DAIRY PRODUCTION PRACTICES AND EVALUATION OF MILK QUALITY IN SEBETA TOWN OF OROMIA REGIONAL STATE, ETHIOPIA

BY

SAMUEL ABOSE BONGASE

JUNE, 2020

JIMMA, ETHIOPIA

DAIRY PRODUCTION PRACTICES AND EVALUATION OF MILK QUALITY IN SEBETA TOWN OF OROMIA REGIONAL STATE, ETHIOPIA

MSc. Thesis

By: SAMUEL ABOSE

Submitted to Jimma University College of Agriculture and Veterinary Medicine in Partial Fulfillments of the Requirements for Degree of Master of Science in (Animal Production)

Advisors

Major Advisor: TayeTolemariam (PhD, Professor)

Co-Advisor: MotumaDebelo(DVM.MSc, Asst. professor

JUNE, 2020

JIMMA, ETHIOPIA

DEDICATION

I dedicated this thesis to my wife, for all loves she has given me and moral support for the success of this thesis.

STATEMENT OF THE AUTHOR

I declare and confirm that this Thesis is my original work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and compilation of this thesis. Any scholarly matter that is included in the Thesis has been given recognition through citation. This Thesis submitted for partial fulfillment of the requirements master degree in Animal Production at Jimma University. The Thesis deposited in the Jimma University Library and will be made available to borrowers under the rules of the library. I solemnly declare that this Thesis has not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

A brief quotation from this Thesis is done without special permission provided that accurate and complete acknowledgement of the source is made. Requests for Permission for extended quotations from or reproduction of this Thesis in whole or in part granted was by the Head of the School or Department when in his or her judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission from the author of the Thesis must obtain.

Name: Samuel Abose

Date: June, 2020

Signature: ____________________

BIOGRAPHICAL SKETCH

The author, Samuel Abose was born in Western Wollega Zone, Gimbi and ManaSibu District in Karawayu Abo kebele on January 10, 1988. He attended his primary and secondary school at Karawayu Abo and Mendi Senior Secondary Schools, respectively. He joined Haramaya University in 2009 and awarded B.Sc. degree in Animal Sciences in July 2011 and completed his BSc in the year of 2013. Then he joined Oromia TVETCollegeand employed as Instructor at Sebeta Polytechnic College. He then joined Postgraduate Programs of Jimma University to study, Master of Science in Animal Production in June 2017.

ACKNOWLEDGEMENTS

Firstly, I would like to thank Almighty God for giving me health, the strength and courage on the course of my life during my study.

I would like to appreciate and give very special thanks to my major advisor Prof. TayeTolemariam for his relevant, timely and constructive comments and valuable suggestion to the successful completion of the thesis work. I am also greatly thankful to my co-advisor Dr. MotumaDebelo for his worthy advice, support and encouragement during the research work and constructive comments.

Sincere thanks also extended to the National Animal Health Diagnosis Investigation center (NAHDIC) and Sebeta Agro-Industry (MAMA milk) Plc. and all officials as well as individuals working there for allowing me to use their laboratory and for providing necessary equipment, technical support and reagents.

Finally, I would like to express my deepest and heartfelt thanks to my Wife, Sebeta polytechnic college and as well as Dr. Abdi Ahmed and Dr. AbebeOlani from NAHDIC for their generous support and contribution made in this thesis.

LIST OF ABBREVIATIONS AND ACRONYMS

CF	Coliform Unit
CLR	Calibrate Lactometer Range
CMT	Californian mastitis test
CSA	Central Statistical Agent
DM	Dry Matter
EMDIDI	Ethiopian Meat and Dairy Industry Development Institute
ESA	Ethiopian Standard Agency
E.coli.	Escherichia coli
FAO	Food and Agriculture organization of the Unit Nation
FDA	Food Drug Administration
GLM	General Linear Model
G	Gram
ISO	International Standard Organization
Lit	Liter
LSD	Least Significant Difference
ML	Milk-Liter
NAHDIC	National Animals Health Diagnostic Investigation Center
S.aureus	Staphylococcus aureus
SAI plc.	Sebeta Agro-industry private Limit Company
SCEFCCA	Sebeta City Environment Forest and Climatic Change Authority
SCLM	Sebeta City Land Management
SHF	Smallholder Farmers
SHMEs	Smallholder Micro Enterprises
SPC	Standard plate count
SPSS	Statistical Package for Social Science
SNF	Solid Non-Fat
STLFAO	Sebeta Town Livestock, Fisher and Agriculture Office

TABLE OF CONTENTS

LIST OF TABLES

PAGE

LIST OF FIGURES

PAGE

LIST OF TABLES IN THE APPENDIX

PAGE

ABSRACT

The study was conducted in Sebeta town South West showa Zone with the objectives of a dairy production practices and evaluation of milk quality. From a total of nine kebeles of Sebeta town, three representative kebeles were selected, purposively based on their dairy production potential. From the selected kebeles,36 smallholder farmers and 51 smallholder micro-enterprises were randomly selected and interviewed. Twenty one pooled milk samples were taken from smallholder farmers (9), smallholder micro-enterprises (9) and selling point of shops (3) were evaluated for microbial and chemical compositions. The result showed that male respondents dominant at both smallholder farmers (77.8%) and smallholder micro-enterprises (64.7%). The present study has identified two production systems; namely, peri-urban and urban dairy production systems where the later type is dominating.Purebred dairy cattle were dominantly owned at both systems. The average milk yield per cow per day in Sebeta town was 11.5 liters.The major feed resources were agro-industrial byproducts, industrial byproducts (brewery grain) and purchased hay grasses. Tape water was the main sources of water and animals were housed in constructed separate sheds/barns with concrete floor. AI was the most common methods for cattle breeding. Feed shortage, cost of feed and shortage of land are the major challenges in the study area. Laboratory examination revealed that the overall mean percent fat content, solid nonfat (SNF), total solid, protein, lactose, added water and solid were; 2.56±0.28, 7.96±0.8, 10.51±1.10, 3.08±0.35, 4.16±0.42, 18.26±11.93 and 0.63±0.05 respectively. The specific gravity of the raw milk ranged from 1.023 - 1.031g/cm3. All milk samples from milk shops, 77.8% from smallholder micro-enterprises and 44.5% from smallholder farmers showed presence of mastitis in the milk. The most important bacteria isolated were E. coli and S. aureus. Milk collected from small micro-enterprise, smallholder farmers and selling point of milk shops were subjected to bacterial infection and does not meet the requirements of international milk quality standard. Therefore, awareness creation and strict quality control is recommended to safeguard public health of the consumers.

Key words: Dairy cattle, Production, Evaluation, Bacterial, Milk composition, Sebeta.

1. INRODUCTION

On the world about 150 million farm house hold are engaged in milk production and the majority of them is from developing countries where annual growth rate in milk consumption is between 3.3-4 percent in 1995-2005(FAO, 2010). In most developing countries, milk is produce by smallholders and contributes to household livelihoods, food security and nutrition (Tedasse*et al.*, 2017). Production of milk is a key activity worldwide since dairy products' supply and demand is not balanced due to ever-increasing need (Sintayehu *et al*., 2008).

With almost 60 million cattle, Ethiopia is estimated to be home to the largest livestock population in Africa; however, the productivity of the largely local breed (accounting for over 98%), is said to fall below the Africa average in terms of milk yields. The diverse and wide-range of agro ecological zones and the importance of livestock in livelihood strategies make Ethiopia home to large numbers of livestock (CSA, 2018).

Dairy production is one of livestock production system well-known in Ethiopia. Even though there are different types of dairy production systems (Tegegne*et al*., 2013).Dairy production, among the sector of livestock production systems, is critical issue in Ethiopia where livestock and its products are important sources of food and income and dairying has not been fully exploited and promoted in the country.

Ethiopian national livestock master plan seeks to enhance investments in improved breeds, feeds and health of cattle to increase milk production by over 90% by 2020.The increased supply in dairy as well as meat from the improved cross breeds is expected to meet the demands of the integrated agro industrial parks for both local use and export sector (Shapiro *et al*., 2015).

Dairy sector is a major contributor to economic development mainly among the developing countries used as an engine of growth; it goes increased income, employment, food and foreign exchange earnings as well as better diet (Yilma, *et al*., 2011). The traditional system of milk production in Ethiopia, containing small rural and peri-urban farmers, uses local breeds, which produce about 400-680 kg of milk per cow per lactation period (Holloway, 2000). Intensive systems as diverse as state enterprises, small and large private farms use exotic breeds and their crosses, which have the potential to produce 1120-2500 liters over 279-day lactation (Ahmed *et al*., 2000).

According to Ahmed *et al*. (2004) also reported livestock is raised in all of the farming systems of Ethiopia by pastoralists, agro pastoral, and crop-livestock farmers. Milk production systems can be divided into two broad systems: Intensive (urban, peri-urban) and extensive (pastoral and highland small household) (Wouters and Vanderlee, 2010). Milk can contribute wide range of available nutrients to maintain health and normal pronounced growth of body (Haug*et al*., 2007).Quality is an important issue in production of hygienic products especially for safety of consumers in which both microbial and chemical properties of milks in normal state (Asrat*et al*., 2016). Urban and peri-urban smallholder producers are the main suppliers of raw milk to milk processors of different scales in Ethiopia (Haile, 2009).

Microbial contamination in milk may cause milk-borne diseases to humans, while others are known to cause milk spoilage. Many milk-borne epidemics of human diseases are spread through milk contamination. 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's and water supplies used in sanitary activities. Other secondary sources of microbial contamination occur during milk handling, transportation and storage of milk (Chala, 2017).

Milk from a healthy udder cow contains very few numbers of bacteria ($<3x10^4$ cfu/ml) but may become contaminated by microorganisms from the surrounding environment during milking and milk handling, from water and milk equipment's. Foodborne diseases are among the widestspread public health problems globally (Bille*etal.,* 2009). .Milk normallybecomes potential source of human infection due to contamination duringproduction, collection, transportation and during processing (Daryani*et al*., 2008).

Milk is the best and cheapest source of nutrition and used by all the age groups in rural as well as in urban areas (Drewnowski, 2011). It provides appreciable amount of fats and protein and provides body building vitamins along with furnishing energy giving lactose and many other nutrients, therefore an ideal food for pregnant female and infants (Ayub*et al.*, 2007). Milk is a prefect diet, readily digested and absorbed. It is an only one natural food for first few months of newborn life and milk is chiefly valuable as a source of high-quality nutrients protein, lactose, fat, minerals and vitamins. Protein in milk supply the amino acids required for repairs of tissues in adults (Kamthania, 2014).

Milk being made up of 87% water is liable to adulteration by unscrupulous intermediaries and unfaithful farm workers. Milk with high nutritive value makes it suitable medium for the rapid multiplication of bacteria, especially under unhygienic production and storage at moderate temperatures (Dugdill, 2001). The number of spoilage bacteria in raw milk, based on the level of hygiene during milking and the cleanliness of the materials used for storing and transporting the milk (Gadaga*et al*., 2004). The chemical composition and number of bacteria in raw milk affect the quality and safety of dairy products (Elmoslemany*et al*., 2010).

In Ethiopia, dairy production is one of the sub-sectors of livestock production that contributes to the livelihood of the owners through important sources of food and income; even though dairying has not been fully exploited and promoted in the country (Yigrem*et al*., 2008).

Milk differs in composition due to different factors like species of animal, variety, individuality, lactation's phase, incidence of milking, age, feed, disease, administration of hormones and drugs (Fahmid*et al*., 2016).The term quality for milk means absence of harmful bacteria, dirt, antibodies, bad flavors, abnormal numbers somatic cell count, chemical analysis to check presence of sufficient amounts of nutrients, removal of fat and other adulterants, verification of hygiene through microbial investigation (Fahmid*et al*.,2016).

Consumers certainly need wholesome, clean and nutritious milk free from pathogens. Quality milk means, milk with normal chemical composition, low bacterial count, free from adulterants and toxic substances, low degree of titer able acidity, good taste and ample in keeping quality. Quality assessment of milk is thus vital (Khan *et al.,* 2008). The natural acidity of milk is 0.16% - 0.18%, and samples with higher 0.16%-0.18 percentage indicate developed acidity (Lu *et al.*, 2013). In developing countries, production of milk and several dairy products take place under rather unsanitary conditions and poor production system (Zelalem and Faye, 2006; Alganesh*et al*., 2007; Asaminew and Eyassu, 2011). The weak relations among the different production system in the dairy sector value chain are some of the main factors that contribute to the poor improvement of dairy production system in Ethiopia's dairy sector (Lemma *et al*., 2008) and (Yilma*et al.*, 2011). Unrevealed production system andthe adulterants, causesdecrease the nutritive value of milk and milk production and also cause to human health related problem (Nishantrai*et al*., 2013). The finding of the study is important to generate information and contracted the existed information gap. It is also important to indicate status of cattle milk production in the study area and also can provide baseline information for other researchers interested in milk production**.**

Sebeta town known by the intensification of smallholder dairy production, but its production system with the relation to feeding practice, breed type, housing system, husbandry practice and milk quality handled methods are not well recorded. To fill the gap, a cross-sectional study was design to assess dairy production system and evaluation of milk quality, particularly by using information from smallholder farmers and smallholder micro-enterprises dairy producers with the following objectives;

1.1. Objectivesofthe Study

1.1.1. General Objective

❖ Todescribe a dairy production practices and evaluation of milk qualityin Sebeta Town of Oromia Regional state, Ethiopia

1.1.2. Specific Objectives

- ➢ To identifythe dairy production practices of the study area
- ➢ To evaluate physico-chemical properties andmicrobial quality of raw milk in the study area

2. LITERATURE REVIEW

2.1.Dairy Production System in the world and Ethiopia

Approximately 150 million households around the globe are engaged in milk production. In most developing countries, milk is produce by smallholders and contributes to household livelihoods, food security and nutrition (Tedasse*et al*., 2017). According to Faye and Konuspayeva (2012), developing countries have increased their share in global dairy production. This growth is mostly the result of an increase in numbers of producing animals rather than a rise in productivity per head. In many developing countries, dairy productivity is constrained by poor-quality feed resources, diseases, limited access to markets and services (health, credit and training) and dairy animals' low genetic potential for milk production.

Ethiopia is one of the tropical and subtropical countries, which have a potential dairy production, and the estimate of total milk production for the rural sedentary areas of the country is about 3.32 billion liters for cows (CSA, 2018). Milk production systems broadly categorized into urban, peri-urban and rural milk production systems; where both the urban and peri-urban systems are located near or in proximity of Addis Ababa and regional towns and take the advantage of the urban markets (Galmessa*et al*., 2013).

Milk and dairy products have become a major part of the human diet in many countries. It is not surprising therefore, that over many years' considerable attention has been pay to improving the quality of milk. Researchers have worked to improve the yield, the compositional quality and the hygienic quality, and have striven to minimize the level of contaminants (Delgado, 2003).

According to Ayza*et al*. (2013) urban milk system consists of 5,167 small, medium and large dairy farms producing about 35 million liters of milk annually. Of the total urban milk production, 73 percent is sold 10 percent is left for household consumption, 9.4 percent goes to calves and 7.6 percent is processed into butter and *ayib* (cheese). In terms of marketing, 71 percent of the producers sell milk directly to consumers. On the other hand, Azage*et al*. (2003) classified dairy production systems in Ethiopia into two broad categories namely: commercial systems, which produce milk mainly for market and subsistence systems, which produce milk mainly to meet household needs for dairy products.

The commercial system generally operates in urban and peri-urban areas with or without holdings of land for feed production. The commercial urban and peri-urban dairy system is concentrated near to Addis Ababa and other regional towns. This system is developing in response to the fast-growing demand for milk and milk products around urban centers (Tsehay, 2001). The peri-urban dairy production system includes most of the improved dairy stocks. The rural dairy production system is part of the subsistence farming system and includes pastoralists, agro pastoralists, and mixed crop-livestock producers mainly in the highland areas. The system is not market oriented and most of the milk produced in this system is retain for home consumption (Ahmed *et al*., 2003).

