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PHYSICOCHEMICAL PROPERTIES AND MICROBIAL QUALITY OF COW MILK
COLLECTED FROM SELECTED SUBCITY OF ADDIS ABABA, ETHIOPIA

MSc Thesis



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June, 2016
Bishoftu, Ethiopia

PHYSICOCHEMICAL PROPERTIES AND MICROBIAL QUALITY OF COW MILK
COLLECTED FROM SELECTED SUBCITY OF ADDIS ABABA, ETHIOPIA



A Thesis submitted to College of Veterinary Medicine and Agriculture of Addis Ababa
University in partial fulfillment of the requirements for the degree of Master of Science in
Tropical Animal Production and Health

By

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June, 2016

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STATEMENT OF AUTHOR

I declare that this thesis is my *bonafide* work and that all sources of materials used for this thesis been duly acknowledged. This thesis has been submitted in partial fulfilment of the requirements for MSc degree at Addis Ababa University, College of Veterinary Medicine and Agriculture and is deposited at the University/College library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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DEDICATION

I dedicate this thesis manuscript to my beloved family, my mother Yetimwork Nigatu and my father Shimeles Zewedie for nursing me with affection and love. I will remember you every step of my success through my life. May your soul rest in internal peace, Amen.

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LIST OF ABBRIVATIONS

AI	Artificial Insemination
APC	Aerobic Bacterial Count
ARAB	Addis Ababa Region Agriculture Bureau
CC	Coliform Count
CFU	Colony Forming Unit
CMT	Califormic Mastitic Test
CSA	Central Statistical Agency
DDE	Dairy Development Enterprise
ESA	East African community Standard
EU	European Union
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration
HACCP	Hazard Analysis Critical Control Point
IDF	International Dairy Federation
ILCA	International Livestock Research Institute
Log ₁₀	Logarism in base ten
LPC	Laboratory Pasteurization Count
MOA	Ministry of Agriculture
NAIC	National Artificial Insemination Center
SCC	Somatic Cell Count
SG	Specific Gravity
SNF	Solid Not-Fat
SPC	Standard Plate Count
SPSS	Statistical Package for Social Science
TBC	Total Bacterial Count
TS	Total Solid
VRBA	Violet Red Bile Agar
WHO	World Health Organization
YMC	Yeast and Mould Count
X ²	Chi- square

PHYSICOCHEMICAL PROPERTIES AND MICROBIAL QUALITY OF COW MILK COLLECTED FROM SELECTED SUBCITY OF ADDIS ABABA, ETHIOPIA

ABSTRACT

The study was conducted in Addis Ababa town, central Ethiopia. To assess the general milk handling practice, determine physicochemical properties and evaluate the microbial quality of raw cow milk produced through the milk sheds found in the town. A cross sectional study was conducted in the study area and then purposively based on dairy potential three sub cities i.e., Akaki-Kality, Nifas Silk-Lafito and Bole sub-cities were selected. A total of 90 dairy farms and crossbreed dairy cattle's were assessed in the study. The result of survey indicates all of the respondents follow the milking procedures washing hands, teats and utensils before and after milking. A majority of the respondents (94.4%) used purchased feeds in the farm and the main source of water was tap water in the study area. For the quality parameter a total of 60 samples of raw milk were collected in the morning from the milk bucket of the respondents. To determine microbial load in raw milk samples total bacterial count, coliform count and somatic cell count were conducted. The analysis result revealed that 8.6 Log_{10} cfu/ml overall mean of total bacteria count, 6.15 Log_{10} cfu/ml overall mean coliform count and overall mean 198cell/ml somatic cell count. There has been a significance variation ($p < 0.05$) for somatic cell count among the three (small, medium and large) different scale farms. Though there was no significance variation shown among the coliform count and total bacterial count made for the three different farm scales. The result revealed that overall mean for specific gravity, freezing point, add water, fat, protein, solid-non-fat and total solid milk samples were 1.031 ± 0.02 , $-0.941 \pm 1.40^{\circ}\text{C}$, 5.5 ± 10.1 , $4.42 \pm 1.16\%$, $3.2 \pm 0.33\%$, 7.6 ± 0.9 and $12.02 \pm 1.79\%$ respectively. In general, except FP, SNF and TS the physicochemical property of milk sample obtained from all scale of production was under the acceptable level. However, the microbial quality raw milk produced by the milk shed was poor. Therefore, to ensure safety and quality of milk and health of the public and dairy cow it is suggested to follow hygienic practice on milk production and handling.

Key phrases: Chemical composition, microbial quality, milk shade and physical property

1. INTRODUCTION

Milk is an important source of nutrients to human and animal's. It is meant to be the first and the only food for the offspring of mammals as is almost complete food. Almost 87% of milk is composed of water and the remaining part comprises total solids (carbohydrates, fat, proteins and minerals) contained in a balanced form and digestible elements for building and maintaining the human and animal body. Other milk ingredients include immunoglobulins which protect the newly born against a number of diseases (Pandey and Voskuil, 2011).

Ethiopia possesses 52.13 million heads of cattle, 2.5 million camels, 22.6 million goats, 24.2 million sheep and 7.73 million of equines (CSA, 2012). Despite the large cattle population and the prevailing favourable climatic conditions and resources for livestock production, the current milk production in the country is low. This is reflected by the low per capita milk consumption and increasing trend in imports of milk and milk products (Getachew, 2003a). Like most developing countries, Ethiopia's increasing human population, urbanization and rising household incomes are leading to a substantial increase in the demand for livestock products, particularly milk and meat. In order to meet the growing demand for milk, milk production has to grow at least at a rate of 4 percent per annum (Azage *et al.*, 2001). The per capita milk consumption (about 17kg) for Ethiopia is much lower as compared to that of Africa (about 25kg), and from the recommended level by World Health Organization (200 litres), the 62.5 kg recommended by FAO (2006) as a minimum level to be kept for a balanced diet and the world's per capita average of about 100 litres/year (FAO, 2010).

In addition to being nutritious food for humans, milk provides a favorable environment for the growth of microorganisms (Walstra *et al.*, 2006; Parekh and Subhash, 2008). Food spoilage is an enormous economic problem in the world wide. The origin of milk pathogens (actually human pathogens found in milk) is primary a result of poor sanitation, animal stress and animal sickness. Although fresh milk from cattle may possess temporary germicidal or bacteriostatic properties, growth of microorganisms is inevitable unless it is processed or well stored (Swai and Schoonman, 2011). Cow need to be clean and healthy allowing sleep or stand in livestock waste expose them to more infection and environmental stress. Similarly another author reported that raw milk is an important vehicle for the transmission of milk-borne pathogens to humans, as can be easily contaminated during milking and handling

(Addo *et al.*, 2011). 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).

Of the dairy health problems known to date, infection of the milk gland by microbial pathogens is the number one factor limiting both the quality as well as the quantity of milk produced in dairy farms (Radostits, *et al.*, 1994). Further losses incurred are quality losses by storing in unclean storage utensil, which is prone to high microbial contamination. Losses in spillage and contamination occur where handling during and after milking are traditional and care is not satisfactory. For instance, due to the narrow tipped milking equipment direct loss of about 2% to 5% has been reported (MoA, 2007). Thus for efficient and quality dairy production, investigation of the herd health for the prevalence of the disease of economic and public health importance that can be through milk and its product is required (Nordhuizen *et al.*, 2005). The post-harvest losses of up to 40% of milk and its derivatives have been reported from milking to consumption (Felleke, 2003).

Different quality tests can be performed quantifying bacterial population and other microorganism present in milk and product, the major one being aerobic mesophilic bacterial count, coliform count, somatic cell count and standard plate count. From the result obtained, the sanitary condition under which has been produced and handled can be judged. Since dairy farms in the resource- limited countries like Ethiopia strive in the widespread presence of disease and in compromised sanitary conditions, they milk of poor quality and higher public health risks (Alehegn, 2004). This is why many countries and concerned international organization have set out minimum standard for the quality of milk at various stages of production, processing and distribution (IDF, 1991).

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

Milk produced at smallholders farm in Ethiopia is marketed without any form of pasteurization or quality control measures. Pasteurization or more severe heat-treatments applied to raw milk is the only way to ensure that pathogens present are killed and that the milk is safe. It also improves the shelf life of milk by reducing the number of non-pathogenic microorganisms that would otherwise cause spoilage (Burton, 1986). Since most of the bovine milk producer milk sheds in Addis Ababa have faced hygienic and nutritional problems through their production system, it is critical to evaluate the microbial load of the cow milk and composition of the milk produced. Moreover, the raw milk producers in the city supply their milk directly to consumers without appropriate measurements taken. Hygienic quality control of raw milk and milk products in Ethiopia is not usually conducted on routine basis (Alehegn, 2004). Thus, the above aforementioned gaps necessitated me to conduct this research.

Therefore, the objectives of this study were

- ✓ To characterize the existing dairy production practices in selected 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 milk produced in the study area

2. LITERATURE REVIEW

2.1 Dairy Industry Development in Ethiopia

Ethiopia has the largest livestock production in Africa; CSA (2014) stated that the total cattle population of the country in 2013 was estimated to be about 55.03 million. Out of this total cattle population, the female cattle constitute about 55.38% and the remaining 44.62% were male cattle, from this 6,675,466 and 10,731,656 were dairy and milking cows, respectively. On the other hand, the result indicated that 98.71% of the total cattle in the country were local breeds. The remaining were hybrid and exotic breeds that accounted for about 1.15 and 0.14%, respectively. A total cow's milk production for the country during 2013 was about 2.9 billion litres with the average lactation period per cow is estimated to be about six months, and average milk yield per cow per day is about 1.37 litres. Cows are common sources of milk (83%) in Ethiopia and the left 17% is from camel and goat (USAID, 2010). In the country households consume 82.9% of the milk collected (produced), 10% of the milk is processed into products with longer shelf life, 6.61% is sold and 0.43% used for wages (CSA, 2009). Estimates according to USAID (2010), showed that Ethiopian per capita milk consumption was 17 litres. 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 centres that specialize in improving specific breeds. 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. 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. The government runs programs focus on disease surveillance, eradication campaigns, vaccine production, drug and vaccine quality control, quarantine, and food hygiene inspection measures (Tegegne *et al.*, 2010).

2.2 Urban and peri-urban dairy production

In Ethiopia, four major systems of milk production systems are distinguished and these are: pastoral, highland smallholder, urban and peri-urban and intensive dairy farming systems (Mohamed *et al.*, 2003). The urban and peri-urban system is developed in and around major cities and towns, which have a high demand of milk (Azage and Alemu, 1998). Both the urban and peri-urban dairy system are located near or approximate of Addis Ababa and regional towns and take the advantage of the urban market with a primary objectives of selling milk as means of additional cash income (ILCA,1995; Azage *et al.*,2000; Stephen *et al.*,2006).

It is estimated that about 5,167 small, medium and large scale dairy farms producing about 35 million liters of milk annually are found in Addis Ababa milk shed (Azage and Alemu, 1998). In Addis Ababa there are about 5,200 dairy farms with some 58,500 cattle, and almost 50% are crossbred (CSA, 2008). Cattle, sheep and goats are the main productive livestock reared in the area.

The majority of small-scale farms found in the three administrative sub-cities namely; Akaki-Kality, Nifas silk-Lafito and Bole sub-cities have been organized to dairy cooperatives (ARAB 2008).These farms supply their milk to either of the pasteurization plants in Addis Ababa or Sebeta. But part of the milk produced by these cooperatives and that produced from large scale dairy produces is supplied mainly to consumers in raw the local/informal market channels (Brahamu and Debra, 1991; Ketema and Teshaye,1995).There are no official rule and regulations to control the quality of milk produced and distinguished to consumers in the

city except the Dairy Development Enterprise (DDE) which makes quality control on milk entering the processing plant for pasteurization, which is a very small portion of the total amount of milk produced in the country (Ketema and Tsehaye, 1995).

2.3 Milk composition and characteristics

Milk is a yellowish-white non-transparent liquid secreted by the mammary glands of all mammals. It is the primary source of nutrition and sole food for offspring of mammals before they are able to eat and digest other types of food. It contains in a balanced form of all the necessary and digestible elements for building and maintaining the human and animal body (Pandey and Voskuil, 2011). It is also the lacteal secretion, practically free from colostrum's, 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).

The main composition of milk is water (87 – 88%); the remaining part is total milk solids which include carbohydrates, fat, proteins and ash or minerals. This composition is not constant, the average percentages of milk components vary with species and breeds of animal, season, feeds, stage of lactation and health and physiological status of a particular animal (Pandey and Voskuil, 2011). Sometimes the composition might even change from day to day, depending on feeding and climate, but also during milking the first milk differs from the last milk drops (Pandey and Voskuil, 2011). Moreover, milk is an excellent source of high quality protein, vitamins, minerals such as calcium and phosphorus. Fresh milk has a pleasant soft and sweet taste and carries hardly any smell.

2.4 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.

2.4.1 Breed and species

There are obvious differences in milk composition and yield among the various breeds of dairy cattle. Differences among individuals within a breed are often greater than differences among breeds (O'Connor, 1994) such differences are due to partly genetic factors and partly to environmental. For instance, Jersey breed gives milk of higher fat content than Friesian cattle, while Zebu cows can give milk containing up to 7 percent fat (O'Mahony, 1998). The milk from indigenous cows contains 6.1 percent fat, 3.3 percent protein, 4.5 percent lactose and 0.7 percent ash (Alganesh, 2002).

