ASSESSMENT OF HANDLING PRACTICES, PHYSICOCHEMICAL PROPERTIES AND MICROBIAL QUALITY OF RAW COW'S MILK IN DALE AND LOKA ABAYA DISTRICTS, SIDAMA REGIONAL STATE, ETHIOPIA

M.SC. THESIS

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HAWASSA UNIVERSITY

COLLEGE OF AGRICULTURE

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A THESIS SUBMITTED TO THE SCHOOL OF ANIMAL AND RANGE SCIENCES, COLLEGE OF AGRICULTURE, HAWASSA UNIVERSITY

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SCHOOL OF GRADUATE STUDIES

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This is to certify that the thesis entitled "**Assessment of Handling Practices, Physicochemical Properties and Microbial Quality of Raw Cow's Milk In Dale and Loka Abaya Districts of Sidama Region, Ethiopia"** submitted in partial fulfillment of the requirements for the degree of Master with specialization in **Dairy Science and Technology** the graduate program of the **School of ARSc** and has been carried out by **Zerihun Bogale** under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the School.

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We, the undersigned, members of the Board of Examiners of the final open defense by **Zerihun Bogale Bolka**, have read and evaluated his thesis entitled ‘‘**Assessment of Handling Practices, Physicochemical Properties and Microbial Quality of Raw Cow's Milk in Dale and Loka Abaya Districts of Sidama Region, Ethiopia’’** and examined the candidate. This is therefore to certify that the thesis has been accepted partial fulfillment of the requirement for the degree of **Master of Science**.

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Wishing all Holy blessings from Jesus Christ and be considered in His eternal Government.

My God's glory continuously shines on you all.

DEDICATION

I dedicate this thesis manuscript to my beloved family, my mother Adugna Haile for nursing me with affection and love and My late father Bogale Bolka I will remembering you every step of my success through my life may your soul rest in internal peace, Amen.

STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this Thesis is my own work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and compilation of this thesis. Any scholarly matter that is included in the Thesis has been given recognition through citation. I confidently declare that this thesis has not been submitted to any other institutions anywhere for the award of any academic degree, diploma, or certificate. This Thesis is submitted in partial fulfillment of the requirements for a Dairy Science and Technology degree at the Hawassa University. The Thesis is deposited in the Hawassa University Library and is made available to borrowers under the rules of the library. Brief quotations from this Thesis may be made without special permission provided that accurate and complete acknowledgement of the source is made. Requests for permission for extended quotations from or reproduction of this Thesis in whole or in part may be granted by Dean of the School of Graduate Studies when in his or her judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission must be obtained from the author of the Thesis.

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LIST OF ABRIVATION

CC	Coliform count
CFU	Colony Forming unit
CSA	Central statistical agency
DDE	Dairy Development Enterprise
FAO	Food and Agricultural Organization
FBD	Food Born Disease
GLM	General Linear Model
HACCP	Hazard Analysis Critical Control Point
IDF	International Dairy Federation
Log10	Logarism in base ten
LSD	List Significance Difference
MOA	Ministry of Agriculture
SAS	Statistical Analysis System
SEDPSZ	Socio-Economic and Demographic Profile of Sidama Zone
SG	Specific Gravity
SNF	Solid Not Fat
SPC	Standard plate count
VRBA	Violate Red Bile Agar
WHO	Word Health Organization
YMC	Yeast and Mould Count

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Assessment of Handling Practices, Physicochemical Properties and Microbial Quality of Raw Cow's Milk in Dale and Loka Abaya District of Sidama Region, Ethiopia

Zerihun Bogale

Major Advisor: Firew Kassa (PhD)

ABSTRACT

The study was conducted in Dale and Loka Abaya districts to assess handling practices, physicochemical properties and microbial quality of raw cow's milk in supply chains of two Agro-ecologies. A total of 120 respondents were randomly selected and interviewed on milk handling practices. For quality parameters analysis, forty five raw milk samples were taken from producers in two agro ecologies using random sampling method. The result indicated that, majority of respondents use clay pot (71.6 %) for milking and 67.5% of them use plastic equipment for transporting their milk to the market. Majority of respondents (83.34%) were not washing udder before milking and only 21.67% of the milkers washed their hands before milking. Cleaning and smoking of milking vessels were common in the study area. Pond was the main water sources used for cleaning purpose whereas Olea africana, Terminalla brownii, and Juniperous procera are the most frequently used plant species for smoking milk vessels. The overall mean for ph , specific gravity, titratable acidity, total solids, fat, solids-not-fat, protein and lactose contents of milk samples were 6.42 ± 0.26, 1.03 ± 0.002, 0.19 ± 0.05, 13.49 ± 0.41, 4.9 ± 0.39, 8.31 ± 0.13, 3.13 ± 0.21 and 4.67 ± 0.44, respectively. The overall mean for Ph, titratable acidity and solid not fat had significant differences between midland and lowland milk samples. The overall mean total bacterial count, coliform count and yeast and mould count of raw milk samples obtained in the study area were 7.64±0.78, 5.89±0.87, and 3.97±0.30 log_{10} cfu/ml respectively. The microbial quality of milk samples obtained from midland producers were significantly higher ($P<0.05$) than those obtained from lowland producers. In general, physicochemical property of milk samples obtained from producers were within the acceptable standard levels, except ph, Specific gravity and Titratable Acidity of marketed milk. Whereas the microbial quality of raw cow milk produced by two agro climatic areas do not meet the national and international standards set by regulatory agencies and thus could pose health hazards to the consumers Therefore, concerned bodies should intervene and support producers in the study area to improve hygienic practices and handling of milk.

Key words: *Chemical composition, microbial quality, physicochemical properties, raw milk and agro ecology*

1. INTRODUCTION

Milk is a translucent white liquid, produced by the mammary glands of mammals with high nutritional value, providing the primary source of nutrition for young mammals before they are able to digest other types of food. Fresh milk considered as a complete diet because it contains essential nutrients such as lactose, fat, protein, mineral and vitamins in balanced ratio rather than the other foods (Khalid, 2006). Raw cow milk is composed of approximately 87.2% water, 3.7% fat, 3.5% protein, 4.9% lactose 0.7% ash and has pH of 6.8 (Olantunji et al., 2012).

In Ethiopia, cows contribute around 95% of the total annual milk produced in the country (CSA, 2010). Physical properties and chemical compositions of milk were the indicators of qualities of milk with the sanitary standard (Haftu Kebede et al., 2018). The physical properties of milk were the specific gravity, freezing point, acidity and pH of the milk. These parameters were an indication of the standard and nutritional quality of milk. Specific gravity and freezing point were important parameters of indicative of the milk adulteration (Teklemichael Tesfay et al., 2015).

Adulteration in food is done either for financial gain or lack of proper hygienic conditions of processing, storing, transportation and marketing. This ultimately leads to the stage that the consumer is either cheated or often become victim of diseases. Such types of adulteration are quite common in developing countries. It is equally important for the consumer to know the common adulterants and their effects on health (Faraz et al., 2013). Physiochemical analysis is important tool to monitor the quality of milk and other dairy products.

Postharvest losses of up to 40% of milk and its derivatives have been reported from milking to consumption (Felleke, 2003). Further losses incurred are quality losses by storing in unclean storage utensil, which is prone to high microbial contamination. Losses in spoilage and contamination occur where handling practices during and after milking are traditional and care is not satisfactory. In most cases, milking utensils used for milking expose the milk to losses through spoilage and contamination. For instance, due to the narrow tipped milking equipment direct loss of about 2% to 5% has been reported (MoA, 2007).

Milk is an excellent growth medium for bacteria; originating from either mastitis or from contamination of the milk with environmental spoilage as well as pathogenic microorganisms during milking or milk handling process (Pospescu and Angel, 2009). Microorganism in raw milk can also originate from different sources such as air, milking equipment, feed, soil, faeces and grass. Milk is a highly perishable commodity and poor handling can exert both a public health and economic loss, thus requiring hygienic vigilance throughout the production to consumer chain. The microorganism load and types found in milk shortly after milking are influenced by factors such as animal and equipment cleanness, season, ambient temperature, storage, personnel health, cleanness and animal health. On this basis the daily production and eventual marketing and sale of milk requires special consideration to ensure its delivery to the market in hygienic and acceptable condition (Kivaria *et al.*, 2006). As a result, hygienic milk handling practices should take into account such as the sanitation of milking environment, the hygiene of the milker and utensils used to collect and store milk (Tsedey and Asrat, 2015).

1.1 Statement of problem

There is limited data on hygienic practices throughout the dairy production system in Ethiopia and standard milking procedures do not exist. Yilma, (2010) reported that many farmers do not properly clean teats prior to milking; they either do not use towel at all for cleaning or use collective towel for two or more cows. This practice can clearly lead to the spread of contagious pathogens. Raw milk is an important vehicle for the transmission of milk borne pathogens to humans, as it can be easily contaminated during milking and handling (Addo et al., 2011; Pal, 2012).

Poor or improper handling of milk can exert both a public health and economic constraints thus requiring hygienic vigilance throughout the milk value chain (Swai and Schoonman, 2011). In some parts of the world including developing countries like Ethiopia, milk is still a significant source of these infections and other Food Born Diseases (FBDs) (Shirima et al., 2003).

Bovine milk producers in Sidama Regional state might also have faced partially hygienic problems through their production practices and there is lack of information on the extent of raw milk contamination by bacteria in this area. Moreover, the raw milk producers in the Dale and Loka Abaya districts supply their milk directly to consumers without appropriate measurements taken. Therefore, it is highly imperative to evaluate the microbial load and composition of cow's milk produced in the study area. So, safety of dairy products with respect to food-borne diseases is a great concern study area. This is especially true in developing countries including Ethiopia in general and the current study area in particular, where production of milk and various dairy products take place under rather unsanitary conditions and poor production practices (Zelalem and Faye, 2006). Meanwhile, some works have been undertaken in Sidama Region in different areas regarding handling practice, chemical composition and Microbial Quality of raw cow's milk collected from producers (Tsedey and Asrat, 2015 and Yetera, et al., (2018). However, there is gap in the present study area in line with works available concerning the handling practices, physicochemical properties and microbial quality of raw cow's milk at smallholder's level of the study area. On this basis, the present study was done with the following objectives:

1.2. Objectives of study

1.2.1 General Objective

The overall objective of this research has to assess handling practices, physicochemical properties and Microbial quality of raw cow's milk in Dale and Loka Abaya District, Sidama Regional State, Ethiopia.

