MEKELLE UNIVERSITY

COLLEGE OF VETERINARY SCIENCES

HANDLING PRACTICES AND POST-HARVEST LOSSES OF RAW COW MILK PRODUCED AND MARKETED IN MEKELLE CITY, TIGRAY REGION, ETHIOPIA

By

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A Thesis Submitted to the College of Veterinary Sciences, Mekelle University, in Partial Fulfillment of the requirements for the Degree of Master of science in Dairy Product Processing Technology

November, 2023

Mekelle, Ethiopia

DECLARATION

I,TEAME ATAKLTI GEBREHIWOT, hereby declare that the research thesis work entitled "**Handling Practices and Post-harvest Losses of Raw Cow Milk Produced and Marketed in Mekelle City, Tigray Region, Ethiopia**" submitted by me for the award of the Degree of Master of Science in Dairy Product Processing Technology is my original work and it has not been presented for the award to any other Degree, Diploma, Certificate or other similar titles of any other University or institution. Finally, I also confirm that all source materials used in the material are recognized and dully acknowledged.

Teame Ataklti Gebrehiwot Signature……. Date……

November, 2023

Mekelle University, Mekelle, Ethiopia

CERTIFICATION

This is to certify that the thesis entitled **"Handling Practices and Post-harvest Losses of Raw Cow Milk Produced and Marketed in Mekelle City, Tigray Region, Ethiopia",** submitted in partial fulfillment of the requirements for the award of the degree Master of science in Dairy Product Processing Technology to the Department of Veterinary Theriogenology and Welfare, College of Veterinary Sciences, Mekelle University. The thesis is carried out by Mr. Teame Ataklti Gebrehiwot under our supervision.

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We, the undersigned, members of the Board of Examiners of MSc Thesis Open Defence Examination, have read and evaluated the Thesis prepared by **Teame Ataklti Gebrehiwot** and examined the candidate. This is therefore to certify that the thesis be accepted as fulfilling the Thesis requirement for the Degree of Master of Sciences in Dairy Product Processing Technology.

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LIST OF ABBREVIATIONS

AI	Artificial Insemination
ANOVA	Analysis Of Variance
CSA	Central Statistical Agency
FAO	Food and Agriculture Organization
PHL	Post-harvest Losses
SPSS	Statistical package for Social Sciences

ABSTRACT

The study was conducted from December 2022 to November 2023 in four selected sub-cities of Mekelle, Tigray region, Ethiopia, aimed to assess the general hygienic handling practice and post-harvest losses of raw cow milk produced and marketed in Mekelle city. A total of 160 respondents were interviewed to collect the required information from milk producers, vendors and cafeteria using a semi-structured questionnaire and observational check lists. Survey work includes hygienic milk handling practices, milk marketing channels, methods of milk quality tests, milk utilization, post-harvest losses of milk and constraints of milk production, processing and marketing. About 52.5% of the respondents were females and the rest 47.5% were males. From the total interviewed members about 33.8% were attend elementary school followed by high school(26.9%),diploma(22.5%),read and write (6.9%),degree (3.1%) and illiterates (2.5%). In the current study area, the average milk production per week was 123.09 liters/week. In the present study showed that majority of the respondents clean the barn once a day. Nearly all respondents used plastic containers for milking, storage and transportation purpose. This survey results revealed that cleaning of milk handling equipment is common in all respondents. The water source for milk producers (46.5%), vendors (100%) and cafeteria (100%) was tap water. The entire household in the study area were washed and smoked their milk containers for the purpose of improving flavor and increasing shelf life. Organoleptic and density test were the main methods of milk quality test. The weekly milk post-harvest losses for milk producers, vendors and cafeteria were 0.60%, 0.25% and 0.70% respectively. The main constraints of milk processing in the study area were lack of small scale processing equipment, low milk supply and poor milk quality. Among the milk handling practices conducted by milk vendors, sources of milk, types of milk containers and cleaning agents were significantly ($p<0.05$) associated with the age of the respondents.

Key words: raw milk, handling practices, post-harvest losses

1. CHAPTER I: INTRODUCTION

1.1. Background and Justification

The total cattle population Ethiopia is estimated to be about 66 million. Out of this total cattle population, the female cattle constitute about 57 percent and the remaining 43 percent are male cattle. On the other hand, 96.76 percent of the total cattle in the country are local breeds. The remaining are hybrid and exotic breeds that accounted for about 2.71 percent and 0.41 percent, respectively. Dairy-cows are estimated to be around 12.8 million and milking-cows are about 7.8 million heads during the reference period (CSA, 2022).