2.4.2 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. The fat, lactose and protein contents of milk vary according to stage of lactation. In temperate type cows, the fat and SNF percentages tend to be higher in the early weeks of lactation, dropping by the third month then rising again as milk yield gradually declines (O'Mahony, 1998). The milks immediately after calving contain a very high percentage of total solids (up to 19 percent) mainly due to the very high fat and milk protein contents (O'Connor, 1993).

2.4.3 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. The decrease in SNF content seems to be due to a decline in casein content. Both fat and SNF contents can be reduced by disease, particularly mastitis.

2.5 Physical properties of milk

2.5.1 pH value

Milk pH gives an indication of milk hygienic and it should not be ≤ 6.6 or ≥ 6.8 when milk temperature is 20°C, because cooling of milk reduces the risk of growth of bacteria while high milk temperature must be considered as favourable to the growth of bacteria in milk (Walstra *et al.*, 1999). The pH values higher than 6.8 indicates mastitic milk and pH values below 6.6 indicates increased acidity of milk due to bacterial multiplication (O'Connor, 1995).

2.5.2 Specific gravity

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

2.5.3. Titratable acidity

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

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

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

2.6 Hygiene and handling of milk

Milk is a perishable product and an ideal medium for the growth of a wide variety of bacteria (Parekh and Subhash, 2008). When it is secreted from a healthy udder, raw milk contains only a very few bacteria of about 500 to 1,000 bacteria per milliliter (Omoro *et al.*, 2005; Pandey and Voskuil, 2011). After milking environmental contamination occurs, which in turn increases the total bacteria count up to 50,000 per ml or may even reach several millions bacteria per millilitre (Pandey and Voskuil, 2011). That count level indicates a very poor hygienic standard of milk during milking and handling or milk of a diseased animal.

However, milk contains a natural inhibitory system or temporary germicidal or bacteriostatic properties which prevents a significant rise in the bacteria count during the first 2 -3 hours (Swai and Schoonman, 2011; Pandey and Voskuil, 2011). If the milk is cooled to 4°C within this period immediately after milking, it maintains nearly its original quality and remains safe

for processing and consumption. Temperature of storage and time since milking are also important in determining milk quality, as these influence the rate at which the bacteria will increase in number (Omore *et al.*, 2005). To prevent a too high multiplication of bacteria,

Therefore, proper milking, cleaning and sanitizing procedures of equipment's and environments are essential tool to ensure quality of milk. Many countries have implemented laws and regulations concerning the composition and hygienic quality of milk and milk products to protect both the consumers and the public health (Pandey and Voskuil, 2011). Unfortunately, these laws and regulations are not often adhered in developing countries making milk-borne diseases a higher health risk to public. This is exemplified by over 75% of milk marketed in many developing countries is sold raw/unpasteurized through informal channels (Bertu *et al.*, 2010; Oliver and Murinda, 2011).

2.7 Measures of milk quality

2.7.1 Bacteriological quality

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

Milk may contain both pathogenic and non-pathogenic organisms. Pathogenic organisms, which may come from directly the cow's udder, are species of Staphylococcus, Myobaterium, Brucella, Escherichia, Corynebacterium, and other which are known to cause disease to animal and man. Generally bacteria in milk classified into three groups based on the temperature for optimal replication namely: psychtrophilic, mesotrophilic and thermophilic bacteria (Dogan and Boor, 2003). Psychtrophilic organisms can grow at

refrigeration temperatures and responsible to spoilage of milk under cold storage. The psychotropic bacteria are killed by pasteurization, however, the enzymes they produce can survive and their importance in dairy sector is due to economic loss from their spoiling action on milk stored at lower temperature there by reducing its shelf life. Thermophilic organisms are less harmful to health, but can cause change in the organoleptic qualities of milk. They can endure heat and survive pasteurization. Mesophilic bacteria are those, which grow best temperatures ranging from about 20-40 °c. These groups of bacteria include the pathogenic genera and are also capable of deteriorating the quality of milk (Hagstad and Hubber, 1986). These group of bacteria responsible for milk born infection of human beings.

Owing to the wide spread occurrence of bacterial agent in milk, this item of food is subjected to various standards and quality tests that can be indicates how safe and nutritionally valuable a given dairy product is. These quality indicator includes the standard plate count (SPC), total coliform count (TCC), laboratory pasteurization count (LPC), and somatic cell count (SCC). In addition to these general bacteriological tests, milk is often subjected to more detailed laboratory analysis to isolate and identify specific pathogens to man and cow itself (Donald, 1996; Rice and Bodman, 1997; Jay, 2000; Loir *et al.*, 2003; Kavaria *et al.*, 2004; Kessel *et al.*, 2004). But routinely applied method for investigation of bulk milk quality is standard plate count and the somatic cell count (IDF, 1991).

Somatic cell count (SCC)

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

Raw milk contains three type of cells; epithelial cell, macrophages and polymorphonuclear cells. The first two cells can be found in uninfected udder while polymorphonuclear cells and macrophages are found in high numbers only in affected udder (Radostits *et al.*, 1994; Quinn *et al.*, 2002). Due to this, the somatic cell count is internationally recognized as a parameter

for assessing both milk quality and udder health .The so-called premium milk or grade ‘A’ milk should have a SCC of less than 4.0×10^5 cells/ml of milk (Degraaf *et al.*, 1997).

Coliform count (CC)

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

Standard plate count (SPC)

The standard plate count (SPC), which is also called aerobic plate count (APC) of raw milk gives an indication of the total number of aerobic bacterial present in milk at the time culturing the samples. Analysis of total bacterial count (TBC) may be performed using the bactocount equipment that applies the flow cytometry technique (Holm *et al.*, 2004). In the SPC method, milk sample are plated on the standard plate count agar media and then incubated for 48hrs at 32 °C to encourage bacterial growth. Single bacteria or cluster grow to become visible colonies that are then counted. All plate count is expressed as the number of colony forming unit (cfu) per milliliter of milk (Murphy, 1996).

A negative aspect of the standard plate count is the possible underestimation of the total bacteria quality because a colony does not always originated from a single bacterium (Quinn *et al.*, 1996) and it does not indicate the type of bacterial species involved in the milk contamination. It is sensitive but also labor intensive and is inaccurate for high-count milk samples (Slaughuis, 1996). It required the samples be processed immediately after collection or within 24hrs of collection, if appropriate cooling facility is in place. However, the SPC is generally accepted as the most accurate and informative method of testing bacteriological quality of milk. Table 1 gives the grading system of raw milk based on its SPC.

Table 1: Grading of raw milk based on standard plate count

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

Source: (kurwijila *et al.*, 1992)

Dye Reduction Test

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

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

Alcohol test

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

Clot on boiling test

Acidity decreases the stability of milk if concentration of hydrogen ion is more than the normal amount (O'mahony, 1988), then casein will get precipitated on heating immediately. The clot on boiling test is used to determine whether milk is suitable for processing. As indicates whether the milk is likely to coagulate during processing (usually pasteurization).It performed when milk is brought to the processing plant if the milk fails the test, it is rejected (O'mahony, 1988). Various other test can be done on milk as summarize in Table 2.

Table 2: List of other test used to test the quality of milk

Type of test	Remark
Phosphetase test	Phosphets, an enzyme, normally present in raw milk, is inactivated by heat. A positive test will indicate that the milk is not properly pasteurized
Sedimentation test	Leaving milk standing still for 15-20 minutes and observing the formation of any sedimentation
Catalase test	This measure the activity of the enzyme catalase content of which depend up on the number of cells in milk. Hence the increased activity of this enzyme indicates mastitis.
Specifying gravity	Normal adulterated cow's milk range between 1.026-1.032 at 20°c measured by lactometer
Freezing test	The normal freezing point of milk between -0.50 and -0.61°c
Conductivity	Milk from mastatic cows will have increased conductivity due to the increasing in the ionic content of milk
Organoleptic test	General appearance, cleanliness, color and smell of the fresh milk should be selected

Source: Hagasted and Hubert (1986)

2.7.2 Biochemical quality of milk

At present more than 200 different constituent have been defined in milk. But the major constitute related to human nutrition, health and dairy aspects. Constitutional variation of milk is not only due to species difference but also function of feed regimens and genotype within the same species of animals (Afif *et al.*, 2007). In addition to the food nutrients, milk also contains immunoglobulins that transferred directly from the blood serum into the milk and enzymes produced from the mammary tissue which impact unique biological properties to the milk. Some of the bioactive molecules in milk and their function include the following:

Lactoferrin: this is iron-binding glycoprotein that is found in milk, saliva, and other body fluid of mammals.

Lactoperoxidase: it is one of the most heat stable enzymes found in milk. It has bacteriostatic effect when it is combined with hydrogen peroxidase and thiocyanate. The lactoperoxidase system has been used to reduce spoilage and extend the shelf life of raw milk in countries where refrigeration may be unavailable (Asaah *et al.*, 2007). The lactoperoxidase system has been recommended to be effective in reducing the growth of *Listeria monocytogenes* in raw milk at refrigerator temperatures. However, as hydrogen peroxide and thiocyanate must be added to milk in order to activate the system to achieve antimicrobial benefit, it is less likely that the lactoperoxidase system contributes significantly to control of pathogens in fresh raw milk (Leeuwen *et al.*, 2000; FAO/WHO, 2006).

Phosphatase: this is another enzyme in milk and whose thermo liability or reduction at pasteurization temperature is used as indicator test for evaluating effectiveness of pasteurization process (Hagasted and Hubert, 1986).

2.7.3 Physical quality of raw milk

Milk is a complex colloidal dispersion of fat globule and protein (casein, whey) in an aqueous solution of lactose, mineral, and other minor constituents. So, its physical characteristics are affected by several factors including the composition and processing or handling (Jay *et al.*, 2000). Physical quality of milk means the general appearance, the purity, color and flavor of the raw milk. As it is hygroscopic in its nature mainly due to the lactose content, milk attracts a number of bad smells from the immediate environment (Hagasted and Hubert, 1986). On the top of this property of milk, its taste and flavor can be the function of a multiple of factors and can of course indicate the hygiene, bacteria and compositional quality of its (Hagasted and Hubert, 1986). They can also affect the consumer acceptance, which can limit the wellbeing of dairy business.

2.8 Factors affecting milk quality

2.8.1 Health of the dairy herd

The health status can be affect the overall performance of the dairy animal including the amount of milk production, reproductive efficiency and the qualities of milk and its product (Radostits *et al.* , 1994). It affects the bacteriological (Jay, 2000) as well as the compositional qualities of milk (Quinn *et al.*, 2002). On the top of their effect on milk quality and cattle productivity, differences of cow have important public health implications. Of such disease, bovine tuberculosis and bovine brucellosis are the major one that can be contracted through consumption of raw milk produced by infected herd (Acha and Szyfers, 2011). Therefore the health status of dairy herd is the sole indicator of the safety as well as the quality of milk produced.

Bacteriological quality of milk is directly influenced by the health statues of the lactating cow in general and that of the udder in particular increased level of infection of udder, as measured by the califormic mastitic test (CMT) score or direct somatic cell count, will increase the bacteriological load of milk thereby causing a degradation of milk quality (Godefaye and Bayelegn, 2000; Alehegn, 2004).

2.8.2 Hygienic status of the farm

The production of quality milk begins with good hygienic practices. Dirty cow, soiled equipment's, unhygienic parlors and dirty milkers hand all constituent an elevated bacterial level in the bulk tank. Several research results have shown that milk produced and handled under hygienic conditions can be expected to have colony count of less than 2×10^4 /ml before pasteurization while milk produced un hygienically can have bacterial load as large as millions and billons of bacteria per milliliters (Godefaye and Bayelegn, 2000; Alehegn, 2004; Chaye *et al.*, 2004; Donkor *et al.*, 2007).

2.8.3 Feed of the dairy

Manipulating a ration of dairy cows can change milk composition (Grummer, 1991; Castillo *et al.*, 2003). Decreasing the amount of forage in relation to the amount of concentrate will quickly milk fat with only a various and slight increase in milk protein percent (Charles 1998).Concentrate that are primarily composed of rapidly digested grain (e.g. barley) will have more effect of depressing fat and increasing protein that slowly digested grain (Charles 1998). Generally, improvements in feed protein quality will show an increase in milk yield than milk protein (Castillo *et al.*, 2003).

2.9 Sources of microbial contamination in milk

Microbial contamination in milk comes from milk itself as it can be naturally contaminated or comes from infected or sick animal, human, environment, water and equipment's used for milking and storage of milk. These sources of contamination include disease-causing organisms (pathogens) shedding in milk, infected udder and/or teats, animal skin, faecal soiling of the udder, contaminated milking and storage equipment's and water used for cleanliness. Other bacterial sources are from air, milkers, handlers, drugs or chemicals used during treatment of animal and from water used for adulteration by unscrupulous and unfaithful workers/sellers who may be contaminated and may cause additional health problems (Swai and Schoonman, 2011).

Exposure of milk to these sources or conditions may lead to increased microbial contamination and affect its quality. However sometimes recontamination may occur after processing mainly due to unhygienic conditions and poor or improper handling of milk during consumptions (Parekh and Subhash, 2008). In general quality of milk may be lowered when it is contaminated by a number of factors such as adulteration, contamination during and after milking, presence of udder infections, mastitis (inflammation of mammary gland) disease and drugs residues used for treatments of disease which is considered to be public health concern and one of the most important causes of economic losses in the dairy industry worldwide. (Syit, 2008; Mdegela *et al.*, 2009).