1.2.2 Specific Objectives

The specific objectives of this study include:

- To assess production and handling practices of raw cow's milk in the study area.
- To determine the physical properties and chemical composition of raw cow's milk in the study area.
- To evaluate the microbial quality of raw cow's milk in the study area.

2. LITRATURE REVIEW

2.1. Dairy Industry development in Ethiopia

The total cattle population of the country is estimated to be more than 61 million head out of which female cattle constitute about 54.68 per cent. Moreover, the indigenous cattle breeds account for 98.24%, hybrid 1.54% and exotic breed accounts only for 0.22%. Out of the female animals 11.03% were used for dairy cows and 20.52% are milking cows (CSA, 2018). All livestock currently support and sustain livelihoods for 80% of all rural poor. However, dairy industry in Ethiopia is not developed even when compared to east African countries. In fact, the national milk production remains among the lowest in the world, even by African standards (Zegeye, 2003).

Due to the policy reforms on supporting dairy development, the dairy industry in Ethiopia is expected to continue to grow over the next decade (Mohamed *et al.*, 2004). Between 1999 and 2009, milk production increased by 500,000 tons - a 42% increase (FAO, 2010). From 1966 to 2000 the increase in production was, on average, 1.6% per year (Tsehay Redda, 2002). Even though there has been a large and consistent increase in production, the dairy industry has generally not been able to keep up with the rapidly expanding population with a 3.0% per year growth rate until recently (CIA, 2011).

For dairy development industry, Ethiopian government established the National Artificial Insemination Center (NAIC) along with several other centers that specialize in improving specific breeds. The centers for breed improvement focus on introducing traits that will optimize production while conserving traits that enable dairy cattle to thrive in harsh environments. The AI services and breed improvement programs are under government control and suffer from limited focus on genetic improvement, lack of selection criteria for bulls, lack of pedigree information, and low efficiency and effectiveness of AI technicians (Tegegne *et al.*, 2010).

Veterinary services are also controlled mostly by the government. Mostly Poor health of dairy cattle can directly affect productivity through death, weight loss and poor fertility (CSA, 2009). Poor livestock health can also lower the quality of the milk produced and introduce pathogens of public health significance into the milk.

2.2. Milk Consumption and Utilization in Ethiopia

In Ethiopia, milk and milk products mainly used for home consumption as it have high nutritional value. In addition, it is a source of cash income to purchase farm inputs like feed, fertilizer 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. This is due to poor pre-milking and post-harvest handling practices and highly perishable (Tewodros et al 2019) characteristics of the milk (Tsadkan and Gurja, 2018). Mishandling and disregard of hygienic measures by milk handling personnel may enable undesirable microbes to come into contact with milk and in some cases to survive and multiply in sufficient numbers and make the milk unsafe for both direct consumption and further processing (Chatterje et al., 2006). High microbial count in milk is an indication of poor hygienic conditions of the milk; consequently it reduces the nutritional quality of milk and causes unpleasant effect on the taste. Moreover, it reduces the market value of milk causing income losses to producers and traders. Furthermore, high microbial count in milk threatens the health of consumers due to toxic metabolites produced by different organisms growing in it (Karmen and Slavica, 2008). The importance of milk in the diet of Ethiopians differs according to the farming systems and the socio-cultural setups. In the lowlands, especially where livestock keeping is the main occupation, milk is consumed by all groups of the society. In the highlands, the rural people are sedentary farmers raising both livestock and crops, with their diet consisting mainly of cereals and legumes (Zelalem et al., 2011). The milk produced on farms is used for calves, consumed by the family or sold in the local markets. In most households in the central highlands of Ethiopia where there are only local cows, the milk is just enough for the calves and there is very small amount left for family consumption and sale (Zelalem et al., 2011).

2.3. Handling and Preservation of Milk and Milk Products

In Ethiopia, hygienic handling practice of milk is below the standard due to insufficient pre-milking handling practices like washing udder with clean water, cleaning milking barn, drying the udder with individual towel, washing of milkers hands and milking utensils, using poor quality and non-boiled water for cleaning of udder and insufficient post-harvest handling practice like poor hygiene of milk equipment and storage containers, prolonged storage at ambient temperature, and transportation and retailing practices predispose the milk to microbial contamination (Tsedey and Asrat, 2015; Fufa et al., 2019).

Moreover, use of plastic containers for handling and transporting of milk increase the risk of contamination of milk, as the number of plastic containers increased the chance of contamination is also increased and most plastic containers have characteristics that make them unsuitable for milk handling (Tsedey and Asrat, 2015). In addition, using clay pot for storing milk is another factor. This device for producers is inconvenient for hygienic cleaning, it also harbors bacteria which causes milk spoilage and consequently imposes risk of quality deterioration (Tsedey and Asrat, 2015).

Most losses of dairy products occur as a result of a combination of poor production and /or handling practices and lack of technical knowledge. Among others, lack of knowledge on clean milk production, use of unclean milking equipment coupled with lack of potable water for cleaning purpose probably contributed to the poor hygienic quality of dairy products produced in central Ethiopia (Zelalem and Faye, 2006).

2.3.1. Container smoking

There are different kinds of milk preservation techniques in different parts of the country. Smoking of milk and milk equipment's using different kinds of plants is one of the cultural practices to increase the shelf life and to add flavour to the product. The ancient Egyptians and Romans were aware of the preservative effects of salting, drying and smoking. Smoking generates cresols, and other antibacterial compounds which penetrates the microbes and products (Michael *et al*, 2005).

The dairy producers clean their milking utensils in different ways, for instance, washing with or without hot water followed by smoking with different aroma producing plants like Woira (*Olea africana*), and Tid (*Juniperous procera*) used for flavoring and extending the shelf life, since fumigation have the power of disinfecting (sterilizing) the milking equipment (Tsedey and Asrat, 2015) . Thus, reducing the numbers of microorganisms and extending the shelf life of milk and milk products, and thereby reducing spoilage (Tsedey and Asrat, 2015).

Shewangzaw et al. (2016) reported that about 55.6% of the producer did not use refrigerator for handling of milk and its products. This may favor the multiplication of bacteria and spoilage of milk and milk products. Generally, poor handling practices result in higher bacterial count, which in turn may cause spoilage of the milk and yields of its poor quality products. Moreover, the rise of bacterial count is unsafe since some of them cause food borne diseases and impose great health risk on the consumers (Tolessa, 2016).

2.3.2. Container scrubbing

Plants that are used to scrub milk containers differ from place to place and even from household to household indicating the variety of materials that need to be exhaustively identified in different areas of Ethiopia. Milk containers are thoroughly washed, smoked and then scrubbed with forbs of desirable aroma which could vary from place to place (Fekadu, 1994; Alganesh 2002; Lemma, 2004). The most common plants used for container scrubbing and preservation of milk and milk products in eastern Shoa were reported by Lemma (2004). He suggested that in case when fermentation rate increases, the herbaceous plants are used to scrub milk storage vessels to correct the problem. Among many herbaceous plants used to scrub milk storage vessels to correct the problem, container scrubbing with *Verbscum sinaiticum* (daaxaxa in sidaamu afoo) is used to normalize fermentation and such herbs might help to inoculate some desirable organisms or selectively inhibit the growth of undesirable organisms and create ideal environment for the former groups of microorganisms in the container to grow and take the advantage for proliferation (Lemma, 2004).

Similar trend was also observed in the semiarid pastoral system of Ethiopia. Before being filled with fresh milk, a milk vessel may be scrubbed with leaves of *Endostmeumtereticullis-ocimumhardiense* (Coppock *et al*., 1992). Fungi in general appear more sensitive to flavoring and seasoning agents in foods than Gram-positive bacteria (James *et al*., 2005). Flavor compounds tend to be more antifungal than antibacterial; as well the non-lactic, Gram-positive bacteria are the most sensitive and lactic acid bacteria are rather resistant to the flavor compounds (James *et al*., 2005).

2.4. Milk Marketing System in Ethiopia

Both formal and informal milk marketing systems exist in Ethiopia. Informal marketing dominates the system where all rural and part of peri-urban and the majority of the urban dairy producers sell liquid milk and dairy products on a house-to-house basis. The smallholder provides the bulk of milk both to the formal (5% of Dairy Development Enterprise (DDE) supply) and informal (95%) marketing system (SNV, 2008). The informal milk marketing system dominates the supply of milk and dairy products to consumers in Ethiopia. Of the total urban milk production, 73% is sold, 10% is left for household consumption, 9.4% goes to calves and the 7.6% is processed into butter and cheese (Tsehay, 2001; Ahmed *et al*., 2003). In terms of marketing, 71% of the producers sell milk directly to consumers (Tsehay, 2001; Ahmed *et al*., 2003). Development and expansion of dairy cooperatives in different areas are important for increasing and improving the milk marketing systems and encouraging the producers. According to Berhane and Workneh (2003), dairy marketing cooperatives could provide farmers with continuous milk outlets, and easy access to essential inputs such as artificial insemination, veterinary services and formulated feeds. Dairy cooperatives help to trigger a series of positive developments in the sub-sector; hence strengthening the existing dairy cooperatives and formation of new cooperatives in different parts of the country is important.

2.4.1. Milk marketing channels and outlets

Marketing outlet is the final market place to deliver the milk product, where it may pass through various channels. A network (combination) of market channels gives rise to the market chain. Marketing survey in Hawassa, Shashemane and Yirgalem depicted that milk producers sold milk through different principal marketing channels (Woldemichael, 2008). These included:

• Producer-consumer (P-C) channel- involves direct sales to individual consumers accounting for 21%, 4.7% and 23.7% of total milk marketed per day in Hawassa, Shashemane and Yergalem, respectively.

• Producer → Retailer → Consumer: The channel represents average of 43% of milk marketed per day in the milk shed. This channel represents for 16%, 38%and 76.6% of total milk marketed per day in Hawassa, Shashemane and Yergalem, respectively.

• Producer → Semi-whole seller → Retailer →Consumer: This channel was identified to be operational only in Hawassa where milk semi-whole sellers undertake both retailing and whole selling activities.