Dairy production is a major contributor to economic development, especially among the developing countries, both driving economic growth and benefiting from it. As an engine of growth, it provides increased income, employment, food and foreign exchange earnings as well as better nutrition.

The demand in consumption of milk and milk product is steadily increasing in the country. Given the considerable potential for smallholder income and employment generation from high-value dairy products, the development of the dairy sector, can significantly contribute to poverty alleviation and nutrition in the country (Tsadkan and Amanuel, 2016).

High spoilage is reported frequently in milk coming from lowland regions due to high ambient temperatures prevalent in the area combined with lack of cooling facilities as well as transport, scattered distribution of producers and long distance to markets, which make difficult to deliver milk (especially raw milk) to urban centers (Lumadede *et al*., 2010). On-farm milk losses caused by spillage during milking and transportation, and spoilage caused by poor hygiene and use of inappropriate containers for milk storage whereas the Off-farm losses were largely due to spillage during transportation and at retailers' premises due to poor handling and use of inappropriate containers.

According to Ayantu (2021) and Tsedey and Bereket (2016) report, reviewing the causes of post-harvest loss of milk and dairy product was necessary to find solutions to the problem and justifying interventions aimed at reducing or eliminating these losses at country level. Other major Influencing factors of milk and milk product losses attributed to marketing constraints

were poor rural infrastructure such as lack of cooling facilities, unreliable or non-existent electricity supply; lack of technical knowledge on safe handling of milk (Tsedey and Bereket, 2016).

Milk processing is one of the mitigation systems used to minimize the loss of raw milk especially in areas where infrastructure is underdeveloped to sale raw milk. Assessment of the quality of traded milk and milk products has shown that value addition through small-scale processing is important for income generation and reduction of post-harvest losses (Lusato, 2006 and Tsadkan and Amanuel, 2016).

1.2. Statement of the Problems

In smallholder and pastoral herds, milk postharvest losses (PHL) in quantity (spillage), quality (spoilage) and in economic value can occur from udder to the farm gate at milking, bulking, evening storage or at the farm gate delivery. At each of these spots, the PHL can result from many causes including seasonal effects, poor housing, feeding practices, and unhygienic practices in milking, milk handli ng and transportation, insufficient access to cooling facilities and market access (Kashongwe, 2017). This implies that dairy processing in the country is basically limited to smallholder level and hygienic qualities of products are generally poor. Information on the hygienic handling of dairy products and postharvest losses of cow milk are generally lacked and limited. Hence, the aim of this study was to generate basic information on the hygienic handling practice of milk and its products as well as the causes of milk post- harvest losses.

1.3. Objectives

1.3.1. General objective

- To assess the handling practice and post-harvest losses of raw cow milk

1.3.2. Specific objectives

- ✓ To assess the hygienic handling practice of milk and milk products
- ✓ To investigate the traditional milk processing and preservation techniques
- ✓ To identify the causes of post-harvest losses of raw milk

- ✓ To determine the post-harvest losses of milk

1.4. Research Questions

1. How is the hygienic condition of the cows and milkers?
2. What are the causes of milk post-harvest losses?
3. What are the plants species used for smoking milk equipment?
4. What are the problems of using traditional milk processing equipment?

1.5. Significance of the Study

The study is attempted to assess the handling practices and post-harvest losses of milk in Mekelle city. Besides, the study identified the basic hygienic milk handling practices carried out by milk producers, vendors and cafeteria which are significantly important inputs for designing appropriate strategies in order to improve the quality of milk produced and marketed in urban and peri-urban area, and hence maintain the health of the end users or consumers. This study also provided information on causes of milk losses and rejection problems, and in addition to this provided the constraints of milk production, processing and marketing in the study area.

Government and Non-Government Organizations which are involved in the development of dairy will be beneficiary from the results of this study. The findings of this study are also believed to be useful to dairy producers, traders and retailers. The study can also serve as an additional source for researchers to conduct studies on the same or related kinds in other parts of the country.