2.1.2. Dairy Cattle Production Practice

Housing conditions have a significant impact on the welfare of dairy cattle. Systems may include loose housing, free stalls, or tie stalls, each with or without outdoor and/or pasture access (FAO, 2017).

Feeding productivity of dairy animals is largely dependent on how well it is fed. Dairy animals are highly sensitive to changes in feeding regimes, and production can fall dramatically with small variations on a day-to-day basis. A good farmer should set a good feeding schedule and as much possible (FAO, 2011)

Dairy Cattle breedingan efficient, systematic and operational breeding strategy is necessary to bring about improvement in the dairy sector. Such a strategy needs to take into account selection within the local cows and crossbreeding local cows of good production potential with known exotic dairy breeds (Yilma*et al.*, 2011).

2.2. Assessment of milk quality

Every dairy operation must ensure that its milk is of high quality and safe for consumption. High quality milk is crucial for processing high quality dairy products per regulations, milk displaying the following must be discarded: contamination by antibiotic residue and added water, blood, high temperature high DMC (Direct Microscopic Count) of bacteria, inadequate sensory factors (smell, taste, visual). Parameters of milk quality include somatic cell count, milk solids (fat, protein, lactose) and mastitis pathogens (e-coli, staphylococcus) (https://www.afimilk.com)on Aguest14, 2019)).

2.2.1. Microbial Quality and Safety of milk

Milk production often does not satisfy the country's requirements due to a mass of factors. Mastitis is among the various factors contributing to reduced milk production (Biffa *et al*., 2005). Milk with high levels of bacterial contamination is problematic for several reasons. Foremost is safety. Dairy environments like animals' feces, barns, milking and equipment of feeding and watering are often contaminate with common bacterial pathogens such as Salmonella, E. coli, and Campylobacter (FAO, 2017).

According to Griffiths (2010) enclosed pipeline milk systems, better sanitary design of equipment, cleaner cows, and more effective "clean in place" systems have provided the opportunity for farms to produce raw milk with low microbial contamination. Rapid cooling of raw milk before the bulk tank within line plate coolers has reduced the growth of contaminating bacteria. Rapid cooling and refrigerated storage of raw milk has favored the growth of psychotropic bacteria in raw milk. None spore-forming psychotropic bacteria, particularly pseudomonas spp., are killed by HTST pasteurization. Pseudomonas spp. would need to grow to relatively high numbers (1×10^6) in raw milk before pasteurization to produce an off-flavor directly (Jing *et al*., 2011).

2.2.2. Sources of Microbial Contamination to milk

Milking area: Are the most sources for the growth of microorganism, which contaminate the milk and prepare it for rapid spoilage of milk. Keeping and maintaining the sanitary condition of milking environment plays a crucial role for production of good quality milk (Zelalem, 2010).

Udder of cow: is also the possible source of contamination of milk as the udder contact with Soil and other dirty material like dung during resting period. So cleaning the udder of the cow is important for the production of clean milk. Therefore, cleaning the udder before milking is the most and crucial thing required for production of clean milk (Chala, 2010).

Milking Equipment**:** improperly, cleaned milking and cooling equipment are one of the main sources of milk contamination. Milk residual left on the surface of the equipment support the growth of variety of microorganism that contaminate and spoil milk (FAO, 2017).

2.2.3. Prevention and control of microbial contamination in milk

Prevention and control of microbial quality of milk is through elimination of organisms from human carriers by general improvements in water supplies, public health education, personal and environmental hygiene. The lack of awareness of milk-borne infections in many developing countries and consumption of raw milk predispose small-scale livestock keepers, consumers and the public at risk of contracting these infections (Mosalagae*et al*., 2011).

2.2.4. Chemicals Properties of milk

Although slightly varies in composition and properties, the milk of different species contains the same constituents in general. On average, milk is made up of 87.4% water and 12.6% milk solids (3.7% fat, 8.9% milk solids-not-fat). The milk solids-not-fat contain protein (3.4%), lactose (4.8%), and minerals (0.7%) (Varnamandand Sutherland, 2001),and (Chandan, 2011).Milk is approximately 87% of water contents. The remaining constituents are refer to as "solids" and are what separates many of the physical properties of milk from other liquids. "Total solids" (TS) refers to all non-water components of milk, including fats, proteins, sugars, vitamins, and minerals. Fats make up about 4% of fresh milk; that varies slightly depending on animal species and breed. The remaining solids are often called “solids-nonfat” (SNF). Of the SNF portion, the majority is protein, which makes up about 5% of milk, and sugars, which make up about 3.5% of milk. The remainder is vitamins and minerals (0.5%). The total solids give milk distinct qualities from other liquids. One of the first milk quality tests is to measure density. The proteins, sugars, vitamins, and minerals add weight to milk. Because the composition of milk varies only slightly from animal to animal, the density of fresh milk should always be within an established range (FAO, 2017).

Proteins are among the most complex of organic substances. They contain carbon, hydrogen, oxygen, nitrogen, sulfur and sometimes phosphorus. The protein of milk is not a single compound but includes two major proteins and small quantities of others. Between them casein constitute about 80 % of the total and lacto albumin 18% (Ayub*et al*., 2007).

Adulteration is defined as intentional addition or substitution/abstraction of substances, which adversely affect the nature, substance and quality of food. A national survey in India has revealed that almost 70% of the milk sold and consumed in India adulterated by contaminants such as detergent and skim milk powder, but impure water is the highest contaminant (Singh *et al*., 2015).

According to Nirwal*et al*. (2013) who reported the national survey on milk adulteration conducted has indicated that water is the most common adulterant followed by detergent in milk. Despite the laws governing the quality and sale of milk existing in India for decades, the adulteration of milk has not been check completely.

2.2.5. Physical property (density) of milk

Milk pH gives an indication of milk hygienic and it should be 6.6 or 6.8 when milk temperature is 20oC, because cooling of milk reduces the risk of growth of bacteria while high milk temperature must be considered as favorable to the growth of bacteria in milk (FAO,2017). The pH values higher than 6.8 indicates mastitis milk and pH values below 6.6 indicates increased acidity of milk due to bacterial multiplication (O’Connor,1994). Specific gravity is the ratio of density of the substance to the density of standard substance (water). The density of a substance varies with temperature; it is necessary to specify the temperature when reporting specific gravities or densities. The proportion of its constituents

(Composition) influences the specific gravity of milk. The specific gravity of milk is decrease by addition of water, while removal of fat and reduction of temperature increase specific gravity of milk. Generally, normally milk has a specific gravity between 1.027g/cm^3 and 1.035g/cm^3 (O'Connor, 1994) while according to FAO (2017) normally milk has a specific gravity between 1.026g/cm^3 and 1.032 g/cm^3

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The study was conducted at Sebeta town, South West Showa zone. Sebeta town is located 25 km far away from the capital city of Ethiopia, Addis Ababa on the ways of main Jimma road. The present Sebeta town consists of nine major Kebele (SCALM, 2019).The map of the study area shown below Figure (1).

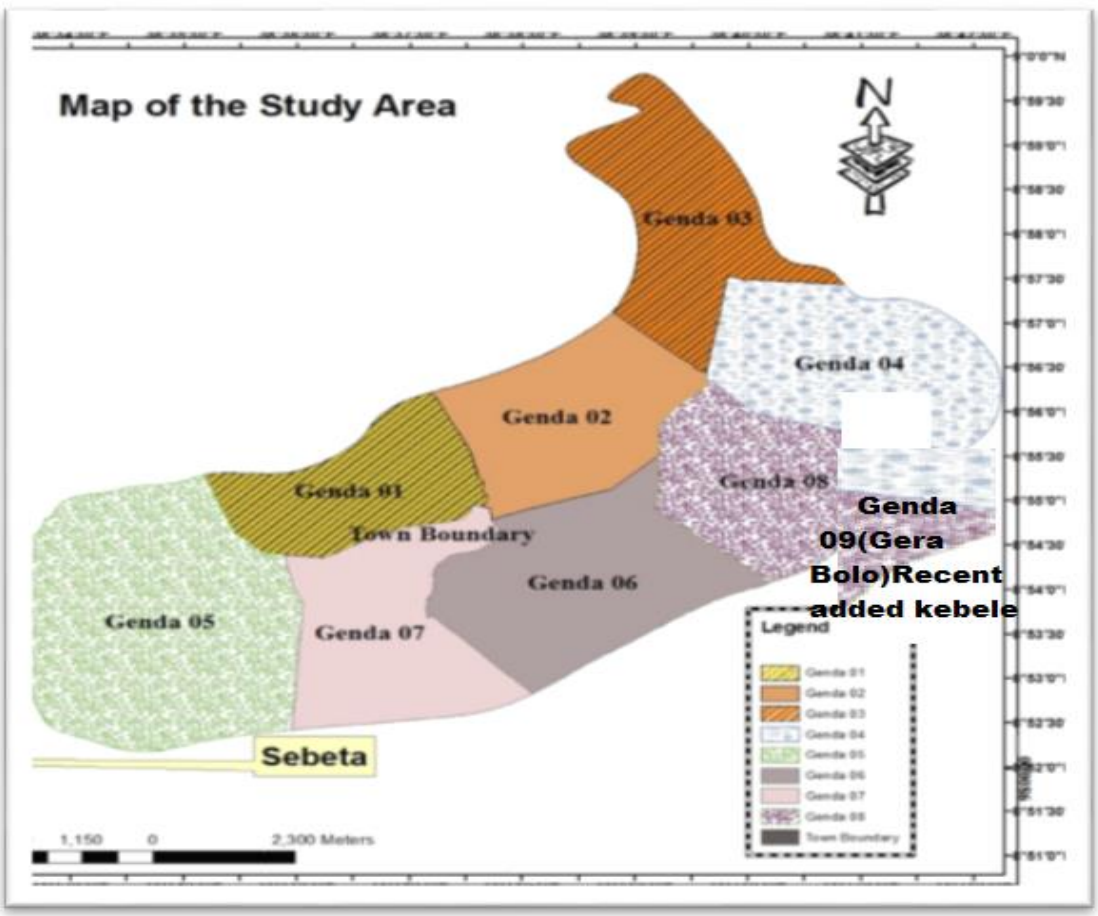


Figure 1: Map of theSebetatown

The climate of Sebeta is predominantly known by *WayinaDega*-(mid-altitude) with geographical co-ordinate between a latitude 8°55′N 38° 37′E and longitude of 8.917 °N 38.617 °E and has an altitude of 2,356 meters above sea level (SCEFCCA, 2019). The majority of rainfall in the area is obtain during the Ethiopian rainy season (May, June, July and August) which covers 76.4% of the total annual rainfall. The minimum rain records in the months of September, October, and November with other short rain during March and April. The average annual rainfall varies between783.6-1422.7mm with mean annual temperature of 12.7^0C-24.4^0C; this is suitable for dairy production system (SCEFCCA, 2019).

The study area, predominantly known by its contribution of animals products, especially dairy products from the smallholder farmers in contributing to food security of the area by direct consumption and income generate for purchasing other food items (CSA, 2018). There is one private commercial dairy farm which is processing milk into different products. The organization collects milk from surrounding smallholder farmers and smallholder micro enterprise with processing capacity about 6300 L milk per day (SAIPLC, 2019). Smallholder microenterprises and smallholders farmers are owned dairy farms. They are doing different activities to improve their dairy animals like breeding methods, feeding, housing, calves rearing and dealing with milk handling and distribution to different milk shops (Yilma*et al*., 2011).

3.2. Sampling Technique and Sample Size

Sebeta town has nine majorKebeles and selected purposively based onpotential ofmilk production of the area (SCALM, 2019). Among the nine Kebeles of Sebeta town, 3 representatives Kebeleswere selected purposively based on their dairy cattle population and per households with random sampling technique. Generally, a sample size of 36 smallholder farmers and 51 smallholder microenterprises of dairy producer respondents were proportionally, selected from the three representative kebeles. Accordingly, from the 230 total populations, 131 smallholder microenterprises and 99 smallholder farmers are present in study areas (STLFAO, 2019).

The study consisted of survey study and laboratory analysis. The survey study focused on dairy production practices by using semi-structural questioner.The interview check lists focused on dairy production practices (feed types, housing, manure handling, water resource, milking times and breeding methods), milk quality characteristic and milk adulterationmethods (Fat removing and addition of water). Laboratory analysis focused on milk quality tests like bacterial isolation and identification such as (mastitis, *E. coli*. and *S. aureus*).Chemical composition such as (fat, solid nonfat, protein, lactose, added water and solid) and physical properties such as (density and freezing points) wereanalyzed by usinglactoscanmachine.The milk samples were collected from smallholder microenterprises, smallholder farmers and selling point of shops.In the study, 87-target population sizes were used for data collection the dairy producers for responding questionnaires were determined by using equation 1 and 2 of the Cochran formula (1977) with 5% sampling error (95%CI). (https://www.statisticshowto.datasciencecentral.com/wp-content/uploads/2018/01/cochran-1.jpeg).

$$n_0 = \frac{Z^2pq}{e^2}$$

$$n_o = \frac{(1.96)^2 * 0.1(1-0.1)}{(0.05)^2} = 138.3$$

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

$$n = \frac{138.3}{1 + \frac{(138.3 - 1)}{230}} = 87$$

Figure 2. Determination of population and target Sample size equation

Where, n_0 = desired sample size Cochran's (1977) when population greater than10, 000,

n_1 = finite population correction factors (Cochran, 1977) less than 10,000,

Z= standard normal deviation (1.96 for 95% confidence interval),

p =0.1(proportion of population to be including in sample size 10%), q =1-p i.e. (0.9),

N= the total number of populations and

d= the degree of accuracy desired (0.05).

The sample respondent was taken from each Kebeles' proportionally according to Pandey and Verma (2008).

Table 1: Proportion of sample taken from each kebeles'

$n_1 = \frac{n*N1}{N}$ $\mathbf{n_2 = \frac{n*N2}{N}}$ $\mathbf{n_3 = \frac{n*N3}{N}}$ Where, n_1, n_2 and n_3**:** are sample sizes of respondents in each Kebele's, N_1, N_2 an N_3: are total number of dairy producers in each Kebele, n=total sample size of respondents in 'each Kebele.

N = is the total number of dairy producers in Sebeta town,

Accordingly, 87-target samples size population of (51 smallholder micro-enterprises and 36 smallholder farmers) dairy cattle producers were randomly, taken from the three representative Kebeles of Sebeta town.

Table 2 Distribution of total population and Sample size determination in Sebeta town

Sebeta town smallholder dairy producers	SHF (N= 36)	SHMEs (N=51)		
Kebeles	01	05	07	Total
Total population of SHF	33	41	25	99
Target sample size of SHF	12	15	9	36
Total population of SHMEs	39	54	38	131
Target sample size of SHMEs	15	21	15	51

SHF=Smallholder Farmers, SHMEs=Smallholder Micro-Enterprises

3.3. Method of Data Collection

3.3.1. Survey Data collection

Both secondary and primary data were collected from the three selected Kebeles. A semi-structured questionnaire was prepared to collect information from smallholder farmers and smallholder micro-enterprises to evaluate dairy production system. The parameters recorded include feed types and feeding system, housing system, breeding methods, milking methods and milking frequency, water resourcesand milking routine such as hygienic milking and milking handling practices, udder health, milk equipment and ways of handling milkingarea.

The questionnaire was prepared with some open and close ended questions. Secondary data was collected from record kept by the Sebeta town Livestock and Fishery, Agriculture office as well as through reviewed documents and publications. Primary data was collected through interviews by using questionnaires, field observation and milk samples collected for laboratory work. Pooled milk samples were collected from smallholder farmers' dairy producers, smallholder micro-enterprises and milk selling shops. 100ml pooled milk samples were collected from each producers and milk shops by using sterile sample bottle, kept in icebox of 5 literscapacity. From each sample 50ml milkwas taken to Sebeta National Animal Health Diagnostics Investigation Center (NAHDIC) for bacterial examination(mastitis, E.coli. and S. aureus), whereas similar quantity sample weretaken to Sebeta agro-industry (Mama Milk) Plc. for analysis of milk physical (density and freezing points) and chemical compositions(fat, solid nonfat protein, lactose, total solid and included added water and solid parts).