• Producer → Cooperative →Consumer: This channel was exceptional for Shashemane and Hawassa where milk cooperatives are found and accounts for 0.81% and 10.67% of total milk marketed per day in Hawassa and Shashemane, respectively.

2.4.2. Market constraints

In Ethiopia milk marketing system is not well developed (Ahmed *et al.,* 2003); especially, market access in pastoral production system is a critical factor (Tsehay, 2002). This has resulted in difficulties of marketing fresh milk where infrastructures are extremely limited and market channel has not been developed. However, the majority of the milk produced is sold fresh through informal market sources. According to Mohammed *et al*, (2004), only 5 percent of the total milk produced in rural areas is marketed as liquid milk due to underdevelopment of infrastructures. In the absence of organization of rural fresh milk market, marketing in any volume is restricted to peri-urban areas. Milk being perishable and demand being high for urban consumption, efficiency in collection and transportation of this bulk from widely scattered rural sources, requires a well-defined method of preservation and distribution. This would impact on the amount that would be available for consumption through losses in quality (Ahmed *et al.*, 2003).

In Borana plateau only households close to the market are able to sell milk more frequently. Effect of distance to market varies with household wealth and has been found to be a critical factor in dairy marketing (Coppock, 1994). A pastoral community depends mainly on milk and milk products for its survival and therefore, these are not perceived to be for commercial purposes. Thus it's only the households who are in a walking distance from the urban centers who sell milk and milk products to urban consumers (IPS, 2000). Difficulty in market access restricts opportunities for income generation. Remoteness results in reduced farm gate prices increased input costs and lower returns to labor and capital. This in turn, reduces incentives to participate in economic transaction and results in subsistent rather than market oriented production systems (Ahmed *et al.,* 2003).

2.5. Milk Characteristics

Milk is considered as nature's single most complete food (O'Mahony 1998) and is definitely one of the most valuable and regularly consumed foods. But at the same time, it is highly vulnerable to bacterial contamination and hence is easily perishable (OECD, 2005). Quality evaluation of milk is thus vital. Quality milk is the milk of normal chemical composition, completely free from harmful bacteria and harmful toxic substances, free from sediment and extraneous substances, has lower degree of titratable acidity, of good flavor, adequate in preserving quality, and low in bacterial counts. It is also the lacteal secretion, practically free from colostrum, obtained by the complete milking of one or more healthy cows, five days after and 15 days before parturition, which contains not less than 8.5 percent milk solids-not-fat and not less than 3.5 percent milk fat (U.S. Public Health Service, 1995). According to Byron *et al.*, (1994), the average composition of milk are (i) Water (87.20%), (ii) Protein (3.50%), (iii) Fat (3.70%), (iv) Milk sugar or lactose (4.90%), (v) ash (0.70%) and (vi) Dry matter (12.80%).

Milk ranges in color from a bluish-white to an almost golden-yellow, depending up on the breed of cattle, the amount of fat and solids present, and, most of all, up on the nature of the feed consumed by the cow. Milk has no pronounced taste but slightly sweet to most persons. Any pronounced taste is abnormal. Fresh milk has a hydrogen ion concentration of approximately 6.5 which indicates that it is really on the acid side of neutrality (Clarence, 2002).

2.6. Physical Properties of Milk

2.6.1. pH value

The milk pH provides a clue of sanitation and its freshness. According to O'Connor (1995) and FAO (2009), fresh normal cow milk has a pH scale that bound from 6.6 to 6.8 when milk temperature is 20℃. The pH values higher than 6.8 indicates mastitic milk and pH values 6.6 indicates increased acidity of milk due to bacterial multiplication (O'Connor,1995).

2.6.2. Specific gravity

The specific gravity of milk, among others, is commonly used for quality test mainly to check for the addition of water to milk or removal of cream. Addition of water to milk reduces milk specific gravity, while removal of cream increases it. Mekonen and Mengistu (2017) reported that the mean specific gravity of raw milk obtained from farmers and dairy cooperatives was 1.029. For normal whole cow milk, specific gravity ranges from 1.028g/ml-1.036g/ml based on the East African Community (EAC) (2006) standard. Having specific gravity below recommended level implies the presence adulteration with water which contributes to production of poor quality milk (Ali et al., 2010).

2.6.3. Titratable acidity

Titratable 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 is 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 titratable acidity (Krishnaiah, 2005).

2.7. Determinants of Milk Composition

Chemical composition of milk is variable and influenced by genetic factors like breed and environmental stress such as stage of lactation, changes in feeding, etc. Milk composition and production are the interaction of many elements within the cow and her external environments (O’Connor, 1994). However, it is generally accepted that the dairyman can alter many of these factors to achieve milk production and increase profit. The major factors affecting milk composition are indicated below.

2.7.1. Breed and species

Milk from different cattle breeds holds distinct composition profiles because of genetic background (Poulsen et al., 2012). The chemical composition of bovine milk and the protein to fat ratio are constantly being modified in order to meet consumer preferences (Boichard et al., 2012) .Exotic breeds mainly Holstein Friesian and Jersey are imported to Ethiopia and crossed with the indigenous cattle breeds to improving the yields of milk volume (Tegegne et al., 2010) and bring the highest economic returns under poor feeding conditions (Tadesse and Dessie, 2003). Crossbreds have increased lactation lengths, shorter calving intervals and calve at a younger age than the indigenous stock (Galukande, 2010).

2.7.2. Feeding system and Stage of lactation

Nutrition has major effect on milk composition. According to (O'Connor, 1994) under feeding cows reduces milk production, the fat and SNF contents of milk produced. As a general rule, any ration that increases milk production usually reduces the fat percentage of milk. Some studies have shown that seasonal variation affects milk composition through several aspects, such as ingestible diets, photoperiod, and temperature (Allore et al., 1997; Nudda et al., 2005; Heck et al., 2009). With diet change, milk composition is changed markedly (Elgersma et al., 2004). The fat, lactose and protein contents of milk also vary according to stage of lactation. Moreover, the milk-pricing system has shifted from ordinary quantity to its composition, affecting the farm income directly (Krovvidi Sudhakar et al., 2013).

2.7.3. Age and Disease

The age of the cows has slight but definite effect on the composition of their milk. O'Connor (1994) suggested that as cow grows older, the fat content of their milk decreases by about 0.02 percentage units per lactation while the fall in SNF is about 0.04 percentage units. In addition to the age, diseases such as mastitis have effect on chemical composition of milk. Mastitis is a heavy burden for the dairy sector worldwide: it is a costly disease due to direct losses (a reduction of output) and expenditure (to reduce its level), both with negative implications for milk hygiene and quality (Hogeveen, Huijps and Lam, 2011; Coulon et al., 2002). As it is a complex disease, and thus there is no simple solution for the control of mastitis, so understanding its occurrence, the related risk factors, and the mastitogenic pathogens involved, are fundamental elements in developing a control program.

2.8. Microbial Quality and Sources of Bacterial Contamination.

The microbial load of milk is a major factor in determining its quality. It indicates the hygienic level exercised during milking, that is, cleanliness of the milking utensils, condition of storage, manner of transport as well as the cleanliness of the udder of the individual animal (Gandiya, 2001). Milk when it emerges from healthy udder contains only a very few bacteria. It picks many bacteria from the time it leaves from the teats of the cow until consumption or further processing. Microorganisms can enter milk via the cow, air, feeds, milk handling equipment and the milker and once they get into the milk their numbers increase rapidly (Tollessa, 2016). Therefore, the microbial content of milk indicates the hygienic levels during milking that include cleanliness of the milking utensils, proper storage and transport as well as the udder health of individual cow. The commonly used microbial quality tests for milk and milk products include determination of total bacterial count (TBC) or standard plate count (SPC), coliform count (CC), yeast and mould counts, and count of Enterobacteriaceae (Alganesh, 2016; Tamirat, 2018; Fufa et al., 2019).

2.8.1. Standard plate count

Before, Due to its complex biochemical composition and high water activity, milk serves as an excellent culture medium for the growth and multiplication of many kinds of Microorganisms (Ashenafi and Beyene, 1994; Soomro *et al*., 2002). The number of bacteria may increase considerably if samples taken at the time of milking from the cows and distribution to the consumers are tested for total bacteriological counts. Information on the bacterial content of a milk sample may reflect the state of health of the cow, the contributions of conditions under which the milk is stored and distributed, and its public health significance (D'Amico *et al.*, 2010).

2.8.2. Coliforms Count

Coliforms are other bacterial group that affects milk quality and associated with the level of hygiene during production and subsequent handling (Tollessa, 2016). According to the ESA (2009), good quality milk should not contain a total coliform bacterial count of more than 1000 Cfu/ml. However, different studies showed that due to higher counts of coliform and other microorganisms, quality of milk is below the standard. For instance, Tsedey and Asrat (2015) reported the coliform count for the raw milk collected from producers and consumers was 4.00 log10Cfu/ml and 4.29log10Cfu/ml, respectively. The presence of high numbers of coliforms provides an index of hygienic standard used in the production of milk, as unclean udder and teats can contribute to the presence of coliforms from various sources such as manure, soil, feed, personnel and water (CDC, 2006).

2.8.3. Yeast and Mold count

Yeast and mould contamination not only causes deterioration of food and feeds, but also can adversely affect the health of humans and animals as well since they are capable of producing toxic metabolites known as mycotoxins causing food poisoning and liver cancer in human (Torkar and Vengst,2008). Yeast and mould may be found as part of the normal flora of a food/feed product on inadequately sanitized equipment or as airborne contaminants. Different groups of fungi are found in soil, barn dust, feeds, manure, and unclean utensils. They can produce toxic metabolites, resistance to freezing environments, and cause off odors and off flavors of foods and, which can spoil/reduce shelf life of milk and may also pose serious health problems to the consumer (Mulugojjam and Aleme, 2015).