2.10 Prevention and control of microbial contamination in milk

Prevention and control of microbial quality of milk is through elimination of organisms from human carriers by general improvements in water supplies, public health education, personal and environmental hygiene. Also it can be achieved through proper boiling or pasteurization of raw milk before processing and consumption. Pathogenic organisms from the lactating animals can be controlled through improvements in animal husbandry and maintenance of good animal practices, and those from the environments and equipment's can be prevented by adhering to general hygienic practices and environmental cleanliness. Generally, microbial

contamination in milk can be minimized through adherence to effective good hygienic practices at farm level; and in order to protect the public against milk-borne infections it is important to screen milk which is informally taken to the market. The lack of awareness of milk-borne infections in many developing countries and consumption of raw milk predispose small-scale livestock keepers, consumers and the general public at risk of contracting these infections (Mosalagae *et al.*, 2011).

2.11 Milk marketing system in Ethiopia and market constraints

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). But in rural areas especially pastoralists use the milk and the products mostly for home consumption; few households sell their milk to the market.

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.

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.

2.12 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 neighbourhood 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). Ethiopia, 95% of the national milk is marketed through informal channels and is 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. MATERIALS AND METHODS

3.1 Description of the study area

The study was conducted at Addis Ababa; Addis Ababa is the capital city and administration center for the Federal Democratic Republic of Ethiopia. Addis Ababa lies $9^{\circ}1'48''\text{N}$ latitude and $38^{\circ}44'24''\text{E}$ longitude. The city is located at the heart of the country, at an altitude ranging from 2,100 meters at Akaki in the south to 3,000(9,800 ft) meters at Entoto Hill in the North. The city is divided in to ten sub-cities which are the second administrative units next to city administration. There are 116 weredas in the city administration. The total

population of Addis Ababa was estimated to 3,048,631 of whom 1,595,968 were females and the rest 1,452,663 were males (AASEP, 2013).

Addis Ababa is a city where various forms of urban agricultural activities are undertaken usually as a sideline business and a system is leisure time duty. The dairy production system is part of this urban agricultural system characterized by intensive production operation in which dairy animals are kept in-door at zero grazing conditions. The greatest majority of the peri-urban and intra-urban dairy producers do produce intensively for the sole purpose of selling the milk directly to consumers and retailers (Ketema and Tsehaye, 1995).



Figure 1: Map of the ten sub-cities (AASEP, 2013)

3.2 Study design

The study involved both cross-sectional survey method aimed to assess handling practices and a laboratory-based investigation aimed to determine the physicochemical properties and microbial quality of raw cow's milk produced and marketed in Addis Ababa city milk sheds. For the survey, both primary and secondary data were utilized. For the primary data semi-structured questioner was prepared and pre-tested in the sampled farms. Secondary data was collected from Addis Ababa sub-city agricultural and micro-small enterprise office, and dairy cooperatives units.

From ten sub cities three of them are known in dairy potential as reported by (ARAB, 2008). For this study, purposively based on dairy potential these three sub cities i.e., Akaki-Kality, Nifas Silk-Lafito and Bole sub-cities were selected. A total of 90 dairy farms were assessed, from each sub city 30 dairy farmers were investigated and 1185 cross breed dairy cattle were inspected for the assessment of survey part. For the laboratory analysis 60 samples of raw cow's milk were collected at the morning from dairy milk sheds from the selected three sub-cities. Based on the reports of ILRI (1996) farms were classified in to three these are; small holders (farms with less than three cows), medium level (farms with 3-10 cows) and large scale (farms with greater than 10 cows).

3.2.1. Milk sample collection and transportation

Prior to the laboratory analysis 90 sampling glass bottles were prepared sterilized and disinfect with detergent. Then approximately 300 ml of raw milk samples was aseptically collected from bulk milk sample of producer's container and placed into sterile glass bottles. Consequently, samples were labelled and put in ice box (4°C) to restrict microbial multiplication and transported as early as possible to the Ethiopian Meat and Dairy Industry Development Institute's laboratory for microbial quality and physicochemical analysis. The laboratory analysis was performed within 36 hours after collecting the sample (Alganesh *et al.*, 2007).

3.3. Data collected

For the survey part, the data regarding to feeding management, housing and ventilation systems, milk and milk utensils hygienic practices, udder management, culling practices, milk marketing system, milk production problems and milking practices (time and frequency) were collected. For the physical and chemical properties the apparatus Eko-milk was used and for the microbial qualities tests considered standard plate counts (SPC), coliform count (CC) and somatic cell counts (SCC) was done.

3.3.1. Standard plate count (SPC)

The bacterial count was made by adding 1ml of milk sample in to sterile test tube having 9ml of peptone water. After thoroughly mixing, the sample was diluted up to $1:10^{-7}$ and the duplicated sample (1ml) were poured using 15-20ml standard plate count agar and mix thoroughly. The plate sample was allowed to solidify and then incubated at 30°C for 48 hours. Colony counts were made using colony counter (Marth, 1978).

3.3.2. Coliform count (CC)

For coliform count 10 ml of milk sample was added into sterile test tube having 9ml distilled water. After mixing, the sample was serially diluted up to $1:10^{-5}$ and the duplicate sample (1ml) were poured using 15-20ml violet bile agar solution (VRBA). After thoroughly mixing, the plate sample was allowed to solidify and then incubated at 30°C for 24 hours. Finally, colony counts were made using colony counter (Marth, 1978). Typically dark red colonies were considered as coliform colonies.

After counting and recording bacterial colonies in each petridish, the number of bacteria in milliliter milk was calculated by the following formula given by American Public Health Association (APHA) (1992).

$$N = \frac{\sum C}{[(n_1 \times 2) + (0.1 \times n_2)]} \times d$$

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

$\sum C$ = sum of colonies on plates counted,

n_1 = number of plates on lower dilution counted,

n_2 = number of plates on lower dilution counted, and

d = dilution from which the first counts are obtained

3.3.3. Somatic cell count (SCC)

In SCC analysis, direct microscopic counting method was performed. Milk film preparation, staining and counting was done according to the standards set by International Dairy Federation (IDF, 1995). To obtain a uniform distribution of cells, milk samples were mixed by moving upside down gently 25 times and allowed to stand for 2 minutes to permit air bubbles and foam to disappear. Microscopic slides degreased with alcohol before milk film preparation. A 0.01ml of milk was taken with a 50µl micropipette calibrated at 10 and spread evenly over one cm² area on a microscopic slide and allowed to dry at room temperature on a leveled table. One cm² area was delineated by a template prepared from a cap board. Dried films were dipped in toluidine blue dye for 30 minutes. After 30 minutes, slides were left to dry for a few minutes, washed with tap water then allowed to dry again in a dust free area. Stained slides were stored in slide box until counted. Using oil immersion objective those cell nuclei clearly recognizable and those at the periphery with more than 50% of the cell body in view was counted.

The number of cells per ml of milk was calculated by multiplying the average number of cells per field with MF

$$MF = \frac{40,000}{d^2}$$

$$3.1416 \cdot d^2$$

Where MF= magnification factor

d= diameter

To measure the diameter, first stage micrometer slide was placed on a microscope stage. Then under oil immersion objective the number of divisions in stage micrometer was counted. Each division on a stage micrometer slide represents 0.01mm and hence to calculate the field diameter, the number of divisions counted will be multiplied by 0.01mm.

3.4. Statistical analysis

The primary data collected from household survey through semi-structured questionnaires was processed (data was checked for accuracy, data entries was coded, coded data was entered in to computer). Processed data was analysed by using Statistical Package for Social

Science (SPSS) version 20.0 software. Descriptive statistics such as percentage, standard deviation, and ANOVA were used to analyse the data quantitatively. Data from microbial counts were first transformed to logarithmic values (log₁₀) before statistical analysis in order to make the frequency distribution more symmetrical, and then SPSS version 20 statistical software was used to analyze the data.

4. RESULT

4.1 Characteristics of the respondents

The age group, educational status and the training information of the respondents in the study area is summarized in Table 3. Majorities of the respondents 70.4% in the study area were within the middle age group while only 12.7% of the respondents were in the age group greater than 55 years. The highest percent (54.4%) of the interviewed members of the milk sheds were attend grade 1-8 while 14.2 of them were illiterate and there was higher literacy in large scale production (17.6%). Diploma/ Degree holders were found only in small scale production system. From the entire respondents of the study area 90% of the respondents

have got training on milk production and handling practice and 10.3% of the respondent did not get any training related with quality milk production. Which was 88.4% from small scale, 93.3% from medium and 88% from large scale got the training offered by different governmental sectors in the city. The remain 11.6%, 6.7% and 11.8% from small, medium and large scale production, respectively didn't get access involved in any training for milk handling and quality production.

Table 3: Characteristics of respondents in the study area

Variables	Small N(43)%	Medium N(30)%	Large N(17)%	Mean
Age group				
20-35yr	9(20.9)	4(13.3)	3(17.6)	17.2
35-55yr	26(60.5)	24(80.0)	12(70.6)	70.4
> 55	8(18.6)	2(6.7)	2(11.8)	12.7
Level of education				
Illiterate	5(11.6)	4(13.3)	3(17.6)	14.2
1-8	5(11.6)	24(80.0)	12(70.6)	54.6
9-12	23(53.5)	2(6.7)	2(11.8)	24
Diploma/degree	10(23.3)	-	-	
Training received				
Yes	38(88.4)	28(93.3)	15(88.2)	89.9
No	5(11.6)	2(6.7)	2(11.8)	10.3

N-number of respondents

4.2 Hygienic quality of milk during productions

4.2.1 Barn type and hygienic practices

The result of hygienic or sanitary practices and barn type is summarized in Table 4. The present study indicated that 58.1% small, 53.3% medium and 35.3% large scale farms have used a closed barn for their production while, 41%, 46.7% and 64.7% of the respondents from small ,medium and large scale farm, respectively had built a semi-opened barns for production in the study area. Majority of the respondents 60.5% used barns floor made from

concrete and only 39.5% of the interviewed respondents used barn floor made from stone. All respondents in the study area did not use bedding for their animals. In the study area 95% of the respondents had no maternity pens for their animals and only 4.5% respondents had well build maternity pens which was practiced by 4.7% small scale and 17.6% large scale milk producer respondents in the study area. The survey result showed that 45.6% of the respondents in the study area had satisfactory drainage while, 36% of the respondents had a poor drainage system. The highest percent (40%) of the respondents that had poor drainage system was observed in medium scale producers. This result also showed that 44.2% 36.7% and 41.2% of the respondents in small, medium and large scale farms respectively employed a laborer for cleaning of their farm with an average monthly salary of 1500 ETB. Moreover on average 83.1% respondents on the study area clean their milking sheds once a week while, the rest 16.9% of the respondents clean their milk shed more than once a week the. It was also observed that majority (95.6%) of the respondents participated in intensive grazing system However, 4.4% respondents were depends on semi-intensive grazing system which found in 4.7% in small farms and 6.7% in medium farms.

Table 4: Barn type and cleaning practices in the study area

Variables	Small N(43)%	Medium N(30)%	Large N(17)%	Mean
Type of housing				
Closed type	25(58.1)	16(53.3)	6(35.3)	48.9
Semi-opened	18(41.9)	14(46.7)	11(64.7)	51.1
Floor type				

Concrete	27(62.8)	18(60.0)	10(58.8)	60.5
Stone	16(37.2)	12(40.0)	7(41.2)	39.5
Bedding				
Yes	-	-	-	
No	43(100)	30(100)	17(100)	100
Maternity pens				
Yes	2(4.7)	-	3(17.6)	7.43
No	41(95.3)	30(100)	14(82.4)	92.6
Drainage conditions of the barn				
Good	5(11.6)	8(26.7)	3(17.6)	18.6
Satisfactory	22(51.2)	10(33.3)	9(52.9)	45.8
Poor	16(37.2)	12(40.0)	5(29.4)	35.5
Cleaner of the barn				
Owner	13(30.2)	3(10.0)	1(5.9)	15.4
Labourer	19(44.2)	11(36.7)	7(41.2)	40.7
Both	11(25.6)	16(53.3)	9(52.9)	43.9
Frequency of cleaning				
Once a week	36(83.7)	25(83.3)	14(82.4)	83.1
More than once a week	7(16.3)	5(16.7)	3(17.6)	16.9
Type of grazing				
Extensive grazing	-	-	-	-
Intensive/zero grazing	41(95.3)	28(93.3)	17(100)	96.2
Semi-intensive grazing	2(4.7)	2(6.7)	-	3.8
N- Number of respondent				

4.2.2. Feeding and watering management practice

As observed in the present study in the study area the main feed resources on average 91.9% of the respondents was purchased animals feed from different animals feed provider sectors in the area and the rest 8.1% of the respondents fed their animals both farm level produced feed (such as alfalfa and green grass) mixed with feeds buy from those animal feed processing sectors. In the present study (71.1%) of the respondents reported the higher

commonly feeding staff used for their animal in the study area was concentrates/supplementary feed (which was made from the mixture nug/beer by product, animals meat/bone by products, wheat bran, wheat mailing, minerals and vitamins), molasses and roughages such as straw or alfalfa. The remain 28% of the respondents only feed their animals hay/straw mixed with beer by products. About 40% and 41% of the feeding work is done by laborer and both laborer and owners of the milk sheds in the study area, respectively while up 18.9% respondents fed their animals by themselves as showed in Table 5. The main source of water in the study area was tape water (98.9%) for hygienic purpose (washing teats, hand, milking equipment's and sanitizing the milk shed), the remain 1.1% of the respondents used well/pond water only for sanitary practices but water their animals tape source of water. Finally 61% of the respondents have a good feeding storage practices and they prepared a separate feeding stocks rooms which is sheltered from sunlight's, rainfall and other dirty materials.