3.3.2. Laboratory based data collection

3.3.2.1. Bacterial isolation

Twenty-one pooled and bulk samples of milk were collected from selling points of shops (1bulk milk sample from each of the 3 Kebeles), SHMEs (3 pooled milk sample from each of the 3 Kebeles) and smallholder farmers (3 pooled milk samples from each of the 3 Kebeles) and taken to investigation center by using a sterile sampling bottle of 50ml capacity. Immediately after the samples were taken from the delivery place, it was placed in the icebox and transported to Sebeta National animal health diagnosis investigation center (NAHDIC) for bacterial analysis.

The twenty-one pooled milk samples taken from milk shops, SHMEs and SHF were screened by Californian mastitis test (CMT) to identify prevalence of Subclinical Mastitis. The positive milk samples were analyzed for milk quality and isolation of milk born bacteria that cause mastitis. The pooled milk sample collected was examined for specific milk born pathogenic bacterial presence (like *E. coli* and S. *aureus*) in replicates following the standard techniques recommended by the International Organization for Standardization (ISO) via culturing on bacteriological media and testing using a series of biochemical tests(ISO,2001).

I. California Mastitis Test (CMT): The California Mastitis Test (CMT) was performed according to the manufacturer's instruction. In brief, a pooled small sample of milk was collected from each three kebeles of smallholderquarter into a plastic paddle that has 4 shallow cups marked A, B, C and D.An equal amount of CMT reagent was added to the paddle rotated to mix the contents and subclinical mastitis was determined. Approximately 10 seconds, the score was cows read while continuing to rotate the paddle; the results were recorded as T (trace), 1, 2 or 3 based on the level of precipitation (coagulation) (Mellenberger, 2000).

II. *Escherichia coli*: Identification of E. coli was carried out according to the protocol of ISO-16654: 2001 standard. The samples were collected under strict aseptic procedures and transported in ice box to Sebeta National Animal Health Diagnosis Center (NAHDIC), stored at +4 °C until processed. For isolation and identification, milk was cultured primarily on MacConkey agar and incubated aerobically at 37 °C for 24 hours. A single, isolated colony was picked and sub-cultured on Eosin Methylene Blue (EMB) agar for formation of metallic sheen.

III. Staphylococcus aureus: Initial culturing was made by streaking 50µl of each milk sample on Tryptic soy agar (TSA) with a 5% horse blood. Plates were incubated at 37^0C for 24 hours. *Staphylococcus* isolation and identification at the species level was conducted according to ISO-6888-3 using biochemical characteristics. Pathogens isolates was identified by MacConkey agar, hemolytic patterns, and growth on blood agar and Mannitol salt agar and biochemical tests (Kumar *et al*., 2011). Finally, identification of *S. aureus* was conducted using Gram staining. Yellow colonies formation with yellow zones after 24 hours of incubation at 37^0C on Mannitol Salt Agar and clotted when mixed with 0.5 ml of horse plasma and incubated at 37^0C for 24 hours.

3.3.2.2. Analysis of Milk Chemical Composition and Density

Twenty-one bulk and pooled samples of milk were collected from selling point of shops (1-bulk milk samples from each 3 Kebele's); smallholder micro-enterprises (3 pool milk samples from each 3 Kebeles) and smallholder farmers (3 pool milk samples from each 3 Kebeles) were taken into investigation center by using a sterile bottle of 50ml capacity each sample. The samples were immediately, taken from the delivery place, put in to the icebox and transported to Sebeta agro-industry (Mama Milk) plc. for analysis of chemical and physical properties. Chemical properties of milk samples analyzed include percent fat content, solid, protein, solid nonfat (SNF), lactose and added water to milk and specific gravity (density) and freezing points of milk were determined with calibrated milk analyzer of lactoscan machine.

3.4. Method of data analysis

Data collected from study area was entered into excel spread sheet and analyzed by using statistical package for the social science (SPSS, 2011, version20). Descriptive statistics such as mean, percentage and standard error were used to present the result. The mean comparison was done using the Least Significant Different (LSD).Data from laboratory analysis was analyzed using Generalized Linear Model (GLM) of SPSS. The bacterial prevalence in a milk sample was reported by percent, whereas the chemical and physical compositions were reported as mean ± standard error of milk. Means were declared significantly different at ($P<0.05$) level and were separated by using least square significant difference.

4. RESULTS AND DISCUSSION

4.1. Demographic Characteristics of the Respondents

The information on socio-economic demographic characteristics of the respondents in the study areas are summarize in Table (3). Male respondents were dominant at both smallholder farmers and micro-enterprises (71.25%).Accordingly, male respondents run the majority of dairy production in Sebetatown, which might be due to socio-cultural attitude of societies of the study area and the difference in gender over share of power on properties and communications.
These result is similar with Haile (2015) who reported that the overall mean male and female households were 97% and 3% respectively in AdeaBerga in West Shewa Zone and Wondatir (2010) who reported 86.7% of respondents were male dairy farmers in the Highland (DebreBirhan, Sebeta and Jimma) system. In Ethiopia, male are the household leaders who participate in most of the trainings and meeting including response to existing questions.

The marital status of dairy producers indicated that (86.1%) smallholder farmers and (56.9%) smallholder micro enterprises were married in Table (3). The study result is an indicated that dairy production might have positive effect on households' livelihood; because of milk related work is generating enough income for the family besides the home consumption. Furthermore, dairy has created a job opportunity for smallholders micro-enterprises dominated by the youth population.

The mean age group (37.3%) of smallholder microenterprises dairy producers were having between 26-33 years indicates thatthe dairy producers are at the productive age and provided employment to the youth. Similarly, majority of the smallholder dairy producers were at age group of 50 and above (44.4%), which could be due to the fact that dairy required a higher investment and it can take longer time to accumulate wealth before being engaged in dairy business. Present result is similar with Aleganesh*et al.* (2019) who reported productive age group was dominants for dairy production in central highlands of Jimma.
Education is entry point for enabling of community and tool for sustainably improves dairy production through knowledge, attitude and skill. From both smallholders, the majority of the

respondents have passed through secondary school about (60%) and diplomas level counts about (23.85%). This finding indicated more numbers of respondentswereeducated and that contributed for the development of dairy production. Education makes easy adoption of new technologies, production of quality milk and food safety practices would be possible.

Table 3. Characteristics of respondents in study area

Parameter	Respondents		
	SHF (N=36)	SHMEs (N=51)	Overall
Sex			
Male	28(77.8)	33(64.7)	61(71.25)
Female	8(22.2)	18 (35.3)	26(28.75)
Marital status			
single	2 (5.6)	17 (33.5)	19(19.55)
married	31(86.1)	29 (56.9)	60(71.5)
divorce	2(5.6)	4(7.8)	6(6.7)
widower	1(2.8)	1(2.0)	2(2.4)
Age			
18-25	2(5.6)	8(15 .7)	10(10.65)
26-33	2(5.6)	19 (37.3)	21(21.45)
34-41	7(19.4)	18 (35.3)	25(27.35)
42-49	9(25.0)	6(11.8)	25(18.4)
>50	16(44.4)	- -	16(22.2)
Educational status			
Illiterate	7(19.4)	5(9.8)	12(14.6)
Primary school	5(13.9)	13(25.5)	18(19.7)
Seconder school	11(30.6)	15(29.4)	26 (60)
Diploma holder	8(22.2)	13(25.5)	21(23.85)
Degree and above	5(13.9)	5(9.8)	10(11.85

4.2. DairyCattle Production System

In the study area, based on own observation and interview results of respondents, two main dairy cattle production systems were identified; namely peri-urban and urban. This classification was based on types of dairy breeds owned; land holdings; main objectives of milk production and management system (types of feed source like concentrate feeding, watering, housing, calf raring etc.) reference??. The respondents indicated that both production systems predominantly owned pure breed (91.7%) by smallholder farmers and (94.1%) by smallholder micro-enterprises), mainly from Holstein Friesian, whereas (8.3% and 5.9%) smallholder farmers and smallholder micro-enterprises respectively raised crossbreed cows for milk production, while indigenous cattle were not reported in study areas. About (58.8%) of smallholder micro-enterprises had 1-5 dairy cows for milk production, whereas (38.9%) of smallholder farmers had 6-10 dairy cows. (13.9%) smallholder farmers had above 20 dairy cows, while smallholder micro-enterprises didn't own above 20 dairy cows. The present study is more or less similar with Ayza*et al.* (2013) who reported two major dairy cattle production systems: peri-urban and urban dairy production system in Boditti town and reports at national level by Tegegne*et al.* (2013).

The smallholder farmers were either peri-urban or urban dairy production system, whereas the smallholder micro-enterprises dairy producers can be categorized under the urban dairy production system. Some of farmers had only purebred and didn't have enough land for keeping their breeds (they produce under rental shade) so that most milk harvested was for sale to increases their daily income. Whereas some of the respondents in smallholder farmers categorized under peri-urban production system; they had their own land, used well water, major feed resource was purchased hay, crop residue and agro-industrial byproducts like wheat bran (*frushka*).

This result is in line of Gebrewold*et al*. (2000) who reported three major production systems identified: traditional smallholder, privatized state and urban and per- urban farms; based on fluid milk market orientation, scale and production intensity. Mekasha (1999) reported seven different categories with more homogeneity within each category as follows: Traditional crop, intensified dairy, Crop/livestock farms with intensive cropping, specialized dairy farms, Peri-urban farms in secondary towns, Intra-urban dairy farms in Addis Ababa and Urban dairy in secondary towns. This means different approaches can be used to classify dairy production system depending on the factors considered and target objective of the researcher.

In this study, peri-urban production system was comprised of majority of smallholder farmers. (over 80%) of milk is produced, mainly for marketing, whereas (13.9%) consumption and (2.8%) processing at smallholder farmers. This difference shows that the main objectives of milk production of smallholder farmers were not only for sale, but also used for house consumption and small amount is processed to yoghurt and cheeses. It was found that pure exotic breeds mainly form (86.1%) Holstein Friesian dairy cows are dominating with (13.9%) Jersey in Table (4) implying they are mainly targeting towards a commercial dairy production but limited with small number of cows. The main feed resources are agro-industrial by-products, purchased roughage and in addition, they use crop residue and pasture land. This result is similar with Anteneh*et al*. (2010) who reported the main feed resources are agro-industrial by-products and crop residue.

In this study, urban dairy production system was comprised of the majority of both smallholder farmers and smallholder micro-enterprises production system. Both dairy producers located mainly in Sebeta town. The urban dairy production system of the study area, as well as most urban dairying of Ethiopia is characterized by fresh fluid market orientation as well as dairy cattle are kept only for sale of fresh milk and sale male calf born. This result was similar with Tegegne*et al*. (2013) who reported urban dairy production system characterized by fresh fluid market orientation central highlands of Ethiopia.

The urban dairy productions system identified in study area were characterized by dominance of purebred which are restricted in closed housing and managed by zero grazing, fed from purchased hay.The major feed resources: include industrial by products like brewery, purchased hay and agro-industrial by products indicated in Table (4). Both smallholder farmers (83.3%) and smallholder micro-enterprises (88.2%) produce milk for the purpose of market as a means of additional cash income and about (11.8% and 13.9%)smallholder micro-enterprises respectively and smallholder farmers respectively used for house consumption. The present study is result similar with Tegegne*et al*.(2013) who reported the urban production system is mainly based on improved dairy cattle genotypes (crossbreds or high-grade) for fluid milk marketing in of Hawassa, Shashemene, Yirgalem and Dilla city/town.

The smallholder micro-enterprises milk producers had the characteristics of urban dairy production system.They all existed in the town; the majority of them had almost purebred, their main objective was sale of fresh fluid milk, they produce under government shade (don't have their own land), major feed resource of their dairy animals were brewery grain, purchased hay and all mixes (*mitten*) like mixes of oilseed cake, wheat bran, corn flour, bone meal, meat meal purchased from nearby shops or industry and supervised by government professional expertise.

Table 4. Number and breeds of dairy cows owned, and purpose of milk production

	Respondents	
Variable	SHF(N=36) N (%)	SHMEs(N= 51) N (%)
Number of dairy cows holder		
2- 5 cows	8(22.2)	30(58.8)
6-10 cows	14(38.9)	15(29.4)
11-15 cows	7(19.4)	5(9.8)
16-20 cows	2(5.6)	1(2.0)
≥ 20 cows	5(13.9)	- -
Purpose of milk production		
For consumption	5(13.9)	6(11.8)
For market	30(83.3)	45(88.2)
For processing	1(2.8)	_ _
Types of dairy breed		
Pure breed	33(91.7)	48(94.1)
Crossbreed	3(8.3)	3(5.9)
Types of Exotic dairy breed		
Holstein breed	5(13.9)	4(7.8)
Jersey breed		

N-Number of respondents, SHF- Smallholder Farmers, SHMEs-smallholder microenterprises

As indicated in Table (5), (75.0% and 31.4%) smallholder farmers and smallholder micro-enterprisesrespectively, were involved in dairy production mainly for income generation, whereas (64.7%) smallholder micro-enterprises were undertaking dairy production activities for job creation to youth while (22.2%) smallholders farmers participated in dairy production for milk consumption at home. About (100%) of both smallholder dairy producers used hand milking methodwith frequency of milking twice per day (early morning and late evening at 12 hours interval), while milking by machine was not a common practice(Table 5). This finding is similar with the milking frequency of practiced in many parts of the country by Sintayehu*et al*. (2008) who reported 96.3% of households milked their cows twice per day in Shashemene-Dilla areas. On the other hand,Tegegne*etal* (2013) reported that hand milking is the sole milking method and milking frequency was twice per day across all the production systems in Ethiopia. The difference between the various studies could be attributed time of study and range of data collected by the researchers.

Table 5. Reason of dairy production, Frequency of milking and milking method

	Respondents	
Parameters	SHF (N=36)N(%)	SHMEs (N=51)N (%)
Reasons for engagement in dairy production		
income generation	27(75.0)	16(31.4)
Job creation	1(2.8)	33(64.7)
Consumption	8(22.2)	2(3.9)
Method of milking		
Hand milking	36(100.0)	51(100.0)
Frequency of milking per days		
Twice	36(100.0)	51 (100.0)

N- Number of respondents, SHF- Smallholder Farmers, SHMEs-smallholder microenterprises

4.2.1. Housing systems and Uses of manure

Housing of dairy cattle is important for protection of the animals from adverse climatic conditions and to confine or control the animals. Most of respondents in study area used separate sheds and concrete floor for dairy cattle production. About (80.6% and 90.2%)

smallholder farmers and smallholder micro-enterprises respectively, used closed wall and concrete floor shade for dairy cattle production, whereas (19.4%) of smallholder farmers used both concrete floor and open muddy floor. The smallholder farmers used the manure of animals for garden vegetable and for other crops planted and/or cultivated. This study was more or less in agreement with Fekadeand Mekasha (2012) who reported 100% and 86.5% small and medium urban respondents keep their dairy animals within closed and attached housing type in Adama milk shade.

In study areas, about (81.2%) dairy farmers used manure for energy by drying in the sun and also as sources of income generation by selling to other costumers for making injera (local bread). Whereas (27.8%) and (9.8%) of smallholder farmers and smallholder micro-enterprises respectively, used dairy manure as fertilizer for growth of vegetable and other crops. However, the use of manure for biogas production was not common from both smallholder farmers in study area. Similar result was reported by Bekele *et al.* (2015) and Asrat*et al.* (2016) who reported in and around Wolaita Sodo Town, Southern Ethiopia.