2.9. Impact of Milk Contaminant Pathogens on Public Health

Improving the microbial safety of perishable foods is currently a major pre-occupation in the food industry (Vachon *et al.*, 2002). The bacteriological quality of raw milk should be of major concern to milk producers, the dairy industry and the public at large. Highly contaminated milk is likely to receive a low grade at the dairy plant and, therefore, low revenue to the producer. The processor cannot produce high quality product from poor quality raw milk (Gandiya, 2001). The consequence of which may be poor consumer satisfaction or even public health risks of milk borne diseases. According to the report of WHO (2000), each day millions of people become ill and thousands die because of food- borne diseases in the world. O'Connor (1993) reported that milk produced under unhygienic conditions or from unhealthy cows may cause illness to human being including tuberculosis, brucellosis, sore throats, diarrhea and abdominal pains. Getachew (2003a) reported that the main threats of public health hazard due to milk borne disease in Ethiopia are *tuberculosis* and *mastitis*.

The incidence of *tuberculosis* is increasing in Ethiopia and had wide coverage and thus poses a great threat to the nation. If it is not possible to inspect the milk before it reaches the consumers, potential for public health hazard exists and should be recognized by everyone concerned. Precautions have to be taken to minimize the risk associated with the consumption of raw milk and products manufactured from raw milk (FAO, 2002). The occurrence of pathogens in raw milk samples indicate that there exists a potential hazard to public health when milk is consumed fresh. Thus, hygienic production of milk has to get due attention to provide more and better quality milk as a source of high nutritious food for consumer especially children. The main method used to safeguard raw milk against pathogens is proper pasteurization.

2.10. Milk Quality Control Measures

For production of good quality and safe dairy products, HACCP systems development is useful. Given the growing public awareness of the importance of food safety and quality knowledge of the microbial and chemical composition of milk is of great significance for further development of its hygienic processing into high quality consumer products (FAO/WHO, 1997). As obviously known, milk can play a role in transmitting zoonotic and food borne diseases if it is not handled under the proper hygienic conditions. If the milk is of low quality and contains bacteria of public health significance, the nutritional value is undermined. Ethiopia, as a developing country, faces many challenges in producing a quality product that is safe for consumption (FAO, 2009). Because there is little access to refrigeration throughout the dairy system and less than 1% of milk produced is pasteurized, focus needs to be placed on measures promoting clean milk production and minimizing the time between milking and consumption or transport to a point of sale or processing (FAO,2009; CSA,2001).

There is limited data on hygienic practices throughout the dairy production system in Ethiopia and standard milking protocols do not exist. A recent study of Zelalem, (2010) showed that many farmers do not disinfect teats prior to milking. The study also showed a trend of farmers either not using a towel at all for disinfection or using a collective towel for two or more cows. This practice can clearly lead to the spread of contagious pathogens. The majority of farmers in the study did wash their hands prior to milking. The study did not mention the use of other hygienic practices such as fore-stripping, drying, and post-milking disinfection (Zelalem, 2010).

Many milk collection centers, co-operatives, and processing plants implement quality control measures through two different quality tests: a lactometer reading and an alcohol test. The lactometer combined with a thermometer reading determines the specific gravity of the milk to make sure there is no adulteration. The alcohol test determines if the milk has undergone too much fermentation to undergo further heat treatment. If milk contains more than 0.21% acid it will form curds when combined with alcohol (Zelalem, 2010; Alemu, 2007). The milk is rejected if it fails either of these tests and is often processed into yogurt and butter within the co-operatives or by the dairy producer (Alemu, 2007). Unfortunately, neither of these tests can determine the presence of bacterial pathogens of public health significance (FAO, 2009). As the dairy industry grows throughout Ethiopia, it is essential to develop standards and procedures for determining the quality of milk and dairy products. The government is currently looking into developing a quality-based payment system to encourage smallholder producers, co-operatives, and processors to produce high-quality milk that is safe for the consumers. In order for a quality-based payment system to be successful, smallholder dairy farmers and co-operatives need to have access to the proper equipment to produce quality milk and there must be an obvious return on their investment in such equipment (FAO, 2009).

2.11. Quality of Marketed Raw Milk

The term 'informal' is often used to describe marketing systems in which governments do not intervene substantially in marketing. Dependable system has not been developed to market milk and milk products in Ethiopia (Zegeye, 2003). Fresh milk is distributed through the informal and formal marketing systems. In both rural and urban parts of the country, milk is distributed from producers through the informal (traditional) means. This informal market involves direct delivery of fresh milk by producers to consumers in the immediate neighborhood or to any interested individuals in nearby towns (Debrah and Berhanu, 1991). In many developing countries in spite of the existence of regulations that require milk pasteurization, a high percentage of the milk is sold raw through informal channels where hygienic measures during milking and distribution are not implemented (Omore *et al*.1999). According to Brokken and Senait (1992) the main problems for efficient dairy marketing in the informal sector of SSA are the small quantities supplied per farmer, seasonal fluctuations in supplies, the low volume of milk per square kilometer (low density), poor and seasonally impossible roads, in availability of transport and low level of education about collection and preservation of quality milk. The advantages of the informal system are low cost, with short marketing channels and potentially good prices for producer and consumer, possibility for small farmers to participate in milk production and marketing and limited competition with imported products. Whereas the disadvantages are no payment for quality and fat content, possibilities for adulteration, problems with seasonal fluctuations in production and no public health control. In Ethiopia, 95% of the national milk is marketed through informal channels and unprocessed. The traditional processing and marketing of dairy products, especially traditional soured butter, dominate the Ethiopian dairy sector. Only 5% of the milk produced is marketed as liquid milk due to underdevelopment of infrastructures in rural areas. Hence, the informal (traditional) market has remained dominant in Ethiopia. Production is non-market oriented and most of the milk produced is retained for home consumption (SNV, 2008).

3. MATERIAL AND METHOD

3.1 Description of the study area

The study was conducted at Dale and Loka Abaya districts of Sidama National Regional State. Dale district is mostly midland and partly located in the Great Rift Valley. The District is situated at about 40 km south of Hawassa and at about 320 km south of Addis Ababa. It is located at 6º44’ to 6º 84’ N and 37º 92’ to 38º 60’ E with an altitude range of 1001–2500masl (average 1624 masl). The district receives an annual mean average rainfall of 1170 mm and average annual temperature of 19ºC (SEDPSZ, 2004).

Loka Abaya is lowland district which is located at western border of Sidama region and situated at about 50 kilometers southwest of Hawassa. The District has low rainfall with an erratic pattern during the two rainy seasons; the belg (February to April), and the kiremt rains (July to early October) (USAID 2005).

3.2. Research Design

The study has two parts, namely, survey and laboratory analysis. The survey work was conducted at household level, by using semi structured questioners while determination of physicochemical properties and microbiological qualities of milk samples were collected from producers conducted in dairy Science and technology laboratory of Hawassa University.

3.3 Sampling Procedures and Sample Size

The households in the study area who owned at least one dairy cow were considered for this study. The study employed multistage sampling technique where Firstly, two districts were selected based on agro-climatic distribution namely Dale (midland: 1500 to 2300) and Loka Abaya (Lowland: 1150 up to 1700 masl) which is preferable for production of dairy cows. In the second stage representative kebele from respective strata (district) were selected based on production potential by using purposive sampling method and accessibility. A total of six, i.e., 3 Kebeles from each agro-ecological zone (District) were selected. Finally, a total of 120 households (20 from each Kebeles or 60 from each stratum) who owned dairy cows were selected for interview using purposive sampling method.

3.4 Data collection

The field survey was conducted to assess milk handling and hygienic practices in the study area. A single-visit-multiple-subject survey method was employed (ILCA, 1990). For data collection, semi-structured questionnaire was prepared and pre-tested and the survey was conducted by interviewing people who were involved in production and marketing of milk. Major components of the data collected through survey include: hygienic practices (the frequency of cleaning the containers, milking procedures, limitations associated with clean milk production), type of containers (plastics, woody or metals) used for milking, methods of milk utilization and marketing.

3.5 Milk sample collection and Transportation

A total of 45 raw cow's milk samples were collected at morning from midland households and lowland household to assess the physicochemical properties and microbial quality of raw cows' milk. Twenty five milk samples from midland milk producer households and twenty raw milk samples from lowland milk producer households were selected randomly. The samples were collected from milk containers immediately after milking. Then, approximately 300ml raw milk sample each was taken from the owner's container for analysis. Subsequently, samples were labeled and put in icebox (4°C) to restrict microbial multiplication and transported as early as possible to Dairy Science and technology Laboratory of the Hawassa University to analyze chemical compositions and microbial quality.

3.6. Physical properties of milk samples

3.6.1. pH

The pH of the milk samples were determined in the laboratory using a digital pH-meter based on the procedures described by O'Connor (1995). The pH meter were calibrated using buffers of pH 7.0 and 4.0 each time before the pH of milk samples was measured.

3.6.2 Specific gravity

Specific gravity is the relation between the mass of a given volume of any substance and that of an equal volume of water at the same temperature. According to ILRI (1995), normal cows' milk should have a specific gravity between 1.028 and 1.032 g/cm3. Accordingly, the following formula was used to calculate the specific gravity of the milk.

$$\text{Specific gravity} = (L/1000) + 1$$

Where,

L = corrected lactometer reading at a given temperature, i.e., for every degree above 15.6°C, 0.2 was added to the lactometer reading but for every degree below 15.6°C, 0.2 was subtracted from the lactometer reading.

3.6.3 Titratable acidity of milk

Titratable acidity of the milk samples was determined according to the method of the Association of Official Analytical Chemists (AOAC, 1990). Nine ml of milk sample was pipetted into a beaker and 3 to 5 drops of 1% phenolphthalein indicator was added to it. The milk sample was then titrated with 0.1N NaOH solution until a faint pink color persisted. The titratable acidity, expressed as % lactic acid, was finally calculated using the following formula.

$$\textbf{Titratable acidity \%} = \frac{N/10\,NaOH(ml) * 0.009}{\text{Weight of milk sample}} * 100$$

3.7 Determination of Chemical composition of milk samples

Milk fat, Lactose, Protein and Solids-Not-Fat contents were determined with calibrated milk analyzer (LACTOSCAN S, LSS001, Bulgaria). In addition, appropriate standard laboratory methods were used to determine milk fat and protein. Total solids component of milk was determined by summation of Fat and Solid-Not-Fat component of milk by using the formula for Solids-Not-Fat (SNF %) which was determined by subtracting the percent fat from total solids (O'Mahoney, 1988). Thus, SNF=%TS-%Fat) x 100, and this implies that %TS= %SNF+%Fat, where %SNF is percentage of Solid Not Fat and %TS percentage of total solids.