Table 5: Feeding and watering practices used in the study area

Variables	Small N(43)%	Medium N(30)%	Large N(17)%	Mean
Source feed				
Farm produced	-	-	-	
Purchased	43(100.0)	23(93.3)	14(82.4)	91.9

Both	-	2(6.7)	3(17.6)	8.1
Commonly used feed				
Concentrates, molasses, beer by product & straw	29(67.4)	22(73.3)	13(76.5)	72.4
Hay, Beer by product & straw	14(32.6)	8(26.7)	4(23.5)	27.6
Feeders of the animals				
Owner	13(30.2)	3(10)	1(5.9)	15.4
Labourer	19(44.2)	10(33.3)	7(41.2)	39.6
Both	11(25.6)	17(56.7)	9(52.9)	45.1
Storage conditions feed				
Good	20(46.5)	18(60.0)	13(76.5)	61
Bad	23(53.5)	12(40.0)	4(23.5)	39
Water source				
Tape water	43(100)	30(100)	16(94)	98
Other (pond, wells....)	-	-	1(5.9)	1.96

N- Number of respondents

4.2.3 Milking and milk handling practices

Milking frequencies and milking procedures used by the respondents in the study area is presented in Table 6. All of the respondents in the study area milk their cows two times a day (morning and evening) in the milk shed and follow the milking procedures (washing hands, udder and milking equipment's before and after milking). 37.2% (small), 53.3% (medium) and 35.5% (large scale) milk producers of the respondents were used shared towels for their cattle .while up 51.2% (small), 36.7% (medium) and 47.1% (large scale) respondent used individual towels and the remain 11.6% (small), 10.0% (medium) and 17.6% (large scale) 12.2% respondents uses both (shared & individual towel) at the farm for drying the teats purpose in the study area. Beside this the majority of the milking process is done by the employee on the farms, 46.6% (small), 53.3% (medium) and 52.9% (large scale).

Table 6: Milking frequencies and Milking procedures used in the study area

Variable	Small N(43)%	Medium N(30)%	Large N(17)%	Mean
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Milking procedure				
Hand washing before milking	43(100)	30(100)	17(100)	100
Udder washing before milking	43(100)	30(100)	17(100)	100
Utensils washing during production	43(100)	30(100)	17(100)	100
Use of towels				
Individual	22(51.2)	11(36.7)	8(47.1)	45
Shared	16(37.2)	16(53.3)	6(35.5)	42
Both	5(11.6)	3(10.0)	3(17.6)	13
Milking frequencies				
Once a day	-	-	-	
Twice a day	43(100)	30(100)	17(100)	100
Milkers				
Owner	13(30.2)	3(10.0)	1(5.9)	15.4
Labourer	20(46.5)	16(53.3)	9(52.9)	50.9
Both	10(23.3)	11(36.7)	7(41.2)	33.7

N- Number of respondents

4.2.4 Milk marketing

According to the current study, 81.1% respondents had encounter market problem for raw milk. As presented in Table 7, the respondents reported that the first main raw milk consumer for their production was individuals (households), 86% (small), 76.7% (medium) and 100% (large scale). The rest 11.6% (small) and 23.3% (medium) supply to hotel and milk collection centers and only 2.3 small scale farms used their milk for house consumptions.

Table 7: Milk marketing the study area

Variables	Small N(43)%	Medium N(30)%	Large N(17)%	Mean
Sales outlets				
Home consumptions	1(2.3)	-	-	0.7
Hotels & milk collection	5(11.6)	7(23.3)	-	11.6

centres				
Individuals(households)	37(86.0)	23(76.7)	17(100.0)	87.6

Milk marketing problems

Yes	38(88.4)	20(66.7)	15(88.2)	81.1
No	5(11.6)	10(33.3)	2(11.8)	18.9

N- Number of respondent

4.2.5 Culling practices

As indicated in Table 8, 73.2% of the respondents in the study area practiced culling in their farms due to many reasons. According to the respondents, they culled their animals for many reasons includes: health problems (21.1%), infertility (17.8%), low level of production (14.4%) shortage of spaces (10.0%), shortages of feed (1.1%) and reasons for old ages (5.6%). The rest 26.8 respondents do not practiced culling of any animals during their production activity.

Table 8: The culling practices in the study area

Variables	Small N(43)%	Medium N(30)%	Large N(17)%	Mean
Culling				
Yes	31(72.1)	16(53.3)	16(94.1)	73.2

No	12(27.9)	14(46.7)	1(5.9)	26.8
Reasons of culling the animals				
Health problems	10(23.3)	7(23.3)	2(11.8)	19.5
Reproductive infertility	8(18.2)	4(13.3)	4(23.5)	18.3
Low level of production	8(18.2)	2(6.7)	3(17.6)	14.2
Space storage	4(9.1)	1(3.3)	4(23.5)	11.9
Feed shortage	-	1(3.3)	-	1.1
Old age	1(2.3)	1(3.3)	3(17.6)	7.7

N- Number of respondents

4.2.6 Constraints of milk production

According to the respondents there were different challenges faced in the dairy production. As presented in Figure 2. The result showed that the nutritional problem is the biggest problems for all respondents in the study area 41.1% , mastitis 34.4% is the second major disease which affect the respondents production activities and lamp skin disease(15.6%) and lack of hygiene or knowledge's (8.9%) are the third and fourth respectively problems faced by the dairy producer milk sheds.

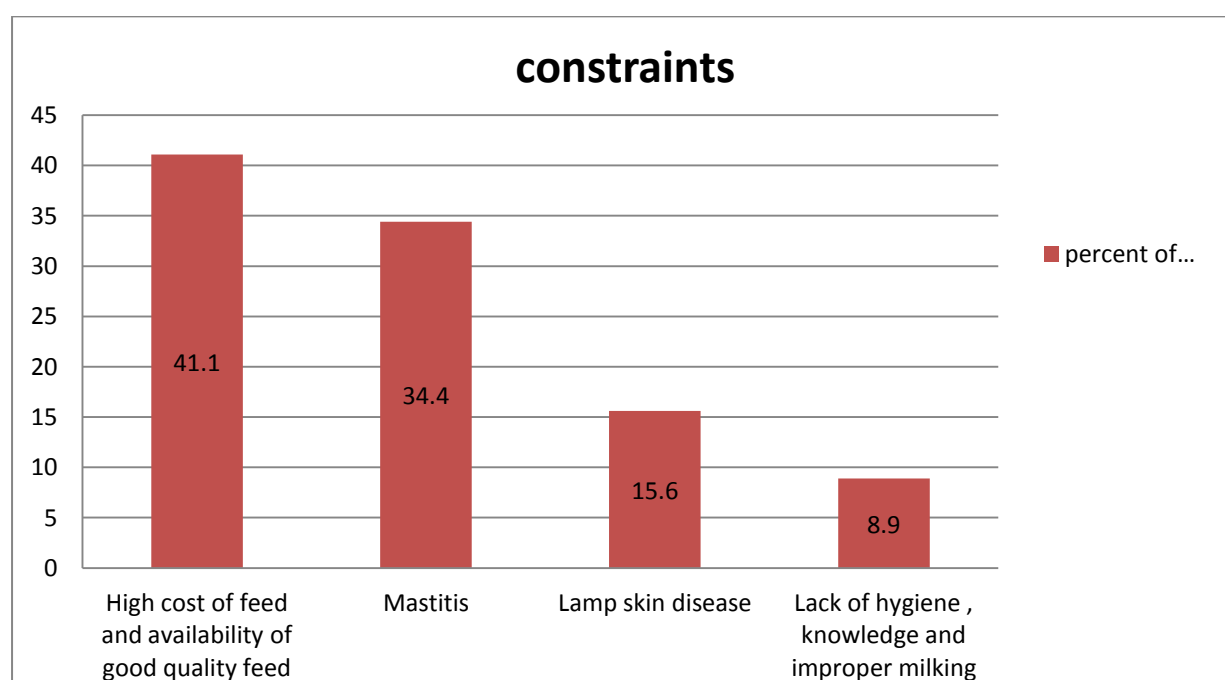


Figure 2: Constraints of milk production

4.3 Physicochemical properties of cow milk

The result of physical properties and chemical composition of milk is summarized in Table 9.

Table 9: Mean (\pm SD) of physicochemical properties of raw cows' milk obtained from milk producers in Addis Ababa (N = 60)

Physicochemical properties	Milk source			Overall mean	p-value
	small	medium	Large		
Fat	4.27 \pm 1.00	4.58 \pm 1.15	4.43 \pm 1.32	4.42 \pm 1.16	0.743
Protein	3.22 \pm 0.22	3.25 \pm 0.19	3.15 \pm 0.60	3.2 \pm 0.33	0.642
SNF	7.65 \pm 0.60	7.72 \pm 0.45	7.43 \pm 1.67	7.6 \pm 0.9	0.634
TS	11.94 \pm 1.38	12.3 \pm 1.28	11.83 \pm 2.7	12.02 \pm 1.79	0.711
Add water	4.41 \pm 5.64	3.22 \pm 4.26	8.59 \pm 20.6	5.5 \pm 10.1	0.539
Density	1.037 \pm 0.05	1.028 \pm 0.002	1.027 \pm 0.006	1.031 \pm 0.02	0.314
Freezing point	-0.534 \pm 0.04	-0.54 \pm 0.03	-1.75 \pm 4.14	-0.941 \pm 1.40	0.131

N= Number respondent SNF=Solid Non-Fat, TS=Total solid, FP= Freezing point

4.4 Microbial quality of raw milk

The microbial count result of the cow milk produced in the study area is presented in Table 10.

Table 10: Mean (\pm SD) microbial counts (\log_{10} cfu/ml) of raw cow's milk samples collected from milk sheds in the study area.

Parameters	Milk source			Overall mean	p-value
	Small	Medium	Large		
Coliform count	6.16 \pm 0.88	6.1 \pm 1.07	6.28 \pm 0.75	6.15 \pm 0.92	0.855
Total bacterial count	8.72 \pm 1.08	8.4 \pm 1.08	8.7 \pm 1.18	8.6 \pm 1.01	0.551

Somatic cell count (cell/ml)	364×10^4	84×10^4	214×10^4	198×10^4	0.007
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CC= coliform count, TBC= total bacterial count, SCC= somatic cell count, cfu= coliform unit
SD=standard deviation

Coliform Count: As a result of coliform count on the milk sample, different counts were recorded among the entire sample with an overall mean of 6.1 ± 0.92 . There was no significance variation shown in the different coliform count were recorded between milk samples collected from small scale farms and from those farm that milk their dairy cow barn exhibited higher coliform count.

Total Bacterial Count: it was revealed that an overall mean of TBC 8.6 ± 1.01 of milk was recorded for all samples indicated in Table 10. Even though there was no significance variation in total bacterial count among the three different farms were milk samples taken.

Somatic cell Count: the result of the present study show that, milk samples collected from the different farm scale show a significance variation ($p < 0.05$) among them. The overall mean of the somatic cell count was 198×10^4 cell/ml.

5. DISCUSSION

The overall purpose this study was to characterize the production system, determine the physical and chemical properties and evaluates microbial quality of bovine milk produced by milk sheds in Addis Ababa town dairy farms. As Table 3 indicates there is no significance variation ($p > 0.05$) between the different levels of farm scale respondents corresponding to age group, educational status and receiving training on the general practices of milk handling procedures. Generally findings show that, there are several practices undertaken at the farm level. Such as washing hand, udder/teats, milking equipment's observed in this study.

According to the survey the entire respondents used a fenced housing system for their cattle, 52% (closed) and 47.8% (semi-closed) barns. The purpose of fencing was to protect the dairy cattle from predators, rainfall, sunlight's and other external environmental factor affecting the productivity. This was agreed with the finding of other reports (Asaminew, 2007; Derese, 2008; Asrat, 2009; Gurmessa, 2014). Similarly the study show comparatively 5.4% of farms

practice semi-intensive farming system. On the contrary 95.6% the respondents were exercised zero grazing and hence all the animals were in total confinements.

As observed in the study there is a significance variation ($p < 0.05$) with the three farm scale having maternity pens on the farm and none of the respondents used a bedding materials used for their cattle which is a similar finding of (Gurmessa, 2014). However using clean, dry and comfortable bedding is necessary to minimize the growth of pathogenic microorganisms. As Ruegg, (2006) stated that practice that expose the teat end to organic bedding sources, wet and muddy pens increase the risk occurrence of mastitis and milk contamination. Similarly Donald, (1998) stated that maintaining the sanitary condition of the barn is important for the production of good quality milk.

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). According to Bisrat Godefaye & Bayelegn Mola (2000), in Ethiopia the dairy hygiene is given less attention. They reported that, exogenous source of milk contamination with bacteria are very common.

Maintaining the sanitary condition of milking area is important for the production of good quality milk. The drainage condition of the milking area is one of the determinant factors (Yilma, 2003). As observed in the current study 17.8% of the respondents had well drained from all the study areas of farm. Since housed and well-built barn can drain easily, it has positive correlation with the overall hygienic condition of a given milking environment rendering the production of better quality milk. However, from the barn owned the highest (40.0%) poor drainage system found in the medium scale farms which is lead to not well drain and difficulty to clean, that lead to poor quality milk production. It is therefore important that producers considered appropriate drainage condition of milking environment as integral part of production hygienic to ensure the supply of safe and good quality milk and its derivatives. As the respondents reported most of (85%) clean the barn more than once a week. Proper and clean housing environment is a prerequisite to produce milk and milk products of acceptable quality (Asaminew, 2007).

