)	3 (12.5)	4(8.3%)	
Sold milk type	Raw milk	13 (54.2%)	21 (87.5%)	34 (70.8%)	0.02
	Boiled milk	1 (4.2%)	2 (8.3%)	3 (6.3%)	
	Raw and boiled milk	5 (20.8%)	1(4.2%)	6 (12.5%)	
	Raw, boiled and fermented milk	5 (20.8)	0	5 (10.4%)	

The results of the present study was showed that (54.2%) respondents in Dilla town and (83.3%) respondents in Dilla zuria district delivered the produced milk for customer on farm gate /farm shop level. And (37.5%) respondents in Dilla town was transport the produced milk by using own vesicle to distribute the milk for customer.

### 11. Means of transporting milk

Districts	Farmers delivering the milk	Using own vesicle	Going to farmers place (on foot)	P – Value
Dilla town	13 (54.2%)	9 (37.5%)	2 (8.3%)	0.051
Dilla Zuria	20 (83.3%)	2 (8.3%)	2 (8.3%)	
Total	33 (68.8%)	11 (22.9%)	4 (8.3%)	

As this study result in both study districts (33.3%) and (47.9%) respondents in Dilla town and Dilla Zuria district respectively used milk containers was plastic pail and only in Dilla town

(41.7%) respondents was used aluminum pail container. According to used Aluminum pail milk container was significance difference between Dilla town and Dilla Zuria district.

**Table 12. Container used for collection, transportation and selling raw milk in Dilla town and Dilla Zuria districts**

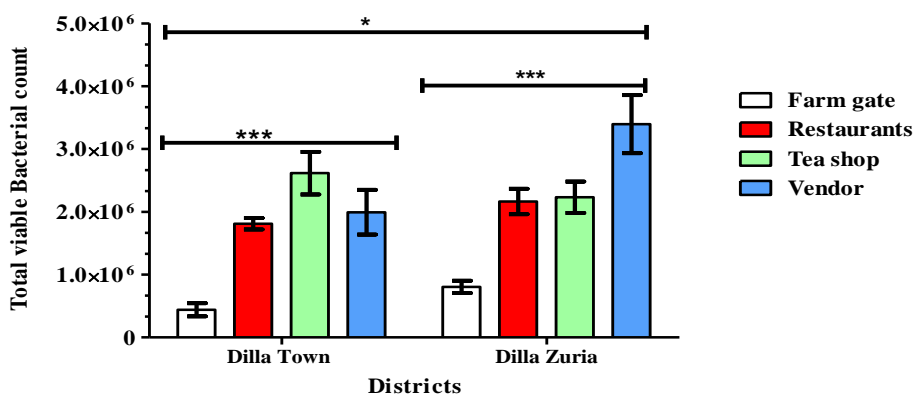
Containers used	Categories	Districts			P – Value
		Dilla town	Dilla Zuria	Total	
Milk Containers	Aluminum	10 (41.7%)	0	10 (20.8%)	0.000
	Plastic pail	8 (33.3%)	15 (62.5%)	23 (47.9%)	
	Mazz can (plastic)	2 (8.3%)	9 (37.5%)	11(22.9%)	
	Plastic and Aluminum containers	4 (16.7%)	0	4 (8.3%)	
Equipment to fetching milk	A cup with a handle and stoppers	6 (25%)	1 (4.2%)	7 (14.6%)	0.011
	A cup with only a handle	14 (58.3%)	10 (41.7%)	24 (50%)	
	A cup without handle and stoppers	4 (16.7%)	13 (54.2%)	17 (35.4%)	
Types of equipment used to delivering milk	A cup with a handle and stoppers	7 (29.2%)	1 (4.2%)	8 (16.7%)	0.008
	A cup with only handle	7 (29.2%)	2 (8.3%)	9 (18.8%)	
	A cup without handle and stoppers	1 (4.2%)	5 (20.8%)	6 (12.5%)	
	Bottles	9 (37.2%)	16 (66.7%)	25 (52.1%)	