Table 6. Types of house and use of manure in study area

	Respondents		
	SHF (N=36)	SHMEs (N=51)	Total
Variable	N (%)	N (%)	N (%)
Types of dairy house			
Closed concrete floor	29(80.6)	46(90.2)	75(85.4)
Open muddy floor	- -	2(2.9)	2(1.45)
Both	7(19.4)	3(3.9)	10(11.65)
Use of manure			
For fertilizer	10(27.8)	5(9.8)	15(18.8)
Source of energy by drying	26(72.2)	46(90.2)	72 (81.2)
As biogas	- -	- -	- -

N= number of respondent, HF-Holder Farmers, SHMEs-Smallholder Microenterprises

4.2.2. Water resources used for Dairy production

The main sources of water in the present study area were tape water and well water. Majority of both smallholder respondents (88%) used tape water as source of water for dairy cattle in Table (7). About (11%) of both smallholders used water from well for their dairy cattle production. The practice of using tape water is important for the farmers to produce hygienic milk through proper cleaning of the environment, the cows, and washing the milking equipment. Respondents indicated that frequency of watering their animals by most of smallholders was three times in a day and all time after feeding. Present study result is similar with Shimeles (2016) who reported (98.9%) the main source of water is tape water in Addis Ababa (Bole sub-city, Nifas silk and Akaki).

Generally, use of clean water has played a great role in quality fresh milk production, whereas milk contents about (87%) is water (FAO, 2017). Uses of quality water is minimizing milk contamination during milk operation by wash person, milk equipment, cows' udder and teats, and milking environments.

Table 7. The main water source used for dairy production in study area

Respondents		
Variable	SHF(N=36)	SHMEs (N=51)
	N (%)	N (%)
Source of water		
Well water	4(11.1)	6(11.8)
Tape water	32(88.9)	45(88.2)

N= number of respondent, HF-Holder Farmers, SHMEs-Smallholder Microenterprises

4.2.3. Feed Resources for dairy cattle production in study areas

Animal feeds are the major input for any animals' production activities. The major feed sources for dairy cattle in the study area include roughage feed (hay grasses and crop residue) and concentrate feed (brewery grain and agro-industrial byproducts) indicated in Table (8). Majority of both smallholder respondents used concentrate feeds (71%), whereas (29%) both smallholders used roughage feed as basic input for milk production. This indicated that concentrate feeds are the well-known input feeds for milk production. Types of roughage feeds used as additional feeds for` milk production were mostly purchased hay grasses as per the response from (77.8%) smallholder farmers and (96.1%) smallholder micro-enterprises. Whereas (22.2%) smallholder farmers feed crop residue as additional feeds while crop residue feed was not reported from smallholder micro-enterprises Table (8).This variation could be due to the fact that some smallholder farmers having their own land for pasture cultivation. The other major feed sources for dairy cattle production were industrial byproducts (Meta brewery grain) as well as some agro-industrial by products (corn flour, wheat barn and oil seed cake) at both categories of the respondents. In study areas, the use of industrial byproducts from Meta brewery grain is very common due to availability of Meta berry byproducts in the area and its suitability for milk production. This result was in line with Galmessa *et al.* (2013) who reported in Jimma area, natural pasture has little importance as the system is almost zero grazing (peri-urban production) and Ayza*et al*.(2013) reported 86.8% of dairy producers in the urban production system use purchased feed Boditi.

As shown in Table (8), significant number of smallholder farmers and smallholder micro-enterprises used wheat bran and all mixes respectively, as major feeds for milk production. Moreover, smallholder micro-enterprises mostly use all mixes (wheat barn, corn flour, meat meal, bone meal, oil seed cake like nugi, cottonseed) as major feeds of dairy production due to their better awareness. This study is similar with Shimele (2016) who reported 71.1% of respondents used concentrates/ supplementary feed (which was made from the mixture nug/beer by product, animals meat/ bone by products, wheat bran, wheat mailing, minerals and vitamins), molasses and roughages such as straw or alfalfa in Addis Ababa.

In the study area, amounts of concentrate feeds provided for dairy cow per day was based on milk production potential, stage of lactation and breed types. About (66.7% and (35.3%)) smallholder farmers and smallholder micro- enterprises respectively provided concentrate feed for their animals 7 kg-9kg DM per cow per day, whereas (58.8%) smallholder micro-enterprises and (33.3%) smallholder dairy farmers provided 10kg -12kg DM per cow per day.

Generally, concentrate feed is significantly vital for milk production and provided by calculation by its cost effectiveness, while feeding roughage was (adlibtum) without considering the quality and quantity. This finding is similar with Ayalew and Abateneh, (2018) who reported urban dairy production system common feed practiced in Dessie town and Mohammed *et al.* (2004) reported the urban and peri-urban milk production system feeding industrial byproducts and agro-industrial byproduct (like corn flour) in the central highland of Ethiopia.

Table 8. Types of feed resources and feeding practice in stud area

Respondents			
	Small HF (N=36)	Small HMEs (N=51)	overall
Source of feeds	N (%)	N (%)	N (%)
Types of feedstuff available for milk production			
Concentrate	25(69.5)	37(72.5)	62(71)
Roughage	11(30.5)	14(27.5)	25(29)
Kind of roughage feeds			
Hay grasses	8(77.8)	49(96.1)	57(86.95)
Crop residue	8(22.2)	- -	8(11.1)
Pasture	--	2(3.9)	2(1.95)
Types of Concentrate feeds			
Brewery (beer byproduct)	26(72.2)	32(62.7)	58(67.45)
Agro-industrial byproducts	10(27.8)	19(37.3)	29(32.55)
Types of Agro-industrial byproducts			
Oil-seed cake	4(11.1)	3(5.9)	7(8.5)
Wheat bran	20(55.6)	9(17.6)	29(36.6)
Flour mill by product	7(19.4)	3(5.9)	10(12.65)
All mixes	5(13.9)	36(70.6)	41(42.25)
Concentra feeds provide for a dairy cow per day			
7kg-9kg	24(66.7)	18(35.3)	42(51)
10kg-12kg	12(33.3)	30(58.8)	42(46.05)
>12kg	- -	3(5.9)	3 (2.95)
Roughage feeds provide for dairy cow per day			
adlibtum	36(100.0)	47(92.2)	83(96.1)
Measured quantity	--	4(7.8)	4(3.9)

N= number of respondent, HF-Holder Farmers, SHMEs-Smallholder Microenterprises

4.2.4. Breeding practices and reproductive performance

Both artificial insemination (AI) and natural services were used to breedingthe dairy cows(Table 9). The frequency of using the two breeding systems varies and most dairy farmers use AI service than natural. About(84.3%) smallholder micro-enterprises and (77.8%) smallholder farmers'producers use AI mating and about (11%) use both natural mating and AI services, whereas (11.1% and 3.9%) smallholder farmers and smallholder microenterprises respectively use natural mating respectively. The result shows that both smallholder dairy producers were not satisfied by the natural service only. Therefore, both smallholder dairy producers in sebeta area had better awareness on technology of uses of AI service. Use of AI is advantageous to improve productivity of their cattle and reduce cost of raising bull. AI also is an important reproductive technology used to reduce the frequency of sexually communicable diseases among cattle, intensifications of the genetically superior sires to improve performance of the milk production. On the other hand, Galmessa *et al.* (2013) who reported 100% of the dairy farmers using natural bulls' service in Ambo and Gimbi. Asrat*et al*. (2015) reported 90% of the respondent in Humbo district of Wolloita zone used local bulls (natural mating) and 10% used AI service for breeding of dairy cows.The Variation among the reports can be attributed to access, level of training and willingness of the farmers.

The majority of respondents in the study area, smallholder farmers (88.9%) and smallholder micro enterprises (84.3%) were able to identify when cows are coming to heat based on behavioral change, loss of appetite, discharge of mucous and mounting other and mounted by other. The farmers who used natural mating has acquired from rental bull Table (9). The source of semen used for AI service in the study area was obtained from governmental extension services. In this dairy production system, male calves were mostly sold for veal. This result is higher than Fekade and Mekasha (2012) who reported 75% of the total farms depended only on AI and 71.5% of farms used rental bull to mate their dairy cows while 28.8% of farms used home born bull in Adama milk shade.

Proper breeding practices are desired for success of reproduction of lactation length. The survey result in Sebeta town indicated that cows from exotic breed provided milk for 10 months and one year indicated in Table (9). Among the respondents (62.7%) of smallholder micro-enterprises and (44.4%) of smallholder farmers indicated that the lactation length of their cows from exotic breed lasted for 10-months, whereas (55.6%) smallholder farmers and (37.3%) smallholder micro-enterprises reported a 1-year lactation length for their cows.

Lactation lengths of dairy cows from smallholder farmers were greater than smallholder micro-enterprises. The reason for variation among dairy producers in study area might be due to smallholder farmers having more knowledge/experience to handle their cows than smallholder micro-enterprises. The lactation lengths of cows are mostly, based on the management of the dairy farmers. Generally, lactation length is the period from when a cow starts to secrete milk after parturition to the time of drying off. This study is agreement with Assaminew and Eyasu (2009) who reported accepted level of 305 days (10.1 month) of lactation length for exotic bred in BahridarZuria and Abera (2016) who found lactation length of crossbred cows to be 9.3 and 10.5 month for exotic cows in urban west showa zone. O.Syrstand (1993) reported that a standard lactation length of 305 days compared to tropical and temperate dairy production at Norway research of agriculture investigation center (NORAGRIC).

Table 9. Breeding practice of dairy cows and source of semen in study area

	Respondents	
Variable	SHF (N=36) N (%)	SHMEs(N=51) N (%)
Methods of mating system cows		
AI only	28(77.8)	43(84.3)
Natural mating only	4(11.1)	2(3.9)
Both	4(11.1)	6(11.8)
Identifies cow's coming to heat		
Farmers	32(88.9)	43(84.3)
AI inseminator technician	1(2.8)	8(15.7)
Natural bull	3(8.3)	- -
Source of bull for natural mating		
Own growth	7(19.4)	3(5.9)
Rental	29(80.6)	46(90.2)
Extension service(DA)	- -	2(3.9)
Source of semen for Artificial insemination		
Government extension	36(100.0)	48(94.1)
Private	- -	3(5.9)
Lactation length cow		
10-moths	16(44.4)	32(62.7)
1- Years	20(55.6)	19(37.3)

N- Number of respondents, SHF- Smallholder Farmers, SHMEs-smallholder microenterprises

4.2.5. Calf management system and colostrum feeding

Respondents from both smallholder dairy producers at study area explained that as soon as calf born, it was separated from dam and put in separated room on the teff straw to maintain its body temperature, clean its body by towels and feeding colostrum within 30 minute. The amounts of colostrum fed to their calves were based on body conformation of newborn (weight) and not less than three liters at one time in the morning only. Both smallholder farmers and smallholder microenterprises didn't allow suckling for calve before and after milking. Both smallholder dairy cattle producers practiced calf feeding by hand starting from the first day to five days drenched colostrum by bottle. After five days, calves practiced freely in bucket feeding Table (10). About (72.25%) of both smallholder dairy producer practiced feeding colostrum calves born for five days, whereas about (24.8%) of both smallholders were feeding colostrum to newborn calves for seven days. This study indicated that the dairy farmers in the study area have prioritized for fluid milk marketing than feeding a calf.

Almost all (100%) both smallholders in study area practiced managing newborn bull (male) calve in a planned manner. They sale male calve for veal prior to weaning because rearing of male calves is not cost-effective. About (3.8%) respondents kept male calves for breeding purpose (natural mating). The decision for maintaining male calve for breeding purpose depends availability of enough land (shade) and future plan to use as source of income by renting the bull for natural mating. About (70.71%) both smallholder dairy producers in study area, started supplementary feed to calves after seven days of birth, whereas (46.39%) started supplementary feed to calves after five days of birth. This result shows that, urban producers follow early weaning practices with the intention of profit maximizations from sale of milk. This result is similar with Sintayehu et al., (2008) who reported Colostrum feeding for early weaning calves in the urban system lasted for 4 to 7 day in shashemane and Addis Ababa.

Generally, colostrum feeding is the important management issue in determining calf health and survival. All calves must receive sufficient colostrum immediately after birth to support their growth and improve their welfare.

Table 10. Calves colostrum feeding and management methods

	Respondents		
	SHF(N=36)	SHMEs(N=51)	Overall
Variable	N (%)	N (%)	N (%)
Colostrum feeding methods			
In bucket	36(100.0)	51(100.0)	87(100.0)
Suckling dam	- -	- -	- -
Days of Colostrum feeding			
Three days	- -	3(5.9)	3(5.9)
5days	28(77.8)	34(66.7)	31(72.25)
7days	8(22.2)	4(27.4)	22(24.8)
Fate of male calve born			
Sold as veal	34(94.4)	50(98.0)	84(96.2)
Growth for natural mating	2(5.6)	1(2.0)	3(3.8)
5days of birth	4(11.1)	18(35.29)	22(46.39)
7days of birth	30(83.3)	30(58.12)	60(70.71)
10 days of birth	2(5.5)	3(5.89)	5(11.49)

N-number of respondents, SHF –smallholder Farmers, SHMEs –smallholder microenterprises

4.3. Milk production potential of dairy cows

4.3.1. Milk yield potential of cows at study area

As shown in Table (11), about (50%) smallholders farmers and (27.5%) of smallholder micro-enterprises were collected milk about 6-9 liters of milk per day per cow. About (41.2%) smallholder micro-enterprises and (38.9%) smallholder farmers were averagely, collected milk 11.5 liters per day per crossbred in the range of 10-13 liters of milk in Sebeta. whereas the well managed and pure exotic cows can yield 17.5 liters per day per cow at the same study area in the range of 18 and above at both smallholders. This variation is due to handling method and uses of superior milk production potential bred. The study area had relatively better access to basic input likes concentrate feeds, AI, veterinary service and handling methods. This study is similar with Saba (2015) who reported 11 litter/ cows per days and

Alemu (2019) with 11.6 and 10.8 liters per day per cow in Bishoftu and Akaki towns respectively, in peri-urban and urban dairy production systems. In general, the amount of milk collected per day by smallholder micro-enterprises were better than smallholder farmers which could be due to better managements like housing, feeding, uses of purebred and handling system. This result is agreement with Tegegne*et al.* (2013) who report daily milk yield of well-managed crossbred dairy cows in urban dairy production ranged from 10.21 to 15.9 liters/cow per day, in towns of Hawassa, and Shashemene.

Table 11. Amounts of milk produced per day as perceived by respondents of the study area

Variable	Respondents	
	SHF (N=36)	SHMES (N=51)
	N (%)	N (%)
Milk in liters per day		
2-5 liters	1 (2.8)	2-5 liters
6-9 liters	18 (50)	14(27.5)
10-13 liters	14(38.9)	21(41.2)
14-17 liters	2(5.6)	5(9.8)
18 and above liters	1(2.8)	3(5.9)

N- Number of respondents, SHF- Smallholder Farmers, SHMEs-smallholder microenterprises

4.3.2. Seasonal distribution of milk yield in study area

According to the current study result, the highest milk productions were reported by both respondents between August and December indicated in Figure (3). The respondent dairy farmers indicated that milk productions were dependent on availability of green pasture of grasses and the season of the month in a year. The most of favorable temperature for peak milk production is mid-summer due to abundance of grasses which is commonly the farmers are feeding their animals in zero grazing. Majority of the smallholder farmers (70.6%) and smallholder micro-enterprises (72.2%), the both smallholder getting the highest amounts of milk recorded in between August and December, while the lowest milk yield was recorded in between January and July, because both smallholders' producers are preserving the grasses as hay. So that would be indicated that shortage of free accesses of grasses for the animals. Even if there were availability of purchased concentrate from agro-industrial by products with high cost in study areas, yet season had greater influence in relation to forage availability. This result is in agreements with Ayalew (2017) who reported that breed and season affect milk yield in south wollo zone, Ahmara Region.