Nutrition has major effect on milk composition. Manipulating a ration of dairy cows can change milk composition (Grummer, 1991; Castillo *et al.*, 2003). As presented in Table 5 there is a significance difference ($p < 0.05$) among the feed source used by the milk sheds. 94.4% of the milk sheds used feed purchased from different sector in the city this due to the fact that majority of the milk sheds have lack of knowledge how to prepared animals feed, money capital problems and shortage of spaces. But the higher number of the respondents used commonly feed staff concentrate feed add with straw and molasses. Besides feeding the animals Gran *et al.* (2002) reported that insufficient cleaning of the udder may result in contamination of milk the use of detergent and good-quality water for cleaning could be expected to remove milk remains, including microorganisms that affect the microbial quality of milk. Therefore data from the survey show that 98.9% of the respondents used tape water as a main sources water for cleaning the udder or teats, washing their hands, and milking equipment's. The other 1.1% used well or pond water source for cleaning and washing purpose. According to Zelalem (2009), when water from non-tape 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.

Most loses of the dairy products occurs as a result of contamination of poor production or handling practices and lack of technical knowledge on clean milk production, use of unclean milking equipment, lack of potable water for cleaning purpose contributed to the poor hygienic quality of dairy products produced in central Ethiopia (Zelalem & Faye 2006). As Getachew (2003b), indicated that milk procedures should follow hygienic during milking and handling, before delivery to consumers or processors. Similarly, Gran *et al.* (2002) reported that insufficient cleaning of the udder may result in contamination of milk. The use of detergent and good-quality water for cleaning could be expected to remove milk remains, including microorganisms that affect the microbial quality of milk.

As presented in Table 6 in this study the entire milk sheds follow the milking procedures (washing hand, udder and milking equipment's before and after milking). Therefore as Murphy (1996) pointed out, cleaning and disinfection of equipment's after each milking is important to reduce contamination of milk by microorganisms from the equipment and with rinsing, about 10% of the number of bacteria found in milk can be reduced. Bramley and

McKinnon (1990) also found out that milk residue left on equipment contact surfaces supports the growth of a variety of microorganisms.

The study made by Getachew (2003b) indicated that milking producers should follow hygienic practices (clean utensils, washing milker's hands, washing the udder, use of individual towels) during milking and handling, before delivery to consumers or processors. However as observed in the current study 42.2% of the respondents use shared towel, 12.2% of respondents use both shared and individual's towels. This is a potential source of contamination of milk microorganisms during milking. Since one of the objectives in dairy farming, in either large or small-scale farms to produce good quality desirable milk which is 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.

Also it was observed that in the study the employees were engaged in several additional workloads other than milking show in the study area. Thus it was possible that those employees who were engaged in milking and other additional assignments like cleaning may contaminate the milk as most of them were not using detergents for washing their hands. This might be increasing the microbial counts of the milk marketed in the study area. According to Bonfoh *et al.* (2006) in milk production area, besides udder cleaning and water quality, hygienic behaviour with respect to hand washing, container's cleaning and disinfection are the key areas that remain of relevance to milk hygiene intervention.

There are basically two marketing system in the central high lands of Ethiopia, formal and informal. In the formal system milk collected at cooperatives or private milk collection centers and transported to processing plants. In this system somehow milk quality tests (alcohol test, clot-on-boiling test and density) experienced as a result, the quality of milk is fairly secured. However informal system producers supply their surplus production to their neighbors or local market, either as liquid milk or inform of milk product (SNV, 2008). This indicates the health of dairy consuming community is not secured (O'Connor 1994). As observed in this study the three farm scales supply their milk production for different type of consumers. The greater amount (85.6%) of fresh milk is sold out for households (individuals) followed by hotels & milk collection centers (13.3%). Moreover on average 81.1% of the respondents have marketing problems. This was due to the fact that recent report on

afflatxin in the country related with fresh milk consuming forced them either discard their milk or sold out with very cheap price. The major milk production related problem in the study area was lack of access to quality feeds for their cattle and too expensive indicated in Figure 2. All the listed factors had negatively affects the quality of milk and milk products.

As Rajala-Shultz and Grohn, (1999) stated generally culling of dairy cow can be for low production or an excess animal, illness, injury, infertility or death. Similarly Groenendaal *et al.*, (2004) and Hadley *et al.*, (2006) pointed that the most common reasons for culling cow have been reproductive problem, mastitis and low production. As the current study indicated in Table 6 the higher culling reasons for the three farm scale in the study area were related with health problems (23.3%small, 23% medium and 11.8%large) and reproductive infertility (18.2% small, 13.3% medium and 23.5% large) scale farms which agree with the above statement.

Composition of milk

The result of physico-chemical composition of milk sample indicated in above Table 9, cow milk composition are very important to determine nutritive value and consumers acceptability (O'Connor 1993). Milk at normal state has unique physic-chemical properties, which are used as quality indicators. The density/specific gravity of milk among others commonly used for quality test mainly to check for adulteration water to milk or removal of cream, addition of water to milk reduce milk density, while removal of cream increase it (O'Connor, 1994). Generally, normally milk has a specific gravity between 1.027 and 1.035 with an average value of 1.032 at 16°C (O'Connor, 1994, Morris, 1999). As observed in the current study the values fall within 1.028-1.032 given to unadulterated milk (O'Connor, 1994).

Freezing point also another parameter to check the physical property of milk. The normal freezing point of milk is between -0.50 °C and -0.61 °C. The maximum and minimum freezing point of the study area was -0.941± 1.40 °C this means the milk collected from the milk sheds is not under the standard of freeing point of milk.

In the present study, the indicated that scale of farming had no significant effect ($p > 0.05$) on total solid content of milk. The average total solid (TS) content of milk in the present study was found to be 12.02 ± 1.79 . This value is less than the finding of Bille *et al.*, (2009), Mirzadeh *et al.*, (2010) and Tekelemichael (2012) who reported TS of 12.33%, 12.57% and 12.58%, respectively. According to European Union recognized quality for total solid content of cow milk not less than 12.5% (FAO, 2007). Therefore, the average TS content 12.02% of milk sample in this study was beyond the recommended standard. This variation could be due to difference in breed, feeding and management practices which have important effect on milk composition quality (O'Connor, 1995).

The average SNF content of milk obtained in this study was 7.6 %. The present finding is less than the finding of Debebe (2010) who reported a minimum (8.3 ± 0.30) and maximum (8.7 ± 0.36) SNF content of raw milk obtained from street-vendors and milk producers in and around Addis Ababa. It also lowers than 8.75 % reported by Teklemicheal (2012) in Dire Diwa. According to European Union quality standard for unprocessed whole milk solid-not-fat should not be less than 8.59% (Tamime, 2009). The SNF obtained in this study was not full fill the criteria set by EU quality standard. The difference observed in SNF content of milk could be due to different in feeding practices, season, milking method and lactation of period exerted (Sunman *et al.*, 1998).

The overall mean protein content of milk in the current study was 3.2%. This is higher than the protein content (3.1%) reported by O'Connor (1994). According to Food and Drug Administration (FDA) protein contain of whole milk is 2.73% (Raff, 2011). Similarly, European Union quality standard for unprocessed whole milk, total protein content should not be less than 2.9%, (Tamime, 2009). The difference due to variability among breed of cow, with in a breed, feeds and stage of lactation. Therefore the average protein content in the current study is within the recommended standards.

The average fat contain of milk obtained in the present study was 4.4 %- The present finding is greater than the early finding of Teklemickeal (2012) and Janstora *et al.* (2010) 3.86% and

3.79% respectively. The fat content was significantly affected by the factor such as feed, parity, and stage of lactation (Kearson, 2005). According to European Union quality standard for unprocessed whole milk fat content should not be less than 3.5% (Tamime, 2009). Similarly, the Food and Drug Administration (FDA) requires not less than 3.25% milk fat for fluid whole milk. Therefore the fat content of the current study is within the recommended standard.

Microbial quality of milk

Total bacterial count was used as an important indicator of microbial quality of raw milk. From the result of this study, it was found that 98% of milk sample had higher TBC than the maximum recommended level of 2.0×10^6 cfu/ml as given by East Africa Community Standard (ESA 67:2007). The presence of high total bacteria loads in the current study may be due to contamination possible from lactating cow, milking equipment's, storage containers, unsatisfactory hygiene/sanitation practiced at the farm level. Unsuitable storage condition, unclean udder/teats, poor quality of water used for cleanliness and dirty hands of milkers increase total bacteria load of raw milk (Bukuku 2013).

The present study finding higher than of $8.23 \log_{10}$ cfu/ml reported by Godifay, and Molla (2000) and $7.58 \log_{10}$ cfu/ml reported by Asaminew and Eyasu (2011). The mean standard plates count found in the present study was higher than the acceptable value reported by American Public Health Association (1992), $2 \times 10^5 - 4 \times 10^5$ cfu/ml

Holm *et al.* (2004). Suggested that high STC can be influenced by poor storage temp, long storage period after milking, health and hygiene of the cow, environment milking is done as well as procedures used in cleaning and sanitizing the milking equipment. It was indicated that the total bacteria count in milk of developing country fall between 5.301 to 5.875 \log_{10} cfu/ml (Febrhad and Micholes, 2004). However, the mean result of the current study is $8.6 \pm 1.11 \log_{10}$ cfu/ml, which is not within the range set for developing country.

In the present study the mean coliform count of milk in the study area was found to be $6.18 \pm 2.7 \log_{10}$ cfu/ml. This result is higher than that of Asaminew (2007), Rahel (2008), Derese (2008), Abebe *et al.*, (2012) from Ethiopian who reported a coliform count $4.49 \log_{10}$ cfu/ml I

milk sample collected from West Shewa zone of Oromiya, 4.84 log₁₀ cfu/ml in milk sample collected from Bahir Dar milk sheds sample, 4.18 ± .01 log₁₀ cfu/ml for raw milk sample and 4.03 log₁₀ cfu/ml in raw whole cow milk in Ezhe district of Gurage zone respectively. In other study, Zelalem and Faye (2006) having higher coliform count of 6.57 log₁₀ cfu/ml for raw cow milk collected from different producer in central highland of Ethiopia.

Mosu *et al.*, (2013), reported a mean coliform count of raw milk was 1.82 log₁₀ cfu/ml in Debrezeite, Ethiopia. A study conducted by Godefay and Molla (2000), in and around Addis Ababa reported a coliform count of 4.1 log₁₀ cfu/ml which is lower than the result of present study. Therefore the result obtained in this study was above the accepted value reported by (APHA, 1992).

The somatic cell count (SCC) is internationally recognized as a parameter for assessing milk quality and udder health (Degraaf *et al.*, 1997). According to International Dairy Federation, (1999) milk SCC is a diagnostic figure for subclinical mastitis is >200,000 cells/ml indicates mastitis. Similarly Hillerton, (1999) proposed that quarter having a cell count of 200000 cells/ml and whole cow milk cell count of 400,000 cells/ml to indicate mastitis. Therefore, mastitis should be detected in a reliable and timely fashion based on SCC values, otherwise subclinical mastitis could develop into a clinical disease (Hallén Sandgren *et al.*, 2008). According to the current study the mean somatic cell count was 198×10⁴ cell/ml is above the finding of Hillerton,(1999). Much of Europe, New Zealand and Australia have a limit 400,000 cells/ml and Canada has a limit of 500,000 cells/ml of raw milk. Due to this, the somatic cell count is internationally recognized as a parameter for assessing both milk quality and udder health .The so-called premium milk or grade ‘A’ milk should have a SCC of less than 4.0*10⁵ cells/ml of milk (Degraaf *et al.*, 1997). Therefor the result of the present study shows that there has been subclinical mastitis occurrence in the milk sheds and not the recommended standard. Also there was no significance variation (p<0.05) between the three farm scale which is the highest somatic cell was made in small scale farming and the lower was in the medium farm scale (Table 10).

6. CONCLUSIONS AND RECOMMENDATIONS

Based on the finding of this study it is possible to conclude that raw milk produced by the intensive dairy milk shed in the three sub city (Akaki-kality, Nifas silk-lafito and Bole) found in Addis Ababa do not comply with the accepted level of bacterial load of 8.6 ± 1.01 in the milk. The high bacterial load was invariable common to all studied farms. The microbial qualities of the milk obtained in current study was poor, as judged from the high values of standard plate count (SPC), coliform count (CC) and somatic cell count (SCC) which were significantly higher than the international standards safe for human consumption. These microbial loads was probably due to the poor hygienic condition of the milking environment, poor sanitary condition of the milk containers, poor udder and teats cleaning practice, failure to use separate towel for each cow and the poor personal hygiene of the milkers. Whereas the physical and chemical qualities of the collected raw cow's milk were within the recommended levels of European Union and FAO established quality standards except total solid, solid-non-fat, freezing point. Therefore practice and regulations, such as on-site pasteurization and implementation should be introduced to facilitate the production of cow milk of high quality and safety.