#### 4.7. Total Viable Bacterial Colony count (TVBC) Result

The results of total viable bacterial counts for milk from different sources of different districts are summarized in Figure 4. The present study showed that the mean total viable bacteria counts were significantly different ( $P < 0.05$ ) among different districts and ( $P < 0.05$ ) different milk sources. The results showed a less count of mean TVBC for the milk sample taken from farm gate in both districts. The higher count was obtained from the milk sample obtained from vendors of Dilla zuria districts. The findings of the present study is much lower than from the report of Alganesh (2016) which indicated that milk sample collected from small holder that has mean total aerobic bacteria was 8.2 log<sub>10</sub> Cfu/ml. Similarly, Fufa et al. (2019),Tola (2002),and Tassew and Seifu (2011) also found that the high total bacterial counts for milk sample collected from different part of the country and different milk sources such as dairy farms, vendors and

restaurants were 8.55, 8.99, and 3.12 log<sup>10</sup>Cfu/ml, respectively. However, there was significance milk bacterial count result difference among milk sampling from different routes.

This high level of contamination of milk might be due to initial contamination originating from the udder surface, quality of cleaning water, milking utensils. Therefore, total bacterial count is a good indicator for monitoring the sanitary conditions practiced during production and handling of raw milk (Chambers, 2002). ( $5.0 \times 10^5$  CFU/ml) for total viable bacterial count and Used formula to calculate total viable bacterial colony was ( Bryan,et,al , 2013).



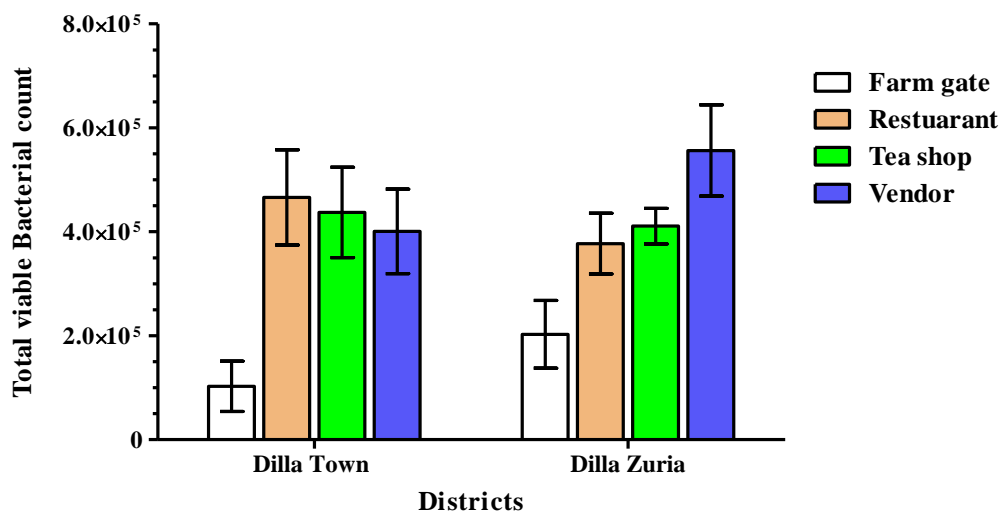
**Figure 4. The total viable bacterial colony counts of different milk sources of the two districts**

The study also showed that along the milk selling line (value chain) the level total viable bacterial count increase except in the case of Dilla town for the milk sample obtained from vendor has lower load as compared with Dilla Zuria districts.

