DAIRY PRODUCTION, QUALITY OF RAW COW MILK AND BUTTER IN SHASHEMENE TOWN, OROMIA REGIONAL STATE, ETHIOPIA

MSc THESIS

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HAWASSA UNIVERSITY

COLLEGE OF AGRICULTURE

HAWASSA, ETHIOPIA

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DAIRY PRODUCTION, QUALITY OF RAW COW MILK AND BUTTER IN SHASHEMENE TOWN, OROMIA REGIONAL STATE, ETHIOPIA

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DEDICATION

I dedicate this thesis manuscript to my family, my father Ato Adere Wakjira, my mother W/ro Desta Balcha and all my brothers and sisters for nursing me with affection, love and for their dedicated partnership in the success of my life.

STATEMENTOF THE AUTHOR

First, I declare that this thesis is my bona fide work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for MSc Degree at Hawassa University, College of Agriculture and deposited at the University. 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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LIST OF ABBREVIATIONS

AFC	Age at First Calving
AI	Artificial Insemination
ANOVA	Analysis of Variance
BOFED	Bureau of Finance and Economic Development
CFU	Colony Forming Units
CI	Calving Interval
CSA	Central Statistical Agency
ETB	Ethiopian Birr
FAO	Food and Agricultural Origination
IDF	International Dairy Federation
LPC	Laboratory pasteurization count
PDA	Potato Dextrose Agar
SD	Standard Deviation
SNF	Solid Not Fat
SNV	Netherlands Development Organization
SPC	Standard Plate Count
TA	Titratable Acidity
TBC	Total Bacteria Count
TCC	Total Coliform Count
VRBA	Violet Red Bile Agar
YMC	Yeast and Mould count

TABLE OF CONTENTS

Contents Pages

LIST OF TABLES

Tables Page

LIST OF FIGURES

Figure Page

Dairy Production, Quality of Raw Cow Milk and Butter in Shashemene Town, Oromia Regional State, Ethiopia

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ABSTRACT

The study was conducted in Shashemene town West Arsi Zone, Oromia Regional State, Ethiopia, with objectives of assessing dairy cow performance, marketing system of butter and raw milk, dairy value chain, and to analyse microbial qualities of raw milk and butter The study had two parts cross sectional survey and laboratory analysis. Totally, 124 randomly selected farmers from Shashemene town were included in the study. For survey data were collected through questionnaire and by observation. For laboratory analysis 48 raw milk samples and 40 butter samples were collected. The results on the major feed resources show that most of the respondents (94%) purchase animals feed from different feed providers in the town. The major feed resources included hay, straw, concentrate and industrial by products and molasses. The overall mean±SD of age at first calving, calving interval, daily milk yield, and lactation length of local cow were 41.18±5.33 months, 21.58±2.31 months, 1.84±0.81 liters/day/cow and 7.02±0.84 months, respectively; where as its counterpart crossbred cows had values of 26.55±3.15 months, 13.85±1.92 months, 10.79±2.22 liters/day/cow and 10.17±0.83 months, respectively. Of the total volume of milk produced by farmers 86.71% was destined to market, 5.51% consumed at home, 3.41% is given to calves, and only 4.2% are usually processed into various products showing that whole milk is the most marketable dairy product in the town. The main outlets for raw milk identified were cooperatives (50.9%), retail shops (31.5%), processors (9.3%), directly to consumers(4.9%) and hotels/restaurants (3.4%).The main out lets of butter were direct to consumers (50.3%), retailers(30.5%), itinerate trader (14.7%), farmer trader (4.5%).Overall mean±SD of raw milk quality for density, acidity, fat, protein, solids not fat and lactose were 1.029±0.003, 0.185±0.02%, 3.73±0.23%, 3.15±0.11%, 7.95±0.34% and 4.13±0.23%, respectively. The physiochemical quality of raw milk among value chain points were not significantly different ($P>0.05$), except for milk acidity and lactose. Total bacteria count/ml of raw milk from milk producers (MP), milk collectors (MC) and milk retailer shop were 5.98±0.21 log10 Cfu/ml,6.41±0.12 log10cfu/ml, and 6.17±0.10 log10 Cfu/ml, respectively and it was statistically different ($P<0.05$) among the value chain actors. The coliform counts/ml of raw milk found from MP, MC and milk retailer shop (MRS) were 4.81±0.14 log10 Cfu/ml,4.99±0.16 log10 cfu/ml and 4.86±0.13log10 cfu/ml, respectively and it was statistically different ($P<0.05$) among the value chains as well. The average values of yeast and mould count/ml counts from raw milk samples collected from MP, MC and MRS were 3.86±0.18 log10 cfu/ml, 4.01±0.07 log10 Cfu/ml and 3.95±0.09log10 cfu/ml, respectively. Overall mean±SD total bacteria count/ml, coliform counts/ml and yeast and mould counts for butter were 6.26±0.19 log10 Cfu/ml,5.09±0.11log10 cfu/ml and4.54±0.22 log10 Cfu/ml, respectively. The result shows that across value chains of raw milk and butters products, the quality and safety are compromised. A value chain approach of interventions is appropriate, considering various actors multidisciplinary approaches

Key words: *Dairy value chain, Dairy cattle, Milk quality, Butter quality*

1. INTRODUCTION

1.1. Background

Livestock production is an integral part of Ethiopia's farming sector and plays a vital role in the national economy. Ethiopia is the first top ranked country for its largest livestock population in Africa having about 59.5 million cattle, 30.70 million sheep, 30.20 million goats, 2.16 million horses, 0.41 million mules, 8.44 million donkeys, 1.21 million camels, 56.53 million poultry and 5.92 million beehives estimated by the year CSA (2016).

According to CSA (2016), Ethiopia earned about 3.1 billion liters of cow milk from milking cows. Cows are the main sources of dairy products in Ethiopia (Gelan *et al.,* 2012).About 82% of total milk in Ethiopia is obtained from cows, of which 97 % is from local breeds with an average milk yield of 1.37 liter per cow per day for about 6 months of lactation period. This production and productivity is very low compared with other countries and world average (FAO, 2011a).Ethiopians consume less milk (19 kg) (World Bank, 2016) when compared with average consumption of Africa (40 kg) and world (105 kg) (FAO, 2011b). Such milk supply shortage in Ethiopia is due to absence of sustainable approach of the dairy development to improve milk production and marketing and due to the challenges of active engagement in milk value chain and market by smallholder milk producers (Eyasu *et al.,* 2014).

Milk is the most popular food for human consumption and contains numerous nutrients such as water, fat, protein, lactose, minerals and vitamins (Walstra *et al*., 2006). It is the major source of regular income for smallholder milk producers because it is produced and sold daily (Dugdill *et al,* 2013).

Microbial contamination in milk may cause food-borne diseases to humans while others are known to cause milk spoilage (Pal, 2012). Sources of microbial contamination in milk include primary microbial contamination from the infected or sick lactating animal. The secondary causes of microbial contamination occurs along the milk value chain which may include contamination during milking by milkers, milk handlers, unsanitary utensils and/or milking equipment and water supplies used in sanitary activities (Pal and Jadhav, 2013).

Quality milk implies the milk which is free from pathogenic bacteria and harmful toxic substances, free from sediment and extraneous substances, of good flavor, with normal composition, adequate in keeping quality and low in bacterial counts (Khan *et al.,* 2008). Consumers need clean, wholesome and nutritious food that is produced and processed in a sound sanitary manner and free from pathogens. Hence, quality milk production is necessary for fulfilling consumers' demand (Khan *et al.,* 2008). To sell raw milk directly to consumers or to a processing factory, it must be handled hygienically and remains fresh and capable of being heated without curdling.

Butter is an important source of food (cooking fat), cosmetics and common marketable form of dairy product for per- urban and rural community. Ethiopians have been using milk products such as butter and its ghee as part of their diet since pre-historic times (Zelalem *et al*., 2011). Butter is made from a variety of animal milk including cow, goat, camel, buffalo and sheep (Curry, 2013). In Ethiopia large amount of dairy products such as butter and ghee are produced on farm from sour milk through spontaneous fermentation (Alganesh and Fekadu, 2012; Sintayehu *et al.,* 2008). Butter has long shelf life as compared to fresh milk, especially when heated at higher temperature (100 120°C) for 30 min; in ghee making it can stay for several months without spoilage (Lejko *et al.,* 2009). The quality of butter is closely related to its physicochemical and microbiological characteristics. Besides fats, butter contains small percentages of proteins, milk sugar and water which make it a suitable substrate for microorganisms (Mahendra *et al*., 2016).

Value chains can either be market driven or relation-based depending on the form of governance they adopt (Farnworth, 2011). Relational value chains are those in which lead actors, such as producers in dairy cooperatives, buyers in contract farming and intermediaries determines the transactional framework within which other actors will work, resulting in producer-driven, buyer-driven, or intermediary-driven relational value chains respectively (Mutua *et al.,* 2014). Dairy value chains in particular is to increase smallholder's incomes by increasing the number of households deriving their livelihood from dairy business through managing high productivity enterprises, while delivering quality and affordable dairy products to the market (SNV, 2008).

1.2. Statement of the Problem

Poor or improper handling of milk can exert both a public health and economic constraints thus requiring hygienic vigilance throughout the milk value chain (Swai and Schoonman, 2011). In Ethiopia milk marketing system is not well developed. 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. Milk being perishable and demand being high for urban consumption, efficiency in collection and transportation of this bulk from widely scattered rural sources, requires a well-defined method of preservation and distribution. In the year 2011, out of the total production of milk, butter and cheese in rural Ethiopia, about 6.55%, and14.35% were sold in the market, respectively (CSA, 2011). This indicates that the demand for milk and milk products is higher and supply is lower in towns than in rural areas due to high pressure of population growth (Zelalem *et al.,* 2011).

1.3. Significance of the Study

The study is valuable as it provides the necessary information about benefit share of milk market actors, determinants of quality of milk in the country. Then, it can be used as economic development for smallholder dairy producer and consumer. It also implementation of improved milk production interventions systems by value chain actors, government organizations, NGOs as well as bilateral organizations engaged in milk development in the area. Also understanding the dairy cattle production and productivity helps to design appropriate technologies which are compatible with the system. Besides filling the existing research gap, the findings of the study could be useful for planners to understand the economic impacts of smallholder dairy farmers and policy governing this activity.

Therefore, the purpose of this research study was conducted to assess the quality of raw cow milk and butter and value chain from producer up to consumer level in Shashemene.

1.4. Objectives

1.4.1. General objective

To assess value chain and quality of raw cow's milk producers at farmers' level in the Shashemene, Oromia, Ethiopia.

1.4.2. Specific objectives

- To assess the value chain of raw cow's milk and butter through identifying marketing actors in the study area
- To determine the physiochemical quality of raw cow's milk in the study area
- To evaluate the microbial quality and safety of raw cow milk and butter produced in Shashemene town.

2. LITERATURE REVIEW

2.1. Milk Production System in Ethiopia

Based on climate, land holdings and integration with crop production as criterion, dairy production systems are recognized in Ethiopia; namely the rural dairy system which is part of the subsistence farming system and includes pastoralists, agro-pastoralists, and mixed crop–livestock producers; the urban and peri-urban dairy systems (Yitaye, 2008). The first system (pastoralism, agro-pastoralist and highland mixed smallholder production system) were found to contribute to 98%, while the urban and peri-urban dairy farms produce only 2% of the total milk production of the country (Sintayehu *et al*., 2008).

2.1.1. Urban milk production system

Urban dairy production system is market oriented like most urban dairying of Ethiopia and other East African countries, is characterized by market orientation. Dairy Producers in the urban production system have a better understanding of dairy management, processing facilities, better genetics (50 – 62.5% crosses) with experience of receiving AI services (Land, 2010).

The types of feed commonly used in urban production system include purchased concentrates and roughages of conventional and non-conventional sources *atela*. In addition to these, different fruits, wastes and road side grazing were also used. (Asrat Ayza. *et al.*, 2016).Type of feed commonly used in this production system includes purchased concentrates and roughages of conventional and non-conventional sources (Asrat *et al*., 2013). As compared to other systems they have relatively better access to inputs and services provided by the public and private sectors, and use intensive management (Azage *et al.,* 2013). The urban dairying using improved dairy cattle with relatively better management may be considered as a key factor for the better performance and highly profitable as compared to other systems (Alemayehu *et al*., 2012).

2.1.2. Peri-urban milk production

Peri-urban system is largely found in the highlands where mixed-crop livestock-farming is practiced as well as within urban centers. The dairy farms in this system rely mainly on purchased feed. They are commercially oriented and will respond to improved technology, input supply and marketing services (Getenet Haile, 2009). The type of housing and facilities in the barn in urban and peri-urban dairy farms are, such that it prevents animals from hot conditions theft and rain (Bekele Aysheshim *et al*., 2015). The farmers have small size of grazing land; they use semi-grazing systems and also practice under stall feeding conditions for improved animals (Yitaye Alemayehu *et al.,* 2009). The peri-urban dairy is characterized as a semi-intensive crop–livestock farming system. Farmers keep crossbred cows indoors with supplementary concentrate feeding. As compared to the rural dairy system, peri-urban dairy systems are mostly located along roads within reasonable distance to urban centers and involved in fluid milk market (Nigatu Alemayehu *et al.,* 2012).

2.1.3. Rural milk production system

Dairy production is practiced almost all over Ethiopia involving a vast number of small scale, medium scale and large scale farms. Rural dairy system is part of the subsistence farming system that contribute up to 98% of the total milk production of in Ethiopia, and includes pastoralists, agro-pastoralists, and mixed crop–livestock producers (Land O'Lakes, 2010). Very few crossbred cows are kept in the rural dairy system. The rural dairy system focuses on butter production rather than fluid milk. Natural pasture, cop residues, stubble grazing were listed as major feed resources, with minimal contribution of improved forage and local beverage by-products (*Diqi* or atela) (Kassahun Gurmessa *et al.*, 2015). Breeding takes place through natural mating using local bulls. About 6% fresh milk is sold to neighbor hoods and the remaining 94% is either home consumed or processed into butter, local cheese (*ayib*) and whey of which 20% is sold (Girma Debele,2008). This indicates that fresh milk and butter sales contribution under rural dairy is not a priority; however, their nutritional contribution to households could be of considerable importance.

2.2. Housing System of Dairy Cattle

Good housing and layout of the farm can reduce stress. In urban and peri-urban area the roof is made of iron sheet, but the wall varies depending on economic status of the owner, some of them have built with block and the other built with wood and mud, whereas the floor was constructed in concrete, soil compact with or without beddings. Drainage system was not sufficient enough to remove slurry. Most of them dispose the slurry inappropriate place outside their compound which contaminate nearby water reserve or lake or well (Mekuria, 2016).

2.3. Feeding of Dairy Cattle

The urban and peri-urban dairy operations depend mainly on the natural pasture hay as a source of roughage feed in the central highlands of Ethiopia (Fekede *et al.,* 2013). The major roughage feed resources for dairy animals across all the different production systems include natural pasture/grasslands, grass hays, crop residues and non-conventional feed resources (Asaminew and Eyassu, 2009;Yitay*et al.,* 2009; Azage *et al*., 2013) Good grass and legume hays are adequate for maintaining most classes of livestock, particularly those in a non-productive state (Streeter *et al.,* 2006). Therefore, dairy cows which depend on poor quality basal feeds will not express their full genetic potential. According to Azage *et al*. (2013), agro-industrial by-products such as bran, middling, oil seed cakes and molasses are fed as supplement to crossbred dairy cows in urban and peri-urban areas.