Based on the conclusion made from this study the following recommendations are forwarded

- Awareness should be created among the milk sheds the importance of milk hygienic production and processing.
- Strictly hygienic measures should be applied during milking and milk handling practices, achievable by educating communities on good animal husbandry practices.
- Routine assessment of milk quality produced in the town and consumed by the general public has to be mandatory in order to safeguard the public from milk-borne zoonotic infections which may radiate through consumption of unsafe milk and milk products
- Further study with wider area coverage is needed to identify the different species of microorganisms that might cause public health hazards

7. REFERENCES

- Abebe Bereda, Zelalem Yilma and Ajebu Nurfeta, 2012. Hygienic and microbial quality of raw whole cow's milk produced in *Ezha* district of the Gurage zone, Southern Ethiopia. *Wudpecker Journal of Agricultural Research*, **1(11)**: 459 – 465
- Abdel Moneim, E.S., Hamid, A.d., Elamin A.E and Ali O.A. (2006): Effect of Refrigerated Storage on Chemical and Sensory Characteristics of Sour Milk Sudan Jour. of *Agri. Res.* **7**, 53-60.
- Acha, P. N. and Szyfers, B. (2001): Zoonosis and Communicable Disease Common to Man and Animals 3rd ED., (I) Bacterioses and Mycoses. Pan American Health Organization, Scientific and Technical Publication, No 580, Washington DC, USA.
- Addo, K.K., Mensah, G.I., Aning, K.G., Nartey, N., Nipah, G.K., Bonsu, C., Akyeh, M.L. and Smits, H.L. (2011). Microbiological quality and antibiotic residues in informally marketed raw cow milk within the coastal savannah zone of Ghana. *Journal of Tropical Medicine and International Health* **16(2)**: 227 – 232.
- Afif, A., faid, m. and Najim, M. (2007): Effects of breeding and hygiene practices on raw cow milk quality in Tadla area, *Morocco Livest. Res. For Rural Dev.* **19**, 12-24.

Ahmed, M.M., Ehui, S. and Yemesrach Assefa, 2003. Dairy Development in Ethiopia. Socioeconomics and Policy Research Working Paper 58. ILRI (International Livestock Research Institute), Nairobi, Kenya. 47p.

Alehegn, W. (2004): Bacteriological Quality of Bovine Milk in Small Holder Dairy Farms in Debre Zeit, Ethiopia Msc thesis faculty of veterinary Medicine, Addis Ababa University.

Alganesh Tola, 2002. Traditional milk and milk products handling practices and raw milk quality in Eastern Wollega. M.Sc. Thesis, Alemaya University. Dire Dawa, Ethiopia. 108p.

Alganesh T, Ofodile LN, and Fekadu B., 2007. Microbial Quality and Chemical composition of Raw Whole Milk from Horro Cattle in East Wollega, Ethiopia.

Asaminew Tassew and Eyassu Seifu, 2011. Microbial quality of raw cow's milk collected from farmers and dairy cooperatives in Bahir Dar Zuria and Mecha district, Ethiopia. *Agriculture and Biology Journal of North America*, **2(1)**:29-33.

APHA (American public health association), 1992. Standard Method for the Examination of Dairy products, 16th edition, APHA, Washington. PP.213-220.

ARAB, (2008) Addis Ababa Region Agriculture Bureau, A Report on the number and composition of the dairy herd in the urban settling, internal report. July, 2008.

Asaminew Tassew, 2007. Production, handling, traditional processing practices and quality of milk in Bahir Dar milk shed area, Ethiopia. M.Sc. Thesis, Haramaya University of Agriculture, Dire Dawa, Ethiopia.

AASEP, (2013) Addis Ababa Administration Integrated Land Information Center, April, 2013.

Asrat G., 2009. Evaluation of Traditional Practices and Effects of Lactoperoxidase System on Keeping Quality of Cottage Cheese, M.Sc. Thesis. Department of Animal and Range Sciences, Hawassa College of Agriculture, School of Graduate Studies, Hawassa University, Ethiopia

Auld, M. J. and Hubble, I. B. (1998): Effects of mastitis on raw milk and dairy products. *The Aus Jour of Dairy Technology* **53**,427-436.

Azage T. and Alemu, G. (1998): Prospect for the peri-urban dairy development in Ethiopia. In: Proceeding of Fifth National Conference of the Ethiopian Society of Animal Production. 15th-17th May, 1997, Addis Ababa, Ethiopia (ESAP) Pp 28-39.

Azage Tegegne and Alemu Gebre Wold, 1998. Prospects for peri-urban dairy development in Ethiopia. In: Proceedings of the 5th Annual Conference of the Ethiopian Society of Animal Production (ESAP). 15-17 May, 1997. Addis Ababa, Ethiopia. pp. 28-39.

Azage Tegegne, Tsehay Reda, Alemu Gebre-Wold and Hizkias Ketema, 2001. Milk recording and herd respiration in Ethiopia. An essential step towards genetic improvement for milk producing, Pastoralism and Agro-pastoralism, which way forward; proceedings of the eight Annual conference of the Ethiopia society of Animal production, 24-26, August, 2000, Addis Ababa Ethiopia. Pp. 90-104.

Azage T., Million, T., Alemu, Y and Yosef, M. (2000): Market oriented urban and peri-urban dairy systems. Urban Agricultural Magazine (The Netherlands) 23-24.

Barbano, D.M., Ma, Y. and Santos, M.V., 2006. Influence of Raw Milk Quality on Fluid Milk Shelf Life. *J. Dairy Sci.* **89**(E):E15-E19.

Barbano, D. M. and Lynch, M. (2006): Major Advances in Testing of Dairy Products: *Milk Component and Dairy Products Attribute Testing Jour. Dairy Sci.* **89**, 1189-1194.

Barrientos, A. A., Arroyo, J., Canton, R. and Nombela, C. (2000): Application of flow Cytometry to Clinical Microbiology. *Clini. Microbial. Rev.* 13, 167-195.

Barkema, H. W., Schukken Y. H., Lam T.J.G.M., Beiboer M. L., Wilmink H., G. Benedictus, and Brand A., 1998. Incidence of clinical mastitis in dairy herds grouped in three categories by bulk milk somatic cell counts. *J. Dairy Sci.*, **81**:411–419.

Berhanu, A. and Debrah, S. (1991): Dairy marketing in Ethiopia, ILCA Research Report No 19, ILCA, and Addis Ababa, Ethiopia.

Bertu, W.J., Dapar, M., Gusi, A.M., Ngulukun, S.S., Leo, S. and Jwander, L.D. (2010). Prevalence of brucella antibodies in marketed milk in Jos and environs. *African Journal of Food Science* **4**(2): 062 - 064.

Berhane Mekete and Workneh Ayalew, 2003. Promotion of dairy marketing using farmer's Cooperatives: Lessons from India. pp. 81-87. In: Proceedings of 10th Annual Conference of the Ethiopian Society of Animal Production (ESAP). August 22-24, 2002, Addis Ababa, Ethiopia.

Bille, P.G., Haradoeb, B.R., and Shigwedha, N. (2009). "Evaluation of Chemical and Bacteriological Quality of Raw Milk from Neudamm Dairy Farm" In Namibia. *African Journal of Agriculture Nutrition and Development*, **9**(7), 1511-1523.

Bonfoh B, Roth C, Traore AN, Fane A, Farah Z (2006). Effect of washing and disinfecting containers on the microbiological quality of fresh milk sold in Bamako (Mali), *17*(2): 153-161.

Bramley, A.J./ McKinnon, C.H. The Microbiology of Raw Milk. In: Dairy Microbiology, I, (Ed.: Robinson, R.K.). London, New York, Elsevier Applied Science, 1990, 171.

Bukuku, J.N. (2013). Awareness of health risks as a result of consumption of raw milk in Arusha City and Meru District, Tanzania. Unpublished dissertation for award of MSc. degree at Sokoine University of Agriculture, Morogoro, Tanzania. pp 1 - 89.

Burton D., 1986. Pasteurized Liquid Milk Specification .1st ed., ICS:67,100-105.

Campbell, J.R and Robert T.M., 1995. The Science of providing milk for man. New York, St. Louis. San Francisco.

Castillo, A. , Taverna, M., Peaz, R., Cuatrin, A., Colombato, D., Bargo., Garcia, M., Garcia, P., Chaves , M and Beauliett. A. (2003): Fatty Acid Composition of milk from fed fresh alfafa based diets. *Anim. Feed Sci. and Tecnol.* **131**, 241-254.

Charles, C. S. (1998): Nutrition Changes Milk composition, Verginiya Cooperative Extension Publication No 404-232, <http://www.ext.vt.edu/pubs/dairy/404-232/404-232.html>

Chaye, F. Y., Abdullah, A. and Ayob, M.K. (2004): Bacteriological quality and safety of raw milk in Malaysia *Food Microbiol.***21**, 535-541.

CIA (Central Intelligence Agency). The World Fact book: Ethiopia: 2011

Courtenay, M., Ramirez, L., Cox, B., Han, I., Jiang, X and Dawson, P, (2005): Effect of Various Hand Hygiene Regimes on Removal and/or Destruction of Escherichia Coli on Hands, *Food Sci. Technos* **5**, 77-84.

CSA, 2008. Summary and Statistical Report of the 2007 population and housing census. federal Democratic Republic of Ethiopia Population Census Commission. Addis Ababa: United Nations Population Fund (UNFPA).

CSA, 2009. Federal Democratic Republic of Ethiopia Agricultural sample survey: Livestock and Livestock Characteristics. Ethiopia Central Statistical Authority. Addis Ababa, Ethiopia.

CSA, 2010. Agricultural Sample Survey. Livestock, Poultry and Beehives population (private peasant holdings). Federal Democratic Republic of Ethiopia Central Statistical Authority (CSA), Addis Ababa, Ethiopia.

CSA, 2012. Livestock and Livestock Characteristics, Agricultural Sample Survey. Volume II, Statistical Bulletin, 532.

CSA. 2014. Agricultural sample survey 2013/2014 (2006 EC). Vol. II. Report on livestock and livestock characteristics. Statistical Bulletin. AddisAbaba, Ethiopia.

Debebe Worku, 2010. Physicochemical Properties and Safety of Street-vended Milk in and Around Addis Ababa City (Kotebe, Bishoftu and Chanco), M.Sc.Thesis. Haramaya University, Ethiopia.

Debrah S. and Berhanu Anteneh. 1991. *Dairy marketing in Ethiopia: Markets of first sale and producers' marketing patterns*. ILCA Research Report 19. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 21 pp.

De Graaf, T., Romero Zuniga, J.J., Cabalellero,M.,Dwinger, R.H.,1997. Microbiological quality aspects of cow's milk at a smallholder cooperative in Turrialba, Costa Rica. PP.57-64.

Derese T., 2008. Present Situation of Urban and Peri-Urban Milk Production and Quality of Raw Milk Produced in West Shewa Zone, Oromia Region. M.Sc.Thesis. Haramaya University, Ethiopia.

Dogan, B, and Boor, K.J. (2003): Genetic Diversity and Spoilage Potentials among *Pseudomonas* spp. Isolated from Fluid Milk Products and Dairy Processing Plants. *Appl. Environ. Microbiol.* **69**, 130-138.

Donald D.M. (1996): the shelf-life of dairy products: 2. Raw milk and fresh product. *Inter Jour. of Dairy Technos*, **49**, 44-48.

Donkor, E.S., Aning, K.G. and Quaye, J. (2007). Bacterial Contaminations of Informally Marketed Raw Milk in Ghana. *Ghana Medical Journal* 41(2): 58 - 61.

EAS (2007). *Raw Cow Milk – Specification*. East African Community (EAC 67:2007) standard. pp 1 - 19.

Elmagli, A. A., Ibtisam, E. M. and EL Zubeir, O. (2006): Study on The Hygienic Quality of Pasteurized Milk in Khartoum State (Sudan). *Res. Jour. of Anim. and Vet. Sci.* **1**, 2-17.

FAO/WHO (2006): Benefit and Potential Risk of the Lactoperoxidase system of Raw milk preservation. Report of an FAO/WHO Technical Meeting FAO Head Quarters, 28th, Nov 2nd Dec, 2005, Rome, Italy.

FAO (Food and Agriculture Organization of the United Nations). 2007. Overview of the Turkish Dairy Sector within the Framework of Eu-Accession, Rome. pp. 58.

FAO, 2010. Status and prospects for smallholder milk production – A global perspective, by T. Hemme and J. Otte. Rome.

FDA(Food and Drug Administration). Food safety from farm to table: A national food safety initiative, 1997

FDA, 2003. Food Sampling and Preparation of Sample Homogenate. Bacteriological Analytical Manual, Edition 8, Revision A. Chapter 1. Authors: Andrews, W.H. and Hammack, T.S. 1998. USA

Febrehadt, L.P. and Micholes, P.S., 2004. Microbiology. The C.V. Mosby company, Saint Louis. PP. 18-19.

Felleke G., 2003. Milk and Dairy Products, Post-harvest Losses and Food Safety in Sub-Saharan Africa and the Near East. A Review of the Small Scale Dairy Sector – Ethiopia. FAO Prevention of Food Losses Programme. FAO, Rome, Italy.

Fernandes, A.M., Oliveiral, C.A.F and Tavolaro, P, (2004): Relationship between Somatic Cell Count and Composition of Milk from Individual Holstein Cow *Arq. Ins, Biol.*, **71**, 163-166.

Getachew Feleke, 2003a. Assessments report on the dairy subsector in Ethiopia. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy.

Getachew Felleke, 2003b. A Review of the Small Scale Dairy Sector in Ethiopia. FAO prevention of food losses programme. Milk and milk products, post-harvest losses and food safety in sub-Saharan Africa and the Near East.

Godefay Bekele and Molla Bayileyeegn, 2000. Bacteriological quality of raw cow's milk from four dairy farms and a milk collection center in and around Addis Ababa. *Berl. Munch Tierarzti. Wschr.* 113:276-278.

Gran HM, Mutukumira AN, Wetlesen A, Narvhus JA (2002). Smallholder dairy processing in Zimbabwe: hygienic practices during milking and the microbiological quality of the milk at the farm and on delivery. *Food Control*, **13**: 41-47.

Griffith, D. G., Druce, R. G., Thomas, S. B (1957): Advisory Microbiological Standards And Tolerances for Raw Milk. *Jour. of Appl. Microbiol.* **20**, 243-250.

Griffiths, M. W., & Phillips, J. D., 1990. Strategies to control the outgrowth of spores of psychrotrophic *Bacillus* spp. in dairy products. *Milchwissenschaft* 45, 621–625.