3.8 Microbiological Quality Tests

The microbial tests considered for determination of the bacterial load in raw milk samples were Standard Plate Count (SPC), Coliform Count (CC), yeast and mould counts using appropriate media. For sample preparation, peptone water was sterilized by autoclaving at 121ºC for 15 minutes. Similarly the Standard Plate Count Agar (Oxoid) used for determination of total viable organisms was sterilized by autoclaving at 121ºC for 15 minutes, while the violet red bile agar (VRBA: Oxoid) used for determination of CC was sterilized by boiling (Richardson, 1985).

3.8.1 Standard plate count (SPC)

For total plate count, appropriate decimal dilutions selected that would give the expected total number of colonies on a plate, i.e., between 30 and 300 colonies were selected (Richardson, 1985). The standard plate count (SPC) agar was autoclaved at 121 °C for 15 minutes and cooled to 45°C before pouring to petri-dish. One ml of milk sample was added into sterile test tube containing nine ml peptone water and serial dilution was conducted up to 10^{-7} with proper mixing before taking the sample homogenate to the next dilution level. Then one ml of the sample homogenate from appropriate decimal dilution was placed on a petri-dish and then molten agar medium (10-15 ml) was poured onto the petri-dish and then it was incubated for 48 hours at 32°C. Finally, colony count was made using colony counter.

3.8. 2 Coliform Count

One ml of milk sample was added into sterile test tube having 9 ml peptone water. After mixing, the sample was serially diluted up to 1x 10^{-7} and duplicate appropriate decimal dilutions were surface plated and incubated at 32^{0}C for 24 hours on Violet Red Bile Agar (VRBA). Typical dark red colonies on uncrowned plates were considered as coliforms and colony counts were made using colony counter (Richardson, 1985).

3.8.3 Yeast and Mold Count (YMC)

Samples of milk were serially diluted following similar methods as for total bacterial count but appropriate serial dilutions were surface plated on yeast and mould Agar (YMA). The dried plates were then incubated at 25°C for 3 to 5 days. Colonies with a blue green color was counted as yeasts and moulds (Yousef and Carlstrom, 2003). The estimated colony count per ml of milk was calculated by using the following formula (IDF, 2001).

$N= \Sigma C/ [(n1x2) + (0.1xn2)]*d$

Where: N= number of colonies per milliliter of milk,

Σ C = sum of colonies on plates counted,

n1 = number of plates on lower dilution counted,

n2 = number of plates on highest dilution counted, and

d = dilution from which the lowest counts are obtained

3.9. Data Management and Statistical Analysis

Data collected during the survey were analyzed by using Statistical Package for Social Science (SPSS) version 20.0 software). The General Linear Model (GLM) procedure of SAS (2012) was used to analyze milk composition and microbial quality. Microbial count data were first transformed to logarithmic values ($\log_{10}$) before subjected to statistical analysis in order to make the frequency distribution more symmetrical. Mean comparisons were done using the Least Significant Difference (LSD) technique when analysis of variance shows significant differences between means. Differences were considered statistically significant at 95% level of significance.

The ranking was expressed as an Index = the sum of (5 times first order + 4 times second order +3 times third order + 2 times fourth order + 1 times fifth order) given for an individual variables divided by the sum of (5 times first order + 4 times second order +3 times third order + 2 times fourth order + 1 times fifth order) for all variables.

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

$$Yij = \mu + \beta i + eij$$

Where, Yij = individual observation for each test

μ = the overall mean

β = the i^{th} effects of Agro ecology (i=1.Midland , 2. Lowland)

eij = the error term

4. RESULTS AND DISCUSSION

4.1 Household Characteristics

The overall mean family size was 5.88±1.34 (Mean±SD) and there was significant difference between agro ecologies (*P<0.01*). Higher family size was found in lowland than in midland (Table 1). The average family size in the current study was lower than the finding: 8.9±0.5 and 7.5±2.5 reported by Zewide, (2010) and Debir, (2016) respectively, while comparable with average family size of 6.5 reported by Central Agricultural Census Commission (CACC, 2011). The overall mean age of respondents was 42.88±10.73 (Mean±SD) and which was not significantly different between the two study areas (*P>0.05*). The current result obtained for age of respondents was lower than the average age of 47±1.7 reported by Zewide, (2010). Out of 120 respondents interviewed, the majority (72.5%) was male and 27.5% were females. The current result was comparable with that reported by Ketema (2014) who found 80% males and 20% females in their study area in Kersa Malima woreda. The respondents have various educational backgrounds which varied significantly (*P<0.01*) between the two agro-ecologies. Overall, 35% of total respondents were illiterate of those higher percentage are from the lowland (50%) which significantly differed (*P<0.05*) from midland. The higher percentage of illiteracy in lowland district could be due to shortage of access to education center as compared to midland district. The percentage illiteracy reported by Beriso et al. (2015) was only 10% as compared to the present result in Aleta Chuko District, Southern Ethiopia. However, the percentage of illiteracy was less than the value reported by Ketema (2014) who illustrated 60% of illiteracy in Kerisa Malima district.

Table: 1 Household characteristic in the study area

	Agro ecology				
Variable	Midland (N=60)	Lowland (N=60)	Overall (N=120)	X^2	P-value
Family size	5.50±1.033	6.27±1.57	5.88±1.342	10.6	0.001
Age (yrs)	42.80±11.099	42.95±10.43	42.88±10.73	0.006	0.939
Sex				0.375	0.540
Male	42 (70)	45 (75)	87(72.5)		
Female	18 (30)	15 (25)	33 (27.5)		
Educational level				19.172	0.000
Illiterate	10^{b}(16.66)	32^{a}(53.33)	42(35)		
Elementary	34^{a} (56.66)	17^{b} (28.33)	51 (42.5)		
High school	12^{a} (20)	10^{b} (16.66)	22 (18.33)		
Diploma	4^{a} (6.66)	1^{b} (1.66)	5 (4.16)		

N= Numbers of respondents, Number in brackets indicates proportion of respondents and column proportion with different subscript deferrer significantly at $P<0.05$.

4.2. Hygienic Quality of Milk during Productions

4.2.1. Barn types and cleaning practices

According to Yetera, et al., (2018), It is very crucial to provide appropriate conditions for rearing dairy cows by reducing the extreme effects of climate such as heat and moisture which reduces their productivity and quality of milk. In this regard good housing management plays an important role in reducing stress due to exposure to tremendous temperature and moisture which in turn affect their performance. The data of barn cleaning frequency were presented in Table 2. All of the respondents provides traditional barn which is made up of locally available materials.

Maintaining the sanitary condition of barn is important for the production of good quality milk. Clean, dry and comfortable bedding condition is important to minimize the growth of pathogenic microorganisms. As observed in the present study all of the respondents have traditional barns and did not use bedding material for their animals. Practices that expose the teat end to organic bedding sources, wet and muddy pens increase the risk of occurrence of mastitis and milk contamination (Ruegg, 2006). Majority of respondents (72.5%) reported that their barn is cleaned once a day, corresponding to Midland 75% and Lowland 70%. However, proper and clean housing environment is a prerequisite to produce milk and milk products of acceptable quality (Asaminew, 2007).

Table 2. Frequency of barn cleaning in the study area

Variables	Agro ecology		
	Midland (N=60)	Lowland (N=60)	Overall (N=120)
Frequency of cleaning of barn			
Once per a day	45(75)	42 (70)	87(72.5)
Twice per a day	9(15)	8(13.33)	17(14.16)
Once in two day	6(10)	10(16.67)	16(13.33)

N= Numbers of respondents, Numbers in brackets represents proportion of respondents

4.2.2. Milking and Milk handling practices

In Ethiopia, there is no standard hygienic condition followed by producers during milk production. The hygienic conditions are different according to the production system, adapted practices, level of awareness, and availability of resources (Zelalem, 2003). Traditional hand milking was the common practice and milking operation was mainly carried out by women (about 70.8%) as shown in Table 3. Ayantu (2006), Rahel (2008), Derese (2008), and Haile *et al.* (2012) also reported a similar situation. Husbands are also involved in milking of cows next to housewives and daughters. The proportion of households involved in washing of teats/udder before milking were varied significantly ($P<0.01$) between the two agro-ecologies. All lowland respondents believe that during calf suckling for milk let-down, the teat get washed by the saliva of calf and therefore it is not as such important to wash the teat before milking than that of Midland respondents. All of the respondents indicated that they milk their cows two times a day.

Hygienic production of milk is important for the safety of consumers. If the hygienic standards of production and handling are poor, the keeping quality of milk will also be very poor especially at high prevailing ambient temperatures and there will be a very high risk of spoilage (Van den

Berg, 1988). Good quality milk production is one of the objectives in dairy farming, in either large or small-scale farms since milk of good quality is desirable and hence saleable to the processors and acceptable by the consumers. Provision of milk and milk products of good hygienic quality is desirable from consumers' health point of view. Most losses of dairy products occur as a result of a combination of poor production and /or handling practices and lack of technical knowledge. Among others, lack of knowledge on clean milk production, use of unclean milking equipment coupled with lack of potable water for cleaning purpose probably contributed to the poor hygienic quality of dairy products produced in central Ethiopia (Zelalem and Faye, 2006). In the present study, majority of the respondents (70.83%) reported that; they do not get training previously on milk handling system, milk utilization, preservation and marketing. While there remaining 29.16% of them got training offered by different Non-Governmental Organizations. Milk can be contaminated by microorganisms at any point from production to consumption. FSA (2006) indicated that cleaning of the udder before milking is important to remove both visible dirt and bacteria from the outer surface of the udder. Getachew (2003b) also indicated that milk producers should follow hygienic practices (clean utensils, washing milkers hands, washing the udder, use of individual towels) during milking and handling, before delivery to consumers or processors. In this study, the result showed that 78.33% of the milk producers did not wash their hands during milking (table 3). Moreover, all of the respondents do not use towel to clean the udder. This is a potential source for the contamination of milk with microorganisms during milking.

Table 3. Milking practices used in the study area.