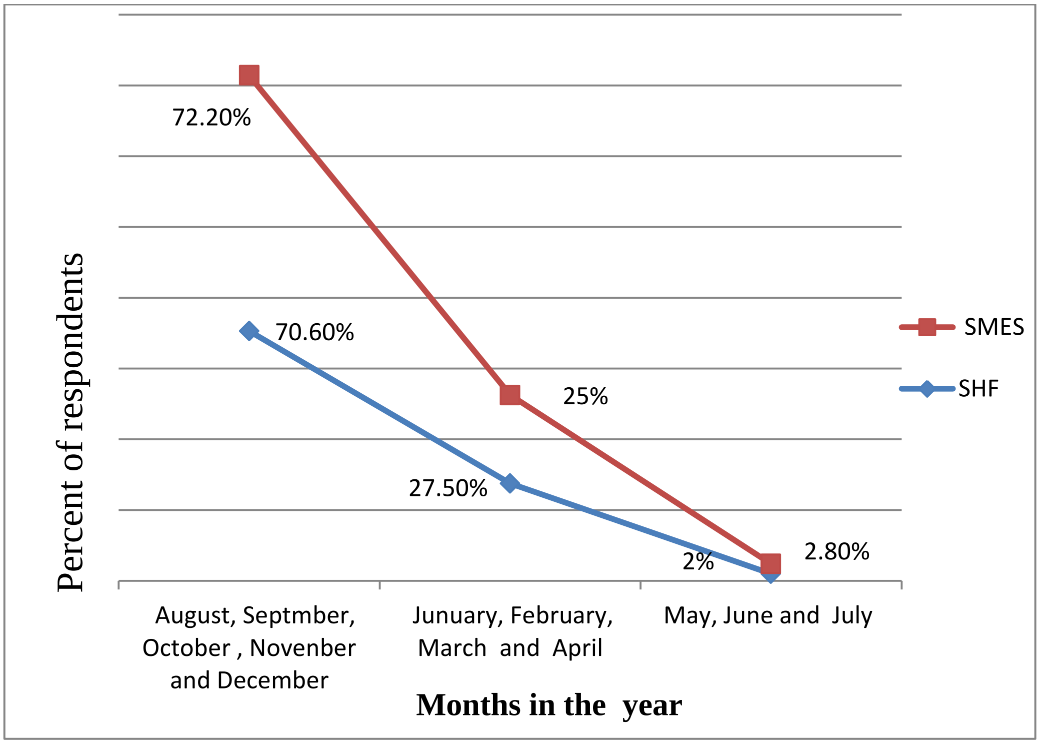


Figure3: Milk produced in different months of the year in study area

4.4. Constraints of Dairy Production in Study Area

Dairy productions in the studied areas were constrained by different problems: mostly, by technical constraint including low feed availability, high feed cost, disease, shortage of land and dairy breed (access of improved gene) in Table (12). Almost all respondent smallholder farmers and smallholder micro-enterprises specified that the most influential constraints of dairy cattle production in study area were technical constraints. About (70.95% and 12.25%) of this constraints was due to low feed availability and high feed cost respectively. The present finding is similar with Galmessa and Fita (2018) who reported the primary constraints to increased milk production under all dairy production systems are inadequate feed resources and the ever-increasing feed prices.

The other technical constraints to dairy production in study area were diseases, shortage of land and low access of improved breeds were some that hold back dairy production in the study area. The shortage of land was more pronounced at smallholder microenterprises than smallholder farmers. This result is similar with Dugumaet *al.* (2011) who reported urban dairy in Jimma town and Fekade (2012) who reported feed shortage as the first most important problem responsible for low milk yield and low productivity of dairy cows in urban and peri urban production systems in Adama milk shed. Poorly feed animals develop low disease resistance, low production and cause infertility. Therefore, monitoring dairy herd health and production are important measures to improve the productivity of the dairy animals

Table 12. Constraints of dairy production in the study area

Parameters	Respondents		
	SHF(N=36) N (%)	SHMEs (N=51) N (%)	Overall N (%)
Types of constraints			
Technical	34(94.4)	44(86.3)	78(90.35)
Non-technical	2(5.6)	7(13.7)	9(9.65)
The main technical constraint			
Low feed availability	25(69.4)	37(72.5)	62(70.95)
High feed cost	6(16.7)	4(7.8)	10(12.25)
Disease	2(5.6)	4(7.8)	6(6.7)
Shortage of land	1(2.8)	7(13.7)	8(8.25)
Dairy breed	2(5.6)	1(2.0)	3(3.8)

N= number of respondent, HF-Holder Farmers, SHMEs-Smallholder Microenterprises

4.5. Evaluation of Milk Quality and Milk handling system

4.5.1. Milk handling and hygienic practices

About (72.5%) smallholder micro-enterprises and (38%) smallholder farmers underscored that they knew how to detect milk quality characteristics by using their organoleptic characteristics like odor or smell of fresh milk, changes in thickness as well as abnormal smell and taste might be due to adulterated. The respondents feel that abnormalities can be caused by environment defect like addition of water/flour, removing of fat/cream, barn /cow, feed dust and physiological taints such as hormonal imbalance in genotypes and stage of lactation. Majority of the respondents reflected the common sources of milk contamination in study areas were due to addition of flour to milk; whereas significant number of farmers suggested addition of water to milk is another potential source of contamination or adulteration indicated in Table (13). As discussed earlier, cows were hand milked and calves were not allowed to suckle dams prior to milking. The milking practice was mainly carried out after washing their hands before milking by almost all respondents (over 96.1%). This result is in agreements with report of Bekele (2015) who reported 100% of the respondents in Dangila town of western Amhara region wash their hands before milking. However, the experience of dipping teat in sanitizer after milking was almost not available due to low awareness at both smallholders. This result similar with Ayalew and Abatenhe (2018) who reported100% urban dairy producer cleans their hand and milking utensils before milking in Amara region and Eshetu*et al*.(2019) who reported 94.31% wash their hands before milking and no experience of dipping teats in sanitizer after milking in Eastern Hararghe.

As indicated in Table (13), both smallholders (over 52%) respondents in study areas used hot water for cleaning of their milking equipment, while (over 47.2%) of both respondents used cold water. The variation might be due the difference in training and experience between the smallholders in study area. Since the use of hot water is the recommended for cleaning of milking equipment and storage before milking to reduce /elimination bacterial propagation, about half of the farmers still need further training on equipment handling and sanitization as well as personal hygiene. The use of detergents for cleaning the milking equipment and storage was not common practice in study area. The present study result was higher than the result reported by Tegegne*et al.* (2013) in peri-urban and urban dairy production system in Shashemene – Dilla milk- sheds 23% of the producers' clean milk utensil by hot water.

In study area, (3.9% and 41.7%) smallholder micro-enterprises and smallholder farmers respectively responded that not washing the udder of cows before milking. This action is mainly due to lack of awareness that leads to production of poor quality milk. Generally, cleaning of the cows' udder before milking is one of the most important hygienic practices required to ensure clean milk production. This is important since the udder of milking cows could have direct contact with the ground muddy, urine, dung and feed waste. Most respondents, (97.2% and 82.4%) smallholder micro-enterprises and smallholder farmers respectively, did not dip teats after milking. This is might be cause infection of teats by milk born pathogen like mastitis, *E. coliand S. aureus*. So that dipping teats after milking is the fundamental important points to produce high quality milk and protection of udder of cows from pathogen.

Generally, the practice of properly cleaning of milk equipment as well as maintenance of equipment is preventing spoilage of milk and milk product by spoilage microbes. However, awareness creation and quality control mechanism should be installing to prevent the practice of adulteration to safeguard public health of the consumers. Food-safety hazards include biological, chemical as well as physical agent in a food that have a potential to cause an adverse health effect on the consumer (WHO, 2003). Adulteration of milk is addition of any material to the milk, or removal of any component of milk as well as contamination of milk by microorganism. Milkquality characteristics is milk that free from any chemical taint and bacterial defects (FAO, 2017).

Table 13: Experience of dairy farmers on milk quality and handling system

Parameters	Respondents	
	SHF (N=36)	SHMEs (N= 51)
Milk Quality detection	N(%)	N(%)
Odor/smelling	14(38.9)	37(72.5)
Color	22(61.1)	30(58.8)
Source of milk adulteration		
Addition of water	14(38.9)	21(41.2)
Addition of flour	22(61.1	30(58.8)
Experience of washing equipment before milking		
Yes	36(100)	51(100)
No	--	--
Type of Water used for wash equipment's before milking		
Cold	17(47.2)	24(47.1)
Hot	19(52.8)	27 (52.9)
Experience of washing udder before milking		
Yes	21(58.3)	49(96.1)
No	15(41.7)	2(3.9)
Experience of Dipping teat in sanitizer after milking		
Yes	1(2.8)	9(17.6)
No	35(97.2)	42(82.4)

N- Numbers of respondents

As indicated Table (14), all respondents had the culture of cleaning dairy cows shade/house. Unhygienic shade/house is one of the sources of milk contamination, so that the producers should give attention for shade/ house hygiene. Although the frequency of cleaning their dairy house/shed was almost daily by majority of the respondents (80.6% and 84.3%) smallholder farmers and smallholder microenterprises respectively, cleaning their dairy animals shade/house three times in a week is not acceptable to assure the hygienic quality of milk and subsequent public health safety issues. The most limiting factor forquality milk productions is lack of awareness and lack of clean environment (over 31% and 43%) respectively reported from both smallholders. This results was better than Haile (2015) who reported 65% clean manure from dairy house daily in Ejerie west Shewa.

The main reason (over 84%) for milk adulteration in study area were for maximizing their daily income through addition of water to increase volume of milk and removing of fat from fresh milk. Therefore, the producer and consumer should pay attention on milk quality issue during marketing of fresh liquid milk at milk shops and on farms. On the other hand, milk contaminated areas can also be associated to cows and milking area/shade. Present study revealed factors like person, milk utensil, cows and milking shade were reported as the most serious sources of milk contamination. Therefore, smallholder dairy producers should pay special care for the type as well as sanitation of milk equipment indicated in Table (14). This result is similar with Bereda*et al.* (2014) who reported the milkers, udder of the cow, the milking environment and the milking equipment the chief sources of the initial milk contamination.

Table 14. Experience of dairy farmers on milk quality and handling systems

Parameters	Respondents	
	SHF (n=36)	SHMEs (N= 51)
Frequency of cleaning house per week		
Daily	29(80.6)	43(84.3)
Four times	6(16.7)	- -
Three times	1(2.8)	8 (15.7)
Constraints of clean milk production		
Lack of awareness	15(41.7)	16 (31.4)
Lack of clean water	3 (8.3)	13(25.5)
Lack of clean environment	8(50.0)	22 (43.1)
The main reason for milk adulteration		
For processing	- -	5 (9.8)
For preservation	- -	3(5.9)
For economic gain	36(100.0)	43(84.3)

N= number of respondents

4.5.2. Evaluation of Milk Sample for Microbial and Chemical Composition

4.5.2.1. Identification of Mastitis

From 21 pooled milk samples collected, (100.0%) of from the selling points of milk shops, (77.5%) smallholder micro-enterprises and (44.5%) smallholder farmers were positive for mastitis test with California Mastitis Test (CMT) indicated in Table (15).The result that positive for mastitis milk sample collected from selling points of shops was higher than that of milk sample collected from smallholder farmers and smallholder microenterprises. The variation between them might be due to the unhealthy cow, feed relating, possibility of contamination by adulterants along supply chain as well as low awareness of milk handling stem. The fact that all samples at selling point of milk shops being positive for mastitis could be associated with lack of hygienic, addition of powder material, milking equipment, milk storage, cows being not regular checked for mastitis. Such situations can cause ill effect on human health status specially, for milk consumer and newborns, cause food safety issue and not only in study areas but also along the milk supply chain. The positive result for mastitis in milk sample collected from smallholder micro-enterprises higher than that of smallholder farmers. The difference might be due to unhealthy cow, feed related and hygienic condition. The Present study is similar with (Yilma, 2010) who reported mastitis infections result in large numbers of bacteria in milk that caused by *S. aureus* which constitute a health hazard to consumer.

Generally, infection such as mastitis (inflammation of udder) observed in milk sample in the present study that changes the milk content such as reduction of fat and main protein (casein) content of milk and thus need training(awareness creation) for milk producers and sellers about milk handling, caustic agents for mastitis and control practice of adulteration.

Table 15. Prevalence of mastitis in study area

Collection centers	no. of sample Examined	Positive samples N (%)
Smallholder micro-enterprise	9	7(77.8)
Smallholder Farmers	9	4(44.5)
Milk of selling points of Shops	3	3(100.0)

N-numbers of positive sample

4.5.3. Identification of *Eschertial coli* and *Staphylococcus aureus* from milk samples

The result of E. coli and S. aureus isolated and identified from milk sample collected from smallholder farmers, smallholder microenterprises and selling points of shops are indicated in Table (16). From the current 21-pooled milk samples were examined, overall (27.78%) were found to be positive for E. coli. Milk samples collected from smallholder micro-enterprises was (44.44%) higher than that of milk sample collected from smallholder farmers (11.11%) and selling points of shops. However, E. coli was not found in milk sample collected from selling point of milk shops. Therefore, among the three milk collection centers, highest ($P < 0.05$) contamination of E. coli (44.44%) was observed at smallholder micro-enterprise. The variation might be due to unhygienic milking practices, contaminated feed, contamination from udder of animals through environment (uncleanliness milking areas, type of feeding and utensils).The current study result is similar with Fatine*et al*. (2012) who reported adulterated milk exercised during milking like unhygienic condition, cleanliness of milking utensils, condition of storage, as well as cleanliness of the udder of the individual animal. The laboratory result agrees with survey study interviewed the most of smallholder micro-enterprises were used industrials byproducts feed like meta juice(brewery grain) as main feed to produce milk, it might be the reason for high percent of prevalence of E. coli in milk sample collected from smallholder micro-enterprises.

Among 21- pooled milk samples examined, overall (18.52%) were positive for S. aureus. This indicates from the total sample, (11.11%, 11.11% and 33.33%) from smallholder micro-enterprises, smallholder farmers and selling point of shops respectively, positive for *S. aureus* and that is the potential for rejection at commercial processing units. The occurrence of milk born pathogenic in milk could be hazardous for consumers. This result is similar with Abunna*et* *al*. (2013); Mekuria*et al*. (2013) reported about 21.13% and 16.2% *S. aureus* prevalence, respectively in Addis Ababa milk shed and also Addis *et al*. (2011) who reported milk collected from farms (19.6%)*S. aureus*in Debrezeit.

The study has indicated relatively the similar contamination rate of *S. aureus* at smallholder farmers and smallholder micro-enterprises. In generally, the variation of bacterial load in raw milk might be due to many factors such as unhealthy animals and unhygienic condition like uncleanliness of milk sheds, types of feed, unclean condition of milkers and adulteration practice that cause food poising and affect gastrointestinal of consumers. However, during survey study all of smallholders practiced washing of dairy equipment with hot water before milking, while some of smallholder microenterprises used cold water for washing of udder before milking.

Generally, milk is an ideal environment for growth of microorganism like bacteria to reproduce, especially in warm conditions. Microorganisms may cause souring of the milk and hence rejection by the consumer or the milk sample collected for examination of prevalence of *S. aureus*.

Table 16: Prevalence S. aureus and E. coli from milk samples collected in the study area

Source of sample					
Bacterial Isolated	number of positive sample	Smallholder Farmers N (%)	Small micro-enterprise N (%)	Milk Shops N (%)	Overall N (%)
E. coli	7	4(44.44)	3(11.11)	- -	7(27.78)
S. aureus	3	1(11.11)	1(11.11)	1(33.33)	3(18.52)

No. p- Number of positive sample, SHF-Smallholder Farmers, SHMEs-Smallholder Micro-enterprises, N (%)-number in percent and S. – Staphylococcus.