2. CHAPTER II: LITERATURE REVIEW

2.1. Milk Production System in Ethiopia

Milk production system can be categorized based on agro-ecology, socio-economic structures of the population and type of breed and species used for milk production can be classified into two major systems, namely rural dairy system (pastoralists, agro-pastoralists, and mixed crop–livestock producers) and urban and peri-urban dairy systems (Getachew and Gashaw, 2001). Milk production depends on mainly indigenous livestock genetic resources dominated by small holder farmers specifically on cattle, goats and camels.

The indigenous breeds accounted for 99.19 percent, while the hybrids and pure exotic breeds were represented by 0.72 and 0.09 percent, respectively. Milking cows in the traditional sector have an average lactation length of 190 days and an average milk yield 1.9 liters per day excluding the calf has suckled. The total annual national milk production in Ethiopia received from 9.6 million dairy cows and the product is estimated to be 2.9 billion liters which is, 1.69 liters yield per cow per day on average (Ayantu, 2021).

2.2. Milk Production in Ethiopia

Ethiopia has the largest livestock population in Africa with the latest estimate of 60.39 million cattle, 30.7 million sheep and 30.2 million goats, 8.4 million donkeys, 409,877 mules, 2.2, million, horses, and 59.5 million chickens (CSA, 2018). Despite its huge population, the livestock sub-sector in the country was less productive in general, and compared to its potential, the direct contribution to the national economy is limited (Yigrem *et al*., 2008). Out of this total cattle population, female cattle constitute about 54.65% and the remaining 32% are male cattle. This livestock is mostly maintained by smallholder, commercial, and pastoral farmers; and more than 99% are indigenous low yielders that creates a high gap between demand and supply of milk and milk products. The traditional (smallholder) milk production system, which is dominated by indigenous breeds, accounts for about 97- 98% of the total annual milk production in the country (YONAD, 2009).

Although the country holds more than 10 million dairy cows, the annual production is only less than 5 billion liters leaving the country a net dairy importer. Productivity of the dominant tropical cattle breed, Zebu types, is very low in terms of lactation period and daily production, 6 months and 1.35 liters per day, respectively. A number of factors affect this yield level; feed quality and quantity, water availability, diseases, genetic potential and husbandry practices (Biniam *et al*., 2016 and CSA, 2015).

According to (Getachew and Asfaw 2004 and Biniam *et al*., 2016) reports, estimated that from the total milk produced it was estimated that 68.4% of the annual milk production is used for home consumption, mainly rural and only 14.6% is marketed leaving 17% for calves suckling. The same report also indicated values of 44.1% of the milk produced as home retained and 55.1% as sale from the total milk produced on the farms surveyed, the remaining 0.8%

considered as loss. These figures are dynamic and may not represent the current situation but the magnitude is worth noting. Getachew and Asfaw (2004) reported that peri - urban dairy farmers that have proximity advantage than rural farmers sell 61.0% to 75.2% of their milk through co-operatives and self -help groups. Urban dairy farmers sell 56% to 71.6% to consumers. Smallholders with indigenous stock use most of the milk for home consumption and processing only. Road access is the key bottleneck to limited market off take of rural dairy farms.

2.3. Milk marketing in Ethiopia

In Ethiopia, liquid milk is marketed through both formal and informal channels. The informal channel involves direct and indirect sales to consumers. In direct transactions, producers sell their milk to final consumers at the farm gate, in their immediate neighborhoods or in the city of Addis Ababa or nearby towns. People transport the milk on foot, by horse, by donkey or by public or private transport. Producers also sell indirectly to consumers through itinerant traders (Azage and Alemu, 1998).

About 95 percent of the marketed milk at national level is channeled through the informal system. In this marketing system, milk and milk products may pass from producers to consumers directly or through one or more market agents. Producers sell the surplus milk produced to their neighbors and/or in the local markets, either as liquid milk or in the form of butter and/or Ayib (O'Connor, 1992 and Tenagnework, 2016).

The informal milk marketing system dominates the supply of milk and dairy products to consumers in Ethiopia. Of the total urban milk production, 73 % is sold, 10% is left for household consumption, 9.4 % goes to calves and the 7.6 % is processed into butter and cheese. In terms of marketing, 71% of the producers sell milk directly to consumers. But in rural areas especially pastoralists use the milk and the products mostly for home consumption; few households sell their milk to the market (Bruktawit, 2016).