Variable	Agro ecology Midland (N=60)	Lowland (N=60)	Overall (N=120)	X^2	p -value
Milking Procedure				**24**	**0.000**
Udder washing before milking	20^{a}(33.33)	0^{b}(0.00)	20(16.66)		
No udder washing before milking	40^{b}(66.66)	60^{a}(100)	100(83.34)		
Hand Wash				**12.570**	**0.000**
Milkers washing hands	21^{a} (35)	5^{b} (8.33)	26(21.67)		
Milkers not washing hands	39^{b} (65)	55^{a}(91.67)	94(78.33)		
Milkers				**1.008**	**0.604**
Women	40(66.67)	45 (75)	85 (70.8)		
Daughter	8 (13.33)	6 (10)	14 (11.67)		
Men	12(20)	9 (15)	21 (17.5)		
Training				**0.391**	**0.532**
Yes	17 (28.33)	14 (23)	31(29.16)		
No	43 (71.67)	42 (77)	85 (70.83)		

N= Numbers of respondents, Number in brackets indicates proportion of respondents and column proportion with different subscript deferrer significantly at $P<0.05$.

4.2.3. Milking Utensils and transporting equipment

Hygienic milk handling practice should take into account the sanitation of milking environment, the milker and utensils used to collect and store milk. This is because, equipment used for milking, processing and storage determine the quality of milk and milk products and this has even be supported by earlier studies (Abebe et al., 2012). According to this study, 71.67% of the producers in midland and lowland have used primarily clay pot as milking equipment and the rest of producers have used plastic bucket (14.17), Wooden container (7.5) and calabash (5.83) respectively (Table 4). Similar study reported that clay pot was major vessel used to store milk in the Mid Rift Valley of Ethiopia (Negash et al., 2012). The statistical test has indicated that there is no significant difference between the two Agro ecologies in the types of milking and transporting equipment's used ($p > 0.05$). According to the local understanding, clay pot is mainly used as milking utensil because it is locally made, easily available and affordable even for lower income households. Even though clay pot could be perceived to minimize the likely temperature of the environment, it is not designed for easy and proper cleaning. Moreover, its porous nature easily harbors bacteria and also makes hygienic cleaning inconvenient and ineffective. As a result, it is more likely to inflict milk spoilage, and consequent quality deterioration and health_risks. Plastic bucket and calabash are the second and third commonly used milking equipments in the study districts, respectively.

Types of milk containers determine the qualities of milk, especially during transportations of milk to the selling point. Milk storage and transportation are aimed at having good quality milk available where and when needed for processing (Walstra *et al.*, 1999). Therefore, producers need to pay particular attention for the type as well as cleanliness of milk equipment.

In the study area, majority of the respondent use plastic equipments (67.5%) and rest of respondent use stainless steel (32.5) for transportation.

Table 4. Types of milking vessel and transporting tools

	Agro-ecology				
Variable	Midland (N=60)	Lowland (N=60)	Overall (N=120)	X^2	p –value
Milking Utensils				**1.105**	**0.776**
Clay pot	44 (73.33)	42 (70)	86 (71.66)		
Plastic bucket	9 (15)	8(13.33)	17(14.17)		
Wooden container	3 (5)	6(10)	9(7.5)		
Calabash	4 (6.66)	4 (6.66)	7(5.83)		
Transporting tools				**0.342**	**0.559**
Plastic Equipment	39(65)	42(70)	81(67.5)		
Stainless steel	21 (35)	18 (30)	39(32.5)		

N= Numbers of respondents, Number in brackets indicates proportion of respondents and column proportion with different subscript deferrer significantly at $P<0.05$.

4.2.4 Cleaning and smoking milk equipment

Degree of cleanliness of milking equipments depends on the procedure which is adopted for cleaning and sanitizing. For example there will be less number of resistant and thermoduric bacteria on the surface of equipments which are washed with hot water. If in spite of hot water cleaning some milk residue left behind- growth of these types of organisms will be slow but persist. Effective use of sanitizing agents like chlorine and iodine reduced the number of psychrotrophic bacteria which are the result of the neglect of proper cleaning, sanitizing and inefficient refrigeration. In case cracked milking equipments large number of bacteria enter and grow in the cracks, are difficult to clean (Druce et al., 2007). Majority of households in the study area were practicing washing and smoking of the milking utensils regularly before and after milking. Procedures of cleaning and disinfection of milking utensils prior to milk collection reported here in, were similar to previous results from Ethiopia (Gonfa et al., 2001; Mohammed, 2003; Sintayehu et al., 2008).

According to the local understanding, the practice of smoking the vessel by burning wooden chips of specific trees has an advantage of imparting special taste and odour to the product, and to disinfect the vessels, thus reducing the numbers of micro-organisms and thereby Extending the shelf life of the product. Similarly, low acid production was observed in milk samples stored in smoked containers (Helen and Eyasu, 2007). Therefore efficient cleaning and sanitation of dairy farm utensils could help to improve the quality of raw milk and its products.

Plants species that are frequently used for smoking milk vessels in the study area were *Olea africana* (Ejersa), *Terminalla brownii (*Bireessa), and Hoomiicho (*juniperous procera*). These are the most frequently used plant species for smoking milk vessels in the study area (Table 5). As respondents reported, the reasons that they use these plants were that: they give good flavor, aroma and increase shelf life of the milk as well as slow milk fermentation process. As Fekadu, (1994); Alganesh, (2002); Lemma, (2004), and Zelalem and Faye, (2006) reported that *Olea africana* is the most frequently used plant for smoking milk containers in other parts of the country.

Table 5. Plants used for smoking of milk utensils in the study area.

Parameter		Midland (60)				Lowland (60)			
		Rank				Rank			
		1	2	3	Index	1	2	3	Index
Olea Africana	Ejersa	37	16	7	0.42	39	13	8	0.42
Terminalla brownie	Bireessa	19	34	7	0.37	18	37	5	0.37
Juniperous procera	Hoomiicho	4	10	46	0.22	3	10	47	0.21

Index = [(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) used for smoking of milk utensils]/[(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) for all smoking of milk utensils]

4.2.5. Source of water used for cleaning

The main sources of water in the study areas used for cleaning propose are indicated in table 6. Majority of respondents used Pond (48.83) and the rest of respondent have used river (13.33), spring 17.5% and Tap water 20.33% for cleaning purpose The proportion of households involved in the water source and water handling /Treatment had no significant difference between the two agro-ecologies ($P > 0.05$). Bonfoh *et al., (*2006) reported that, besides udder infection and water quality, hygienic behavior with respect to hand washing, containers cleaning and disinfection are the key areas that need hygiene intervention. About, 70% of the respondents used cold water while 30% of them used warm water for cleaning milk utensils in the study area. When water from non-tap sources is used for cleaning purpose, it is important that producers should at least filter and heat treat it before use because the quality of water determines the amount of bacterial counts (Zelalem 2009).All of the respondents they indicated washed, smoked and cleaned milk utensils regularly before and after milking.

Table 6, Water source and Water handling/treatment in study area.

Variable	Midland (N=60)	Lowland (N=60)	Overall (N=120)	x^2	p- value
	Agro-ecology				
Source of water				1.367	0.713
Pond	28 (46.67)	30(50)	58 (48.83)		
River	7 (11.67)	9 (15)	16(13.33)		
Spring	10 (16.67)	11(18.33)	21(17.5)		
Tap water	15 (25)	10 (16.67)	25(20.83)		
Water handling/treatment				1.429	0.232
Boiling water	15(25)	21 (35)	36 (30)		
unboiled water	45(75)	39 (65)	84 (70)		

N= Numbers of respondents, Number in brackets indicates proportion of respondents and colu proportion with different subscript deferrer significantly at *P<0.05*.

4.3 Milk Marketing

4.3.1 Milk Marketing and its Constraints

As it is common in other African countries, dairy products in Ethiopia are channeled to consumers through both formal and informal dairy markets (Ahmed *et al*., 2003). In line with this, in current study areas milk was marketed in informal ways (i.e. from producers to consumers directly and also from producers to local traders).

In the study area, individual producer sell fresh whole milk for Hotel and cafeteria in the form of rent and retail as common practices (Table 7). Lemma *et al*. (2005) reported that many farmers did not sell fresh whole milk in Eastern Shoa zone and Eastern Wollega mainly due to scarcity and cultural restriction. However, unlike in the study area farmers, selling of fresh whole milk was common now. Milk and milk product marketing was entirely done by the women and young females. The purpose of milk marketing did not significantly vary ($P>0.05$) between the different agro-ecologies. In the current study, the major outlet for fresh milk markets is: individuals (51.17%) while the rest of the outlets were retailers (28.33%) and 'hotels and cafeteria' (20%) respectively. The proportion of households problem of marketing fresh milk and Spoilage of raw milk due to market problems varied significantly ($P<0.01$) between the two agro-ecologies. About 75% of the respondents in lowland reported marketing problem of fresh milk than that of Midland respondents. The major problem in marketing of milk were spoilage of milk due to long distance to reach market place, lack of market outlet for the lowland residing at the distant place from the road and the market, and lack of milk collection centers.

Table 7 .Market outlets and fresh milk marketing problems in the study area.

Variable	Agro-ecology Midland (N=60)	Lowland (N=60)	Overall (N=120)	x^2	p- value
Sales outlets				3.790	0.150
Individuals	30 (50)	32 (53.33)	62(51.17)		
Retailers	14 (23.33)	20 (33.33)	34 (28.33)		
Hotels and Cafeteria	16(26.67)	8(13.33)	24 (20)		
Marketing problems					
Problem of marketing fresh milk				20.979	0.000
Yes	20^a(33.33)	15^b (25)	35(29.17)		
No	40^b(66.67)	45^a (75)	85(70.83)		
Spoilage of raw milk due to market Problem.				48.348	0.000
Yes	13^b (21.67)	51^a (85)	64(53.33)		
No	47^a (78.33)	9^b(15)	56 (46.67)		

N= Numbers of respondents, Number in brackets indicates proportion of respondents and column proportion with different subscript deferrer significantly at *P<0.05*.

4.4 Major Milk Quality Related Constraints

Milk quality related constraints ranked during group discussions with the respondents are summarized in Table 8. The major milk quality related constrains in the study area include: Mastitis can affect milk quality directly through changes in technical and hygienic milk quality, resulting in less efficient processing of milk, and might result in products with less favourable properties. Examples are unstable and rancid taste of milk, a lower cheese yield and a decreased shelf life, which means economic damage to the dairy industry (Hogeveen, 2005). Mastitis can be a threat to human health due to bacterial contamination tick, lack of knowledge on hygienic handling, lack of clean water and cultural taboo. All these factors negatively affect the quality of milk and milk products.