Groenendaal, H., D.T. Galligan, and H.A. Mulder. 2004. An Economic Spreadsheet Model to Determine Optimal Breeding and Replacement Decisions for Dairy Cattle. *J. Dairy Sci.* 87:2146-2157

Grummer, R. R. (1991): Effect of Feed on the Composition of Milk Fat. *Jour. of Dairy Sci* **74**. 3244-3257.

- Grumessa T., 2014. Physicochemical Properties and Microbial Quality of Raw Cow's Milk in Ybello District Borena Zone, Southern Ethiopia. MSc Thesis.Haramaya University,Ethiopia.
- Hailu, T. (1989): Bacteriological Quality of Raw Milk Supplied to Shoal Milk Processing Plant and Prevalence of Bovine Mastitis in Three Selected Dairy Farms in Shoal Region. DVM Thesis. Faculty of Veterinary Medicine, Addis Ababa University.
- Hadley,G. L., C. A. Wolf, and S.B.Harsh.2006.Dairy Cattle Culling Patterns, Explanations, and Implications.*J.Dairy Sci.***89**:966-978
- Hagstad, H.V and Hubbert, W.T (1986): Food Quality control, Foods of Animal origin 1stEdition, The IVVA state university press/Ames, PP **52**, 87-88.
- Heineman P G,. 2001. Milk. pp. 266-337, 195-197, W. B. Saunders Company, Philadelphia and London.
- Hillerton, J. E., 1999. Redefining mastitis based on somatic cell count. *Intl. Dairy Fed. Bull.*, **245**: 4-6.
- Holm, C., Mathiasen, T. and Jespersen, L.,2004. A flow cytometric technique for quantification and differentiation of bacteria in bulk tank milk. *Journal of Applied Microbiology* **97**: (5) 935-941
- IDF, (1991): International Dairy Federation Milk and Milk Products: Enumeration of Microorganisms. IDF standard 100 B. Brussels: International Dairy Federation.
- ILCA, (1995): Dairy Industry Development Scope in Ethiopia, Synopsis, Interational Livestock Centered for African, Addis Ababa, Ethiopia. In: The Food Chain-experience and lessons learned. Conference on Food Safety and Quality. Conference paper, 25th- 28th Feburary.2002, Budapest, Hungary.
- ILRI (International Livestock Research Institute), 1996. Annual Report. ILRI, Addis Ababa.Yoseph, M., 1999. Impact of feed resources on productive and reproductive performance of dairy cows in the urban and peri-urban dairy production system in the Addis Ababa milk shed and evaluation of non-conventional feed resources using sheep. An MSc Thesis presented to the School of Graduate Studies of Alemaya University. 3p.

Janštová, B., Necidová, L., Navrátilová, P. and Vorlová, L. (2010). Quality of raw milk from a farm with automatic milking system in the Czech Republic.

Jay, J. M. (2000): Modern Food Microbiology 6th ed. Aspen Publications Inc., Gaithersburg, Maryland, USA. Pp 113-128.

Kearson, D., 2005. The Chemical Analysis of Food. 7th Ed., Chemical Publishers Co., Berlin, pp. 9-11.

Ketema, H. and Tsehay, R. (1995): dairy production system in Ethiopia. In: Kurwijila, L., R. Henriksen, J., Aboud A.O.O. and Kifaro, G.C. (1995): Strategies for market orientation of small scale milk producers and their organizations, Food and Agricultural Organization of the United Nation Rome Proceeding of Workshop Held at Morogoro, Tanzania, 20th -24th March, 1995.

Kessel, J. V., Karns, J. S., Gorski, L., McClusky, B. J. and Perdue, M. L. (2004): prevalence of Salmonellae, Listeria monocytogenes, and Fecal Coliforms in Bulk Tank Milk on US Dairies. *Jour. Dairy Sci.* **87**, 2822-2830.

Krishnaiah, N., 2005. Quality control of milk and processing. Dept. of Veterinary Public Health. ANGRAU, Rajendra Nagar, Hyderabad

Kivaria, F.M., Noordhuizen, J. P. T. M. and Kapaga, A. M. (2004): Risk Indicator Associated with Subclinical Mastitis in Smallholder Dairy Cows in Tanzania. *Trop. Anim. Hlth and Prod.* **36**, 581-592.

Kivaria, F.M., Noordhuizen J.P. and Kapaga A.M., 2006. Evaluation of the hygienic quality and associated public health hazards of raw milk marketed by smallholder dairy producers in the Dar-es-alaam Region, Tanzania. *Tropical Animal Health Production*, **38(3)**:185-194.

Kurwijila, R.L., Hansen, K.K., Macha, I.E., Abdallah, K. and Kadigi, H.J.S. (1992). The bacteriological quality of milk from hand and machine milked dairy herds in Morongo, Tanzania, *Journal of African Livestock Research* **2**:59-67.

Lampart L.M., 2005. Milk and dairy products, their composition, food value, chemistry, bacteriology and processing. Chemical publishing Co., Inc., Brooklyn, N.Y p. 242.

Leeuwen P., Oostinig, S.J., Mouwen, J.M.V.M., Verstegen, M.V.A. (2000): Effect of a lactoperoxidase system and lactoferrin, Added to a milk replacer diet, on severity of diarrhea, intestinal morphology and microbiology of digesta and faces in young calves. *Jour. Anim. Physiol. Animal. Nutr.* **83**, 15-23.

Linzell, J. and Peaker, M. (1971): Mechanisms of milk secretion, *Physiological Reviews* 51, 564-597.

Loir, Y. L., Baron, F and Gautier, M. (2003): *Staphylococcus aureus* and Food Poisoning *Genet. and Molec. Res.* **2**, 63-76.

Marth E H (ed.) 1978 Standard Methods for the Examinations of Dairy Products. American Public Health Association, Washington, DC. 416p

Mdegela, R.H., Ryoba, R., Karimuribo, E.D., Pire, E.J., Løken, T., Reksen, O., Mtengeti E. and Urio, N.A. (2009). Prevalence of clinical and subclinical mastitis and quality of milk in smallholder dairy farms in Tanzania. *Journal of the South African Veterinary Association* **80(3)**: 163 - 168.

Mirzadeh, K.H., Masoudi, A., Chaji, M. and Bojarpour, M. (2010). “The Composition of Raw Milk Produced by Some Dairy Farms in Lordegan Region of Iran”. *Journal of Animal and Veterinary Advances*, **9(11)**, 1582-1583.

MoA, 2007. National Livestock Development Programme, Ministry of Agriculture, Addis Ababa.

Mohamed A, Ahmed M, and Ehui S., 2004. Dairy Development in Ethiopia. Washington DC.

Mohamed, A. M., Ahmed, S. E. and Yemesirach, A. (2003): Dairy Development in Ethiopia, paper presented at the IFPRI/NEPAD/CTA conference; Successes in African Agriculture Conference Paper No.6 December 1-3, 2003, Pretoria South Africa.

Morris B. Jacobs, 1999. *The chemical analysis of foods and food products. Third edition.* CBS, Publishers and Distributors. New Delhi, India.

Mosalagae, D., Pfukenyi, D.M. and Matope, G. (2011). Milk producer's awareness of milk-borne zoonoses in selected smallholder and commercial dairy farms of Zimbabwe. *Tropical Animal Health and Production* 43: 733 - 739.

Mosu, S., M. Megersa, Y. Muhie, D. Gebremedin and S. Keskes, 2013. Bacteriological quality of bovine raw milk at selected dairy farms in Debre Zeit town, *Ethiopia. Comprehensive Journal of Food Sciences and Technology Research*, **1(1)**: 1-8.

Murphy, S.C (1996): Source & causes of High Bacteria count in raw milk: an Abbreviated Review corne University, Ithaca, and N.Y. pp 1-4.

Noorduizen, J. P. T. M. and Metz., J. M. (2005): Quality Control on Dairy Farms with Emphasis on Public Health, Food Safety, Animal Health and Welfare. *Stocarstva* **59**, 39-55.

O'Connor, C.B., 1993. *Traditional Cheese Making Manual*. ILCA (International Livestock Center for Africa), Addis Ababa, Ethiopia. 43 pp.

O'Connor C B., 1994. Rural Dairy Technology ILRI training manual No. 1. International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia. 133pp.

O'Connor, C.B., 1995. Rural Dairy Technology ILRI Training Manual I, International Livestock Research Institute, Addis Ababa, Ethiopia.

Oliver, S.P. and Murinda, S.E. (2011). Milk and raw milk consumption as a vector for human disease. (Edited by D.O. Krause and S. Hendrick). *CAB International. Zoonotic Pathogens in the Food Chain*. 231 pp.

O'Mahony, F. (1988): Rural Dairy Technology, Experiences in Ethiopia, ILCA, Manual 4.

O'Mahony, F., 1998. Rural Dairy Technology- Experiences in Ethiopia. ILCA manual No 4. Dairy Technology Unit. ILCA, Addis Abeba, Ethiopia. 64pp.

Ombui, J. N., Arimi, S. M., Mcdermott, J. J., Mbugua, S. K., Githua, A.A., and Mouthoni. J (1995): Quality of raw milk collected and marketed by dairy cooperatives societies in Kiambu District, Kenya. *Bull. Anim. Hlth. Prod. Afr.* **43**, 277-284.

Omore AO, Muriuki H, Kenyanjui M, Owango M & Staal S., 1999. The Kenyan Dairy Sub-Sector: A Rapid Appraisal: Research Report of the MoA/ KARI / ILRI Smallholder Dairy (R&D) Project. International Livestock Research Institute, Nairobi, Kenya, pp. 51.

Omore, A., Lore, T., Staal, S., Kutwa, J., Ouma, R., Arimi, S. and Kang'ethe, E. (2005). Addressing the public health and quality concerns towards marketed milk in Kenya. Smallholder Dairy Project Research and Development, Report 3. ISBN 92-9146-168-7.

Pandey, G.S. and Voskuil, G.C.S. (2011). Manual on Milk safety, quality and hygiene. Golden Valley agricultural Research Trust, Zambia. 52pp.

Parekh, T.S. and Subhash, R. (2008). Molecular and bacteriological examination of milk from different milch animals with special reference to Coliforms. *Current Research in Bacteriology* 1(2): 56 - 63.

Quinn, P.J., Carter, M.E., Markey, B. and Carter, G.R. (1994). *Clinical Veterinary Microbiology*, Mosby, London. pp. 22 - 91.

Quinn, P. J., Markey B. K., Carter, M. E., Doneley, W. J. and Leonard, F. C. (2002): *Veterinarian Microbiology*. Wolfe, Baltimore, London, 327-344.

Radostits, O.M., D.C. Blood, C.C. Gay (1994): Bovine Mastitis. In Radostits, O.M., and Blood, D.C. (eds): *Veterinary Medicine: A textbook of the disease of cattle, sheep, pig, goats and horses*. 8th edition, Baillier Tindal, London, Pp 563-614.

Raff, H., 2011. Market implications of changing fat content of milk and dairy products, fat content and composition of animal products. *J. Food Science and Technology* 5 (2): 6 - 17.

Rahel N., 2008. Traditional and Improved Milk and Milk Products Handling Practices and Compositional and Microbial Quality of Milk and Buttermilk in Delbo Watershed of Wolayta Zone, M.Sc.Thesis. Department of Animal and Range Sciences, Hawassa College of Agriculture, School of Graduate Studies, Hawassa University, Ethiopia.

Rajal-Schultz, P. J. and Y.T.Grohn. 1999. Culling of dairy cows. Part I. Effects of Diseases on culling in Finnish Ayrshire cows. *Prev. Vet. Med.* 41:195-208

Rice, D.N. and Bodman, G.R. (1997): the somatic cell Count and Milk Quality. Cooperatives Extension, Institute of Agriculture and natural Resources, University Of Nebraska-Lincoln. G93-1151-A, Pp 1-5.

Ruegg L., 2006. Role of hygienic in efficient milking. WCDS advances in Dairy Technology. Department of Dairy Science, University of Wisconsin, 18: 285-293.

Slaghuis, B (1996); Sources & Significance of Contaminants on Different levels of Raw milk Production. In: symposium on Bacteriological quality of raw milk International Dairy federation proceedings. Brussels, 13-15.march, 1996, Brussels, Belgium.

SPSS, 1999. (Statistical Package for Social Sciences) SPSS for windows. Users Guide: Statistics Version 12. Inc, Cary, NC.

Stephen, J. S., Alejandro, N. P., and Mohammed, J. (2006): A Comparison of dairy Policies and Development in South Asia and East Africa, International Livestock Research Institute, a report prepared for the FAO Pro-Poor Livestock Policy Initiatives pp20-35.

SNV Netherlands Development Organisation, 2008. Study on Dairy Investment Opportunities in Ethiopia, Addis Abeba.

Suhren, G. and Walte, H. G. (1999): First Experience with Automation Flow Cytometric Determination of Total Bacterial Count in Raw Milk. *Michwissenschaft* **50**, 249-275.

Swai, E.S. and Schoonman, L. (2011). Microbial quality and associated health risks of raw milk marketed in the Tanga region of Tanzania. *Asian Pacific Journal of Tropical Biomedicine* **1(3)**: 217 - 222.

Syit, D.A. (2008). Detection and determination of oxytetracycline and penicillin G antibiotic residue levels in Bovine bulk milk from Debrezeit and Nazareth dairy farms in Ethiopia. In: *Proceedings of the 1st International Technology, Education and Environment Conference African Society for Scientific Research*. (Edited by Human Resource Management Academic Research Society). May, 2008, Addis Ababa, Ethiopia. pp. 325 – 346.