2.4. Milking Techniques

It is important to follow proper milking procedures in order to obtain milk of good and consistent quality. A properly executed routine milking procedure is part and parcel of clean milk production. Milking is the most important activity in producing quality milk. Milk can be

extracted either by hand or by machine. Hand milking is an art, which can be improved with practice. Traditionally, hand milking is mostly performed in open air and with hand and this may expose the milk to contamination (Biniam *et al*., 2016).

Hand milking is the common method of milking. It is important that before milking the hands should be washed using clean water and soap and dried well and fore-stripping should be done to discard the first few strokes of milking in order to avoid milk contamination by extraneous bacteria and allow a quick check for signs of clinical mastitis. Farmers are advised to use pre and post dipping in order to reduce the resident teat skin bacterial population and prevent the transmission of contagious bacteria respectively. The teats of the cow should be dried after washing to avoid milk contamination with water remaining on the teats. Moistening hand in milk, water or oil is not recommended and the technique of pulling teats in milking should be avoided as it can cause irreparable damage to the udder due to the fact that the udder is made by tissues and ligaments (Hyera, 2015).

2.5. Hygienic Milk Handling Practice

At farm level, milk quality is directly related to the farmer‘s capacity to apply handling practices that reduce exposure to pathogens and eliminate their transmission during milking. These practices include the animal factor which can, due to latent diseases (e.g. mastitis) contaminate the milk and unhygienic milk handling practices. These hygienic practices include cleanliness of animals (udder), milking environment, milking person and milk storage containers (Lore *et al.*, 2006). Mixing of evening and morning milk can also contribute to milk spoilage depending on the preservation of evening milk (Younan, 2004).The handling and safety of milk and milk products is of great concern around the world, this is especially true in the developing countries where production of milk and its product take place under unsanitary condition (Oliver, 2017).

The equipment’s used for milk handling and the sanitary practices related to milk handling include any material made up of locally available input or plastic jar in the market used from milk collection up to product arrive to final consumer. The majority of milk producers and all milk collectors and transporters as well as vendors and some consumers in the eastern part of the country using plastic containers for raw milk handling (Ayantu, 2021).

The use of plastic containers is not advisable as it is sensitive to heat. Moreover, its surface is easily scratched by nature with the common cleaning systems. As a result, after some time the surface will contain a number of scratches, which can hardly be seen but are nearly impossible to clean with the common cleaning systems and provide hiding places for bacteria during cleaning and sanitization. This allows the multiplication of bacteria on milk contact surfaces during the intervals between milk handlings and becomes a potential source for contamination of milk with spoilage and pathogenic microorganisms (Tadele *et al*, 2016).

Raw milk is also known to be associated with pathogenic bacteria which cause milk -borne diseases such as tuberculosis, brucellosis or typhoid fever, among others. Hygienic milk production, proper handling and storage of milk, and appropriate heat treatment can reduce or eliminate pathogens in milk. Hygienic milk handling includes using clean equipment, maintaining a clean milking environment, observing good personal hygiene and preserving the quality of milk during storage and transportation to the consumer or processing plant (Biniam *et al*., 2016).

2.6. Traditional Milk Processing and Preservation

2.6.1. Traditional milk processing

Farmer process milk produced in their farms to other milk product in order to increase its shelf life. Out of the total milk produced was used for traditional processing and convert it into dairy products. The major products of the traditional milk processing were naturally fermented milk, traditional butter, butter milk, cottage cheese, whey and ghee (Alganesh, 2002). Much of the milk produced by rural smallholders is processed on-farm using traditional technologies which is why it is important to describe such systems. While the processes used have not been subject to extensive scientific studies, traditional milk processing methods appear to be effective methods of converting milk into stable marketable products and have long been used for processing surplus milk (Biniam *et al*., 2016).

2.6.2. Traditional milk preservation

While most smallholder farmers do not have cooling facilities, it is important to cool milk and store it at as low a temperature as is practically possible if it cannot be delivered within 2-3 hours

after milking. This is particularly important for evening milk or where morning milk cannot be transported to the milk collection point within 2 – 3 hours. Simple means of cooling, such as immersing milk cans in ice blocks or cold water in a trough, are better than leaving the milk uncooled. Where available, domestic refrigerators may be used but avoid freezing milk as this destabilizes the fat (Biniam *et al*., 2016).