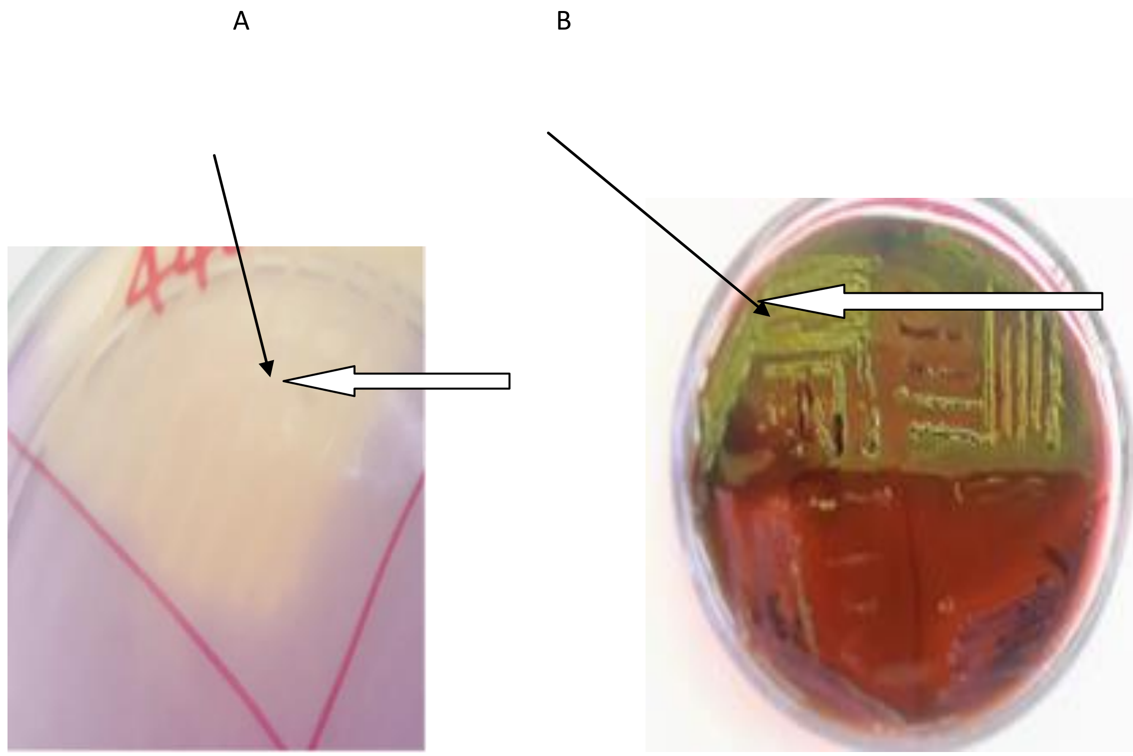


Figure 4: Image for S. aureus (a) and E. coli (b) incubated on media in the lab

A) Yellow colon shows prevalence ***S.**aureus* B) Metallic sheen colon milk shows prevalence **E.** coli.

4.5.2.3 Chemical composition of milk samples collected at study area

Avery important aspect of raw milk quality is its composition as well known that milk composition is influenced by many factors such as breed, age, parity, stage of lactation, feeding, health, milking technique and the milker (FAO, 2008). According to Ethiopian Standards authority Agency recommended composition of milk, ESA (Ref No ES 3460:2009) and the specification of all nutrients of milk by Abebe (2015) from Ethiopian Meat and Dairy Industry Development Institute.

All chemical compositions of milk have shown significantly different values among the collections sites as shown in Table (17) below. The fat contents of milk collected from smallholder micro-enterprises, smallholder farmers and selling points of shops were 2.81±0.13, 3.47±0.46 and 1.37±0.25 respectively and the differences were significant at ($P<0.05$).The overall mean value of milk fat (2.56%) in the current study areas were lower than that (3.50%) indicated in the Quality Standard Authority of Ethiopian (ES, 2009) reported by Eshetu*et al*. (2019) and Abebe (2015). In the current study, the mean fat contents of milk sample collected from smallholder farmers was higher than milk sample that collected from smallholder micro-enterprise and selling points of shop. The wide range of variation in fat percent content of milk might be due to possible adulteration of milk by fat removal and/or addition of water to increase milk volume and to gain additional income. This result strengths the response of farmers during survey study, which revealed that the main milk adulteration activities were practiced by removing fat from fresh milk. Especially, the lowest fat content from the milk sample collected from selling milk shops indicated double adulteration by addition of water and fat removed from fresh milk after arrival at shops.

The Food and Drug Administration (FDA) and Milk Ordinance and Code of USA recommended that acceptable milk fat contents require not less than 3.25% milk fat for fluid milk by (Eshetu*et al*., 2019). A study made by Alganesh*et al.* (2019) has shown that adulteration of milk and milk products increased along the value chain from producers to whole seller or consumption site.

The overall solid nonfat (SNF) of milk samples in the study areas was (7.96%). According to Food and Drug Administration (FDA) as well as European Union (EU) quality standards, a minimum solid not fat (SNF) content of completely fresh milk is (8.25%). Therefore, the mean SNF content of milk sample collected from smallholder micro-enterprises and smallholder farmers at acceptable level; while milk collected from selling points of shops had lower than recommended value. The difference in values among the source of sample collected might be due to adulteration activities like removing of fat that decrease SNF contents of milk.

Total solids are one of the parameter used for the quality of milk and the total addition of (fat and solid nonfat).Among the milk samples the total solids content of milk obtained from selling points of shops (7.97%)lower compared to that of milk samples obtained from the smallholder farmers (12.53%) and smallholder micro-enterprises (11.05%)respectively. The overall mean total solids content in the present study (10.51%) was lower than with Ayshim*et al*. (2015) who reported total solid (13.48 %) of crossbred dairy cows in Western Amhara Region. The overall mean total solid of milk samples in the study areas were (10.51%) and this value is lower to Ethiopian standards (ES, 2009) for total solid content of fresh cows' milk should not be less than (12.8%) by Haftu and Degnet and (2018) and European Union (EU) quality standards not less than (12.5%) by Raff (2011). In view of that, the total solid content obtained from the smallholder microenterprises milk producers and selling points of shops were below the quality standard due to adulteration practices.

The protein contents of milk samples collected from smallholder micro-enterprises, smallholder farmers and selling points of shops were (3.16±0.11, 3.47±0.32 and 2.62±0.63) respectively. The average protein content of milk as observed in the current study was (3.08%) and this value is close to Ethiopian standards (ES, 2009) for protein content of fresh cows' milk should not be less than (3.20%) except the lower values recorded from selling shops. According to ISO (2013), protein percent is not less than 3.5% of milk protein. Therefore, the average protein content observed from all sources of milk sampling was below this recommended standard. Milk sample collected from selling points of milk shops lower than smallholder micro-enterprises and smallholder farmers. This might be due to adulteration practiced after arrived shops, these activity cause frauds food quality issue. This finding is close to the acceptable level of protein percent when compared with FAO (2008) milk and milk product training manual. The present study similar with Alganesh (2016) who reported the overall mean protein in milk samples from Ejere,Walmera, Selale and DebreBirhan was 3.10 %.

The lactose percent contents of milk collected from smallholder micro-enterprises, smallholder farmers and selling points of shops were 4.35±0.13, 4.74±0.41 and 3.39±0.71)respectively (Table 17). This result is significant difference at ($p<0.05$). The overall lactose percentage of milk samples in the study areas were (4.16%). These finding is similar with EU and FDA who set that fresh whole milk lactose content should not be less than 4.2% (Tamine, 2009). However, the lactose content (3.39%) of milk sample collected from selling points of shops is lower than that smallholder micro-enterprises and smallholder farmers. These might be due to considerably affected by the extraneous addition of water and adulteration is practiced we progress from production to consumption areas of the milk supply chain.

The added water percent (not water content, only added water) contents of milk collected from smallholder micro-enterprises, smallholder farmers and selling points of shops were 5.43±2.61, 8.25±3.65 and 41.09±29.53, respectively. The conclusion from this result is more diluted milk by addition of water is significant. The overall mean added water percentage of milk sample in the study areas was (18.26±11.93) percentage. Accordingly, added water to milk sample collected from smallholder micro-enterprises and smallholder farmers were lower than of selling points of milk shops: these indicated addition of much water to milk significantly seen as far from production areas. Present result higher than Genzebu*et al*. (2016) who reported overall mean value of added water 2.80±3.6 in Bishoftu and Akaki towns of urban milk production.

Generally, addition of water to milk caused big problem where we have unfaithful farm workers, milk transporters and greedy milk sales persons. Many of urban residences and a few farmers also full sufferer of this illegal practice. This finding showed the reason of adding water to increase the quantity of milk to gain more income, this result makes sure the reason of adulteration observed during survey study in this study areas.

The solid percent (dried powder left after all the water is removed from liquid milk) contents of milk collected from smallholder micro-enterprises, smallholder farmers and selling points of shops were 0.66±0.016, 0.49±0.1, and 0.75±0.04 respectively, indicate in Table (17). The overall mean of solids content of the current study was (0.63%) lower. The variations of this study are might be due to lactation stage, fat removed and type of feed consumed. The solid of milk contents refers to all non-water components (whether fat or not) of including fat, proteins, vitamins, lactose and minerals. However, in these work the only solid part was examine to identify solid parts of milk was either removed or added. In generally, the difference in milk composition was described in this research among different milk collection centers with in Sebeta town, might be due to many factors including stage of lactation, type of feed, fat removed, addition of powder and water

Table 16. Mean value ± SE for chemical composition and sample collected

Respondents					
Nutrient	SMEs (N=9)	SHF (N=9)	milk Shop (N=3)	over all mean	
Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE		p-value
Fat	2.81±0.13^{b}	3.48±0.46^{a}	1.37±0.25^{b}	2.56±0.28	0.015
SNF	8.24±0.26^{b}	9.05±0.78^{a}	6.6±1.44^{b}	7.96±0.83	0.17
Total solid	11.05±0.39	12.53±1.24	7.97±1.69	10.51±1.10	0.07
Protein	3.16±0.11^{b}	3.47±0.32^{a}	2.62±0.63^{b}	3.08±0.35	0.27
Lactose	4.35±0.13^{b}	4.74±0.41^{a}	3.39±0.71^{b}	4.16±0.42	0.13
Added Water	5.43±2.61^{b}	8.25 ±3.65^{b}	41.09±29.53^{a}	18.26±11.93	0.034
Solid	0.66±0.016^{b}	0.49±0.10^{b}	0.75±0.04^{a}	0.63±0.05	0.016

Mean within the same row that different as superscripts are significantly different at ($p<0.05$). SE=standard error of mean, SNF= solid not fat, SHMEs=Smallholder micro-enterprises, SHF= Smallholder Farmers, N= Number of sample, **Added water** = is not water contents. The water added by producer or by milk sale men. **Solid =** is not total solid (only solid part)

4.5.2.4 Physical properties of milk:Density and Freezing points of Milk

The specific gravity recorded in study areas ranged from 1.023g/cm^3 - 1.031 g/cm^3 indicated in Table (18). This result is more or less similar with Haile (2015) who reported specific gravity range 1.022 g/cm^3- 1.031 g/cm^3 in AdeaBerga districts, but higher than report of Mebratu (2015) overall density 1.023g/cm3 in Addis Ababa.

The normal density of raw milk depends on its composition and temperature can usually found in the range of 1.026 g/cm^3 – 1.032 g/cm^3 at 20°C (FAO, 2017). Whereas samples of milk from herds should have reading the average milk, but wrong feeding might result in low readings. According to current result, the most of the milk samples collected from smallholder micro-enterprises and smallholder farmers were within normal range for specific gravity. However, samples collected from milk selling shops were not in the normal range of specific gravity. These variations might be due to the different sources of milk in the mixed, adulterated with water and removal of fat. In general, addition of water and removal of fat decreases the density of milk, while addition of solids increases the density of milk. The density measurement of milk quickly indicates nonconformities from the normal milk composition due addition of water. A similar result was also reported by Teklemichael*et al*. (2015) where specific gravity of milk samples collected from milk wholesalers were significantly lower (P<0.05) than that obtained from dairy farms in Dire Dawa Town, Eastern Ethiopia.

The overall mean freezing point content of the current study was (-0.46±0.08). When compared with FAO (2008) who reported standards freezing points (-0.521) in Ethiopia, the study result was below quality Standard Authority of Ethiopia recommended. These result is higher than that of Genzebu*et al.* (2016) who reported freezing point of milk in Bishoftu (-0.54±0.03) and Akaki (-0.56±0.02). As indicated in Table (18), milk sample collected from smallholder micro-enterprises and smallholder farmers were in the range of acceptable level. While milk sample collected from selling points of shops below normal acceptance level of freezing point. The variation of these result among sample collected in study areas were due to adulteration of milk by addition of water as well as removal of fat for the reason of economic gain.

Generalization, the overall milk obtained from selling shops had the lowest quality in terms of both chemical composition as well as bacteriological quality compared to the smallholder farmers and smallholder micro-enterprises.

Table 17. Specific gravity and Freezing points of milk sample from study area

Sampling source	N	Specific gravity Mean ±SE	Freezing point Mean ±SE
SHMEs	9	29.31 ± 0.92^{b}	-0.51 ± 0.02^{b}
SHF	9	31.34 ± 2.91^{b}	-0.55 ± 0.06^{b}
Milk Shop	3	$2\,3.38 \pm 4.89^{a}$	-0.31 ± 0.15^{a}
Over all means	21	28.01±2.90	-0.46±0.08
significance		0.234	0.082

Mean within the same column having different as superscripts are significantly different at (p<0.05). SE=standard error of mean, SHMEs=Smallholder micro-enterprises, SHF= Small holder Farmers, N= Number of sample

5. SUMMERY AND CONCLUSION

The study was conducted in Sebeta town, South West Showa Zone with the general objectives to describe dairy production system and evaluation of milk quality. The present study has identified two production systems; namely, peri-urban and urban dairy production systems. In study area, purebred dairy cattle are dominant when compared to local breeds and crossbred. Dairy production was the main source of income for smallholder farmers (975%) and job opportunity (64.7%) for the youth organized as smallholder micro-enterprises.

The major feed resource available for dairy animals was agro-industrial byproducts (bran of cereal crops, oilseeds cake), industrial byproducts like Meta brewery (brewery grain) and purchased hay grasses. Tape water was the main sources of water for the dairy animals in study areas. Most of dairy cattle owners have constructed separate sheds/barns with concrete floor for their dairy cattle. AI was the most common methods for cattle breeding. All smallholders have practiced hand milking as the only methods of milking but they had practice of washing their hand prior to milking. The average daily milk yield from pure bred and crossbred was 11.5 liters per day per cow. The current study result showed the highest milk production was possible during August to December from both categories of respondents in study areas. Therefore, the current study presented that milk production has relation with green harvest during wet season. The main constraints of dairy production in study areas were shortage and cost of feeds as the major bottlenecks for the development of dairy sector

Milk collected from selling of shops and ready to sale for consumers had the lowest quality in terms of chemical composition, physical properties like specific gravity and bacteriological quality compared to the smallholder farmers and smallholder micro-enterprises due to poor hygienic practices and possible adulterations. The average mean values of freezing point were (-0.46) which is below standard due to adulteration acts as compared with FAO (2008) reported (-0.521).Overall, milk obtained from selling shops had the lowest quality in terms of both chemical composition as well as bacteriological quality compared to the smallholder farmers and smallholder micro-enterprises.

6. RECCOMMEDATION

Based on the current finding, the following can be recommended;

A) Dairy production in study area was challenged by low availability and high cost of feeds. Therefore, farmers need to be supported with more access to feed production and/or purchase as well as training skills for feed conservations.

B) Milk samples collected from all sampling points were indicative of bacterial contamination, adulteration and did not meet quality standards set by quality standard authority of Ethiopia and the world. Therefore, it is recommended to provide awareness creation about hygienic practice of milk handling and production among smallholder farmers, smallholder micro-enterprises, milk shops and consumers in addition to strong regulatory mechanism by the relevant authorities.

7. REFERENCES

AbebeBereda, 2015. Milk Quality for Consumers' Safety. Ethiopian Meat and Dairy Industry, Development Institute:Proceedings.**5** (2):284-291

Abunna F,Fufa G, Megersa B, Regassa A.,2013.Bovine mastitis: prevalence, risk factors and bacterial isolation smallholder dairy farms in Addis Ababa city. Ethiopia Glob: **10**(6):647–52.

Addis M, Pal M, Kyule M. 2011.Isolation and identification of Staphylococcus species from raw bovine milk in Debrezeit. Ethiop Vet Rese.4:45–9

Mohamed.A., Ehui, S.andAssefa,Y, Y., 2004. Dairy development in Ethiopia.Intl Food Polices InstBook 1:pp. 26-29.

Ahmed, M.M., Jabbar, M. and Ehui, S., 2000.Household-level economic and nutritional impacts of market-oriented dairy production in the Ethiopian highlands. Food and Nutrition Bulletin, 21(4): 460-465.