#### 4.8. Viable total E. coli bacteria counts result

The results of total viable *coli* form counts for milk from different sources of different districts are summarized in Figure 5. The present study also showed that the mean total viable *coli* form counts were significantly different ( $P < 0.05$ ) among different districts and ( $P < 0.05$ ) different milk sources. The results showed least bacterial count for the milk sample collected from farm gate in both districts. The higher count was obtained from the milk sample obtained from vendors of Dilla zuria districts. The findings of the present study is nearly similar with mean *coli* form count by Fufa et al., (2019) (2.2, 5.9 and 5.7 log<sub>10</sub>Cfu/ml) for the study conducted in different sub city of Addis Ababa, Ethiopia report that for milk sample collected from dairy

farms, vendors and restaurants. The result of current study expressed that greater than reported coli form count ( $4.84 \log_{10} \text{Cfu/ml}$ ) in Ade Berga and Ejerie districts of West Shoa Oromia, Ethiopia (Saba Haile, 2015). Abebe et al, (2012) ( $4.03 \log_{10} \text{Cfu/ml}$ ) southern Ethiopia and Zelalem (2010) ( $4.58 \log_{10} \text{Cfu/ml}$ ) in central high lands of Ethiopia. the present study result was larger than the acceptable limit of total viable bacterial count result of East Africa community (EAC) standard result ( $5.0 \times 10^5 \text{ CFU /ml}$ ).



**Figure 5. Viable total E. coli bacteria counts**

Coliforms are other bacterial group which affects milk quality which is associated with the level of hygiene during and subsequent handling (Tollessa, 2016). According to, the ESA (2009) good quality milk should not contain a total coliform bacterial count of more than 0-1000 Cfu/ml. However, different studies showed that this coliform is beyond the standard. For instance, Tsedey and Asrat (2015) reported the coliform count for the raw milk collected from producers was  $4.00 \log_{10} \text{Cfu/ml}$  and  $4.29 \log_{10} \text{Cfu/ml}$  for producers and consumers, respectively.

The higher coli form count result observed in the current study it might contributed to the initial contamination of the milk through the milking person, milk containers and milking environment. Even at high hygienic condition there is presence in raw milk tolerated. However, the present

study result was larger than the acceptable limit of total viable *coli* form count result of East Africa community (EAC) standard result ( $2.0 \times 10^5$  CFU/ml).

Researchers suggested that the higher total viable coliform counts may be due to contamination of milk during milking either from poor milking person hygiene or fecal contamination from the udder and lower abdominal parts of the body of cows mainly from bedding materials as a result microorganisms gain access into milk during milking.

## **5. Conclusion and Recommendation**

The study was carried out in Dilla town and Dilla zuria District of Gedeo zone Southern, Ethiopia to assess raw cow milk quality. The survey works were involved interviews of dairy farmer and restaurant, vendor and tea shop level milk seller surveys parts which includes; dairy cattle farming system, barn type, types of used floor materials, milk containers cleaning practices of milk containers, floor and cow udder, hygienic condition of milking person during milk production, source of water used for cleaning purposes and related constraints in both study districts of raw cow milk quality. The further parts of the study involved bacteriological quality and chemical composition of raw cow milk and the milk sample was collected from farm gate, restaurant, vendor and tea shop for laboratory analysis. The major related milk quality constraints in both study districts was shortage of clean water in Dilla town, lack of milk handling equipment and cooling facility in Dilla zuria district, and lack of awareness in hygienic milk handling in both study districts.

The level of milk bacterial contamination in this study was high indicating the presence of significant difference in both study districts were was the result obtained from the total viable bacterial count and total viable coli form count as laboratory analyzed result. The milk sample collected from restaurant, vendor and tea shop was significantly associated with higher level of milk bacterial contamination compared to milk sample collected from farm gate. Therefore, considering this study finding, the following recommendation are made milk seller at restaurant, vendor and tea shop should apply good hygienic and sanitary practices during handling of milk use appropriate, clean containers and very clean milk selling environment during transporting, storing and selling the milk. Both study districts livestock sector should be follow quality and

sanitary condition at restaurant, vendor and tea shop level to control milk bacterial contamination to supply quality milk for consumer. Further research is required to asses contamination of milk by other important pathogens particularly *salmonellosis*, species, *staphylococcus aureus*, *campylo-bacteriosis*, tuberculosis, brucellosis.