The milk producers used different techniques to preserve fresh milk without clotting, such as smoking of the container and boiling of fresh milk before collection, or refrigeration. In different production systems, smoking was the predominant practiced. The most of urban farmers uses a refrigerator, an option which was almost not present in the peri-urban areas (Zollitsch *et al*, 2009). It is obvious therefore, that for technical and economic reasons technologies in fluid milk processing such as steam-pasteurization, sterilization and aseptic packing are not common on Ethiopian smallholder farms(Sintayehu *et al*., 2008).

The practice and purpose of smoking was to improve taste and flavor of milk and milk products. Smoking was also practiced to destroy bad microorganism and improve milk fermentation. The smoking practice in urban area to kill bad microorganism was because of better awareness of community in proper handling of dairy products (Japaro, 2021).

2.7. Post-Harvest Losses of Milk

Post-harvest milk losses (PHL) are of substantial volumes (spillage) and quality (spoilage) and forced consumption (Oliver, 2017). Post-harvest losses in the dairy industry can be described as losses at the farm level after milking and through the market chain up to the consumption. This is the milk, either raw, fresh or in its various products forms that gets spoilt due to poor handling and lack of cooling facilities. The spillage losses are most likely on the minimum side. Most of the milk is lost through spoilage (FAO, 2003).

Postharvest loss is a major problem of the dairy sector in tropical countries. The high temperature coupled with the absence of cooling facilities and inadequate transportation means hasten the spoilage of milk produced in these countries (O'Mahoney and Peters, 1987). Postharvest loss of milk and dairy products reported about 40%,estimated to cost the Eastern Africa countries over 90 million USD annually (www.fao.org). In Ethiopia, the rural milk production system accounts for about 97% of the total milk production in the

country where it is difficult to transport the raw milk to the market areas or to the processing plants due to poor infrastructure (Staal and Shapiro, 1996). Only about 5 % of the milk reaches the market area and the rest is processed at the farm into different dairy products (Mohammed *et al*, 2004).

According to Ayantu (2021) report, the largest proportion of milk post-harvest losses in Ethiopia are experienced in the small-scale informal dairy sector and formal milk processors generally incur minimal losses. In terms of quantity, significant milk losses occur at the farm level. These losses are occasioned by poor road infrastructure and inadequate markets for raw milk are the main causes of farm-level losses, which are largely in form of spoilage, spillage, and forced home consumption (including by calves and humans) over and above normal household consumption as well as irregular power supply in milk processing plants.

From the total amount of milk postharvest losses, the largest proportion is caused by milk spillage due to different post-harvest handling practice. Milk spillage problem was one among the several postharvest loss problems accounting for about 43% and 47% milk producing households in Ada'a and Lume districts (central Ethiopia), respectively (Kassahun *et al*.,2014). According to FAO (2001) most postharvest loss of milk and milk product are associated with poor handling, contamination, poor level of technology applied in the preservation of milk to extend its shelf life and lack of market.

Different practices have been implemented by small scale milk producing households to alleviate postharvest milk losses. Smoking of milk handling equipments using different plant materials and processing of milk by traditional way are among the mechanisms used to minimize the post-harvest losses of milk (Tsedey and Bereket, 2016).