Alemu, M.M., 2019. Urban and peri-urban dairy cattle production in Ethiopia: a review. *Online J. Anim. Feed Res*, **9**(4), pp.173-177

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

AOAC.(1990). Official methods of analysis of the AOAC, 15th ed. Methods 932.06, 925.09.

Asrat, A., Feleke, A. and Ermias, B., 2016. Characterization of Dairy Cattle Production Systems in and around WolaitaSodo Town, Southern Ethiopia.Scholarly*Journal of Agricultural Science*, **6**(3), pp.62-70.

Ayalew, H. and Abatenhe, A., 2018. Dairy Cattle Production, Processing and Handling of Milk and Milk Products in Enemay District, East Gojjam, Amhara.Ethiopia.JAdv Dairy Res, 214 (6), p.2.

AyalewM., 2017. Assessment and Monitoring of Traditional Milking and Milk Product Handling, Processing and Marketing in DessieZurieaWoreda and Dessie Town, South Wollo Zone, Amhara, Ethiopia (Doctoral dissertation, Bahir Dar University).

Ayub, M., Q. Ahmad., M. Abbas., I. M. Qazi and I. A. Hattak. 2007. Composition and adulteration analysis of milk samples. Sarhad J. Agri. **23** (4): 1127-1130.

Ayza, A., Yilma, and Nurfeta, 2013.Characterization of milk production system.*Journal of Dairy Farming and Milk Production* 81-082

Barbano, D.M., Ma,Y.and Santos, M.V.2006. Influence of raw milk quality on fluid milk shelf life. *Journal of dairy science, 89*:15-19.

Bekele, A., Fekadu, B. and Mitiku, E., 2014. Chemical composition and microbial quality of cow milk in urban and peri urban area of Dangila town, Western Amhara Region. Ethiopia. *Global Journal of Dairy Farming and Milk Production*, 3(1):081-085.

Beyene, B., Hundie, D. and Gobena, G., 2015. Assessment on dairy production system and its constraints in HoroguduruWollega Zone, Western Ethiopia. *Science, Technology and Arts Research Journal*, ***4***(2), pp.215-221.

Biffa, D., E. Debela and F. Beyene, 2005.Prevalence and risk factors of mastitis in lactating dairy cow in southern Ethiopia.Intern. J. Appl. Res. Vet. Med., e 3: 189-1.

Bille, P.G., Haradoeb, B.R. and Shigwedha, N., 2009. Evaluation of chemical and bacteriological quality of raw milk from Neudamm dairy farm in Namibia. African *Journal of Food, Agriculture, Nutrition and Development*,***9***(7).

Chala, Adugna.,Yosef, T. and Mitiku, E., 2017. Dairy Cattle Production Practice, Microbial milk quality, and Marketing of milk and milk product in Eastern Wolega zone of Sibu Sire District, Ethiopia.pp.27-31

Chandan, R.C., 2011. Dairy ingredients for food processing: an overview. Dairy ingredients for food processing: in USA, minessota.pp3-33.

Cochran W.G., 1977. Sampling techniques, 3rd edition. New York:JohnWiley and Sons

CSA (Central Statistical Agency), 2017.Agricultural sample survey.Federal Democratic Republic of Ethiopia Central Statistical Agency. Private Peasant Holdings. Statistical Bulletin 570, Addis Ababa, Ethiopia

CSA (Central Statistical Authority), 2018.Agricultural sample survey and livestock characteristics (private peasant holdings), Ethiopia. Statistical bulletin 587, Addis Ababa, Ethiopia

Dehinenet, G., Mekonnen, H., Ashenafi, M. and Emmanuelle, G., 2013.Determinants of raw milk quality under a smallholder production system in selected areas of Amhara and Oromia National Regional States, Ethiopia.Agric. Biol. JN Am, **4**(1), pp.84-90.

Delgado, C.L., 2003. Rising consumption of meat and milk in developing countries has created a new food revolution. *The Journal of nutrition*, **133**(11):3907S-3910S.

Drewnowski,A.,2011.The contribution of milk and milk products to micronutrient density andaffordability of the US diet.*Journal of the American College of Nutrition*, ***30***(sup5):422S-428S.

Dugdill, B.T., 2001. Training Program for the Small-scale Dairy Sector in Kenya (FAO-TCP/KEN/6611).*Discussion paper* 3.3.

Duguma, B. and Janssens, G.P.J., 2016. Assessment of feed resources, feeding practices and coping strategies to feed scarcity by smallholder urban dairy producers in Jimma town, Ethiopia.SpringerPlus, **5**(1), p.717.

Elmoslemany, A.M., Keefe, G.P., Dohoo, I.R., Wichtel, J.J., Stryhn, H. and Dingwell, R.T., 2010. The association between bulk tank milk analysis for raw milk quality andon-farm management practices. *Preventive veterinary medicine*, 95(1-2) :32-40.

El-Salam, M.H.A. and El-Shibiny, S., 2011.A comprehensive review on the composition and properties of buffalo milk.*Dairy science & technology*, **91**(6):663.

Ethiopian Standards Ref No ES 3460:2009 (2009): Unprocessed whole/raw cow milk specification. *2nd edition by* Dehinenet, G., Mekonnen, H., Ashenafi, M. and Emmanuelle, G., 2013.Determinants of raw milk quality under a smallholder production system in selected areas of Amhara and Oromia National Regional States, Ethiopia. *Agric. Biol. JN Am*, ***4*****(**1), pp.84-90.

Fahmid, S., Sajjad, A., Khan, M., Jamil, N. and Ali, J., 2016. Determination of chemical composition of milk marketed in Quetta, Pakistan. International Journal of Advanced Research in Biological Sciences, 3(5):98-103.

FAO, 2008.Characteristic and composition of hygienic and quality Milk production manual in Kenya and Ethiopia, Rome, Italy.

FAO. 2017. Gender assessment of dairy value chains: evidence from Ethiopia, Rome, Italy.

FAO, 2017.Hygienic and Quality Milk Production Training Manual I and II dairy extension, Rome, Italy.

FAO/TCP/KEN/6611 2017: Milk Testing and Quality Control. Training Programme for Small Scale Dairy Sector and Dairy Training Institute Naivasha vol.2 pp.4-18.

FatineH.Abdelmoula E, Doha B, Hinde H.,2012. Bacterial Quality of Informal marketed raw milk Kenitra City, Morocco. Park.J. Nurtr.**11**(8): 662-669.

Faye, B. and Konuspayeva, G., 2012. The sustainability challenge to the dairy sector–The growing importance of non-cattle milk production worldwide.*International dairy journal*, **24**(2), pp.50-56.

Fekade, N. and Mekasha, Y., 2012. Evaluation of Urban and Peri-Urban Dairy Production SystemsinAdama Milk Shed East Shoa *Zone OromiaNationalRegional State Ethiopia*.

Food, U.S., 2011. Drug Administration (FDA).*Production record of health functional food and analysis result of that inFDA; 2008. Retrieved from FDA*

Fiseha, K.T.D., Dairy Production and Marketing Systems in Kaffa and Sheka Zones, Southern

Ethiopia. Age, 21(30), pp.31-40

Gadaga, T.H., Nyanga, L.K. and Mutukumira, A.N., 2004. The occurrence, growth and control of pathogens in African fermented foods., T.H., Nyanga, L.K. and Mutuku Mira, A.N., 2004. *The occurrence, growth and control of pathogens in African fermented foods*.

Galmessa, U., Dessalegn, J., Tola, A., Prasad, S. and Kebede, L.M., 2013. Dairy production potential and challenges in western Oromia milk value chain, Oromia, Ethiopia.*Journal of Agriculture and Sustainability*,**2**(1).

Gebrewold, A., Alemayehu, M., Demeke, S., Dediye, S. &Tadesse, A. 2000.Status of Dairy Research in Ethiopia. In The Role of Village Dairy Co-operatives in Dairy Development. Smallholder Dairy Development Project (SDDP) Proceeding, Ministry of Agriculture (MOA). Addis Ababa, Ethiopia.

Griffiths, M.W. ed., 2010.*Improving the Safety and Quality of Milk: Improving quality in milk Products. Springer, Boston, MA. Milk quality :(40-59).pp.*

Haftu K S, Degnet H M., 2018. Determination of Adulteration and Chemical Composition of Raw Milk Sold in Hossana Town, South Ethiopia.

Haug, A., Host mark, A.T. and Harstad, O.M., 2007.Bovine milk in human nutrition–a review. Lipids in health and disease, **6**(1):25.

Hemme, T. and Otte, J., 2010. Status and prospects for smallholder milk production: aglobal perspective*. Food and Agriculture Organization of the* United Nations *(FAO).*

Herikstad, H., Motarjemi, Y. and Tauxe, R.V., 2002. Salmonella surveillance: survey of public health serotyping. Epidemiology Infection, **129**(1):18.

Holloway, G.J., 2000. How to make a milk market: A case study from the Ethiopian highlands (**Vol. 28)** ILRI (aka ILCA and ILRAD).

Https://www.qlip.nl/en/dairyfarmer/qualityassurancedairyfarm*onApril 14,2019*

Hu, W., Murphy, M.R., Constable, P.D. and Block, E., 2007. Dietary cation-anion difference effects on performance and acid-base status of dairy cows postpartum. *Journal of dairy science,***90**(7):3367-3375.

Hussen, K., Tegegne, A., Kurtu, M.Y. and Gebremedhin, B., 2008. Traditional Cow an Camel Milk Production and Marketing in Agro-Pastoral and Mixed Crop-Livestock Systems:the Case of Mieso District, Oromia Regional State, *Ethiopia(***No. 13**).ILRI (aka ILCA and ILRAD*).*

ISO (International standard organization), 2001. ISO-16654-Sample collection culturing on bacteriological media and testing using a series of biochemical

Jing-hui, S., Min-yan, Y. and Fan-yu, M., 2011.Discussed Psychrophilic Bacteria to Raw Milk Quality Influence and the Control Method.Food and Fermentation Technology, 3.

Kamthania, M., Saxena, J., Saxena, K. and Sharma, D.K., 2014. Milk Adulteration: Methods of Detection &Remedial Measures. *International Journal of Engineering and Technical Research*, 1:15-20

Kassa, T. and Dekamo, F., 2016.Dairy production and marketing systems in Kaffa and Sheka Zones, Southern Ethiopia. J. Market. Cons. Res, 27, pp.242-256.

Kurwijila, L.R., 2006. Hygienic milk handling, processing and marketing: guide for training and certification of small-scale milk traders in Eastern Africa.Lactoperoxidase method preserving raw milk in areas without cooling facilities. *African Journal of Food, Agriculture, Nutrition and Development*, ***7*****(**2):1-

Lu, M., Shiau, Y., Wong, J., Lin, R., Kravis, H., Blackmon, T., Pakzad, T., Jen, T., Cheng, A., Chang, J. and Ong, E., 2013. Milk spoilage: Methods and practices of detecting milk quality. *Nutrition Sciences*, ***4***(7):720-726.

Mebratu, A., 2015. Evaluation of the Chemical and Microbial Properties of Domestic Commercial Pasteurized Milk Available in Addis Ababa, Ethiopia (Doctoral dissertation, Addis Ababa University).

Mekasha, Y. 1999. Impact of feed resources on productive and reproductive performance of dairy cows in the Addis Ababa milk shed. School of Graduate Studies, Alemaya University of Agriculture, Ethiopia (MSC thesis).

Mekuria AD, Asrat YW, Tefera G.,2013. Identification and antimicrobial susceptibility of Staphylococcus aureus isolated from milk samples of dairy cows and nasal swabs of farm workers in selected dairy farms around Addis Ababa, Ethiopia. African J Microbiol,**7**(27):3501–10

Mellenberger, R., 2000. Dept. of Animal Sciences, Michigan State University and Carol, J. R., Dept. ofDairy Science, University of Wisconsin-MadisonApril.

MitikuEshetuGuya, Mekdes Seyoum and Yesihak Yusuf Mummed 2019. Milk production, marketing practices and qualities along milk supply chains of Haramaya District, Ethiopia. *African Journal of Agricultural Research.Vol.* ***14****(35), 1990 -2005pp.*

Nirwal, S., Pant, R. and Rai, N., 2013. Analysis of milk quality, adulteration and mastitis in milk samples collected from different regions of Dehradun. *International Journal of PharmTech Research*, ***5***(2):359-364 pp.

O’Connor C.B.1994. Rural Dairy Technology.ILRI training manual No.1.International Livestock Research Institute, Addis Ababa, Ethiopia.

Pandey, R. and Verma,M.R. 2008.Sample allocation in different strata, impact evaluation of developmental program. Rev. Mar. Estat.,**24**(4),103-112.

Perera, P., Munasinghe, H. and Marapana, R.A.U.J., 2019. Quality assessment dairy products in Sri Lankan market.*Journal of food quality*, 2019.

Powell, J.M., MacLeod, M., Vellinga, T.V., Opio, C., Falcucci, A., Tempio, G., Seinfeld, H. and Gerber, P., 2013.Feed–milk–manure nitrogen relation dairy production systems. LivestockScience,**152**(2-3):261-272.

Raff H., 2011. Market implications of changing fat content of milk and dairy products, fat content and composition

Rao, P.S. and Reddy, B.R.,2014.An overview of dairy Industry in India.Productivity,**55**(1):43.

Rizani, H., Cabeli, P., Jashari, B., Shala, S., Rizani, M. and Kamberi, N., 2018.Determination of Aerobic Mesophilic Bacteria and Coliforms in Raw Milk in the Region of Kosovo.*Albanian. Journal of Agricultural Sciences*, **17**(1):37-4

Santos, M.V., Ma, Y. and Barbano, D.M., 2003. Effect of somatic cell count on proteolysis and lipolysis in pasteurized fluid milk during shelf-life storage.*Journal of dairy science*, **86**(8):2491-2503.

Sarkar, U., Gupta, A.K., Sarkar, V., Mohanty, T.K., Raina, V.S. and Prasad, S., 2006. Factors affecting milk yield and milk composition in dairy animals. *Journal of Dairying, Foods and Home Sciences*, ***25***(2), pp.129-132.

Sebeta Agro-Industry Private Limit Compainy,2019. The plan collects milk from nearby smallholder dairy farmers and small micro enterprise processing in to different products.

Sebeta City Administration Environment, Forest and Climatic Change Authority, 2019. Environment and weather condition study in Sebeta and its surrounding.

SebetaCityAdministration and Land managements, 2019.Demography of population and location of the town.

Sebeta Town Livestock and Fisher, agriculture office, 2019.Dairy cattle population distribution in kebeles.

Shimeles, B., 2016. Physicochemical Properties and Microbial Quality of Cow Milk Collected from Selected Sub city of Addis Ababa, Ethiopia (Doctoral dissertation, Addis Ababa university.

Sintayehu Yigrem, FekaduBeyene, AzageTegegne and BerhanuGebremedhin. 2008. Dairy production, processing and marketing systems of Shashemene-Dilla area, South Ethiopia

Soomro, A.A., Khaskheli, M., Memon, M.A., Barham, G.S., Haq, I.U., Fazlani, S.N., Khan, I.A., Lochi, G.M. and Soomro, R.N., 2014. Study on adulteration and composition of milk sold in Badin. *Intl J Res Appl Nat Social.2*(9):57-70.

Tamine.AY., (2009). Milk processing and quality management. Society of Dairy Technology, United Kingdom

Teddasse, Y., Chala A. and Mitiku E., 2017. Dairy Cattle Production Practice, Microbial milk quality, and Marketing of milk and milk product in Eastern Wolega zone of Sibu Sire District, *Ethiopia* (Doctoral dissertation, Haramaya University).

Tegegne, A., Gebremedhin, B., Hoekstra, D., Belay, B. and Mekasha, Y. 2013. Smallholder dairy production and marketing systems in Ethiopia: IPMS experiences and opportunities for market-oriented development. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 31. Nairobi: ILRI.

Tekliye, M. and Gizaw, M.,2017. Handling Practices, Evaluation, Adulteration and Microbial Quality of Raw Cow Milk around Bahir Dar, Ethiopia.