2.4. Butter Making

Butter is made by churning *Ergo* (sour milk) which has been collected over a few days. When sufficient amount of milk (7-8 liters) is collected, it is transferred to a churn made of gourd or clay pot. The gourd churn used in the area is hanged on a tripod and swung to and fro. When using clay pot, the churn is placed on a mat on the floor and rocked back and forth until butter grains are formed (Eyassu Seifu and Asaminew Tassew, 2014**).**

2.5. Handling of Milk and Milk Products

Ethiopian farmers particularly women have their own practices to improve the keeping quality of locally produced dairy products through sanitation of milk and milk handling equipment as well as by applying locally evolved processing knowledge (Abebe *et al.*,2014). Milk handling is essential at each stage; at the farm, cooling centre for collection during transport and the processing plants and supermarket (Pandey and Voskuil, 2011). Dairy products are a source of high quality animal protein. Milk and milk products forms part of the diet of many Ethiopians; they consume dairy products either as fresh milk or fermented or in soured form (Derese, 2008). The consumption of milk and milk products varies geographically between the highland and the lowlands and depending on the proximity to urban. Farmers in rural production systems were processing milk to increase shelf life of the product (cheese& butter) for home consumption and for marketing (Negash *et al*., 2012). The small quantity of milk produced by the majority of the rural households in the traditional system is usually processed into butter and cottage cheese by the farm household and sold to traders or other consumers in the local markets (Belay and Janssens 2014; Negash *et al.,* 2012).

Milk residues left on equipment and utensil surfaces provide nutrients to support the growth of microorganisms, including pathogens (Grillet *et al.*, 2007). In case of cracked milking equipment large numbers of bacteria enter and grow in the cracks, are difficult to clean. The bacterial load of milk increases during transportation and if the transportation equipment is not appropriate. The bacterial counts increase causing spoilage before milk reaches its destination. Milking equipment should be easy to clean. Aluminum and stainless steel equipment are mostly preferred (Zelalem, 2010).

2.6. Milk Collection and Transportation

In Ethiopia collection of milk is carried out at milk collection centres by dairy cooperative or private milk collectors where most of smallholder dairy farmers are delivered their milk to the nearby collection centres or along a main road. These milk collection centres are either owned by dairy cooperative or private milk processing company to collect the milk from milk collection centres (Land, 2010). Smallholder farmers take their raw milk to milk collection points, where the milk is weighted and tested by lactometer and alcohol test to assure the quality of milk delivered by farmers (VanderValk and Tessema, 2010). The accepted milk is transported to the nearest chilling centre, where it is cooled to temperatures below six degrees Centigrade. Milk is usually delivered to the collection centres and milk cooperatives by producers either on foot, by horse or donkey back. The establishment of village milk marketing groups, small-scale dairy associations and cooperatives in many milk shed areas by government, local and international development partners has contributed positively to promote milk collection.

2.7. Butter and Milk Marketing System in Ethiopia

Marketing includes all activities performed in moving commodities from the producer to the consumer (Woldemichael, 2008). The population of Ethiopia is estimated to grow at 2.9% per year, while the urban population increases at a rate of 4.4%. Therefore, growth in population and income are expected to increase fluid milk demand in the market (Gatwech Tang, 2012). Milk and milk products in Ethiopia are channeled to consumers through both formal and informal marketing systems. Formal marketing system milk is collected at the cooperative or private milk collection centers and transported to processing plants (Fussi, 2010). In this system, milk quality tests (principally acidity using alcohol and clot-on-boiling test, and density) are performed on delivery, thereby assuring the quality of milk. This has encouraged the producers to improve the hygiene conditions, storage and transportation of the milk in order to avoid rejection of the product on delivery to the collection centre (Zelalem, 2010a).

In the informal market, milk may pass from producers to consumers directly or it may pass through two or more market agents. This system is characterized by no license to operate; low cost of operation, high producer prices as compared with formal market and no regulation of operation (SNV, 2008). Generally milk marketing systems are traditional; during milk marketing, in majority of household whole milk and butter are used for sale (Azage Tegegne *et al.*, 2008; Gatwech Tang, 2012).

2.7.1. Marketing channel

Marketing channels are routes through which products pass as they are moved from the farm to the consumer (Adebabay Kebede, 2009). In any marketing system, various actors participate in marketing of commodities and process of transactions made. These include itinerate /mobile traders, semi-whole sellers, retailers, cooperatives and consumers. Marketing outlet is the final market place to deliver the milk product, where it may pass through various channels. A network (combination) of market channels gives rise to the market chain. Milk can be collected either by the buyers or taken by the producer to the sales point, but generally, with the exception of a few commercial farms, farmers are responsible for the delivery of their milk into the market chain (Reddy and Kanna, 2016).

Marketing survey in Hawassa, Shashemane and Yergalem depicted that milk producers sold milk through different principal marketing channels (Woldemichael Somano, 2008). These included:

Producer-consumer (P-C) channel- involves direct sales to individual consumers accounting for 21%, 4.7% and 23.7% of total milk marketed per day in Hawassa, Shashemane and Yergalem, respectively. Producer → Retailer → Consumer, The channel represents average of 43% of milk marketed per day in the milk shed. This channel represents for 16%, 38% and 76.6% of total milk marketed per day in Hawassa, Shashemane and Yergalem, respectively. Producer → Semi-whole seller → Retailer →Consumer, This channel was identified to be operational only in Hawassa where milk semi-whole sellers undertake both retailing and wholesaling activities. Producer → Cooperative → Retailer →Consumer: This channel account for 2.2% and 46.9% of total milk marketed per day in Hawassa and Shashemane, respectively. Producer → Cooperative →Consumer: This channel was exceptional for Shashemene and Hawassa where milk cooperatives are found and accounts for 0.81% and 10.67% of total milk marketed per day in Hawassa and Shashemene, respectively.

2.7.2. Dairy value chain

Value chain is an innovation that enhances or improves an existing product or introduces new products or new product uses (Fleming, 2005). The major ones include: actors along the chain and their functions and linkages among themselves, governance mechanisms for the chain and roles of actors e.g. power relations and principal drivers of the chain functions, impact of upgrading products, services and processes within the chain and distribution of benefits among actors within the chain (Rich *et al*., 2008). Dairy value chain development comprises extension, input supply (feed, bull services, and veterinary services) milk production, dairy processing and milk and milk products marketing (Tilahun*, et al*, 2012). Value chain actors are those involved in supplying inputs, producing, processing, marketing, and consuming agricultural products (Getnet, 2009). The partners within the value chain usually work together to identify objectives: They are willing to share risks and benefits, and share in time, energy and resources to make the relationship work (Bammann, 2007).

Value chain analysis is essential to an understanding of markets, their relationships, the participation of different actors, and the critical constraints that limit the growth of livestock production and consequently the competitiveness of smallholder farmers (Bammann, 2007).

2.8. Compositional and Physical Property of Milk

2.8.1. Physical properties of milk

Milk, at its normal state, has unique physical properties, which are used as quality indicators. The density of milk, among others, is commonly used for quality test mainly to check for the addition of water to milk or removal of cream (Almaz, 2014). Specific gravity is the ratio of density of the substance to the density of standard substance (water). 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 (O'Connor, 1995). Generally, normally milk has a specific gravity between 1.027 and 1.035 with an average value of 1.032 at 16^{o}C (Morris, 1999).

Titratable acidity is determined in the dairy industry mainly for two reasons: (a) to check the freshness of milk and milk products and (b) to control the manufacture of cultured (fermented) dairy products (McCarthy and Singh, 2009). The initial acidity of milk from individual cows varies within the range 0.08–0.25% lactic acid but the titratable acidity of fresh bulk milk seldom falls outside the range of 0.14–0.16% (McCarthy and Singh, 2009).

Titratable 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 (Lampart, 2005).

2.8.2. Chemical composition of milk

A very important aspect of raw milk quality is its composition. The principal components of milk are water, fat, protein, ash and lactose. However, the exact composition of cattle milk varies with individual animals, breed, season, diet, feeding system, stage of lactation and microbial quality (Pandey and Voskuil, 2011; Kittivachra *et al.,* 2007).

As a general rule, any ration that increases milk production usually reduces the fat percentage of milk (Soyeurt *et al*., 2007; Schennink *et al*., 2008). Different breeds differ in their milk protein and fat contents. Jersey milk has higher protein and fat contents than Friesian (Schennink *et al*., 2008). Milk composition and production are the interaction of many elements within the cow and her external environment (Asaminew, 2007). Milk composition varies between species, breeds and individual animals depending on the management systems. However, it is generally accepted that the dairyman can alter many of these factors to achieve milk production and increase profit. The gross milk composition of cows contains 87.2% water, 3.7% fat, 3.5% proteins, 4.9% lactose and 0.7% ash (Park, 2009).

2.8.3. Factors affecting milk composition

The composition of milk is not fixed since many factors influence the end product. Milk composition is affected by various factors, including stage of lactation, breed differences, number of calving (parity), age and health of animal, feed and management effects including number of milking per day and herd size (Lujerdean *et al.* 2007; Jenkins and McGuire, 2006). At farm level, this may be due to problems with feeding, udder health or incomplete milking. Unbalanced diets and mastitis are also known to decrease and lactose contents in severe cases fat. The age of the cow is closely related to the number of lactations, as an increase in number of lactations is associated with decrease in fat and solid not fat (SNF) content of milk (Almaz, 2014).

2.9. Microbial Quality of Milk and Milk Products

The composition of milk makes it an optimum medium for the growth of microorganisms that may come from the interior of the udder, exterior surfaces of the animal, milk handling equipment and other miscellaneous sources such as the air of the milking environment (Worku *et al.,* 2012). Bacterial contamination of raw milk can originate from different sources: air, milking equipment, feed, soil, faeces and grass can affect the quality, safety, and consumer acceptance of dairy products (Coorevits *et al.,* 2008). It is hypothesized that differences in feeding and housing strategies of cows may influence the microbial quality of milk (Coorevits *et al*., 2008). The 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).

2.9.1. Standard plate count (SPC)

The standard plate count (SPC), which is also called aerobic plate count of raw milk gives an indication of the total number of aerobic bacterial present in milk at the time culturing the samples. Many countries have milk quality regulations, including limits in the total number of bacteria in raw milk, to ensure the quality and safety of the final product (Worku *et al.,* 2012). High initial counts (more than 500,000 bacteria per ml of milk) are evidence of poor production hygiene (Oliver, 2010). However, most countries have put 200000cfu/milliliter as the acceptable bacterial limit and the United States has a standard of 100000 bacterial cells per milliliter (Lore *et al*., 2005).

2.9.2. Total Coliform count

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). In proportion to the numbers present, existence of coliform bacteria in milk is suggestive of fecal contamination and unsanitary practices during milk production (Abebe *et al.,* 2012). High bacteria counts > 10,000 cfu/ml suggests that bacteria are entering milk from a variety of possible sources. They may be found in the soil, on vegetables and untreated water (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.

Table 1 Ethiopian standard requirement on microbial of quality of raw milk.

Aerobic Mesophilic Bacteria count	
Quality	**Counts/ml**
Very good	0-200,000
Good	200,000-1,000,000
Bad	1,000,000-2,000,000
Very bad	>2,000,000
Coliform count	
Quality	**Counts/ml**
Very good	0-1,000
Good	1,000-50,000
Bad	50,000-500,000
Very bad	>500,000

Source :(Alganesh, 2017)

2.9.3. Yeast and mould count

Yeasts and moulds commonly associated with milk and milk products are: Saccharomyces spp., Candida spp., Torulopsis spp.; and Penicillium spp., Rhizophus spp., Aspergillus spp., Geotrichum Candidum, Alternaria spp., Cladosporium spp., respectively (Vishweshwar and Krishnaiah, 2005). Yeasts and moulds attack a number of food items and produce toxic metabolites which affect the health of the consumers. These organisms grow relatively in wider range of environmental conditions, that is, from a pH value of 2 to greater than 9 and temperature range of 10-35^{0}C. Moisture requirements of foodborne moulds are relatively low; most species can grow at a water activity of 0.85 or less, although yeasts generally require a higher water activity (FAO, 2005). Different groups of fungi are found in soil, barn dust, feeds, manure, and unclean utensils. They can produce toxic metabolites, resistance to freezing environments, and cause off odors and off flavors of foods and which can spoil/reduce shelf life of milk and may also pose serious health problems to the consumer.

2.9.4. Sources and microbial load of raw milk

Milk may contaminate and increment in microbial load along at different critical points of milk marketing from farmer to the consumer level. Poor milking practices, dirty udders or teats, damaged teats, and poor operator hygiene can all lead to increased contamination of raw milk (Blowey and Edmondson, 2010). Higher microbial loads observed in raw milk could probably be due to lack of knowledge about clean milk production, use of unclean milking utensils and plastic containers for collecting and keeping milk, initial contamination of the milk samples either from the udder of the cow or the milkers' hand and the poor hygienic quality of milking area as well as further contamination during transportations (Gurmessa, 2015). This could be due to cross contamination of milk during transportation, lack of sanitation of storage container and lack of temperature control (Amistu *et al.,* 2015).

2.9.5. Control of milk contamination

Microbiological quality control is to provide fluid milk from disease-free udders (physiologically healthy animals) to milk processing plants to manufacture wholesome milk and milk products (Barbuddhe and Swain, 2008). Physicochemical and microbiological analyses are an important tool to monitor the quality of dairy products (Hettinga, *et al*., 2008). Chilling the milk fast ensures a longer keeping quality and it tastes better if it is chilled quickly and stays cool. If milk does not stay cool, it will sour and phase separate (Martin *et al.,* 2007).Microbial control includes minimization of microbial sources in the farm environment, minimization of microbial transmission, prevention of microbial growth, and infection of animals. Many aspects of farm management (e.g. feed management, facility hygiene and milking operations) are involved in the control sources of the microbial contamination of bulk tank milk. To ensure a good microbial quality of bulk tank milk, quality assurance systems for dairy farms are being developed and bacteriological schemes are being implemented in payment systems of farm raw bulk milk (IDF, 2006). The most commonly used microbial quality tests for milk and milk products include determination of total bacterial count (TBC) or standard plate count (SPC) and coliform count (CC) (Amistu *et al*., 2015; Demissu, 2014). Provision of microbiological quality parameters of raw milk and milk products plays an important role in quality control. It is necessary to minimize technological and economic losses in milk processing and obtain a longer shelf life (Gurler *et al.,* 2013). To meet increased raw milk quality standards, producers must adopt production practices that reduce mastitis and reduce sources of bacterial contamination of bulk tank milk. Use of effective management strategies to minimize contamination of raw milk and proven mastitis control strategies will help dairy producers achieve these important goals (Oliver, 2010). The use of detergents and good quality water for cleaning the equipment could be expected to remove milk remains, including microorganisms, and thereby affect the microbiological quality of the milk. Use of disinfection, either chemical or hot water, would mostly reduce the numbers of microorganisms (Ngasala, 2013).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The study was conducted in Shashemene town in Oromia regional state, West Arsi zone. It located 255 km south of Addis Ababa and 20 km far from Hawassa city. It is located between 7°11 ′09″ to 7°13′19″ North latitude and 38°35′02″ to38°37′05″ East longitude. The town is located at an altitude ranging from 1900 m to 1950 m above sea level (mals). Its annual average temperature ranges between 18 and 25^0C. It has moderate annual rainfall ranging between 800 mm and 1300 mm (BoFED, 2012). The total human population of Shashemene town is estimated at 100, 454; out of which 50,654 male and 49, 800 female. The town has eight kebeles. The domestic animals reared in Shashemene town cattle population 11,164, followed by 62,670 poultry, 2385 equine, 5430 sheep and 1,876 goats. Farmers in this area own 10,164 thousand cows under smallholder, medium and large dairy farms of which around 8,643 are dairy cattle (Holstein Friesian crossbreds) (Shashemene town livestock development office, 2019).