## **6. Ethical consideration**

Research permission letters was obtained from Dilla University Agriculture and Natural Resource collage, Animal Production and Range Science Department.

Verbal consent was obtained from each respondent after explaining the purpose and importance of the study prior to commencement of interviews and sampling. Participation in study was on voluntary basis. All the information was collected from the participants and laboratory results obtained after milk samples analysis was kipped under the custody of the researcher as confidential.

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## Appendix

ANNEX 1. ANOVA Table 1

Source of variation	SS	DF	MS	P value
Interaction	8.90852E+12	3	2.96951E+12	P=0.0156
Districts	4.14557E+12	1	4.14557E+12	P=0.0263
Source of milk	5.59441E+13	3	1.8648E+13	P<0.0001
Residual	6.47206E+13	80	8.09007E+11	

### Appendices

#### Part 1; Questionnaire for Interview on

**“Dairy Cattle production system, milk production, milk handling practices, and estimation of milk quality and hygienic conditions of raw whole milk in Dilla town And Dilla zuria District of Gedeo Zone”**

Dear respondent:

This questionnaire is used to get background information concerning on **Milk production, Hygienic practices** and **microbial quality** of raw cow’s milk. The information will be used for research purpose at Dilla University only. We appreciate your kind cooperation in completing this questionnaire.

#### **General information**

1. Date of Survey (DD/MM/YYYY) : -----/----- /-----
2. Enumerator Name : -----
3. Head of Household Name : -----
4. Site/State/Region/District Name : ----- Site Code: -----
5. Village/Kebele Name : ----- Village Code: -----
6. Name of survey Respondent : -----

**Basic Household Information**

1. Respondent’s position in the household (with respect to the head):

- Husband
- Wife
- Daughter
- Other, please specify.....
- Son
- Relative living in a house
- Farm labourer

2. Respondent’s educational background:

- Primary school
- Secondary school
- Other, please specify.....
- Vocational school
- College / University

**Household socio-economic background**

1. Size of the household.....people

2. Household composition by sex, role in milk production and handling; and age

Male (tick)	Female (tick)	Position in the household (with respect to milk production and handling)	Age (year)

**Dairy cattle production information**

- 1. How many cows do you keep? -----
- 2. Do you keep young and old animals together? Yes or No

3. Type of dairy farming that practiced by the respondent

- Free grazing//Extensive dairy farming
- Semi-Intensive dairy farming
- mixed
- others

4. First source of Dairy Cattle to start Dairy Cattle Production

- Home breeds  Cross breed
- Other source; Specify it \_\_\_\_\_

5. What are the main aims of dairy cattle production for you and others live in your locality?

- milk for home consumption  others
- Milk for selling
- milk to produce other products

6. Daily Produced milk yield from local breed in your farm-----

7. Daily Produced milk yield from Cross breed in your farm-----

8. Which one is more important in terms of production of Cattle products milk)?

- Indigenous  Exotic

9. Production inputs the dairy farmer uses and their sources for dairy Cattle production

Inputs	Sources	Rank of sources
Feed resources	1. natural pasture 2. grazing on own pasture 2. improved forage 4. agricultural by products 5. feed on aftermath 6. agro-industrial by products	

	7. purchased from the market	
vaccine and treatment	<ol style="list-style-type: none"> <li>1. Gov.t donation</li> <li>2. purchase from gov.t</li> <li>3. Purchase from private clinic</li> <li>4. From research center</li> <li>5. Use traditional treatment</li> </ol>	
Labor for dairy cattle Production	<ol style="list-style-type: none"> <li>1. Family members</li> <li>2. Employment</li> <li>3. Working with others</li> <li>4. Exchange of labor</li> </ol>	