Table 8.Milk quality related constraint in study area

	Priority level						
	1	2	3	4	5		
Constraints						Index	Rank
Midland (60)							
Mastitis(udder disease)	84.4	15.5	0	0	0	0.32	1
Tick	15.5	13.3	11.1	0	0	0.27	2
Lack of knowledge on Hygienic handling	0	8.9	82.2	6.2	2.2	0.21	3
Lack of clean Water	0	0	2.2	40	57.8	0.16	4
cultural taboo	0	4.4	4.4	51.1	40	0.12	5
Lowland (60)							
Mastitis(udder disease)	86.7	13.3	0	0	0	0.32	1
Tick	11.1	53.3	35.6	0	0	0.25	2
Lack of Knowledge of Hygienic Handling	0	35.6	64.4	0	0	0.22	3
Lack of Clean Water	0	0	0	62.2	37.8	0.11	4
Cultural taboo	0	0	0	37.8	62.2	0.09	5

Index=the sum of (5 times first order + 4 times second order +3 times third order + 2 times fourth order + 1 times fifth order) for individual variables divided by the sum of (5 times first order + 4 times second order +3 times third order + 2 times fourth order + 1 times fifth order) for all variables.

4.5 Physicochemical properties Raw cow milk

The results of physical properties and chemical composition of cow's raw milk samples which were collected from Midland and lowland household milk producers are shown in Table 9.

4.5.1 Physical properties of Milk

The specific gravity of milk samples from both Agro ecologies were within limits of Ethiopian Standard /1.026 - 1.032/ and indication of free of adulterations. In this study, the specific gravity of the milk samples from both Agro ecology didn't show significant ($P>0.05$) difference. Similar results of 1.028, 1.0312, 1.030 and 1.030 were reported by Teshome Gemechu and Tesfaye Amene (2015), Mohamed et al., (2010), Teshome Gemechu et al.,(2015), Teklemichael Tesfay et al.,(2015) respectively. The Titratable acidity was another important parameter that indicates development of acid-producing microbes and lactose fermentation in the milk as well as an indicator of freshness of milk. According to Ethiopian standard normal fresh milk has titratable acidity of (0.2%). However, in this study, titratable acidity ranges from 0.16 to 0.23%. Higher titratable acidity / 0.23%/ was recorded from samples of Lowland and lower titratable acidity / 0.16%/ was result of samples from Midland (Table 9). This might be associated with the nature of the equipments used for milking (Clay Pots; it is not designed for easy and proper cleaning), milk contamination from the udder as the majority of producers do not practice washing the udder prior to milking, the milker and the source of feed the animals fed and might be subclinical mastits be also responsible for this. According to this study milk samples from both agro ecologies of the study area failed to qualify for Ethiopian standard. Related results of 0.25, 0.215, 0.29 and 0.22% were reported by Eklemichael Tesfeye et al., (2015), Leggese et al., (2017), Teshome Gemechu et al., (2015), and Gurmessa Terfa et al., (2015) respectively in cow milk from producer and market. The pH has a significant difference between Agro ecology. Significantly lower pH of 6.25 and 6.56 was observed in Lowland and Midland milk samples. However, milk samples collected from both agro ecologies had pH values lower than the one indicated in Ethiopian standards for fresh milk (6.6 to 6.8). Similar results of 6.39, 6.32 and 6.195 were reported by Gurmessa Terfa et al, 2015, Teshome Gemechu et al., 2015, and Legesse et al., 2017, respectively in milk from farms and market.

Table 9.(Mean ± SD) of physicochemical properties of raw cows' milk obtained from Midland and lowland household milk producers in study area (n = 45)

	Agro-ecology			
Variable	Midland (N=25)	Lowland (N=20)	Overall (N= 45)	p- value
SG	1.0287±0.0025[b]	1.0296±00173[a]	1.0296±0.0022	0.191
Ph value	6.56±0.156[b]	6.25±0.257[a]	6.42±0.256**	0.000
TA	0.165±0.0394[b]	0.239±0.0459[a]	0.197±0.056**	0.000
Fat	4.988±0.273[a]	4.79±0.4811[b]	4.9±0.388	0.089
Protein	3.17±0.237[a]	3.07±0.156[b]	3.13±0.21	0.105
Lactose	4.73±0.497[a]	4.565±0.349[b]	4.67±0.441	0.222
SNF	8.26 ±0.115[b]	8.37 ± 0.13[a]	8.31 ±0.132*	0.006
Total solid(TS)	13.56±0.28[a]	13.42 ±0.52[b]	13.49 ±0.41	0.222

Means followed by different superscript letters within a row are significantly different ($P < 0.05$), Where :- TS- Total solid, SNF-Solid not fat, TA-Titratable Acidity, SG- Specific Gravity.

4.5.2 Chemical Composition of Milk

The composition of milk have crucial role in the manufacturing of milk products. The mean contents of Fat, Protein, Solid-Not-Fat, Lactose and Total Solids of the cow milk were presented in Table 9. The overall mean of fat (4.9±0.388) obtained in the current study was higher than mean value of 4.17% was reported by Bekele et al. (2015) in urban and peri urban area of Dangila town, Western Amhara Region, Ethiopia, 4.71 reported by Asaminew (2007) in Bahridar milk shed and 4.28±0.05 reported by Teshome (2013) in Shashemene town. Fat value obtained in the current study fall within the acceptable range which is between 2.5 to 6.0% (O'Connor, 1994). The Ethiopian Standard Agency set the minimum fat percent for whole (fresh milk) not to be less than 3.5 percent (ESA, 2009). Thus, the current finding also fullfilled the requirement for standard set by ESA (2009) for fresh milk. The Lactose and protein content of milk do not vary among location (P>0.05).The overall mean of Lactose (4.67) obtained in the current study was comparable with 4.34±0.13 reported by Belay and Janssens (2014) in smallholder urban dairy farms in Jimma Town of Oromia Regional State, Ethiopia, 4.43±0.06 was reported by Teshome (2013) in Shashemene town and slightly lower than 5.08% reported by Alganesh (2016) in central highlands of Ethiopia. According to O'Mahony (1998) the lactose content of fresh milk should fall between 3.6 to 5.5% and the percentage of lactose recorded for the current study (4.67±0.441) is within the range established. The overall mean protein obtained in the current study was lower than 3.71% reported by Bekele et al. (2015), for local and comparable with 3.34% for cross bred respectively, in urban and per urban area of Dangila town, 3.31% protein reported by Alganesh et al. (2007), 3.46±0.04 by Fikrineh et al. (2012), 3.29±0.05 reported by Getachew et al. (2016) in Angolelanatera district, Amhara region, Ethiopia and slightly higher than 2.81 reported by Adebabay (2009) at Bure district. Protein content of milk in the current study falls within the acceptable range of 2.9 to 5.0% (O'Connor, 1994). Solid-Not-Fat (8.31±0.32) obtained in the current study was higher than 7.79±0.63 reported by Belay and Janssens (2014) in smallholder urban dairy farms in Jimma Town of Oromia Regional State, Ethiopia and comparable with 8.22% SNF reported by Alganesh et al. (2007) in East Wollega, Ethiopia, and also with 8.56% reported by Alganesh (2016) in Central Highlands of Ethiopia and lower than 9.10±0.09 reported by Fikrineh et al. (2012) and also with 9.46% reported by Gurimessa et al. (2015) in Borana Zone, Yabello District. The current result for SNF is slightly lower than standard set by European Union Quality Standard for unprocessed whole milk which states solid-not-fat should not be less than 8.59% (Tamime, 2009). This variation could possibly be related to management practices in different localities which have important effect on milk composition quality. Total Solids in current study was higher than 12.24% of Total Solids reported by Aliganesh (2016) in central highlands of Ethiopia and 12.87±0.11 reported by Teshome (2013) in Shashemane town. European Union, recognized quality standards for total solids content of cow milk is not to be less than 12.5% (FAO, 2007) and thus TS in current finding is in acceptable range.

4.6. Microbial Quality of Raw Cows' Milk

The microbial count results of cows' milk produced in the study area is presented in Table 10.

Bacterial counts in milk reflect the level of hygiene practiced during milking and milk collection, the storage temperature and the time elapsed since milking (Soler *et al.,* 1995). While total bacterial counts mainly reflect the time elapsed since milking or the processing at ambient temperature, coliform bacteria generally reflect fecal contamination due to poor hygiene. According to Reinemann *et al.,* (1999) bacteriological contamination of raw milk can occur from organisms that can contaminate milk from environmental sources and from shedding of mastitis organisms within the udder. In addition, Aumaître (1999) described that the health of the dairy herd, milking and pre-storage conditions are also basic determinants of milk quality. However, due to its high water activity and nutritional value it serves as an excellent medium for growth of many kinds of microorganism under suitable environment (Mesfin et al., 2017).

4.6.1 Total bacterial count

The total bacterial count obtained in this study is generally high compared to the acceptable level of 1×10^5 bacteria per ml of raw milk (O'Connor 1994). The total bacterial count obtained from lowland household producer was significantly higher ($P < 0.05$) than milk samples collected from Midland household producer (Table 10). This might be due to further contamination of the milk during transportation, use of poorly cleaned milk containers and absence of cooling system. In general, higher total bacterial count of milk samples obtained from study areas could be attributed to improper cleaning of the udder and milking containers before and after milking, failure to use towel for each cow, improper cooling system and milk contamination from the hands of producers. In the present study, total bacterial count of raw cow milk collected from two areas were lower than that reported by Ahmed et al. (2008) who found high total bacterial count of (9.089 ± 0.281 log10 cfu/ml) in milk samples collected from dairy farms of Khartoum State. The mean total bacterial count of raw cow's milk (7.64 log10 cfu/ml) obtained in this study was lower than the earlier findings of Zelalem (2010), Haile et al. (2012) and Teklemichael (2012) who reported a total bacterial count of 9.10 log10 cfu/ml for milk samples collected from different parts of Ethiopia, 10.28 log10 cfu/ml from distribution containers (at selling point) and 9.137 log10 cfu/ml from vendors, respectively. Milk produced under hygienic conditions from healthy cows should not contain more than 5×10^{4} bacteria per milliliter (O' Connor, 1993). Higher total bacterial count observed in the present study could probably be due to lack of knowledge about clean milk production, use of unclean milking utensils and plastic containers for collecting and keeping milk, initial contamination of the milk samples either from the udder of the cow or the milkers hand and the poor hygienic quality of milking area.