Teklemichael T, Ameha K, Eyassu S, 2015. Physicochemical Properties of Cow Milk Produced and Marketed in Dire Dawa Town, Eastern Ethiopia. Food Science and Quality Management 42:56-61.

Varnam, A. and Sutherland, J.P., 2001. Milk and milk products*:* technology, chemistry and microbiology (V **1***): Springer Science & Business Media.*

Verdi, R.J. and Barbano, D.M., 1988. Preliminary investigation of the properties of somatic cell prot.*Journal of Dairy Science*, **71**(2):534-538.

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

Wouters, B. and van der Lee, J., 2010, November.Pathways to growth.In Outlook for dairy development in Ethiopia.*Background paper for the* National workshop 'Enhancing dairy development in Ethiopia.

Yigrem, S., Beyene, F., Tegegne, A.andGebremedhin, B. (2008).Dairy production, processing and marketing systems of Shashemene–Dilla area, South Ethiopia.Improving Productivity and Market Success (IPMS) of Ethiopian farmers' project, International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia.

Zelalem, Y., Guernebleich E, Sebsibe A. A Review of the Ethiopian Dairy Sector.Ed. Rudolf Fombad. Addis Ababa: Food and Agriculture Organization of the United Nations, Sub Regional Office for Eastern Africa (FAO/SFE). 2011. pp. 81. http://www.fao.org/3/a-aq291e.pdf.

Zelalem, Y., 2010. Quality factors that affect Ethiopian formal milk business; experience from selected dairy potential areas. Addis Ababa, Ethiopia. Netherlands Development Organization (SNV).

Zelalem, Y., Guernebleich, E., Sebsibe, A. and Fombad, R., 2011. A review of the Ethiopian dairy sector. Addis Ababa, Ethiopia: FAO Sub Regional Office for Eastern Africa (FAO/SFE), 10.

8. APPENDIX

Appendix 1: ANOVA Tables

AppendixTable 1. ANOVA table for percent of prevalence of staphylococcus for small micro-enterprise, smallholder farmers and selling points of milk shops

Source	DF	Sum of Squares	Mean of Square	F value	Sig.
Prevalence of S. aureus	2	329.15	164.576	0.00	0.00
Error	0	0.000	0.000		
Total	2	329.152			

AppendixTable 2. ANOVA table for percent of prevalence of Coli for smallholder micro-enterprises, smallholder farmers and selling points of milk shops

Source	DF	Sum of Squares	Mean of Square	F value	Sig.
Prevalence of E. coli	2	1069.745	534.872	0.00	0.00
Error	0	0.000			
Total	2	1069.745			

Appendix Table 3. ANOVA table for percent of fat for smallholder micro-enterprises, smallholder farmers and selling points of milk shops

Source	DF	Sum of Squares	Mean of Square	F value	Sig.
Fat	2	10.075	5.037	5.320	0.015
Error	18	17.045	0.947		
Total	20	27.119			

Appendix Table 4. ANOVA table for percent of solid nonfat for smallholder micro-enterprises, smallholder farmers and selling points of milk shops

Source	DF	Sum of Squares	Mean of Square	F value	Sig.
Solid Nonfat	2	13.336	6.668	1.955	0.170
Error	18	61.380	3.410		
Total	20	74.715			

Appendix Table 5. ANOVA table for percent of total solid for smallholder micro-enterprises, smallholder farmers and selling points of milk shops

Source	DF	Sum of Square	Mean of Square	F	Sig.
Total Solid	2	46.583	23.291	6.560	0.007
Error	18	63.904	3.550		
Total	20	110.487			

Appendix Table 6. ANOVA table for percent of protein for smallholder micro-enterprises, smallholder farmers and selling points of milk shops

Source	DF	Sum of Squares	Mean of Square	F value	Sig.
Protein	2	1.653	0.827	1.416	0.268
Error	18	10.506	0.584		
Total	20	12.159			

Appendix Table 7. ANOVA table for percent of lactose for smallholder micro-enterprises, smallholder farmers and selling points of milk shops

Source	DF	Sum of Squares	Mean of Square	F value	Sig.
Lactose	2	4.088	2.044	2.274	0.132
Error	18	16.180	0.899		
Total	20	20.268			

Appendix Table 8. ANOVA table for percent of added water for smallholder micro-enterprises, smallholder farmers and selling points of milk shops.

Source	DF	Sum of Square	Mean of Square	F value	Sign.
Added water	2	3051.071	1525.536	4.106	0.034
Error	18	6688.38	371.577		
Total	20	9739.459			

Appendix Table 9. ANOVA table for percent of Solid for smallholder micro-enterprises, smallholder farmers and selling points of milk shops

Source	DF	Sum of Squares	Mean of Square	F value	Sig.
Solid	2	0.152	0 .076	5.277	0.016
Error	18	0.259	0.014		
Total	20	0.411			

Appendix Table 10. ANOVA table for percent of milk density for small micro-enterprises, smallholder farmers and selling points of milk shops

Source	DF	Sum of Squares	Mean of Square	F value	Sign.
Density	2	142.530	71.26	1.576	0.234
Error	18	813.964	45.220		
Total	20	956.494			

Appendix Table 11. ANOVA table for percent of Freezing point for smallholder micro-enterprises, smallholder farmers and selling points of milk shops

Source	DF	Sum of Squares	Mean of Square	F value	Sig.
Freezing point	2	0.131	0.066	2.886	0.082
Error	18	0.409	0.023		
Total	20	0.541			

Appendix 2: Questionnaire on assessments of milk production at study area

Title: Assessments of milk production system and Evaluation of milk quality

Objective of the study: to describe dairy production system and analyze the fresh milk**samples for microbial quality, composition and density of milk at study areas**.

Dear respondents: Please spare a few minutes to complete this questionnaire. Your participation is in the milk production system. Research Survey would help us to understand your milk production system and give you a chance to get to know the milk production system Perspectives in Sebeta town. Please be assured that your responses would be treating with the strictest confidence

Name of Enterprises or holder farmers:

Kebeles___________Date of interview _________Code number_________

I.General characteristics of the respondent

1. Sex Status A) Male B) Female C) other

2. Marital Status A) Single B) Married C) Divorced D) Widowed E) Other (Specify)_____

3. Respondents age A) 18-25 B) 26-33 C) 34-41 D) 42-49 E) 50 and above

4. Educational Status--A) Illiterate B) Primary School C) Secondary School D) Diploma holder E) Degree and above

II. Dairy cattle production system

1. How many dairy cow you have? A) 1-5 B) 6-10 C) 11-15 D) 16-20 E) >20
2. What are purposes of milk production? A) For consumption
   B) For market C) for processing D) other (specify) ________________
3. What types of breed you have? A) purebred B) Indigenous C) crossbreed
4. What types of dairy cattle pure/cross breed you have? A) Holstein Friesian B) Jersey C) Guernsey D) Brown Swiss Other(specify)_______________
5. What is motivated you to engage in dairy production system enterprises or Sector? A) to expand income B) unemployment C) for consumption D) for business profit
6. Frequency of milking per day A) 2x B) Once C) 3x D) others (specify)___
7. method of milking A) hand milking B) machine milking C) other(specify)-

Housing and manure management system

1. What types of your dairy house? A) Closed concrete floor B) open muddy floor C) both

2. How to manage manure? A) used for fertilizer B) used for biogas C) used for energy by drying

A) **water resource**s

1. What is Source of water? A) Well water B) Tape water C) River D) spring
2. Water frequency A) 3 times day B) twice a day C) once a day D) four times

B) Feed resources and Feeding practice

1. What types of feedstuff available for milk production? A) Concentrate B) Rough D) others (specify)__________________________

2. If roughage, which kind? A) Hay B) crop residue C) pasture

3. If Concentrate, Which types of? A) Brewery B) Agro-Industrial byproducts C) Sugar byproducts(molasses) D) others(specify)____________________

4. Witch types of Agro-industrial byproducts feeding your diary animal for milk production? A) Oil-seed cake B) Wheat bran C) Flour mill by product D) all mixes

5. How much concentrate do you provide for your dairy cow per day? A)7kg-9kg B) 10kg-12kg C) 13kg and above

How much roughage do you provide for your dairy cow per day? A) Without quantity for 24hrs B) with quantity for 24hrs C) other (specify)__________

Breeding practicesand Reproductive management

1. What methods of mating system of your cows? A) AI B) natural mating C) both D) other(specific)____

2. Who identifies your cow's coming to heat? A) myself B) AI inseminator technician C) Natural bull D) other (specify)_________________

3. If natural bull, where is source of bull? A) Own growth B) Rental C) Extension serve

4. If Artificial, where is source of semen? A) Government extension B) Private C) Other (specifics) ___________________________________

5. How many lactation lengths of your cow? A) 10-month B) 1-years C) above 1-year

C) Calf Managements and colostrum feeding

1. How to feeding Colostrum? A) in bucket B) suckling dam C) other

2. For how many days Colostrum feeding? A) 3days B) 5days C) 7 days D) 10 and above

3. How to management bull calf born? A) Sold as veal B) Culling after few days C) Used for fattening D) Growth for breeding purpose

4. Calf starting supplementary feeds A) after three days B) after five days C) After seven days

III. Milk production potential

1. How much liters of milk obtained from a cow per day? A) 2-5 B) 6-9 C)10-13 D) 14-17 E) 18 and above
2. At what months in a year do you produce more milk? A) August, September, October November and December B) January, February and march C) April, May, June and July

IV. Milk quality Characteristics

1. What are the quality characteristics of milk? A) Color white /yellowish color/golden color B) Odor/smelling C) Other (specific) ____________

2. Do you know adulterated milk? A) Yes B) No

3. What is source of milk adulteration? A) Addition of water B) Flour C) other (specific)___

4. Do you wash your hand before milking of your cows? A) Yes B) No

5. Do you wash equipment's before milking? A) Yes B) No

6. What types of water for wash equipment is before milking? A) Cold water B) hot water

7. Do you clean udder of the cow before milking? A) Yes B) No

8. Do you use any teat dipping? A) Yes B) No

9. Do you clean the house of your cows? A) Yes B) No

10. If yes Q8, how many times do you clean in a week? A) 2 B) 3 C) 4 D) daily

11. What are the constraints of clean milk production? A) Lack of awareness B) Lackof Clean Water. C) Lack of clean environment

12. What is the main reason for milk adulteration? A) For processing B) for preservation C) For economic gain D) other (specific) ______________________

13. Do you know locally, how to detect adulterated milk? A) Yes B) No

14. What are the major milk adulterating materials in your areas?

A) Milker B) Milk utensil C) Feed Dust D) Cows and milking area

V. Constraints Dairy Production at study area

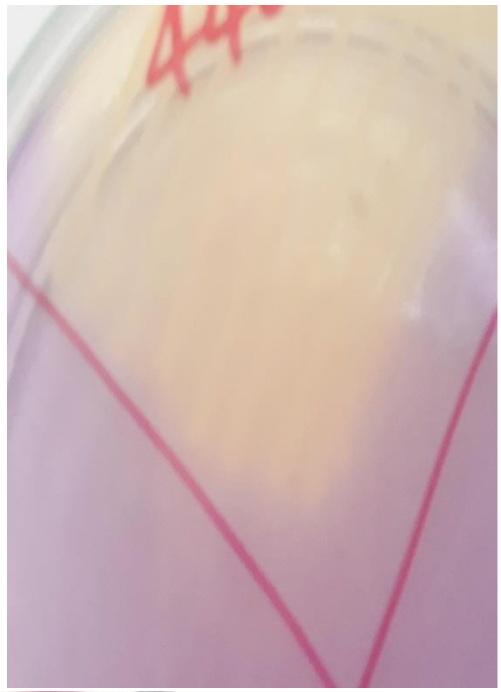
1. Either any constraint in your production system? A) Yes B) No

2. If yes, what types of constraint? A) Technical B) Non-technical C) other (specific) _

3. If technical constraint, what is the challenge to your dairy production system? A) Feed shortage B) Feed cost C) Disease D) Shortage of land E) dairy breeds improved gene.

VI). DIFFERENT PICTURE AND PHOTO DURING LABORATORY SESSION

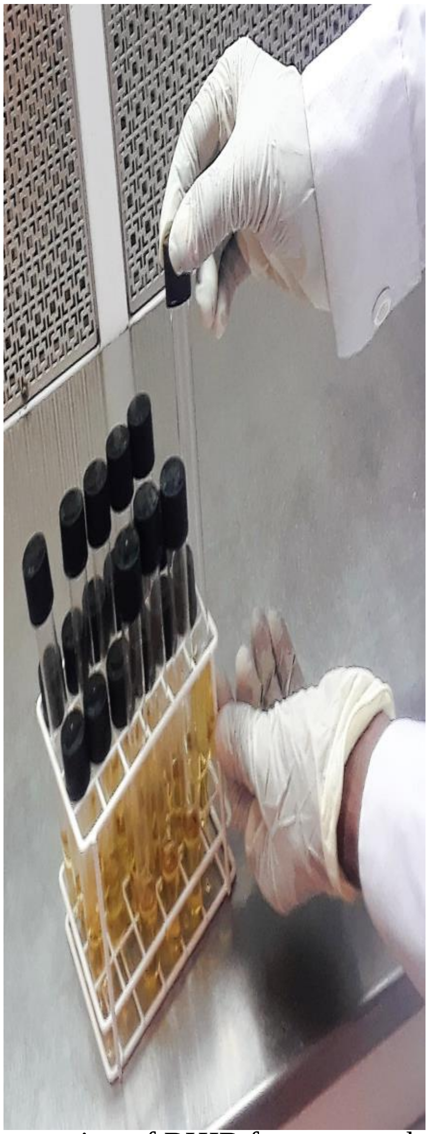
Presence of E. Coli Color of Metallic sheath

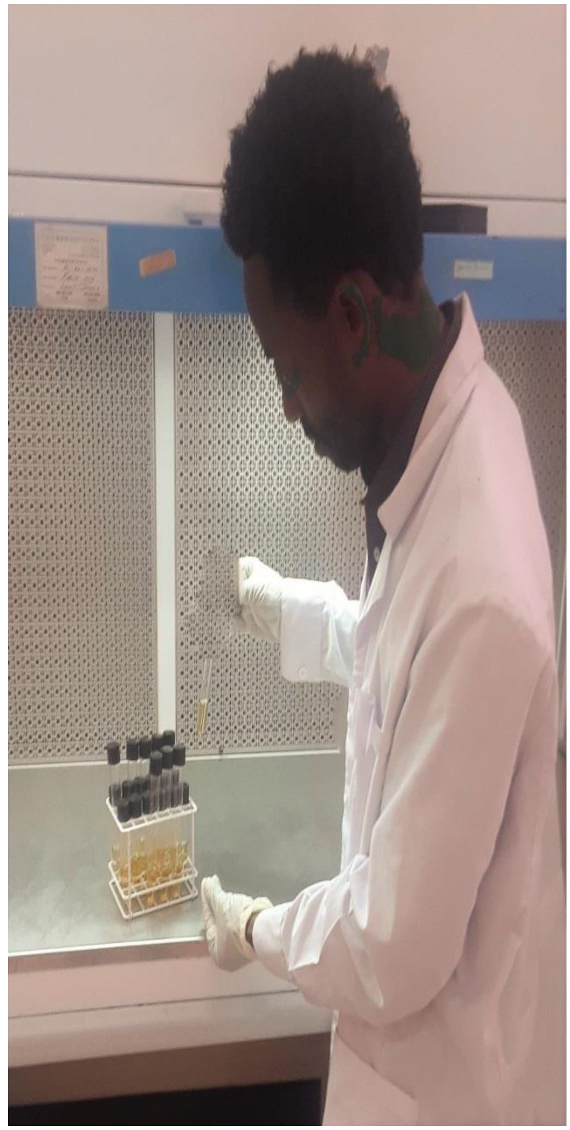


Picture: S. aureus indicated yellow color ring

Picture of mastitis test with CMT

California mastitis Test (CMT) at NAHDIC





Preparation of BHIB for per- reach samples used for bacteria isolation at NAHDIC