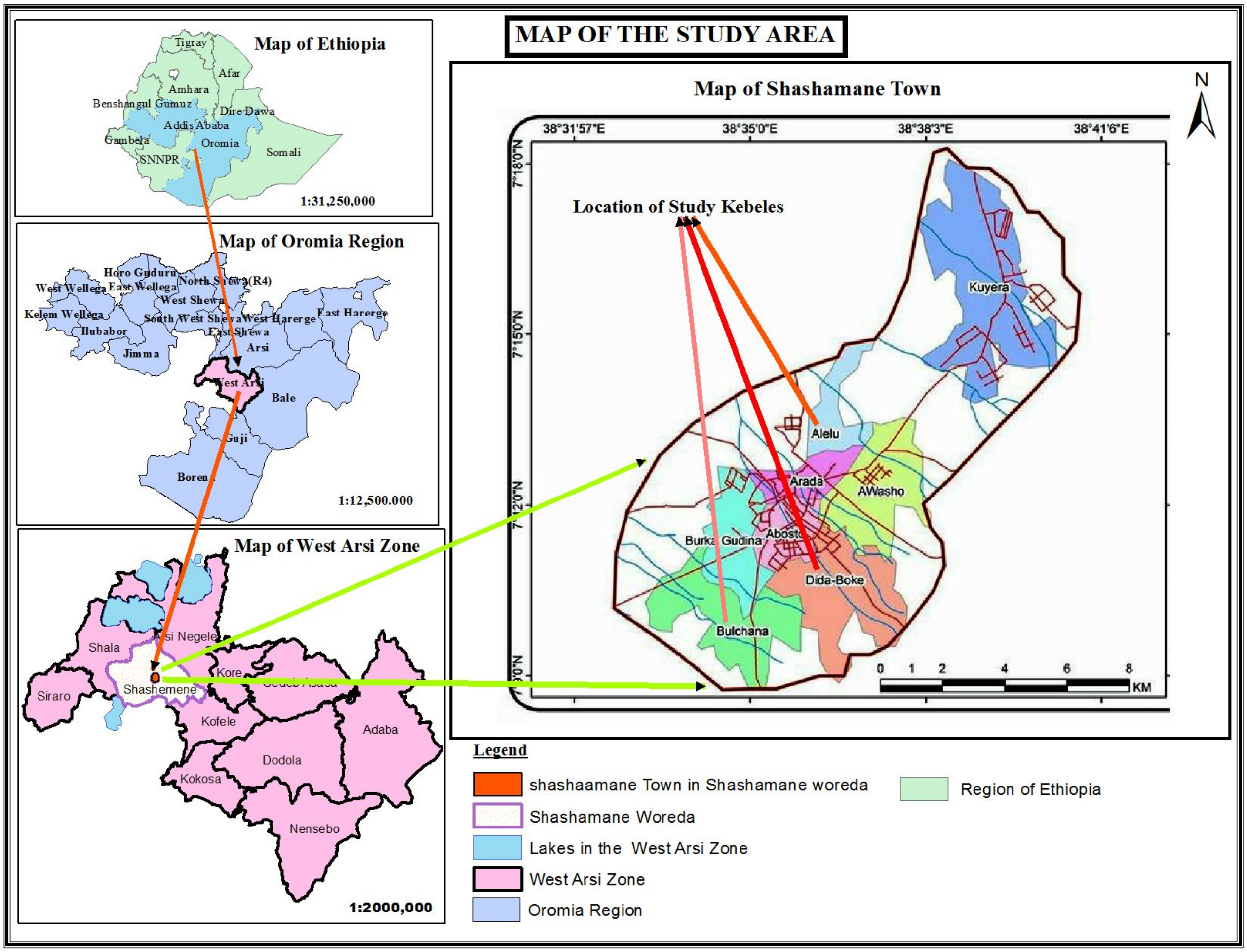

Figure 1: Location map of the study area.

Source: CSA, 2013 Developed from ArcGIS 10.1

3.2. Study Design

The study was conducted from March to June 2019, in Shashemene town. The study involved cross-sectional survey method aimed to assess value chain of raw milk and butter, general milk production and marketing, and a laboratory-based investigation aimed to determine the physiochemical composition of raw milk and microbial quality of raw cow milk and butter produced and marketed in Shashemene town. For the survey, both primary and secondary data were collected. For the primary data semi structured questioner was prepared. Secondary data was collected from Shashemene town Livestock development office and dairy cooperatives units. To select a representative sample, dairy cattle potential of kebeles of Shashemene were identified. Shashemene town has eight (8) kebeles. Three kebeles were selected purposively based on dairy cattle potential and these included Alelu, Bulchana and Dida Boke. Based on the method which is used by (Bruktawit, 2016) and reports of ILRI (1996) the dairy farms were classified in to three groups as small scale (dairy farms with less than three cows), medium scale (dairy farms with 3-10 cows) and large scale (dairy farms with greater than 10 cows).

3.2.1. Sample size

Sample size was determined according to the sampling formula provided by Yamane (1967).

$n = \frac{N}{1+N(e2)}$……………………………………………………………………Equation 1

With±8.5% level of precision Where, n= Sample size; N=Population size; e= level of precision

Then, the sample size was calculated and the probability proportional to size (PPS) method of calculation was used to distribute the total sample size for each *kebele* as indicated in Table 2 which depicts the selected *kebeles* and sample size of milk producer household heads per *kebele*.

Table 2 Sample of milk producer households for kebeles in the study area

No.	Name of the *kebeles*	Total milk producer households	Sample size
1	Alelu	319	33
2	Bulchana	512	54
3	Dida Boke	352	37
Total		1183	124

According to the above formula 124 households were selected randomly from the selected *kebeles*: 33, 37 and 54 households of Alelu, Dida Boke and Bulchana kebeles, respectively.

On the other hand, 48 raw milk samples were collected from three kebeles, 30,6and 12, from milk producers, milk collectors and milk retailer shop respectively were collected for laboratory analysis. For butter sample, 26, 8 and 6 butter samples from butter producer, market and retail shop respectively were collected for laboratory analysis. A total 40 butter samples were collected.

Table 3 Sampling of raw milk from selected kebeles

No.	Raw milk sample sources	Number of samples
1	Milk producers	30
2	Milk collectors	6
3	Milk retailer shop	12
Total		48

Table 4 Sampling of butter from selected kebeles

No	Butter sample sources	Number of samples
1	Butter producers	26
2	Market	8
3	Retail shops	6
Total		40

3.3. Data Collection

3.3.1. Survey

For the survey part, the data regarding characteristics of the study participants, general milk production, and feeding, housing system, handling of milk and milk product, milk collection and transportation, butter and milk marketing and utilization situations were collected. The questionnaires were pre-tested to check clarity and appropriateness and changed to Afan Oromo language. Both primary and secondary data were collected. Primary sources were household heads that own dairy cattle and who are familiar with cattle husbandry and cow milk and butter traders. Secondary data such as the human population and livestock population of the town were collected from Shashemene town livestock office. For conducting the field survey, two enumerators who are college graduates and have the knowledge about the area and well acquainted with the culture and can speak Afan Oromo language were employed and trained on the methods of data collection and contents of the interview. The data were collected by single visit-multiple subject diagnostic survey method. The researcher was following the enumerators and was checking the collected data on regular basis.

3.4. Laboratory Analysis

3.4.1. Collection of raw milk and butter samples

Raw milk samples were collected from individual the three farm scales milk producer's storage container at farm gate, after collection from collection centers and from milk retailer. A total of 48 (30 milk producers, 6 from milk collectors, 12 from milk retailer shops) raw milk samples were taken. For butter sample, 26, 8 and 6 butter samples from butter producer, market and retail shop respectively were collected. Approximately 350 ml of milk and 60 g butter were collected from each selected kebeles and placed into sterile glass bottles. Consequently, samples were labeled and put in ice box (4°C) to restrict microbial multiplication and transported as early as possible to Hawassa university dairy science and technology laboratory for microbial quality and physiochemical quality analysies and kept in refrigerator until the analysis was performed. The laboratory analysis was finished within 4 to 5 hours after collecting the sample.

3.4.2. Physical and chemical analysis of raw milk

For the physical and chemical properties the apparatus LACTOSCAN (Model: EN ISO 9001:2008, Bulgaria) was used. Reliable, automated multi-parameter milk analyzer providing rapid test results for chemical composition of milk (fat, protein, lactose and solid not fat) and physical characteristics (milk density) were done.

3.4.3. Titratable acidity

Titratable acidity of milk sample was determined according to the method of association of official analytical chemists (AOAC, 1990). Nine millilitre milk samples was pipette in to a beaker and 3 to 5 drops of 1% phenolphthalein indicator was added. Then the sample was titrated with 0.1N NaOH until pink color persists. Acidity was expressed as percentage of lactic acid, and finally calculated using the formula:

$$\textbf{Titratableacidity}\ \% = \frac{\textbf{0.1N}\times \textbf{mlofNaOH}\times \textbf{0.0009}}{\textbf{Weightofmilksample}} \times \textbf{100} \text{.................................Equation 2}$$

3.5. Microbial Analysis of Raw Milk and Butter

Preparation of Dilution

Ten ml from each extracts sample was taken into sterile pippette and blended with 90 ml 10^{-1} sterile buffered peptone water. Further dilutions was prepared by transferring 1ml from 10^{-1} dilution into a sterile test tube containing 9 ml sterile peptone water to make 10^{-2} dilution. The process was repeated to make 10^{-1}_10^{-7}serial dilution. The results were reported in log cfu/ml of the sample.

3.5.1. Total bacteria count

The standard plate count of raw milk samples was performed by putting 1 ml of milk sample into a sterile test tube having 9 ml peptone water. After mixing, the sample was serially diluted up to 1: 10^{-7} and duplicate samples of 0. 1 ml of diluted milk samples was spread on 15-20 ml nutrient agar media and then incubated for 48 hours at 32^0C to encourage bacterial growth. Finally, colony counts was made using colony counter. Single bacteria species clusters grown to become visible colonies that were enumerated. Colonies ranging from 30-300 were considered countable (Yorko colonycounter, India).

3.5.2. Coliform count (CC)

Milk sample (0.1ml) was added into sterile test tube having 9 ml peptone water. After mixing, the sample was serially diluted up to 1: 10^{-7} and duplicate samples (0.1 ml) was spread plated using 15-20 ml Violet Red Bile Agar solution (VRBA) oxide (high media). After thoroughly mixing, the plated sample was allowed to solidify and laying over by Violet Red bile Agar solution (VRBA) then incubated at 32ºC for 48 hours. Finally, colony counts was using colony counter. Typical dark red colonies were considered as coliform colonies.

3.5.3. Mould and yeast count

Samples of milk were serially diluted following similar methods as for total bacterial count but dilutions were surface plated on Potato Dextrose Agar (PDA) (High media). The dried plates were then incubated at 25^0C for 5 days. The plates that contain 10-150 colonies were counted. Colonies with a blue green and white colour were counted as yeasts and mould. The counts for each dilution were computed by the following formula (APHA, 1992).

$$\boldsymbol{N} = \frac{\sum \boldsymbol{colonies}}{[(\mathbf{1}\times \boldsymbol{n}\mathbf{1})+(\mathbf{0.1}\times \boldsymbol{n}\mathbf{2})]\times \boldsymbol{d}} \quad \text{.....Equation 3}$$

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

ΣC = sum of colonies on plates counted in duplicate

n1= number of plates on lower dilution counted,

n2 = number of plates in next higher dilution counted and

d = dilution from which the first counts are obtained

3.6. Data Analysis

The data collected from the study area was entered into Micro-soft-Excel spreadsheet for managing the data and analyzed using SPSS version 20. Statistical methods like descriptive statistics (mean, standard deviation, percent and charts) were performed. Data from microbial counts were first transformed into logarithmic scale (log10 cfu/ml) before statistical analysis to make the frequency distribution more symmetrical and analyzed using One-way ANOVA statistical analysis of SPSS version 20software and using two-way ANOVA statistical analysis for productive and reproductive performance of dairy cattle. Significant log mean differences were separated based on Least Significant Difference (LSD) mean separation technique and means were declared significant at ($p<0.05$). The statistical models used in the present study included:

Model I

$Y_{ij}=\mu+a_i+b_j+(a*b)_{ij}+e_{ij}$……………………………………………Equation 4

Y_{ij}= Variables (productive and reproductive performance of dairy cattle)

μ = overall mean

a_i=Effect due to farm scale

b_j =Effect due to breed

$(a*b)_{ij}$= Effect due to interaction between farm scale and breed

e_{ij}= residual error

Model II. Specific to raw milk quality analysis in the value chain points& analysis of microbial quality of butter

$Y_{ij} = \mu + T_i + e_{ij}$**……………………………………………………**Equation 5

Where; Y_{ij} = Observed value for (physical, chemical and microbial properties)

μ = Overall mean

T_i = Effect of value chain points where where $i = 1$ is milk producers, $i = 2$ is milk collectors, $i = 3$ is milk retailer shop e_{ij} = residual error

4. RESULTS AND DISCUSSION

4.1. Socio-economic Characteristics of Study Households

The socio-economic characteristics of farmers are summarized as Table 5.In the study area, 79% of the study participants were male headed and 21% female headed. This result is comparable with the findings reported by Mustefa (2012) with 67.2% of the study participant households with male headed and 32.8% female headed for Sululta and Welmera district. It does not mean that more men are involved in dairy activities than women. It suggests a possibility of both men and women controlling most household resources and hence both play crucial role in household income generation.

The average age of the respondents in the study area was 41.94±10.131years with the range of 25 to 67 years. This finding is in agreement with the report of Megersa (2016), who reported a mean age of household heads with 42.5 years in West Shoa, Zone, Oromia, Ethiopia which is more or less has similar farming system to the present study area. This shows that most farmers are at the productive age and can actively manage their own dairy cows. The highest proportion of them (94.3%) was married and only 2.2% were widows. This implies that dairy production activities are dominated by married people and the reason could be that they kept dairy cows for the purpose of supporting their family members using income generated by selling dairy products. This finding also is in agreement with the finding of Lucas (2013) who reported that the majority of the married farmers engage in milk production activities in order to generate income to meet various household needs or expanding their household income base. Most of the respondents (52.2%) at least had education levels up to elementary school while 9.2% of them had joined diploma/degree. The results in general indicate that most of dairy cattle owners in the study area are literate; indicating that with good extension and training program to improve their dairy production and marketing systems. The result of Kerealem Ejigu, (2005) and Assemu Tesfa *et al*., (2013) also supports the importance of education on the agricultural activities.