Table 10. Mean (±SD) microbial counts (log10 cfu/ml) of raw cow's milk samples collected from two Agro ecologies (n=45)

Variable	Agro-ecology Midland (N=25)	Agro-ecology Lowland (N=20)	Overall (N= 45)	X^2	p- value
TBC	7.4^{b}±0.70	7.93^{a} ±0.788	7.64±0.777	5.557	0.023
CC	5.46^{b}±0.78	6.43^{a}±0.653	5.89±0.869	19.738	0.000
YMC	3.94±0.29	4.02±0.32	3.97±0.30	0.766	0.386

TBC= Total Bacteria count, CC= Coliform count, YMC= Yeast and mould count, N= number of samples

4.6.2 Coliform count

The mean coliform count in milk samples collected was significantly different (P<0.05) between agro ecologies (Table 10). The coliform count obtained from midland producers was significantly lower (P<0.05) than milk sample obtained from lowland producers .The overall mean of coliform count observed in raw cow's milk samples collected from Midland and lowland producers were 5.46±0.78 and 6.43±0.653 log10 cfu/ml, respectively (Table 10). The coliform count obtained in the current study was greater than that reported by Abdalla and Elhagaz (2011) who found coliform counts of 2.23±0.136 log10cfu/ml from milk samples collected at Khartoum State dairy farms. On the other hand, Zelalem and Bernard (2006) obtained higher coliform count of 6.57 log10 cfu/ml for raw cow's milk collected from different producers in the central highland of Ethiopia. In the current study area, some animals are kept in muddy barn and hygienic conditions were poor. This possibly has exposed the milk to high risk of contamination, which in turn increase the microbial count. The existence of coliform bacteria in high production is suggestive of unsanitary condition or practices during production or storage. According to the European Union standards for total bacterial and coliform counts of raw milk should be less than 10^5 and 10^2 cfu/ml, respectively (Fernandes, 2009). The present study showed that the coliform count of all milk samples exceeds the standards given for raw milk by European Union and US regulations (Fernandes, 2009). Generally, the presence of high numbers of coliforms in milk indicates that the milk has been contaminated with fecal materials, unclean udder and teats of cows, inefficient cleaning of the milking containers, poor hygiene of milking environment, contaminated water and cows with subclinical or clinical coliform mastitis can all lead to elevated coliform count in raw milk (Jayarao et al., 2004).

4.6.3 Yeast and mould count (YMC)

The mean of YMC were 3.94±0.29 and 4.02±0.32 log10 cfu/ml for milk samples collected from the midland and lowland milk producers, respectively. Mean value of yeast and mould counts was not significantly different ($P<0.05$) between milk samples collected from two agro ecologies (Table 10). However, numerically the YMC of lowland milk producers was higher than the milk samples obtained from midland milk producers. Teshome et al. (2014) reported higher overall mean Yeast and mould counts of 4.206 ± 0.082 for milk sample collected from small scale milk producers, small shops, hotels and dairy cooperative milk collection centers. Numerically higher YMC observed in milk obtained from lowland milk producer might be attributed to contamination from air, containers or poor personal hygiene of milk handler.

5. SUMMARY AND CONCLUSION

5.1. Conclusions

The current study aimed to determine the handling practices, physicochemical properties and Microbial quality of raw cow's milk in the supply chain of Dale and Loka Abaya District, Sidama Regional State, Ethiopia. Accordingly, physicochemical properties of milk obtained from the study area were mostly within the range of national and international standards. However, the microbial qualities of raw cow milk produced from two agro ecology do not meet the national and international standards set by regulatory agents. This might be due to the poor hygienic condition of the milking environment including absence of separate area for milking and failure to clean milking areas regularly, absence of cooling system, poor sanitary condition of the milk containers, poor udder and teats cleaning practice, failure to use separate towel for each cow, use of plastic buckets, keeping the milk at room temperature and poor personal hygiene of the milkers.

5.2. Recommendations

Based on the above findings corrective measures should be taken to improve the quality of milk produced and marketed in the study area. Thus the following recommendations are given to address the problems:

- Proper hygienic handling of milk and milk products should be practiced through washing the milking containers, use of separate towel in udder washing and drying off udder, use of stainless steel containers instead of plastic containers for transporting, collection and storage of milk.

- Controlling milk quality system along the dairy value chain, i.e., from milk producers until milk reaches the consumers and reducing the spoilage of milk produced through establishing milk collection centers, cooling facilities at collection point and sheds need to be considered.

- Further study with wider area coverage is needed to identify the different species of Microorganisms that might affect milk qualities.

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8. Appendix/Questionnaires

Assessment of Hygienic Practices on Raw Cow's Milk Produced in Dale and Loka Abaya District, Sidama Region, Ethiopia

Dear respondent:

This questionnaire is used to get background information concerning on Hygienic practices (frequency of cleaning the containers, detergents use for washing of the utensils, milking procedures, methods of milk utilization and limitations associate with clean milk production).

Instructions:

To full fill the questionnaire you are kindly requested to follow the following rules. In the space provided, give short answers and description. For questions that have multiple choice **encircle** on the given alternative.

I. General information

1. Date: _________________, GPS reading: Alt._______lalt._________longt .___________

2. Enumerator name: _____________________________

3. Respondent name: ____________________________. Zone: __________________

District ____________________ Kebele/PA ______________ Sex: ________

II. Household size and age distribution

1. Respondent position at the house hold (HH) ___________________
2. Respondent sex A. Male B. Female
3. Age (Years) ________,
4. Total Family size ___________________

III. Educational level of the owner/respondent:

A, Illiterate B, Primary school not finished C, Primary school finished

D, High school not finished E, High school finished F, TVET not finished

G, Complete TVET

IV. Barn facilities and ease for cleaning

1.What type of barn do you own?

A) Traditional barn (free stall) B) Modern barn with individual cattle pen

C) Modern barn without individual cattle pen D) Open barn (only fence)

2. Bedding materials used?

a. grass and/or cereal straw b. no bedding material c. others (indicate)

3. How frequent do you clean the barn?

a. Once per aday b. Twice per aday c. once a week d. once a month
e. do not clean f. others (specify)

V. Milk production and Hygienic practices during milking.

1. Number of lactating dairy cows do you have? ____________

2. Which milking procedure used?

a. Hand b. Machine c. Both

3. Milking frequency per day: a. Once b. Twice c. three or more times

4. What is average daily milk yield per cow in your farm? _______L/day

Highest _______ Lowest ______

5. Did you got training previously on milk handling system, utilization, preservation and marketing? a. Yes b. No

6. If yes, who gave the training? a. GO's b. NGO's c. others (specify)_______

7. For how long was the training given

a. less than 5 days b. one week c. two weeks d. Other (specify)__________

8. Do you Wash your hands before milking? a. Yes b. no

9. If yes, what type of water do you use? A. Tap water, B. Ground water C. River D. Bore hole E. Other (Specify)

10. Do you heat treat the water you use for hand and dairy equipment washing?

A. Yes B. No

11. Are you washing the udder during milking? a. Yes b. no

12. If yes, when do you wash the udder? A. Before milk b. After milking

c. Both

13. Do you use towel during milking? a. Yes b. no

14. If yes, how? A. Use one towel per cow (Individual) B. Use one towel two cows and more (Collective)

15. Do you wash milking equipment a. Yes No

16. If yes, what type of water do you use? A. Tap water, B. Ground water C. River D. Bore hole E. Other (Specify)

17. Do you wash milk storage equipment a. Yes No

18. If yes, what type of water do you use? A. Tap water, B. Ground water C. River D. Bore hole E. Other (Specify)

19. Do you smoke milking/milk handling equipment? A. Yes B. No

20. If yes, what is the smoke you use

____

21. Why do you prefer these plants/smokes over the other?

____

VI. Milk utensils and Preservation

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

a. Pond b. Wells (spring)

c. River d. Tap water

e. Others (Specify)____________

2. Do you heat-treat/warm the water before using it for cleaning? a. Yes b. No

3. What type of equipment/material do you use for milking?

a. Clay pot b. Stainless steel

c. Plastic equipment d. Wood e. Others (Specify) ____________________

4. Is milk containers cleaned regularly before and after milking? a. Yes b.No

5. What do you do for cleaning the milking container?

a. Washing c. both

b. smoking d. if any (specify)____________

6. If you smoke, what types of plant do you use

1. _____________________ 2. _______________________

3._____________________ 4.___________________________

7.Why do you use these plants?

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

d. It just a tradition c. Facilitate fermentation

e) Other (specify)______________

8. Do you use cooling system for milk? a. Yes b. No

9. If yes how? a. Refrigerator b. At room temperature

c. Traditional cooling d. If others ___________________

VII. Utilization and Marketing of milk

1. Do you use raw milk for home consumption? a. Yes b. No

2. Do you heat treat/boil the milk before consumptions? a. Yes b. No

5. Do you sell fresh whole milk? 1. Yes 2. No

6. What is the means of transportation to take the milk to the market?

a. On foot b. On animal back

c. Car d. Other means (specify) ______________

7. What type of equipment do you used for the transportation processes while marketing?

a. Clay pot b. Plastic equipments (jar, highland, etc) c. Stainless steel
d. Woods e. Others (Specify) _______________

8. Distance of the market place from your home? __________________ in hours

9. Do you use cooling system for milk at market place? a. Yes b. No

10. If yes how? a. refrigerator b. At room temperature

c. Traditional cooling d. If others ___________________

VX. Milk quality related constraints

1. What are the major problems related to quality of clean milk productions? Rank them according to their importance.

Constraints	**Rank** (1st, 2nd, etc.)
Lack of clean water	
Lack of flavoring plants	
Lack of knowledge on hygienic handling	
Udder health problem (mastitis)	
Type of materials used for milking	
Tuberculosis (TB)	
Type of barn	

2. Any comment that you want to make concerning milk quality, utilization and marketing:

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Thank you for your cooperation