8. Trends of dairy Cattle production and relative number in the area from year to year

Dairy Cattle number trend	Reason for increasing	Reason for decreasing
Increase <input type="checkbox"/>		
Decrease <input type="checkbox"/>	<ol style="list-style-type: none"> <li>1.Short generation interval</li> <li>2. feed availability from pasture land</li> <li>3. presence of good facility(vaccine, treatments and others</li> <li>4. Presence of productive Cattle breed</li> <li>5. presence of good milk market access</li> <li>6. presence of governmental support for dairy development</li> </ol>	<ol style="list-style-type: none"> <li>1.Presence of disease and parasites</li> <li>2.decrease in productivity and size of grazing lands</li> <li>3. Absence of animal health clinics/veterinary service</li> <li>4.low attitudes of farmers to Cattle rearing</li> <li>5. poor market access for milk</li> <li>6.Expensive feed coast presence</li> </ol>
Unchanged <input type="checkbox"/>		

		7. low production potentials of available cattle breeds
--	--	---

9. What are the main feed resources you use in your area to feed your dairy cattle?

Feed resources	Wet season		Dry Season	
	Tick(√)	Rank	Tick(√)	Rank
Natural pasture				
Agricultural by products				
Improved forage production				
Agro industrial by products				
Brewery by products				

10. Is there seasonal fluctuation in feed availability in your area? Yes/No

11. If yes at which season of the year do you experience feed shortage? Wet/ dry

12. What mechanisms do you use to withstand seasonal feed shortage?

Feed conservation

Reducing dairy cattle size

Other method; specify it -----

13. Do you provide supplementary feeds to your dairy cattle?

Yes

No

14. If your answer is yes for question No 13 fill the table below

Categories'	Type of supplement	Time of provision	Reason of provision

Pregnant cow			
Lactating cow			

15. What are the sources of water for your dairy cows?

- Permanent rivers or streams                       Springs  
 Dams/ Pond     Borehole  
 Other; specify it -----

16. In which categories is water availability grouped?

- Sufficient                       Insufficient                       Intermediate

17. What type of barn do you have?

- Housed                       Fenced                       No barn  
 Other (specify) -----

18. Wall/ Roof material

- Thatched                       Trees wood  
 Block house  
 Other(s) specify -----

19. Do you use bedding materials?

- Yes                       No.

20. If yes, what type of the bedding materials do you use?

- Grass and/or cereal straw                       Saw dust  
 Others (specify). -----

21. Floor material

- Concrete/cement                       Stones  
 Mud/earthen  
 Other(s) specify -----

22. Do you clean the floor?

- Yes                       No

23. If your answer for number 22 is yes with what do you clean?

- Water  Water with disinfectant
- Water with soap
- Other(s) specify -----

24. How often you clean the floor? -----

- Once a day  Twice a day
- Other(s) specify -----

**Hygiene in relation to milking practices**

1. What time(s) of the day do you do the milking? -----

- Very early in the morning  Evening hours
- In the morning hours  Late night
- Afternoon hours  At any time

2. Age of the study cow

- Young(3-5 years)  Adult (6-9 years)  Old (>9)

3. Category of party

- 1-3 Calves  Many (> 7years)
- Moderate (4-7 calves)

4. Lactation stage of cow

- Early (1-4 months)  Late (>8 month up to
- Medium (5-8 months)

5. Do you tie the cow with rope? -----

- Yes  No

6. Do you wash hands before milking? -----

- Yes  No

7. What is the source of water for washing?

- Tap water  Pond
- Well water  River

- Other(s) specify -----

8. Do you wash the udder during milking?

Yes  No

9. If the answer for question **number 8** is yes how do you practice udder washing?

- Using warm and clean water before milking
- Remove feces or any dirt attached to udder or teat
- Use individual towel to clean udder/teat
- Use collective towel to clean udder/teats of more than one cow
- Other (Specify) \_\_\_\_\_

10. Do you use towel to clean udder during milking?

Yes  No

11. Do you observe udder/teat health problem in your farm?

Yes  No

12. If you give treatment (antibiotics) to the cow with udder health problem, what do you do with the milk during treatment?