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

Tegegne A, Gebremedhin D, and Hoekstra D., 2010. Livestock input supply and service in Ethiopia: Challenges and opportunities for market-oriented development. *Working Paper No 20*.

Teka,G(1997)food Hygiene principles and food Born Disease control with special Reference to Ethiopia.1stEdition,Faculity of medicine, Department of Community Health, Addis Ababa University. Pp 73-86.

Teklemichael Tesfaye, 2012. Quality and Safety of Raw and Pasteurized Cow Milk Produced and Marketed in Dire Dawa Town, M.Sc.Thesis. Haramaya University, Ethiopia.

Tsehay Redda, 2001. Small-scale milk marketing and processing in Ethiopia. In: proceeding working paper 28. International Livestock Research Institute (ILRI), Nairobi, Kenya. 28p.

Tsehay Redda, 2002. Small-scale milk marketing and processing in Ethiopia. 352-367 pp. In: Smallholder dairy production and market opportunity and constraints. Proceeding of a southsouth workshop held at NDDDB, Anand, India, 13-16 march 2001. NDDDB (National Dairy Development Board), Anand, India,and ILRI (International Livestock Research Institute), Nairobi, Kenya.

USAID. 2010. Ethiopian sanitary and phytosanitary standards and livestock and meat marketing program (SPSLMM)Texas A&M University system. Feed resources assessment in Amhara national regional state.Addis Ababa, Ethiopia.

U.S. Public Health Services, 1995. Grade A Pasteurise milk ordinance, U.S. Department of Public Health *Education and Welfare Service*, P.I.

WHO/FAO (1953): Advances in the control of Zoonoses: Bovine Tuberculosis, brucellosis, Leptospirosis, Queen Fever and Rabies. Issued as WHO Monograph Series 19, intly Publicashed by WHO/FAO, Rome, Italy.

Walstra, P., Geurts,T.J., Noomen, A., Jellema , A. and Van Boekel, M.A.J.S., 1999. Dairy Techniology: Principles of Milk Properties and Processes. 1st.ed. Newyork: Marcel Dekker. PP 149-170.

Walestra P, Wouters JM, Geurts TJ (2006). Dairy Science and Technology Second Edition.CRC Press Taylor and Francis Group. p763.

Zegeye Yigezu, 2003. Imperative and challenges of dairy production, processing and marketing in Ethiopia. In: Y Jobre and G Gebru (editors), Challenges and opportunities of livestock marketing in Ethiopia. Proceedings of the 10th annual conference of the Ethiopian Society of Animal Production, Addis Ababa, Ethiopia, August 21-23, 2003: pp.61-67.

Zelalem Yilma and Bernard Faye, 2006. Handling and microbial load of cow's milk and irgo-fermented milk collected from different shops and producers in central highlands of Ethiopia. Ethiopian Journal of Animal Production.6 (2)-2006:67-82.

Zelalem Yilma, 2003. Sanitary Conditions and microbial qualities of dairy products in urban and peri-urban dairy shed of the central Ethiopia. DEA.Lyon, France

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

8. ANNEXIES

8. Which kind of water drink source does you drinking the cow?

River water..... Tape water.....wall water..... stagnant water.....

9. Health service provide

Vet..... traditional healer..... Owner.....

If yes which disease, name.....

10. Milk production..... It/day, amount soldlit/day

11. Market used..... Name.....

-Is there any marketing problems, yes..... No.....

13. Average salary of employee.....

14. Have you received any training yes..... No....

if yes on what topic of dairy husbandry? Name.....

15. The main problems affecting your productivity.....

16. Who take care of the animals?

Feeding:- owner.....

Family worker.....

Labor.....

Cleaning the barn:- owner.....

Family worker.....

Labor.....

Milking:- owner.....

Family worker.....

Labor.....

17. Is there any practice of recording keeping yes..... No.....

If yes, breeding records.....

Production records.....

Health records.....

Financial records.....

Feeding records.....

Others.....

18. Culling practice yes..... No.....

If yes, common cause of culling

Health problem.....

Space shortage.....

Feed shortage.....

Reproductive problem.....

Low production level.....

Other.....

Method of removal

Selling.....

Death.....

Slaughtering.....

19. Milking practice

- Do you wash hand between milking? Yes..... No.....

- Do you wash udder before milking? Yes..... No.....

- Do you use separate towel for drying teat? Yes..... No.....

- Do you use shared towel for drying teat? Yes..... No.....

- Do you practice milking mastitis cow last? Yes..... No.....

- Cleaning the milk utensil before milking? Yes..... No.....

- How many times you milk the cowper/day

- Source of water used for washing milking utensil

River water..... Well water..... Tap water..... Stagnant water.....

20. Mastitis situation

Previous mastitis problem in barn yes..... no.....

Person treated mastitis cow:- Vet..... professional..... My self.....

Problem of cause mastitis cow

Farm inspection

1. Housing

Housing, closed type semi-open..... Open.....

Floor, concrete..... stone..... mud.....

Roof, metal sheet..... Grass..... Other (specific).....

Drainage (slope), good..... Satisfactory..... Poor.....

Maternity pens, yes..... No.....

Bedding, yes.....No.....

If yes hygienic condition, excellent.....satisfactory..... poor.....

Frequency of cleaning the bar

1. Once a week..... 2. Twice a week.....3.once in a month.....

2. Farm cleanness

Excellent..... satisfactory..... poor.....

3. Feed and water trough

Excellent..... satisfactory..... poor.....

4. Hay and concentration storage condition

Excellent..... satisfactory..... poor.....

Annex 2: Material and equipment's used for laboratory



Eko-milk apparatus

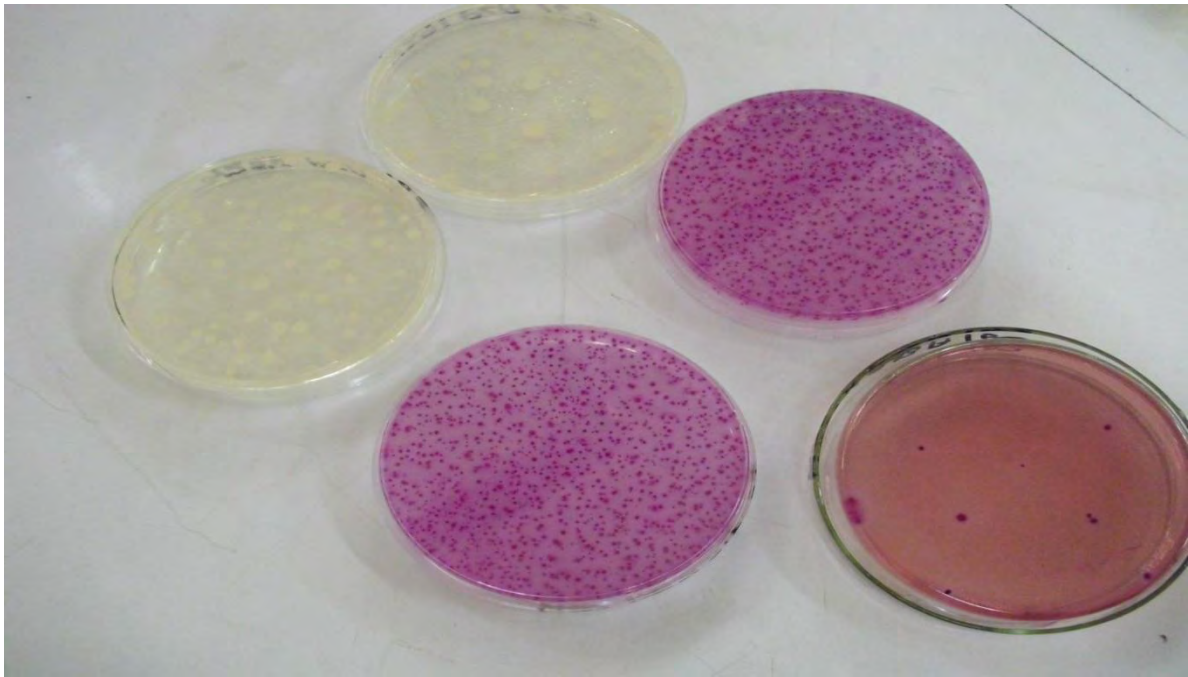


Milk mixer

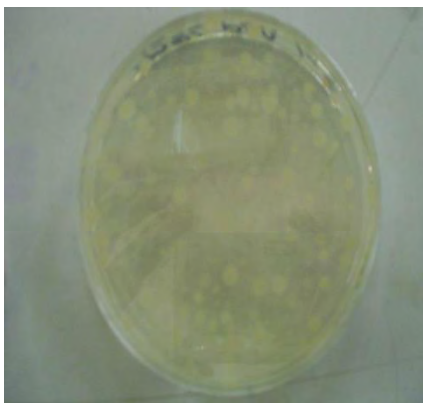


Colony counter

Annex 3: Different bacteria's count



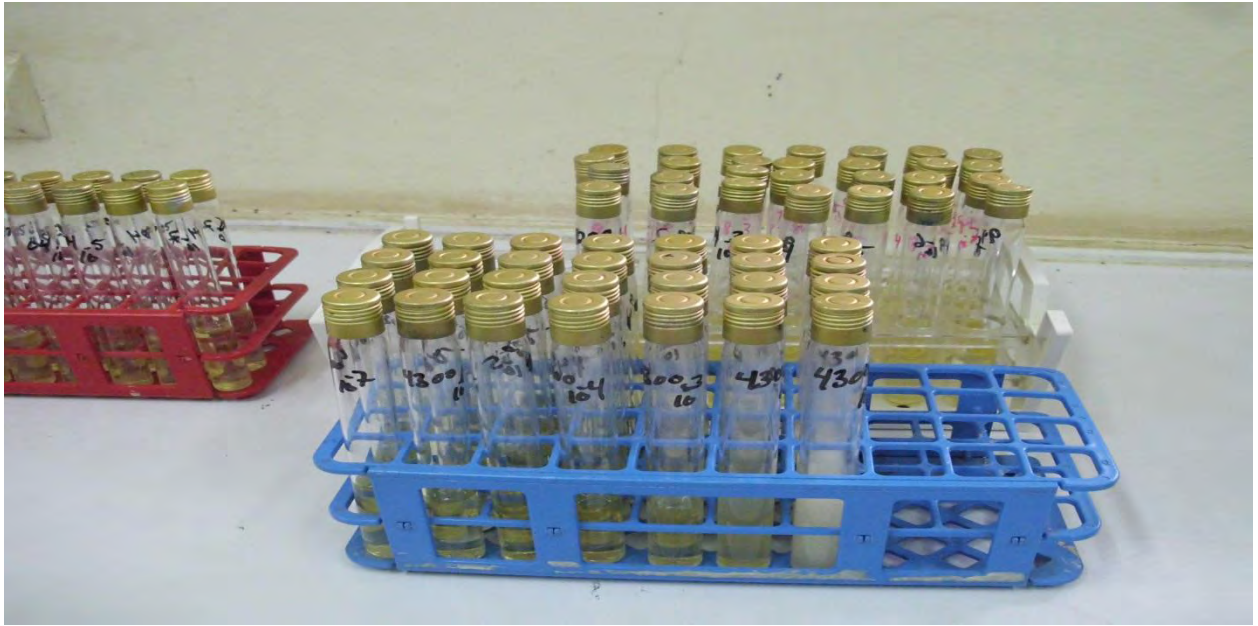
Coliform bacteria's



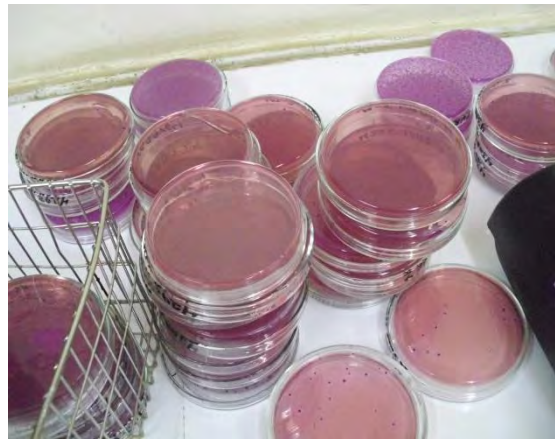
Standard plate bacteria's



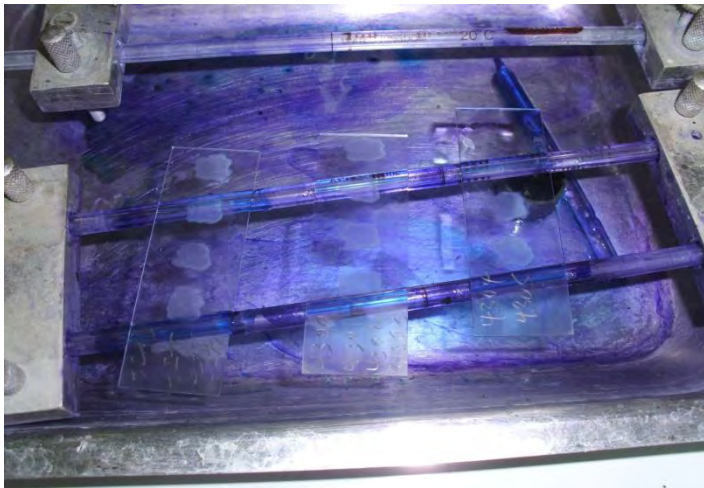
Annex 4: Duplicated of milk samples prepared for bacterial colony count



Annex 5: Bacteria's grown in prepared media prior for counting



Annex 6: Stained somatic cell



Annex 7: Autoclaves