Table 5 Socio-economic characteristics of small, medium and large scale dairy farmers in

Variables	Farm scale			Overall
	Small	**Medium**	**Large**	
	N(42) %	**N(57)%**	**N(25)%**	**(N=124)**
Sex of household				
female	9 (21)	15 (26)	4 (16)	21
Male	33 (79)	42(74)	21(84)	79
Age Category				
25-45	35(83)	45(79)	18(72)	78
46-60	7(17)	12(21)	4(16)	18
60-67	-		- 3(12)	4
Education level of household				
Illiterate	11(26.2)	8(14)	2(8)	16
1-8 grade	27(64.3)	39(68.4)	6(24)	52.2
9-12 grade	3(7.1)	7(12.3)	12(48)	22.5
Diploma/Degree	1(2.4)	3(5.3)	5(20)	9.2
Marital status				
Married	37(88.1)	54(94.7))	25(100)	94.3
Unmarried	1(2.4)	-		0.8
Divorced	2(4.8)	2(3.5)	-	2.8
Widow /Widower	2(4.8)	1(1.8)	-	2.2

Shashemene town

N=number of respondent

4.2. Cattle Composition

Table 6 shows the size and composition of cattle in the study area. The cattle holding per household was highly significantly different between the three farm scales ($P<0.05$).The average cattle holding per household was 6.08±0.72, 11.91±0.68, and 22.36±4.78 under the small scale, medium scale and large scale farms, respectively. The overall mean cattle holding per household were 13.45±4.76 with 8.75 TLU. The overall mean of cattle in the current study is higher than that of Dawit Asseffa (2013) who reported for Adami Tulu Jiddo Kombolcha (8.27 TLU cattle). This result is also higher than the average number of cattle per household 7.10 TLU reported by Kassu (2016) in Bona Zuria district of Sidama Zone. But, this result is lower than (10.81 TLU cattle) reported by Abegaze Beyene *et al. (*2018) in Hadiya zone. The overall mean of lactating cows or milking cows owned by the respondent farmers was 1.27±0.04 local or 0.89 TLU and 3.68±0.38 crossbred cow or 3.01 TLU. This local lactating cow is less than the overall mean of local cow (1.76±0.920) that reported by Mustafa (2012) in Sululta and walmara district. But, crossbred milking cow was greater than the reported value by Mustafa (2012) which was 2.8±3.45).In the present study area the cattle herd was dominated by Holstein-Friesian crossbred dairy cows. The farmer prefer to have crossbred cows because of their greater milk production, even though they require high management and susceptible to disease than local breeds. Local bull and crossbred bull fewer in number. As study participants indicated crossbred bull is not important in the study area.

Table 6 : Mean±SE Cattle herd size (TLU) and compositions (%) in small, medium and large scale dairy farms of Shashemene town

Variables	Farm Scale levels					
	Small (N=42)	Medium (N=57)	Large (N=25)	Overall (N=124)	p-value	TLU
Cattle	6.08±0.72^{c}	11.91±0.68^{b}	22.36±4.3^{a}	13.45±4.76	0.000	8.75
L calves	1.05±0.03^{a}	1.07±0.07^{a}	1.24±0.09^{a}	1.10±0.04	0.145	0.22
L heifers	0.76±0.10^{c}	0.84±0.06^{b}	1.32±0.10^{a}	0.91±0.05	0.000	0.48
LMC	1.17±0.07^{a}	1.32±0.07^{a}	1.36±0.09^{a}	1.27±0.04	0.216	0.89
LDC	0.88±0.10^{b}	0.61±0.07^{c}	1.08±0.08^{a}	0.80±0.05	0.001	0.61
L bull	0.64±.08^{b}	0.82±.05^{b}	0.68±.10^{b}	0.73±04	0.124	0.70
C calves	0.60±0.08^{c}	2.09±0.09^{b}	3.28±0.44^{a}	1.82±0.14	0.000	0.40
C heifers	0.69±0.08^{c}	1.11±0.07^{b}	3.08±0.82^{a}	1.36±0.19	0.000	0.81
CMC	1.17±0.08^{c}	3.53±0.07^{b}	8.24±1.53^{a}	3.68±0.38	0.000	3.01
CDC	0.50±0.08^{c}	1.26±0.07^{b}	2.32±0.97^{a}	1.22±0.21	0.006	0.95
C bull	0.48±0.08^{b}	0.58±0.06^{b}	1.12±0.17^{a}	0.65±0.06	0.000	0.68

Means followed by different superscripts letters within a row are significantly different ($p<0.05$). N=number of respondents, L=local, LMC=Local milking cow, LDC=Local drying cow, C=Crossbred, CMC=Crossbred milking cow, CDC=Crossbred drying cow, SE= standard error, TLU=Tropical livestock units

4.3. Feeding of Dairy Cattle

The common feed and a water source to dairy farms in the study area is summarized as Table 7. Nutrition has major effect on milk microbial quality and chemical composition. There was significance variation ($p < 0.05$) among the feed source and commonly feeding practice. As observed in the present study area the main feed resources on 94.4% of the respondents was purchased animals feed from different animals feed providers in the area and 5.6 % of the respondents fed their animals both farm level produced feed (such as alfalfa and green grass) mixed with feeds bought from animal feed processors (Table7). Dairy producers in the urban areas, who lack farming land mainly, adopted industrial and household by-products and less forage seeds. This is in agreement with Sintayehu Yigrem *et al.,* (2008) who reported that urban farmers mainly purchased roughage and concentrate feeds. This result is similar with the finding of Bruktawit (2016) feed resources on average 91.9% of the respondents was purchased animals feeding in selected sub city of Addis Ababa. This shows that there is shortage of land in and around towns for the production of forages. In the present study, 78.5% of the respondents reported commonly feeding staff used for their animal was among which concentrates and industry by- products were highly mentioned which included the mixtures of (oil seedcakes /beer by- product, wheat bran, wheat mailing. The remaining 21% of the respondents feed their animals' hay/straw and molasses. This result is similar with the result of Azage *et al*. (2013), which mentioned agro-industrial by-products such as bran, middling, oil seed cakes and molasses as most important feed resources to crossbred dairy cows in urban and peri-urban areas. Addisu Bitew *et al.,* (2011) reported that agro-industrial by-products and concentrates were mainly used in high market quality sites. Study participants also indicated problems of accessibility; afford ability and price instability of feeds as important problems related to feeding of their animals.

The most source of water was obtained from pipe line quantify it in the study town. This is comparable with the reports of Gebrekidan *et al.* (2012) (61.25%) and Asrat (2013) (91.6%).

Table 7 Common feed sources, type of feeds, and water sources for dairy farmers in Shashemene (N=124)

Variables	Farm scale level			Overall	P-value
	Small	Medium	Large	(N=124)	
	N(42)%	N(57)%	N(25)%		
Source feed					
Purchased	40(95.2)	57(100)	22(88)	94.4	0.037
Both	2(4.8)	-	3(12)	5.6	
Commonly used feed					
Concentrate, industrial by product, molasses & straw	26(61.9)	51(89.5)	21(84)	78.5	0.003
Molasses, hay & straw	16(38.1)	6(10.5)	4(16)	21.5	
Source of water					
Pipe water	42(100.0)	55(96.5)	25(100)	98.8	
Pond water	-	2(3.5)	-	1.2	

N=number of respondents, %= percent

4.4. Housing System and Dairy Barn Management

Table 8 shows the housing types and conditions of dairy cattle in the study area. The analysis showed that there were significant differences ($P<0.05$) among the three farm scales in housing type and frequency of cleaning the barn. The current study indicated that 81% small, 78.9% medium and 16% large scale farms have used a closed house for their production, while 19%, 21.1% and 84.4 % of the respondents from small, medium and large scale farm, respectively had built a semi-opened house for production in the study area. The purposes of housing in the study area were to protect cattle from theft and from extreme weather conditions. This is in agreement with other urban dairy farms in most towns and cities of Ethiopia as reported by Derese, 2008; Asrat, 2009; Gurmessa, 2014. The majority of the respondents (87.8%) used barns floor made from concrete and 6.2%of the respondents used barn floor made from stone. The remaining 6% of the respondents used barn floor made from soil. Due to easy to clean, the concrete floor is preferable over the soil floor. It is difficult to clean the soil floor. The general dairy cattle housing and hygiene conditions of the current study is in line with research finds reported by (Hunduma, 2013; Mulisa *et al.,* 2011, Zemenu *et al.* 2014) in peri-urban and urban of Ethiopia. Moreover, this is in line with observations made in several urban and per-urban dairy units of East Africa (Gillah *et al*., 2012). Maintaining the sanitary condition of milking area is important prerequisite for clean milk production (Zelalem, 2010a). Most of (49.9%) respondents in the study area clean their milking shade twice a day while 40.5% of the respondents clean their milk shed three times a day. This result is similar with (35%) of the respondents clean their barn three times reported by Saba (2015) in Adea Berga and Ejerie Districts of West Shoa Zone.

Table 8: Type of dairy cattle housing and cleaning practices in the study area

Variables	Farm scale			Overall	P-value
	Small N(42)%	Medium N(57)%	Large N(25)%	(N=124)	
Type of house					
Semi open	8(19.0)	12(21.1)	21(84.0)	41.4	
Closed	34(81.0)	45(78.9)	4(16.0)	58.6	0.000
Floor type					
Concrete	34(81.0)	42(82.5)	25(100)	87.8	
Stone	4(9.5)	6(10.5)	-	6.2	0.094
Soil	4(9.5)	5(8.8)	-	6	
Frequency of cleaning					
Once a day	12(28.6)	-	-	9.6	0.000
Twice a day	24(57.1)	46(80.7)	3(12)	49.9	
Three times a day	6(14.3)	11(19.3)	22(88.0)	40.5	

N= number of respondents

4.5. Milking Equipments and Handling Practices

Most of the respondents (97.6%) in Shashemene were using plastic pail for milking and milk handling (Table 9). Only 2.4% were using Stainless steel pail. This result is in agreement with the reported 94% values by Mustafa (2012) in Sululta and Walmara and, (100%) reported by Saba (2015) in Adea Berga and Ejere districts of West Zone. This result is also comparable with the finding of Teklemichael (2012) and Teshome *et al*.(2014) who reported that 83% of the surveyed urban dairy farms in Bahir Dar and Gondar, 75% of the surveyed in Dire Dawa town used plastic utensils. In the present report all of respondents had no problem of using these utensils. Eight five (85.2%) of the respondents cleaned their milking utensils before and after every use and 14.8% cleaned only before every use. This result is in agreement with the finding of Dessalegn *(*2017*)* who reported about 89.2 % of the producers washed milking utensils before and after every use in Bishoftu and Akaki towns. About 73.2% of the respondent washed their milk utensil with cold water and soap while 26.8% used hot water and soap. This result is in agreement with the finding of Saba (2015) who reported about 77% of the respondents who wash their milk container with cold water and soap while 23% used hot water and soap.

As illustrates on Table 9, all of the respondents in the study area washed their cow′s udder before milking. This result is disagreement with the finding 100% of respondents in Ezha districts of Gurage Zone does not wash udder before milking reported by Abebe *et al.* (2013). The use of individual towel and following essential cleaning practices during milking is important for the production of quality milk (Zelalem, 2010). Most of 85.6% of the farmers were using individual towels for drying udder of milking cows and 14.4% had no towel use practice.

All of the respondents in the study area milking their cows two time a day (morning and evening). Similar findings were also reported by Asaminew and Eyassu (2009), Amistu *et al.* (2015) and Sintayehu *et al.* (2008) that farmers milked their herds twice using hand milking.

Table 9 : Milking equipment and milking procedure in the study area

Variables	Farm scale			Overall	p-value
	Small	**Medium**	**Large**	**(N=124)**	
	N(42)%	**N(57)%**	**N(25)%**		
Milking equipment					
Plastic pail	42(100)	53(93)	25(100)	97.6	
Stainless steel pail	-	4(7)	-	2.4	0.024
Cleaning frequency of milk equipment					
Cleaned before and after every use	30(71.4)	48(84.2)	25(100)	85.2	0.009
Cleaned before every use	12(28.6)	9(15.18)	-	14.8	
Cleaning of milk equipment					
Cold water and soap	34(81)	47(82.5)	14(56)	73.2	0.023
Hot water and soap	8(19)	10(17.5)	11(44)	26.8	
Use of towel					
Individual towel	35(83.3)	51(89.5)	25(84)	85.6	0.057
No towel	7(16.7)	6(10.5)	4(16)	14.4	

N=number of respondents

4.6. Reproductive and Production Performance of Dairy cow

4.6.1. Production performance of dairy cow

Table 10 shows age at first calving and calving interval of dairy cows in the study area. First calving marks the beginning of a cow's productive life and influences both the productive and reproductive life of the female, directly through its effect on her lifetime calf crop and milk production and indirectly through its influence on the cost invested for up-bringing (Azage Tegegne *et al*., 2001; Tewodros Bimerew, 2008).

Age at first calving was not significant differences ($p>0.05$) among the three farm scales. Statistical analysis showed that there was significant difference ($p<0.05$) between the local and crossbred cows in AFC. The respondents in the study area confirmed that the overall mean AFC for the local and crossbred cows were 41.18±5.33 and 26.55±3.15 months, respectively (Table 10). The overall mean age at first calving of local in this study is greater than the mean of 39.4 ±1.7 months in and around Mekele town reported by (Niraj Kumar *et al.,* 2014). However; the overall mean result of the age at first calving of local cow in the present study is shorter than the mean of 49.95 months in Meta District of Eastern Hararghe Zone, reported by (Mitiku Eshetu *et al.,* 2019). The overall mean age at first calving of cross bred in this study is similar to (26.5±2.5) months that reported in crossbred dairy cows under small holder conditions in and around Debre Zeitby *Niraj Kumar* (*et al.,* 2017*).* However, the overall mean result of the age at first calving was lower than that of Hunduma (2012) in Assela, kumar and Tkui (2014) in Mekelle, and Nibret (2012) in Gonder who reported 34.8±4, 36.4 ±1.7 and 32.4 months, respectively for crossbreed cows. The prolonged AFC of cows in the present study may be related to environmental conditions and husbandry practices which may affect on the cattle growth. Hence, there should be concerted efforts to improve the feeding and nutrient profile of feeds offered to the cattle, housing, disease prevention and management especially during harsh climatic conditions in order to improve on age at first calving. With good feeding, it is expected that heifers would exhibit fast growth and attain higher weights at relatively younger ages. Younger age at first calving is beneficial in that it can potentially lead to an earlier return on investment.

Extended calving interval is one of the major problems that reduce lifetime productivity of dairy herds (Belay Duguma *et al*., 2012) However, calving interval is probably the best indicator of reproductive efficiency.