- Discard  Use for home consumption
- Give to calves  Mix with milk from healthy cows and sell
- Give to cats or dogs
- Others (Specify) -----

13. What equipment do you use for milking?

- Plastic pail  Grass weaved container
- Stainless steel pail  Wooden container
- Aluminum pail  Calabash (ቅል)
- Clay pot
- Others (specify) -----

14. Do you clean milk containers regularly before and after milking?

Yes  No

15. If your answer for question number 11 is yes what do you do for cleaning the milking container?

- Washing  smoking  both

If any (specify)

---

16. If you use smoke, what types of plant do you use?

1. -----
2. -----
3. -----
4. -----

**Milk quality related constraints**

<b>Constraints</b>	<b>Rank (1<sup>st</sup>, 2<sup>nd</sup>, etc.)</b>
Lack of clean water	
Lack of knowledge on hygienic practices	
Types of bedding materials	
Types of barn	
Lack of appropriate milking and cooling equipment	
Poor market access	

## Part 2: Questionnaire for Interview on

“Dairy Cattle production system, milk production, milk handling practices, and estimation of milk quality and hygienic conditions of raw whole milk in Dilla town And Dilla zuria District of Geddeo Zone”

For Milk Restaurant, vendor and kiosk/shop

### Dear respondent:

This questionnaire is used to get background information concerning on **Milk handling practices, Hygienic practices and microbial quality** of raw cow’s milk. The information will be used for research purpose at Dilla University only. We appreciate your kind cooperation in completing this questionnaire.

#### A. General Information

7. Date of Survey (DD/MM/YYYY) : -----/----- /-----
8. Enumerator Name : -----
9. Site/State/Region/District Name : ----- Site Code: -----
10. Village/Kebele Name : ----- Village Code: -----
11. Sex Male-----Female-----Age-----

#### B. Milk Collection And Delivery/sale

1. What type of milk do you collect and sell?
  - A. Raw
  - B. Boiled milk
  - C. Fermented milk
  - D. Others
2. From where do you get milk?
  - A. farmers from in the same Village
  - B. More than 2 in the same village
  - C. Farmer from neighboring village
  - D. Other (s) specify it-----
3. How do you get milk from the farmer(s)?
  - A. Farmer(s) delivering the milk
  - B. By using own transport (mention means of transport -----)

- C. Go on by foot to the farmer(s) place-----
  - D. Other (s) specify it-----
4. What type of containers do you use for collecting and selling the milk?
    - A. Aluminum containers
    - B. Plastic containers
    - C. Other (s) specify it-----
  5. How long it take to reach to the selling point? -----  
-----
  6. What time is the milk transported? -----
  7. Who are your customers?
    - A. Neighboring house hold
    - B. Restaurants /Kiosk
    - C. Other (s) specify it-----
  8. How do your customers get the milk?
    - a. Delivery to their places/specify means of transport-----
    - b. At the special selling point
    - c. Other (s) specify it-----
  9. How is the acceptance/rejection percentage in general? -----  
-----  
-----
  10. Approximately how many liters of milk do you sell per day? -----
  11. Approximately how long does for the milk to finish hours?-----
  12. The clean lines of milk selling environment
    - A. very clean
    - B. clean
    - C. dirty
    - D. Other (s) specify it-----
  13. Types of containers used to fetch milk from larger container?
    - A. A cup with handle
    - B. A cup without a handle
    - C. Other (s) specify it-----
  14. Type of small containers used to delivery milk to the customers?
    - A. Narrow necked used bottles with stoppers
    - B. Other (s) specify it-----

**THANK YOU FOR YOUR COOPERATION!!!**



