There was no significant difference (P>0.05) in the average calving interval among the three farm scales. Statistical analysis showed that there was significant difference (p<0.05) higher in calving interval of local than crossbred. The result of this study showed that the calving intervals (CI) of local cows and crossbred were 21.58±2.31 and 13.85±1.92 months respectively. The result of this study the calving interval of local cow is in agreement with 22.15±4.22 months (Melku, (2016) rular, prei – urban and urban of Gojjem; 20.93 ± 0.22 months (Bayissa Amenu *et al., 2017)* in Gindeberet and Abuna Gindeberet Districts of Western Shoa Zone, Oromia Regional State. However; in the present study, the calving interval of local cow was greater than 14.36±78.03 months reported by (Niraj Kumar *et al*, 2014) in and around Mekelle town but; lower than 24.94±4.1 months (Mulugeta Ayalew and Belayeneh Asefa, 2013) at Angolellantera district and in line with for local cows 23.16 months (Gebrekidan Tesfaye *et al*., 2012) peri urban area of Tigray. Overall mean of calving interval of crossbred in the present study was 13.85±1.92 month which is in agreement to 13.8±1.9 months for crossbreed cattle Akaki, (Desalegn *et al.*, 2016). However, this result is higher than that reported by Hunduma, 2012 (372.8 days) in crossbred dairy cows under smallholder condition in Ethiopia. The overall mean calving interval of crossbred cow observed in this study is shorter than 16.04±0.13 months who reported by Kassu (2016) in Bona Zuria district of Sidama Zone. The high calving interval reported here may be related to poor management practices and other environmental stress that could affect the animals return to oestrus, heat detection, serving and conception.

Table 10 Reproductive performance of local and crossbred dairy cows managed under small, medium and large scale dairy farms in Shashemene town

Parameters	Farm scale				P-value
	Small (N=42)	**Medium (N=57)**	**Large (N=25)**	**Overall**	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
AFC in month					
Local	41.9±5.77[a]	41.07±5.02[a]	40.24±5.29[a]	41.18±5.33	0.342
Cross	26.95±3.68[b]	26.21±2.63[b]	26.64±3.34[b]	26.55±3.15	
Overall	34.43±8.93	33.64±8.46	33.44±8.14	33.86±8.53	
P-Value		0.000			
CI in month					
Local	21.97±0.95[a]	21.35±2.70[a]	21.48±2.85[a]	21.58±2.31	0.912
Cross	13..62±1.18[b]	14.02±2.40[b]	13.84±1.71[b]	13.85±1.92	
Overall	17.79±4.34	17.68±4.48	17.66±4.50	17.72±4.42	
P-value		0.000			

Means with the same superscripts for the same variable across the same row are not significantly different (p>0.05). And [a-b]means with different superscripts for the different variable in the same columns are significantly different (p<0.05). N= number of respondents, SD= standard deviation, AFC=Age at first calving, CI= calving interval

4.6.2. Milk production performances

Table11 shows lactation length and daily milk yield of dairy cows. Lactation length refers to the time of period from when a cow starts to secrete milk after parturition to the time of drying off. There was no significant difference (P > 0.05) in the average lactation length among three farm scales. The lactation length was significantly (p<0.05) higher between genotypes greater in crossbreed than local cow. Overall mean of lactation length of local and crossbred milking cows were 7.02±0.84 months and 10.17±0.83 month respectively (Table 11). The lactation length of local cow observed in this study is in agreement with the report of Mitiku Eshetu *et al.*, (2019) who reported that average lactation length of local cows in private holdings 7.15 months in Meta District of Eastern Hararghe Zone. The result of current study was shorter than previous reported by Kefyalew Gebeyew, *et al*, (2016) an average lactation length of local breed cow 8.37 months in Dawa Chefa District, South Wollo zone. However, this result is higher than average lactation length local bred 6.78 month for Simada cattle in Tach Gayint district (Assefa *et al*., 2015). In case of crossbred the average lactation length present study is agreement with 10.1 month reported by Keteme(2014) in Kersa Melima district, 10 month reported by Kassu (2016) in Bona district of Sidama zone. Also this result is comparable with the lactation length of 10.45±1.3 and 10.00±1.23 months reported for crossbred cows in urban and peri-urban in Dangila zone (Bekele *et al*., 2015). However, the mean lactation length of crossbreed cows in the present study is higher than the mean lactation length of crossbreed 9 and 9.3 months for Bishoftu and Akaki town respectively reported by Dessalegn Genzebu *et al, (* 2016). However, the overall mean lactation length of this study is less than the mean value of 11 months reported in crossbred cows in North Showa zone, Ethiopia (Mulugeta and Belayeneh, 2013).

The average daily milk yield of dairy cows were not significant differences ($P>0.05$) between the three farm scales. There was highly significant difference ($p<0.05$) between genotypes. Crossbred was higher than local. Overall mean daily milk yield of local and crossbred cows in the study area was 1.84±0.81and 10.79±2.22 liter/day respectively (Table11). The present study is in agreement with the overall daily milk yield per cow per day (1.9 liters) of local cow in sululta and Walmara district (Mustafa, 2012). However the present study showed higher than the value reported by Kassu (2016), which was (1.65 L) in Bona district of Sidama zone, Fikrineh Negash *et al*, (2012) reported that the overall daily milk production per cow was (1.71L) from local breed cow in Mid-Rift valley study areas. The average daily milk yield of crossbreed dairy cow the current study is comparable with overall average of cross bred 11.6±3.1 and 10.8±2.4 litters per day/cows in Bishoftu and Akaki town respectively (Dessalegn Genzebu *et al.*, 2016**).** In general, the variation in lactation length and average daily milk yield per cow in the present study might be attributed to the difference breed of animal, management practice (housing, feeding system and feed nutritional value).

Table 11 Lactation length and daily milk yield of local and crossbred milking cows managed under small, medium and large scale farms in Shashemene town

Parameters	**Farm scale**				**P-value**
	Small (N=42)	**Medium (N=57)**	**Large (N=25)**	**Overall**	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
LL in month					
Local	6.95±0.79^{b}	7.01±0.77^{b}	7.16±1.02^{b}	7.02±0.84	0.232
Cross	10.19±0.80^{a}	10.07±0.82^{a}	10.4±0.86^{a}	10.17±0.83	
Overall	8.57±1.81	8.54±1.73	8.78±1.88	8.6±1.78	
P-Value		0.00			
DMY/C/l/day					
Local	1.79±0.71^{b}	1.89±0.94^{b}	1.81±0.65^{b}	1.84±0.81	0.565
Cross	10.71±2.21^{a}	10.98±2.02^{a}	10.52±2.67^{a}	10.79±2.22	
Overall	6.25±4.77	6.44±4.83	6.16±1.80	6.32±4.78	
P-value		0.000			

Means with the same superscripts for the same variable across the same row are not significantly different ($p>0.05$). $^{a-b}$means with different superscripts for the different variable in the same columns are significantly different ($p<0.05$). N=number of respondents, SD=standard deviation, LL=Lactation length, DMY=Daily milk yield

4.7. Butter Handling Practice

Traditional Churning was the only method to obtain different milk products in Shashemene town. After milk was spontaneous fermented for more than two days it is transferred in to churning equipment, stirred and churned in forward and back ward movement. During the process, the churning equipment is opened within three to five minutes intervals especially for the first 30 minutes to remove the gas. Then it is chucked wether butter granules are formed or not and if enough size of butter granules are formed then it is collected and washed using cold water and the resulting product is called butter. The procedure of butter making was the same with Eyasu and Asaminew (2014), Amistu *et al.* (2016) and Bekele *et al.* (2015) in Bahirdar zuria and Mecha, Alle and Dangila districts, respectively.

According to the current study, most of the respondents (91.6%) were using clay pot to churn butter in Shashemene town. However, 8.4% respondents were using machine churner (Table 12). This result is agreement with Wondu (2007) reported a similar result where 88% of small-scale producers in Southern Ethiopia used traditional clay pot for fermentation and butter-making. However this result was disagreed with the result reported by Melku (2016) 73% and 27% of respondents used gourd and clay pot, respectively in rural areas of West Gojjam Zone. As indicated Table 12 most of respondents (81.2%) were using plastic equipment for butter handling and (18.8%) were using nickel equipment. The result was not the same with the report of Eyasu and Asaminew (2014) 56.2%, 33.1% and 10.6% of respondents used gourd, clay pot and plastic equipment for butter storage in Bahirdar Zuria and Mecha districts.

Table 12 Utensil of churning and handling of butter

Utensil for churning	Farm scale			Overall
	Small N(42)%	Medium N(57)%	Large N(25)%	(N=124)
Clay pot	42(100)	54(94.7)	20(80)	91.6
Machine	-	3(5.3)	5(20)	8.4
Utensil for handling				
Nickel equipment	12(28.6)	9(15.8)	3(12)	18.8
Plastic equipment	30(71.4)	48(84.2)	22(88)	81.2

N=number of respondents

4.8. Consumption and Utilization of Butter in Shashemene

The proportion of butter utilized for home consumption, marketing and used for cosmetics is presented in (Figure2). Butter used in home was used for ghee making and cosmetics. All respondents were used butter for cosmetics purpose. According to the respondents, butter as a hair ointment was used to cure headache and also to keep the healthiness of their eyes. Out of total butter produced 56% was used for household consumption while 23% for cosmetics in study area. Only 21% of total butter produced was spent for marketing in study area. The proportion of butter spent for marketing was lower than the result reported by CSA (2016) 38.1%, 36.1% and 22.6% at the national level, in Amhara region and in East Gojjam Zone, respectively. In addition, butter spent for marketing in this study was lower than the finding of Lemma and Mekonnen (2015) 29.2%, 17% and 25.5% of the total produced butter was spent for marketing in Boset, Ada and Gimbichu districts of East Shoa Zone, respectively. This might be due to the producers were participated in raw milk marketing because milk marketing is not a problem in Shashemene

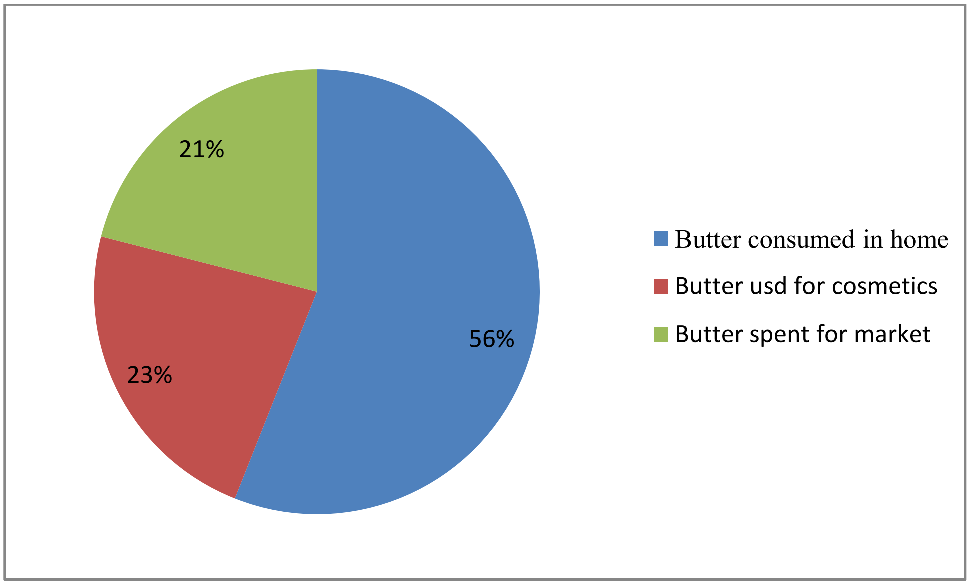

Figure 2: Butter utilization practice in Shashemene

4.9. Dairy Value Chain Actors

The value chain actors identified include input suppliers, dairy farmers, milk collectors, butter processors, milk distributors and consumers. Description of roles of the value chain actors is given below

4.9.1. Feed suppliers

Farmers indicated that they purchase concentrate feeds and associated ingredients from either local processing units or small retailers in Shashemene town and Molasses, straw and native grass hays from neighboring rural kebeles and enclosures from government institutions.

4.9.2. Veterinary services and artificial inseminations (AI)

The majority (72.1%) were using governmental organization actors and (27.9%) private actors for cattle health care (Table 13). The current result and the findings of Anteneh (2008) and

Girma (2012) have similarity who reported that governmental organization and private sector play a vital role in provision of different inputs (veterinary service, AI). However, this service was rated to be inadequate in terms of drugs, financial, material and knowledge capabilities in Shashemene town.

The majority of respondents stated "grading up" as their breeding strategy indicates that AI is more widely used than crossbred bulls. The results of this study indicated that farmers in all scale level had very good access to AI service and that the majority (90.86%) was satisfied with the availability and the service they received (Table13).

Table 13 Veterinary services and artificial inseminations in the study area

Input service	Farm scales			Overall (N=124)	P- value
	Small N(42)%	Medium N(57)%	Large N(25)%		
Access of AI Services					
Yes	37(88.1)	55(96.5)	22(88)	90.86	0.080
No	5(11.9)	2(3.5)	3(12)	9.13	
Health care service					
Government actors	25(59.5)	46(80.7)	19(76)	72.1	0.060
Private actors	17(40.5)	11(19.3)	6(24)	27.9	

N=number of respondents

4.9.3. Dairy producers

Producers perform plenty of activities within production stage. These include milking, selling, deliver their milk and butter to collection center, to hotels, restaurants and cafes, processing and retail shops. Hygienic care of milk during and after milking was practiced to keep the neatness of the milk.

There were a significant differences ($p < 0.05$) in herd milk production, amount of milk sold, milk processed and amount of milk used for home consumption were observe among three farm scales. In all farm scales higher amounts of whole milk were sold than used for home consumption or processed at home. As indicted (Table14) 86.71% of milk produced was destined to market while amount of milk consumed, processed and for calves was 5.51%, 4.2% and 3.41 % respectively. This result is in agreement with study conducted in Sululta and Walmara where 86.77% is sold, 4.6% processed, 4.8% consumed and 3.84 % for calves Mustafa (2012). However it was higher than the result reported by Kitaw *et al.* (2012), Josephine (2014) and Misgana *et al.* (2015) 68%, 70% and 24.8% of the total milk produced per day was sold in Wolmera district, Tanzania and Guto Gida and Leka Dullacha districts, respectively. The proportion of raw milk used for household consumption was relatively small and also milk processed into butter or other milk product was small in Shashemene. This result is disagreed with the result of Belete *et al.* (2010) who reported 64.7% of milk was processed in to butter in Fogera district and East Wollega Zone. This indicates that the objective of milk production in Shashemene was to generate cash income through sale of fresh milk.

Table 14 Mean (±SD) milk production, consumption, processing and selling in Shashemene

Raw milk	Farm scales				P-Value
	Small (N=42)	Medium (N=57)	Large (N=25)	Overall (N=124)	
TMP/lit/day/HH	12.40±2.72[c]	29.74±4.20[b]	50.96±35.56[a]	28.15±21.18	0.000
MCH/liter/day	1.14±.35[b] (9.2%)	1.56±0.50[b] (5.2%)	2.20±0.6[a] (4.32%)	1.55±0.62 (5.51%)	0.001
MP /liter/day	0.84±0.30[b] (6.77%)	1.20±0.29[ab] (4.03%)	1.64±0.53[a] (3.2%)	1.17±0.45 (4.2%)	0.000
MGto calf	0.68±0.24[c] (5.5%)	0.97±0.26[b] (3.3%)	1.40±0.38[a] (2.75%)	0.96±0.38 (3.41%)	0.001
MS /liter/day	9.7±2.56[c] (78.2%)	25.90±4.08[b] (87.1%)	45.70±34.65[a] (89.7%)	24.41±20.26 (86.71%)	0.0000

Means with different superscripts for the same variable across the same row are significantly different ($p<0.05$) N=number of respondents, SD=standard deviation, TMP= total milk produced, MCH=milk consumption at home, MP= milk processing, MG= milk given, MS=milk sold

4.9.4. Milk collection and transportation

Table 15 shows means of transportation, utensil of milk collection and distance to milk destination. The majorities of respondents (76%) were transporting raw milk on foot. Some farmers used different transportation means such as horse cart, and bajaj. This is in line with Amistu *et al.* (2015) who reported majority of participants were travelling on foot by holding milk in different critical points of Oromia special zone. This is agreement with Revoredo-Giha *et al.,* (2013) who reported on the milk delivered by the farmers usually by bicycle or by foot) is bulked at the collection centers, and collected by the dairy processors on a daily basis.

Most (96.9%) of respondents collected their milk to transport with jerry can or utensil made from plastic material while 3.1 % of respondents used to collect their milk with aluminium can (Table 15). This is in line with Hyera (2015) who reported that plastic containers were commonly used for collection, storage and transportation of milk and can be easily scratched and are difficult to clean. Thus provide hiding places for bacteria and this is in line with FAO (2011) that reported occasionally plastic cans, are used for bulking milk from individual suppliers and delivering it to processors' collection, bulking and cooling centers, from where it is transported in cans or by refrigerated tanks to the main processing plants.

Most of the households 70.5% were nearby to the market center for their raw milk marketing while about 29.5% of household travel within 1-3 km. This result is comparable with finding of Woldemichael (2008) who reported that (50%) of the respondents in Yirgalem travelled less than 1km and this is consistent with findings by Dries and Swinnen (2004) where the proximity to milk collection centers or processing plants facilitated the preservation of selling or deliver of milk. Thus the longer the distance from milk collection center the lower the number of smallholder dairy farmers delivering their milk. This is supported by Sumuni (2013) remoteness and poor infrastructures constitute the largest bottlenecks to collection and marketing of milk in Tanzania.

Table 15 Utensil of milk collection, distance of market place and means of transportation

Variables	Farm scale			Overall	P-value
	Small N(42)%	Medium N(57)%	Large N (25)%	(N=124)	
Means of transportation					
On foot	37(88.1)	41(71.9)	17(68)	76	
Horse cart	3(7.1)	2(3.5)	-	3.5	0.018
By bajaj	2(4.8)	14(24.6)	8(32)	20.5	
Utensil of milk collection					
Aluminium can	1(2.38)	4(7.01)		3.1	0.024
Plastic can	41(97.6)	53(92.9)	25(100)	96.9	
Distance to milk delivered					
Less than 1 km	32 (76.2)	36(63.2)	18(72)	70.5	0.116
1-3km	10 (23.8)	21(36.8)	7(28)	29.5	

N=number of respondents

4.10. Marketing of Milk and Butter in Shashemene

4.10.1. Milk and butter marketing channel

From this survey, different butter and milk market participants were identified between producer and the final consumer. The main outlets for raw milk and butter indicated in (Table 17) were: Cooperatives, milk retail shop, processor, directly to consumer and hotels/restaurants. This is in line with the findings of Assaminew (2014) who reported raw milk was the main output from dairy cattle and sold to collectors for processing, hotels, cafeterias and directly to consumers at Holeta, Amsitu *et al*. (2015) who reported majority of the participants brought their milk to the collection center and private dairy processing plants and Njauri *et al.* (2012) who reported dairy products distributed directly to the market and sold their products across the counter within their premises. The main outlets for raw milk in Shashemene were 50.9%, 3.4 %, 9.3 % 31.5 % and 4.9 % of respondents sold milk for dairy cooperatives, hotels/restaurants, processor, retail shop and directly consumer. This result is comparable with Tsegaye and Gebreegziabhar (2015) who reported that 41.9%, 13.3%, 2.9% and 41% of respondents sold milk for consumers, retailers, cooperatives and both consumers and retailers, respectively in Wolaita Zone. Milk sold to dairy cooperative in this study was very high.

The formal marketing system there are cooperatives and private milk collecting and processing plants that receive milk from producers and channel to consumers, caterers, retail shops and retailers. This is similar with Fussi (2010) who indicated formal milk value chain was described as a process involving all the channels through which farmer delivers milk directly to a milk collection center or to traders who buys milk from the farmer and sell it to the milk collection center or processors. In the informal system, milk passes from producers to consumers directly or it may pass through two or more retailers. Diriba *et al.* (2014) who reported that there is no formal milk marketing system in Nekemte and Bako milkshed in western Ethiopia and Eyassu and Doluschitz (2014) who reported that there is no formal milk marketing system in Dire Dawa, Eastern Ethiopia. Milk and butter outlet channels of the formal and informal value chain are carried through different channels in Shashemene.

Raw milk

Channel: producers→ Individual consumers

Channel: producers→ Dairy cooperatives→ Rural assembler (during dry season) → Consumers

Channel: producers→ Retail shops (sale dairy products only) → Consumers

Channel: producer→ Retails (Hotel, restaurants, cafes, coffee and tea) → Consumers

Channel: producer→ Small milk processors→ Consumers

Channel: producer→ Collection center→ processing plant→ consumers

Butter

Producer → Retailer→ Consumer

Producer→ Farmer trader→ Retailer →Consumer

Producer→ Itinerate trader→ Retailer → Consumer

Producer→ Consumer

Table 16 Milk and butter marketing channel of small holder in Shashemene

Milk out let	Farm scale			Overall	P-value
	Small N(42)%	Medium N(57)%	Large N(25)%	(N=124)	
Dairy cooperatives	22(52.4)	23(40.4)	15(60)	50.9	
Hotels /restaurant	2(4.8)	3(5.3)	-	3.4	
Processor	2(4.8)	4(7)	4(16)	9.3	0.632
retail shops	12(28.6)	24(42.1)	6(24)	31.5	
Directly to consumer	4(9.5)	3(5.3)	-	4.9	
Butter outlet					
Retailer	2(4.8)	22(38.6)	12(48)	30.5	
Itinerate trader	5(11.9)	7(12.3)	5(20)	14.7	0.000
Farmer trader	4(9.5)	-	1(4)	4.5	
Consumer	31(73.8)	28(49.1)	7(28)	50.3	

N=number of respondents

4.11. Milk and Butter Marketing Constraints

Milk and butter marketing constraints in the study area are shown in (Table 18). Marketing constraints mostly occurred in the studied area mainly during fasting and the wet season. About 59.6 % of the respondents reported that there was less demand for dairy products during fasting time and 40.4 % of respondents, reported that price variation in the wet seasons. During the wet season due to better availability of feeds, there is an increase in milk yield and in turn other milk products per household and per animal compared to the dry season, hence, the better supply to the destination market. The price of butter and milk were highly affected by fasting periods of especially Orthodox Christians. This finding is in line with the finding of

Adebabay (2009) at Bure district. Overall, Orthodox Christians abstained from dairy products for about 200 days per year (Ahmed Mohamed *et al.*, 2004). During fasting period and a high proportion of fresh whole milk was processed into butter and other milk product. However, during periods of various festivals and holidays, dairy product especially raw cow milk is highly demanded and higher prices in Shashemene town.

Quality based payment was also another raw milk and butter marketing constraints of the study area. They indicated quality based payment was enhanced quality of milk supplied to processors at the same time as encouraging them to produce more and quality milk. This concurs with Pandey and Voskuil (2011) who reported spoilage as the major reason for milk postharvest loss.

Table17 Milk and butter marketing constraints in Shashemene

	Farm scale			**Overall**	**P-value**
	Small	**Medium**	**Large**	**(N=124)**	
Variables	**N(42)%**	**N(57)%**	**N(25)%**		
price variation	25(59.5)	26(45.6)	4(16)	40.4	0.002
lack of demand	17(40.5)	31(54.4)	21(84)	59.6	

N=number of respondents

4.12. Constraints of Dairy Cattle Production in Shashemene

According to the present survey based results, there were different challenges faced in the dairy production. Respondents from urban dairy production system 58.1%, 18%, 15.6%and 8.5%) reported high cost of animal feed, lack of grazing land, inadequate water supply and poor veterinary service as the major constraints for milk production, respectively indicated in (figure 4) Different researchers identified similar constraints in smallholder dairy production in different pre-urban and urban areas of Ethiopia (Fayo, 2006; Zemenu *et al.,* 2014; Haile *et al.,* 2012; SNV, 2008; Solomon, 2006). According to Ketema (2014) disease, scarcity of improved breed, lacks of space and water shortage were identified as the major constraints of dairy production. Similarly, different research works Agza *et al.* (2013) and Teshager *et al.* (2013 in different parts of Oromia were implicated that milk production in Ethiopia is highly hindered by one or more of mentioned factors that affect dairy production.

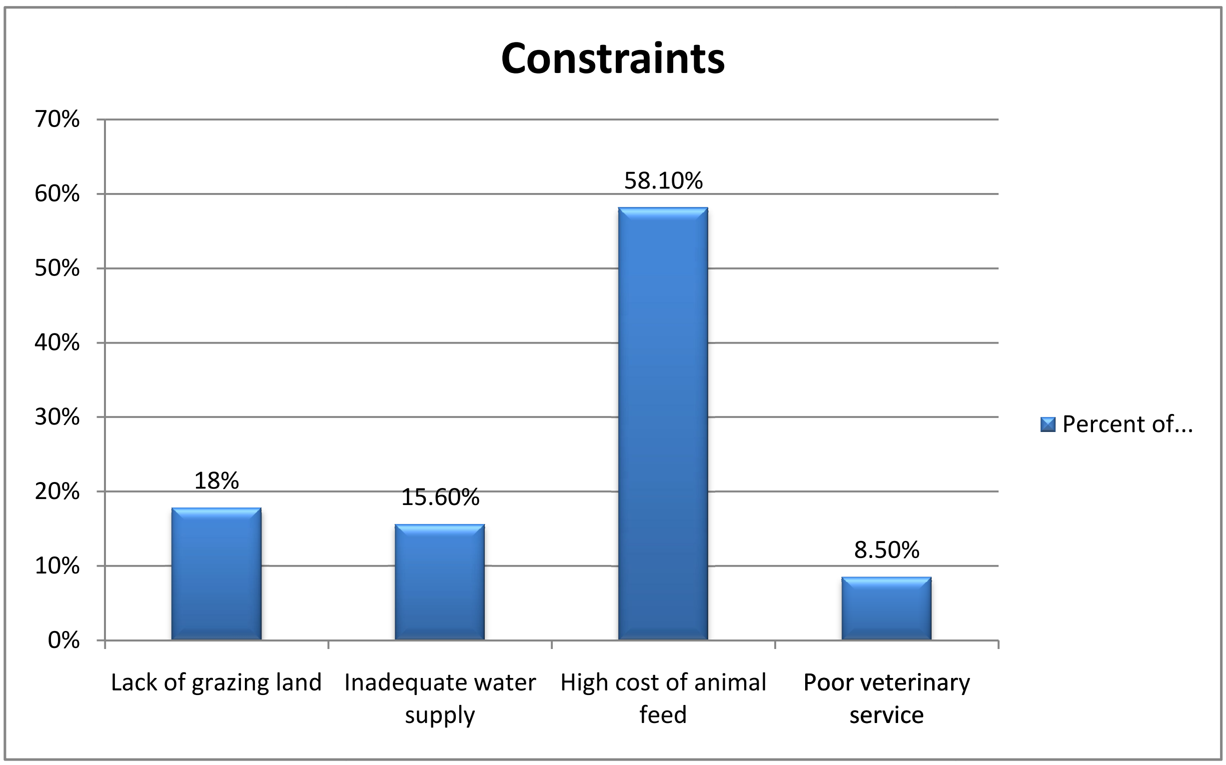

Figure 3: Constraints of dairy cattle production in Shashemene

4.13. Physiochemical Analysis of Raw Milk

Milk samples were collected from the milk value chain points such as milk producers, milk collectors and retail shop in Shashemene town. Milk at normal state has unique physicochemical properties, which are used as quality indicators.

4.13.1. Density

The mean and standard deviation of the specific gravity of raw milk samples collected from milk producers MP, milk collection MC and milk from retail shops were 1.029±0.03, 1.028±0.004 and 1.027±0.002 respectively. Statistically it was found that there was no significant difference (P > 0.05) within the specific gravity of milk collected from the different milk sample sources (Table 19). The overall mean of density (1.029±0.003) content obtained in this study was comparable with the report of (Teshome *et al.,* 2015) who found (1.03±0.000) specific gravity of raw milk in Shashemene town. However, this result is higher than the report of **(**Gurmessa *et al*., 2015**)** who found (1.022±0.001) specific gravity of raw milk in Borana zone, Yabello District. The specific gravity of milk is influenced by the proportion of its constituents (composition). 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 (O'Connor, 1995). Generally, normal milk has a specific gravity between 1.027 and 1.035 with an average value of 1.032 at 16^{o}C (O'Connor, 1995, Morris, 1999). As observed in the current study, the result of milk samples fall within this ranges 1.028-1.032 given to unadulterated milk.

4.13.2. Titratable acidity

The analysis showed that there was significant differences (P<0.05) within the acidity percentage of milk collected from different milk sources. The titratable acidity obtained from retail shop was higher than that of milk collection center and milk producer. This might be due to bacterial growth and multiplication during transportation of milk and longer storage of the milk before sale. The mean value and standard deviation of acidity in raw milk samples collected from MP, MC and retail shop were 0.169±0.01, 0.194±0.004 and 0.201±0.01

respectively (Table 19). The overall mean (0.185±0.02) of acid content obtained is higher than the result reported by Teklemichael *et al*. (2015) (0.165±0.022). It is comparable with the result reported by Teshome and Tesfaye (2016) (0.190±0.023) TA in Bench Maji-Zone, South western Ethiopia. However this result is lower than the result reported by (Gurmessa *et al.,* 2015) (0.197±0.004) TA in Borana zone, Yabello District. The current finding is above the range reported by O'Connor (1994) who stated that the normal fresh milk has an apparent acidity of 0.14 to 0.16% as lactic acid. In general, the high percent lactic acid of milk observed in the present study may be due to microbial activities or enzymatic reaction, time required from milking up the processing plants and longer storage of the milk before delivered.

4.13.3. Fat content

Statistical analysis showed that there was no significant differences (P>0.05) within the fat content of milk collected from different distribution units. However the fat content of milk from milk producer higher than the fat content of milk from milk collection center and retailer shop. The mean value of fat content in milk samples collected from milk producer was 3.76±0.24 followed by MC and retail shop (3.65±0.26 and 3.71±0.23 respectively (Table19). The overall mean of fat (3.73±0.23%) content obtained was higher than the report of Melesse and Mustefa **(**2019**)** who found **(**3.6043 ± 0.122%**)** fat in smallholder dairy farms around Addis Ababa. However this current result is lower than the report of Teshome *et al.* (2015) who found (4.28±0.05) fat from raw cow's milk produced and marketed in Shashemene town, Southern Ethiopia, and Kunda *et al.* (2015) who reported 3.9% raw milk produced by smallholder dairy farmers in Lusaka Province of Zambia and also Alganesh **(**2016**)** who found 3.76% fat content from raw milk collected in peri-urban areas of Ejere, Walmera, Selale and Debre Birhan districts of the central highlands of Ethiopia. The lower fat content of milk may be due to cows of that farm were high milk producing crossbreeds cows which reduces the fat content of the milk samples or water may be added with milk or partly skimming the milk or due to the feed they offered. According to the Ethiopian standard agency, the minimum fat percent for whole milk should not be less than 3.5 percent (ESA, 2009). Consequently, the average fat content (3.73±0.23) observed from the three milk samples obtained fulfilled the recommended standards.

4.13.4. Protein content

Statistical analysis showed there was no significant difference (P>0.05) in protein percentage among the three sample spots. The average protein contents of raw milk samples collected from milk producer, milk collectors and retail shop were3.17±0.09, 3.11±0.12 and 3.13±0.26 respectively (Table19). The overall mean of protein (3. 15±0.11) content obtained in this study is similar with the report of Dehinnent *et al.* (2013) (3.12±0.32%) who found that the mean value of protein content in milk collected from selected areas of Amhara and Oromia National Regional States. But slightly, it is lower than from the research result of (3.94±0.07) Gurmessa *et al.* (2015) who reported for the raw cow's milk in Yabello District, Borana Zone. The current finding of protein content was also lower than the reports of Debebe (2010) (3.2±0.22), Mirzadeh (2010) (3.2±0.22%) and Belay and Janssens (2014) (3.21±0.06). According to Ethiopian standards Agency, the minimum percent protein content of whole milk should be 3.2 % (ESA, 2009). Hence, the average protein content for the current study is below the recommended standards.

4.13.5. Solids not fat

Statistical analysis showed there was no significant difference (P>0.05) in SNF percentage among the three supply chains. The average SNF contents of raw milk samples collected from

MP, MC and retail shop was 7.99±0.39, 7.82±0.11 and 7.97±0.30 respectively (Table19). The overall mean of SNF (7.95±0.34) content of raw milk current result was in agreement with Estifanos *et al.* (2015), who report the average SNF (7.98±0.98) of raw cow milk. However this result is higher than the report of Bruktawit (2016) who found 7.6% SNF from small scale, medium scale and large scale milk produced in selected sub city of Addis Ababa. This result is lower than the findings of Dehinnet *et al.* (2013) who reported that the average SNF (8.44±0.72) of raw milk from selected areas of Amhara and Oromia National Regional States, Fikrineh *et al.* (2012) found the average SNF percentage of raw milk of Adama town to be 9.05±0.16 and Debebe (2010) also reported the minimum (8.3±0.36) and maximum (8.7±0.36) SNF content of raw cow's milk obtained from street-vendors and milk producers in and around Addis Ababa, respectively. The minimum standard for SNF content of whole cow milk is 8.25% (FDA, 2010). The low SNF content of the samples from the study area could have been attributed to a variety of factors including the feed, genetics, season of the year, stage of lactation and disease (Harris and Wattiaux, 2012).

4.13.6. Lactose

Statistical analysis showed there was significant difference ($P<0.05$) in lactose percentage among the three milk sample sources. The average lactose contents of raw milk samples collected from milk producer, milk collectors and retail shop were 4.21±0.14, 4.01±0.31 and 4.09±0.28 respectively (Table19). The overall mean of lactose content was (4.13±0.23%) (Table19). This result is lower than the research result of (4.27±0.17) Gurmessa*et al.* (2015) who reported for the raw cow's milk in Yabello District, Borana Zone. It is also less than the findings of Belay and Janssens (2014) who reported the lactose content (4.34±0.13) of raw milk samples collected from different urban dairy farms located in Jimma town and Soomro *et* *al.* (2014) who reported cow's raw milk (4.56±0.21). According to European Union quality standards for unprocessed whole milk, lactose content should not be less than 4.2% (Tamime, 2009). However, the current average lactose content (4.13±0.23) found for the raw milk samples was below the recommended standards. This might be due to the action of lactose hydrolyzing enzymes produced by microorganisms as result of storage temperature variation. In general the composition of milk can vary depending on breed, management practices such as feeding management, and environmental factors influenced the milk composition (Pandey and Voskuil, 2011).

Table 18 Physiochemical properties of raw milk in value chain points

	Milk sources				
Parameters	**Milk producers (N=30)**	**Milk collectors (N=6)**	**Retail shop (N=12)**	**Overall (N=48)**	**P-value**
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Density(g/cm^3)	1.030±0.003	1.028±0.004	1.027±0.002	1.029±0.003	0.063
TA (%)	0.169±0.01^{c}	0.194±0.004^{b}	0.201±0.01^{a}	0.185±0.02	0.000
Fat (%)	3.76±0.24^{a}	3.65±0.26^{a}	3.71±0.23^{a}	3.73±0.23	0.148
Protein (%)	3.17±0.09^{a}	3.11±0.12^{a}	3.13±0.26^{a}	3.15±0.11	0.238
SNF (%)	7.99±0.39	7.82±0.11	7.97±0.30	7.95±0.34	0.342
Lactose (%)	4.21±0.14^{a}	4.01±0.31^{b}	4.09±0.28^{ab}	4.13±0.23	0.028

Means followed by different superscripts letters within a row are significantly different ($p<0.05$). N=number of samples, SD=standard deviation, TA= titratable acidity, SNF=solids not fat

4.14. Microbial Quality of Butter and Raw Milk in the Study Area.

4.14.1. Total bacteria count

Statistically there was a significant difference ($P<0.05$) in total bacteria count/ml of raw milk collected from the three different supply spots and was greater in milk from milk collectors as compared to milk from the producers and retail shop. This might be due to further contamination of the milk during transportation, use of poorly cleaned milk containers, mixing of milk from different sources. The average values of total bacteria count/ml of raw milk from producers (MP), milk collectors (MC) and milk retailer were 5.98±0.2 Cfu/ml, 6.41±0.12 log10 cfu/ml and 6.17±0.10 log10 cfu/ml, respectively (Table20). The overall mean of TBC from raw milk in the present study was 6.12±0.22 log10 cfu/ml. This result is comparable with the research conducted in the Meta district of eastern Hararghe zone by (Mitiku *et al*., 2019) (6.21±0.05 log10 cfu/ml). However this result is lower than the total bacteria count reported by Zelalem (2010) (9.10 log cfu/ml), Abebe *et al*. (2012) (9.82 log cfu/ml) and Asaminew and Eyassu (2011) (7.58 log cfu/ml). It also lower than research conducted in the country by Tsedey and Asrat (2015) (7.03±0.07 log10 cfu/ml) and Fikrineh *et al*. (2012) (7.08 log cfu/ml). However this is generally high as compared to the acceptable level of 1x105 (5.0 log10 cfu/ml) bacteria per ml of raw milk (Lore *et al*, 2005) and (USAID, 2015) This indicates a general trend of decreasing quality from farms to milk collectors, which clearly raises food hygiene concerns about contamination by suitability of raw milk consumption for long time in the milk value chain points of Shashemene town. This might be due to the contamination originating from the udder surface, in farm level, lack of cooling technology and transport, uncleaned milk containers, quality of water used for cleaning milking utensils and the time lapse from production to marketing. This is also supported by Hossain *et al.* (2011) the most frequent causes of high bacterial load are poor cleaning of the milking system, milking dirty udders, maintaining an unclean milking and housing environment, and failure to rapidly cool milk to less than 4°C after milking.

4.14.2. Coliform count

There was a significant difference ($P<0.05$) in coliform count/ml of raw milk collected from the three different milk source. The average values of coliform count/ml of raw milk from milk producers (MP), milk collectors (MC) and milk retailer were 4.81±0.14 log10 cfu/ml, 4.99±0.16 log10 cfu/ml and 4.86±0.13 log10 CFU/ml, respectively (Table 20). The overall mean of CC obtained from raw milk in the current study was 4.86±0.20 log10 cfu/ml. The current result of coliform counts/ml is higher than the findings of (Mitiku *et al.,* 2019) (4.82 ±0.082log10 cfu/ml),Melesse and Mustefa (2019) (3.400± 0.10352 log10 cfu/ml), Tesfay *et al*. (2013) (4.13 ±0.76 log10 cfu/ml), Asaminew and Eyassu (2011) (4.49±0.11 log10 cfu/ml) and Fikrineh *et al*. (2012) who found coliform count (CC) of 4.35±0.06 log10 cfu/ml for raw cow's milk. However this result is lower than the finding of Teshome andTesfaye (2016) who reported CC of 5.100±0.288 log10 cfu/mL for raw cow's milk samples collected from Bench Maji-Zone,Southwestern Ethiopia. The presence of high numbers of coliforms in milk indicates that the milk has been contaminated with fecal materials and this could be attributed to insufficient pre-milking udder preparation, poor hand washing practice of milker and use of poor quality and non-boiled water for cleaning of milking utensil. This is supported by Grillet *et al*. (2007) higher coliform counts result may be due to the contamination of the milk either from dirty equipment or from milking cows with environmental coliform mastitis. Moreover; bulk milk coliform bacteria are used as indicator presence of pathogens in milk.

4.14.3. Yeast and mould

Statistical analysis showed that there was a significant difference ($P<0.05$) in yeast and mould count/ml of raw milk collected from the three different value chain points. The average values of yeast and mould count/ml of raw milk from milk producers, milk collectors and milk retailer were 3.86±0.18 log10 cfu/ml, 4.01±0.07 log10 cfu/ml and 3.95±0.09 log10 cfu/ml, respectively (Table 20). The overall mean of YMC obtained from raw milk of the present study was 3.92±0.16 log10 cfu/ml. According to Malaysia food quality standards, YMC in raw milk samples should be lower than 2.1 log10 cfu/mL (Torkar & Vengust, 2008). However, the mean values of YMC found in the current study at all were higher than this set maximum YMC. Yeast and mould found in this study is similar with the finding of Teshome and Tesfaye (2016) who reported YMC of 3.902±0.477 log10 cfu/mL for raw cow's milk from Bench Maji-Zone, South western Ethiopia. This result is also similar with the finding of (Mitiku *et al.,* 2019) who reported YMC of 3.9±0.08 log10 cfu/mL for raw cow's milk from Meta District of Eastern Hararghe Zone, Ethiopia. However this result is lower than the finding of Teshome (2013) and Haile *et al*. (2012) who reported higher YMC of 4.206 log10 cfu/ml for samples collected from Shashemene town and 4.65 log10 cfu/m for milk from storage containers and 7.13 log10 cfu/ml for milk samples collected from distribution containers in Hawassa, Southern Ethiopia. The presence of yeasts and moulds in milk from the producers, milk collector and milk retailer is higher than the acceptance levels of yeast and moulds in raw milk. The high YMC observed in milk obtained from milk collector might be attributed to contamination from dust, air, containers, water used, poor personal hygiene, and poor hygiene of milk selling environment.

Table 19 Microbial counts of raw cow milk in the value chain points CFU/mL

Variables	Milk sources				P-value
	Milk producers (N=30)	Milk collectors (N=6)	Retail shop(N=12)	Overall (N=48)	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
TBC (log10cfu/ml)	5.98±0.21[c]	6.41±0.12[a]	6.17±0.10[b]	6.12±0.22	0.000
CC (log10cfu/ml)	4.81±0.14[b]	4.99±0.16[a]	4.86±0.13[b]	4.86±0.20	0.002
YMC (log10cfu/ml)	3.86±0.18[c]	4.01±0.07[a]	3.95±0.09[b]	3.92±0.16	0.032

Means with different superscripts for the same variable across the same row are significantly different ($p<0.05$) N=number of samples, SD=standard deviation, TBC== total bacteria count, CC= coliform count YMC= yeast and mould count, cfu= colony-forming units

4.15. Microbial Quality Analysis of Butter

4.15.1. Total bacteria count

Statistically there was a significant difference ($P<0.05$) in total bacteria count/ml of butter collected from the three different butter sample source and was greatest in butter samples from market as compared to butter from the producers and retail shop. The average values of total bacteria count/ml of butter from butter producer, market and retail shops were 6.19±0.19 log10 cfu/ml, 6.46±0.07 log10 cfu/ml and 6.33±0.028 log10 cfu/ml, respectively (Table 21). The overall mean of TBC from butter of the present study was 6.26±0.19 log10 cfu/ml. This result is higher than the average total bacterial count of butter samples collected from Selale (6.18 cfu/g) and lower than butter samples collected from Sululta (7.25cfu/g), (Zelalem, 2010). Another report by Wondu (2007) in Awassa, Southern, Ethiopia, indicated that an average total bacterial count of 7.49 cfu/gram with high variation from different sources. However this result is higher than the acceptable level of 6log cfu/ml set by Ethiopian standard (ES, 2009). This might be attributable to the materials and methods of production, handling, hygiene of the producer and the animal from which the milk is obtained.

4.15.2. Coliform count

Statistically analysis showed there was a significant difference (P<0.05) in coliform count/ml of butter collected from the three different butter sample source. The average values of total coliform count/ml of butter samples collected from butter producer, market and retail shops were 5.04±0.0.09 log10 cfu/ml, 5.23±0.06log10 cfu/ml and 5.14±0.06 log10 cfu/ml, respectively (Table 21). The overall mean of CC obtained from butter of the current study was 5.09±0.11 log10 cfu/ml. This result is lower than the findings of Debela (2016) who reported mean of total coliform count of 5.62 log cfu/gram of fresh butte samples from west Shewa, Ethiopia. However, this result is higher than studies conducted in Sudan (Ahmed *et al.,* 2016) where values of log10 2.51 cfu/g, log10 2.38 cfu/g and log10 2.41 cfu/g for butter from farmers, butter from dairy plant and butter made by investigators were seen, respectively. Coliforms are indicators of presence of pathogens, premises and equipment Idoui *et al.* (2010).

4.15.3. Yeast and mould count

As indicated on (Table21) there was a significance difference (p<0.05) in yeast and mould count among the three different butter sample source. The overall mean of yeast and mould obtained from butter of the current study was 4.54±0.22log10 cfu/ml. This result is lower than the report of Debela (2016) revealed yeast and mould count of 6.7 cfu/g of fresh butter samples. But higher than the mean yeast and mould count observed in the Sudan, values of log10 3.39 cfu/g, log10 3.03 cfu/g and log10 3.08 cfu/g were reported for butter samples from traders, butter samples from dairy plants and samples from butter made by investigators

(Ahmed *et al*., 2016). Moulds are the primary spoilage factors in butter and presence in butter indicates post production contamination from air or water.

Table 20 Microbial count of butter in the study area

Variables	Butter source				P-value
	Butter producer (N=26)	**Open market (N=8)**	**Retail shop (N=6)**	**Overall (N=40)**	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
TBC (log10cfu/ml)	6.19 ± 0.19^{c}	6.46 ± 0.07^{a}	6.33 ± 0.028^{b}	6.26±0.19	0.001
CC (log10cfu/ml)	5.04 ± 0.09^{bc}	5.23 ± 0.06^{a}	5.14 ± 0.06^{b}	5.09±0.11	0.000
YMC (log10cfu/ml)	4.47 ± 0.24^{bc}	4.67 ± 0.08^{a}	4.64 ± 0.056^{ab}	4.54±0.22	0.029

Means with different superscripts for the same variable across the same row are significantly different ($p<0.05$) N=number of samples, SD=standard deviation, TBC= Total bacterial count, CC=coliform count, YMC= Yeast and mould count, cfu= colony-forming unit

5. CONCLUSIONS AND RECOMMENDATION

The cattle herd in Shashemene town was dominated by Holstein-Friesian crossbred dairy cows**.** The farmers prefer the crossbred cows because of their greater milk production. The main feed resources was purchased animals feed from different animals feed providers. Production performances CI and AFC of dairy cattle was no significant differences ($p>0.05$) among the three farm scales. Statistical analysis showed that there was significant difference ($p<0.05$) higher local than crossbred in CI and AFC. There was no significant difference ($P > 0.05$) in the average lactation length among three farm scales. There was highly significant difference ($p<0.05$) between genotypes.

The commonly used utensils for milk and butter handling in Shashemene town were plastic. Butter, churn was using clay pot in Shashemene town. Washing udder before milking and using individual or collective towels for cleaning udder of milking cows were practiced.

The proportion of raw milk used for household consumption was relatively small and the major milk produced was destined to market. The main outlets for raw milk identified were cooperatives, processors, retail shops directly to consumer and Hotels/restaurants. It is also main outlets for butter were retailer, itinerate trader, farmer trader and consumer.

Physicochemical properties of milk from the milk producers, milk collectors and milk retail shop fat, protein and density were within the standards. While titratable acidity, SNF, and lactose of the milk samples obtained from the milk value chain points were not recommended standard.

The outcome of this study showed that, all the microbial qualities were poor, as judged from the high total bacterial count (TBC), coliform count (CC) and Yeast and mould count (YMC) were higher than the recommended international standards of food safety for human consumption. In general, the results indicated that important measures are needed microbial quality and safety of milk production at all scales of production to consumption.

Recommendation to:

- Improving the existing feed resource through encouraging private sectors in animal feed production supply.
- Support on forage development, genetic improvement, milk quality assurance and safety improvement.
- Investigation on the status of the farms, milk handling, and transportation delivery of milk from the farm up to consumers.

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7. APPENDICES

Appedix1: Questionnaires

Questionnaire: Household interview

This questioner is for the purpose of value chain and milk quality assessments,

I. General

1. Zone: ______________________________

2. District (*Wored*a): ____________________

3. Site/town: ____________________________________

4. Kebele: ________________________________

5. Farmer/owner name: ________________________________

6. Gender of the owner: A. Male B. Female

7. Age of the owner: ________________________________8 Educational level of the owner

a. Illiterate b. Write and read c. Primary education (1-8)

d. 9-.10th grad completes e. 11-12 grade completed f. Other (specify) ___________

I. Milk production

1. How many milking cows do you have? Local) ___________ crossbreed) ___________

No	Breed	Numbers of calves	Number of heifers	Number of lactating cow	Number of drying cow	Number of bull/oxen
1	Local					
2	Crossbreed					
3	exoticbreed					

2. Productive and reproductive performance of dairy cow

No	Breed	Ag at first calving in month	Calving interv in month	Lactation length in month	Daily milk yield/(L/day /cow
1	Local				
2	Crossbreed				
3	exotic breed				

3 What amount of total milk do you get per day, sold, consumed, and processing in home?

No	Breed	Total milk L/day	Total sold/L/day	Consume at home/L/day	Processed /L/day	Give to calf/L/day
1	Local					
2	Crossbreed					
3	exotic breed					

4. What is the problem of milk production?

a, Lack of grazing land b, Inadequate water supply c, High cost of animal feed d, poor veterinary service

e, Other(

specify)………………………………………………………………………………

II Housing of dairy cow

1. What type of housing for dairy cows do you use?

a. Open without enclosure b. closed c. Semi open

2. What materials did you use for the construction of the milking shade floor?

a. Concrete b. stone c. Soil d. Others (specify) ___________________

3. How frequently do you clean your cows' house?

a. once a day b. Twice a day c. Three times a day d. Four times a day

III. Feeding system

1. Where you get feed for your dairy cattle?

a. farm produced b. Purchased c. both

2. What is used to feed your dairy cattle?

a. Concentrates, industrial by products molasses& straw b. molasses, hay& straw

3. What is source of water used for your dairy cattle?

a. Pipe water b. river c. pond water

IV. Veterinary services and artificial inseminations (AI)

Access of AI Services	a, yes
	b, No
Health care service	a, Government actors
	b, Private actors

V. Milking Equipments and Handling

1 what equipment do you use for milking and milk handling? a. Plastic pail

b. Aluminum pail c. Grass weaved container d. Calabash e.Stainless steel pail

f. Clay pot g. Wooden container h. Other (specify) __________

2. What problems/ difficulties do you face in using those equipments?

a. Difficult to cleaning b. Fragile c. Difficult for handling d. Not accessible in local market e. Others (specify__________

VI. **Milking hygienic practice**

1. Do you wash your hands before milking? (1)Yes………… (2)No…………………

2. Do you wash your cow's udder before milking? (1) Yes….. (2) No……..

If yes, when do you wash it?

a. Cleaned before milking only b. cleaned after milking only c. cleaned before and after milking

3. If you wash the udder what materials do you use for drying?

a. Collective towel b. Individual towel c. Just with hands d. Others (specify)

4. How often do you wash the container?

a. before every use b. After every use c. Before and after every use

5. How do you clean the container? a. cold water b. hot water c. cold water and soap d. hot water and soap e. detergent and water

VII. Marketing system

1. Do you sell all your milk at your farm or transport it to market place? i. sell at farm ii transport

2 .If transport how far (km) the market place from your farm**?** a**,** less than 1 km

b, 1-5km c. 5-10 km d, Above 10km

3. What is the means of your transportation? 1. on foot, 2. Horse cart, 3. On animal back, 4. Public transport 5. Private car 6 . Other means (specify) __________

4. At which market do you sell your milk? a. super market b. cooperatives

c. Hotels /restaurant d. neighbours e. local nearby markets f. processor g. shop h. other (specify)

5 Who are your customers? a. neighbours b. Collection centers c. Cafes and restaurants d. large processors e. Others (specify) __________

6. How much do you cell (birr) 1 liter of milk?

7. Do you observe some quality and hygiene measure on your farm and milk production processes? a. Yes b. No

8**.** What marketing problems for your milk do you face?

a. Price variation b. Lack of fair market c. Lack of demand d. Others (specify)……….

VII. Marketing system of butter

1. Who is direct buyer of the butter produced by the household at present? a. Selling to individual traders in the village b. Whole sellers in woreda main town c. Whole sellers in near market place d. Marketing cooperative e. Individual customers in the nearby local market f, Individual customers in woreda main town

g. Individual customer found in Zonal market h. Wholesalers in zonal main town and or other town next to zonal town

i. Hotel/ cafeteria/ hospital found in woreda main town or zone main city or other city near to zonal town

j. Other specify -------------------------------------

2. Distance travelled per day (km) to sell butter.

a .less than one km b. 1 to 3 km c. 3 to 5 km d. 5 to 7 km

3. What kind of transportation system producer uses to transport butter?

a. Mule or horse transport b .Donkey c. bicycle

d. motorbike e. cart f. car g. Walk on foot h. other

specify……………………………

4. Constraints in cow butter marketing faced by producers

a. Small milk quantity b. Distance to market, c. cultural restriction, d. high transport cost

e. spoilage f. No market g. competition h. No attractive price for the producer i. lack of access to market information j. there is no any constraint

k. other specify ---

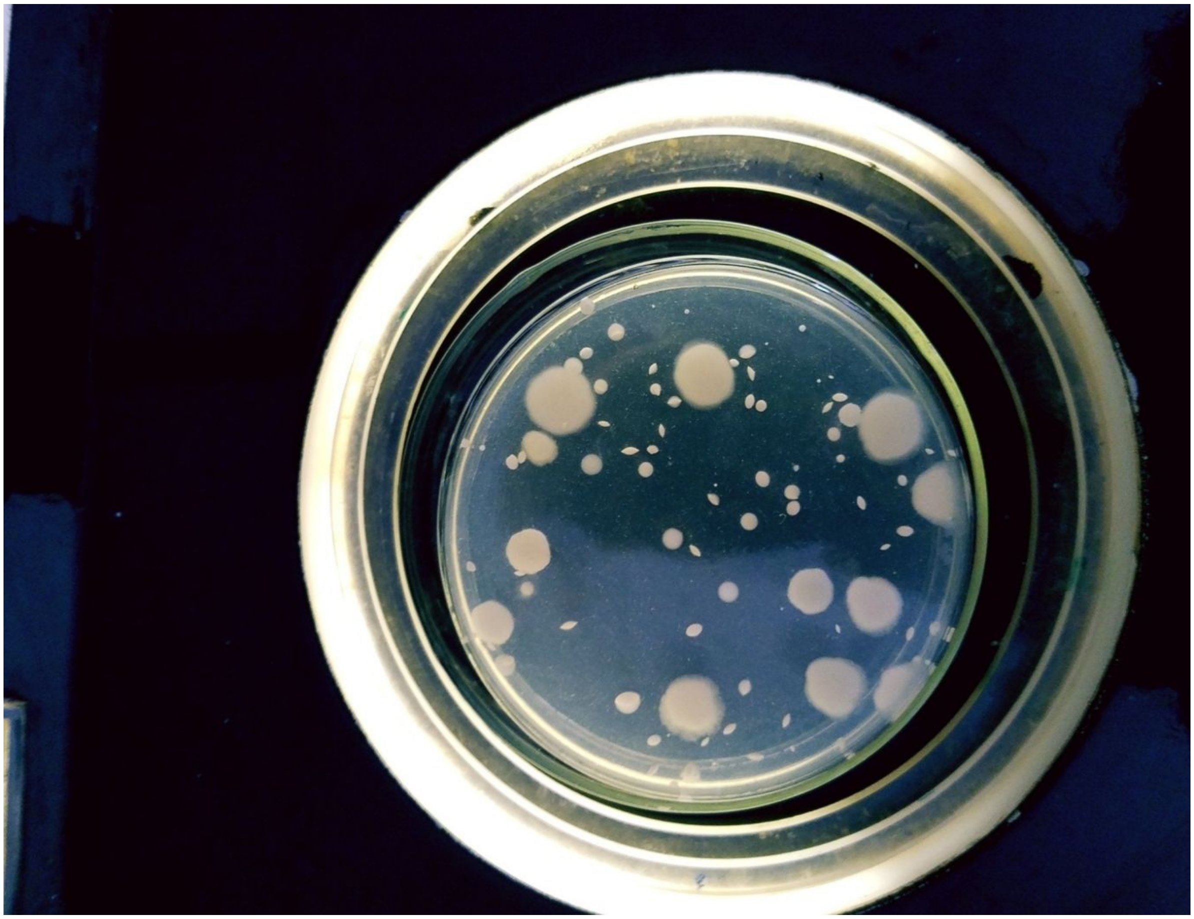
Appendix2: Materials and equipments used for laboratory analysis

Autoclave

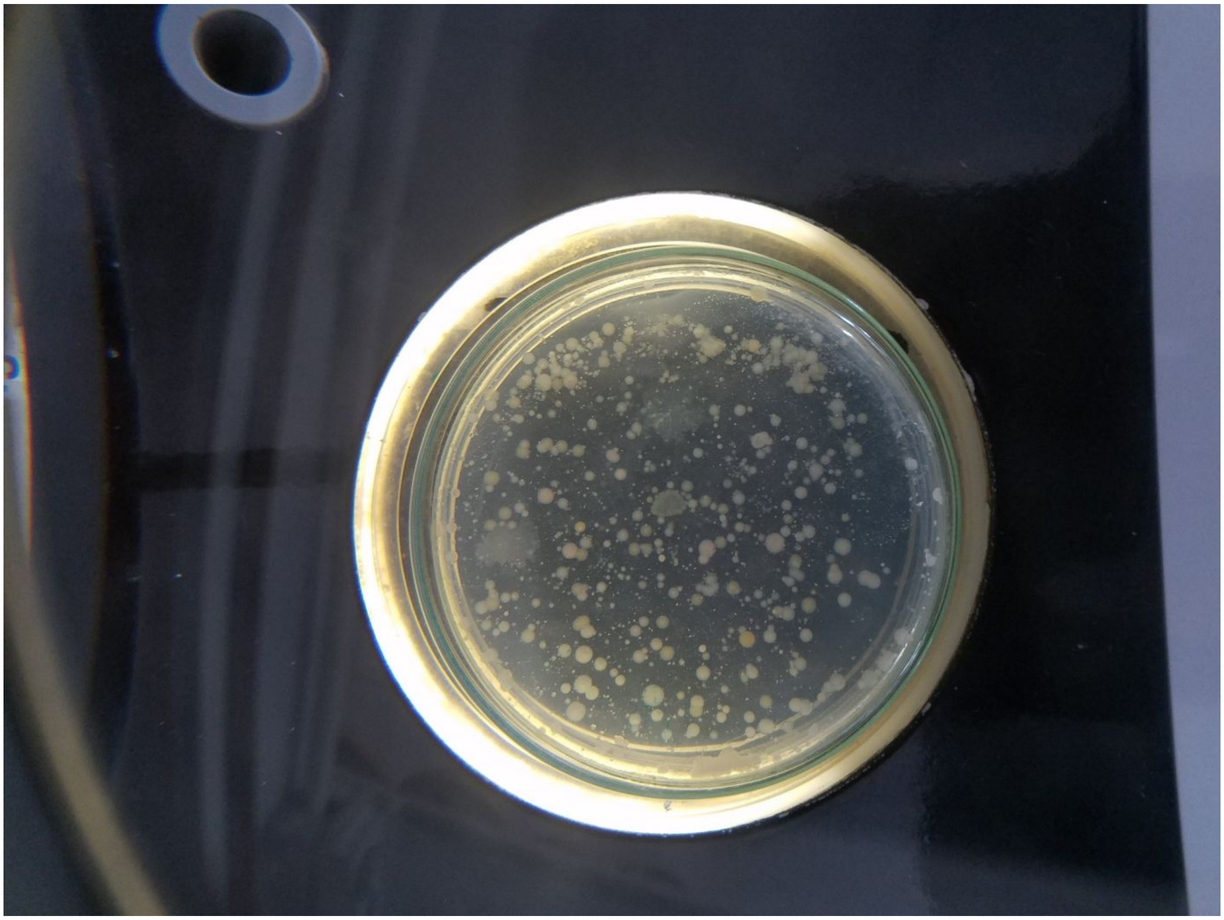
Colony counter

Determining of Titratable acidity at dairy laboratory

Appendix3: Different microbial examined in the laboratory



Yeast and mould median



Standard plate count

BIOGRAPHICAL SKETCH

The author Hana Adere was born from her mother w/zaro Desta Balcha and her father Ato Adere Wakjira in Wara Jarso woreda in North Shewa Zone Administrative Zone in Oromia Regional State in January, 1995 G.C. She attended her primary education at Gaba Jimata primary School, from 2002 – 2009 G.C. She had attended her secondary School (9^{th}–10^{th}) from 2010-2011 G.C. at Tulu Milki Secondary School. She had also attended her preparatory School from 2012-2013 G.C. at Gebre Guracha preparatory School. After completion of preparatory school education she joined Haramaya University of Agriculture in 2014 G.C and graduated with BSc degree in Dairy and Meat Technology in July 2016 G.C. After graduation, she recruited as Graduate assistance I at Oda Bultum University. She joined Hawassa University, College of Agriculture School of Animal and Range Science for the Degree of Master of Science in Animal Production in October 2017 G.C. Now she is ready to defend her MSc thesis.