3. CHAPTER III: MATERIALS AND METHODS

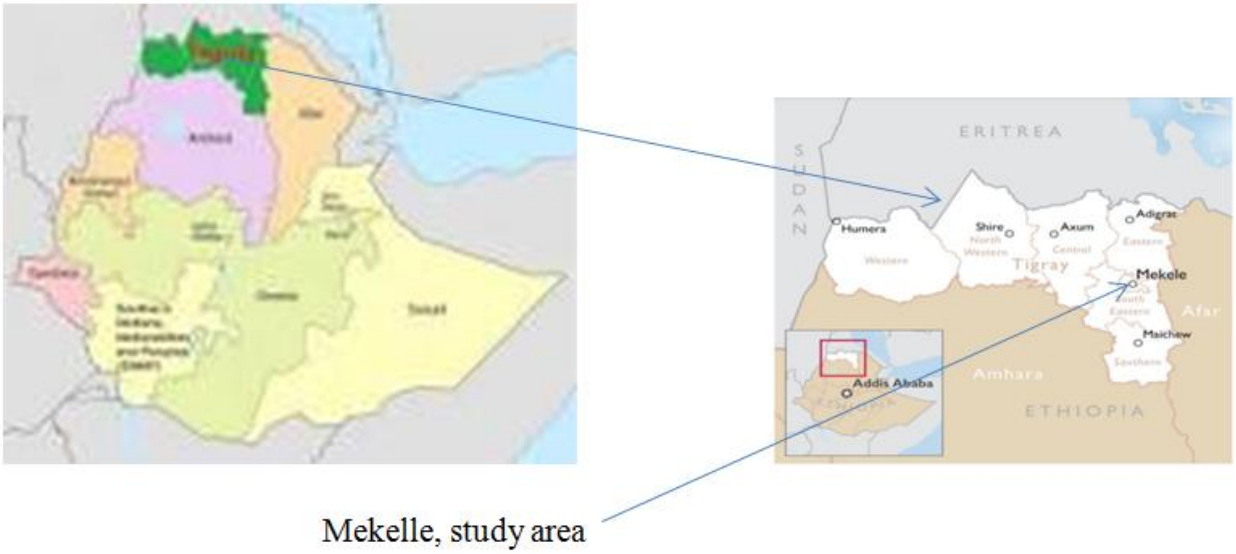
3.1. Description of the Study Area

This study was conducted from March 2022 to November 2023 in Mekelle city, Tigray regional capital, Northern Ethiopia having a total human population of 310,436 (CSA, 2018). About 90% of the total population was believed to be orthodox Christians, 6% Muslims and the

remaining 4% being Catholic and Protestants (Mekelle City Development Plan and CSA, 2007). Mekelle is administrated by a mayor council system, in which municipal aspects are managed by a city manager. The total area of Mekelle city is 53 km square (Mekelle Strategic Plan 2005-2007). Geographically, Mekelle is situated at 783 km from Addis Ababa, Ethiopia and lies at an elevation of 2,254 meters (7,395 ft.) above sea level (at the airport), close to the edge of the northern portion of the Ethiopian Rift Valley, on a Jurassic limestone plateau, in a semi-arid area with a mean annual rainfall of 714 millimeters and its monthly average temperature is 18 ^{o}c. Mekelle is divided into seven local administrations: Hawelti, Adi-Haki, Kedamay Weyane, Hadnet, Ayder, Semien and Quiha. Within each local administration there are *kebeles* or *ketenas*.

In recent years, Mekelle has experienced increased agricultural production due to improved farming techniques and a transition from subsistence to cash crop farming. There are numerous opportunities for investment in Mekelle. One area of particular interest is agriculture and agro processing. Livestock-based agro-processing can provide a myriad of opportunities for investors in the dairy, meat and leather industries.

In the year 2013, the Office of Urban Agriculture Development of Mekelle City registered 770 small dairy farmers and 20 dairy cooperatives having 36,516 total numbers of cattle; from this 25,369 are female cows and 9,014 are milking cows (Solomon, 2014).



Location map of the study area

3.2. Study Design

The study involved a cross-sectional survey method aimed to assess handling practices and post-harvest losses of raw cow's milk produced and marketed in Mekelle city . A total of 160 respondents were selected using purposive sampling technique and interviewed using a semi structured questionnaires.

3.3. Sample Size Determination and Sampling Strategy

3.3.1. Sample size determination

A formula by Kothari (2004) for unknown population (i.e. $n = Z^2SD^2/e^2$) was used to calculate the sample size for this study. Where Z, is the level of significance at 95% confidence interval (CI) which was considered the point of the normal distribution corresponding to the level of significance (Z=1.96). Standard deviation (SD) was estimated at 0.15 or 15% and e, is the estimated error and was considered at 0.05 or 5%. Therefore, the sample size 'n' was calculated as:

$n = (1.96)^2 \times (0.15)^2 / (0.05)^2$

$= 34.6$ approximately $n = 35$ samples per each sub-city

But the researcher was supposed 40 samples per each sub-city (40*4=160) to be collected through the semi-structured questionnaires from the respondents (milk producers, vendors and cafeteria). The sample sizes were distributed to each study area on proportional bases.

3.3.2. Sampling strategy

Household milk producers, milk vendors and milk cafeteria that involved in the study were selected based on potential of milk production, market orientation and willingness of the households to provide information. Purposive sampling method is used to select respondents and a total of 160 respondents (80 milk producers,40 milk vendors and 40 milk cafeteria) respondents were selected from four sub-cities (Adi-haki, Hadnet, Hawelti and Semen) which were chosen deliberately based on production potential.

3.4. Data Collection

3.4.1. Questionnaire survey

A cross-sectional survey was employed to collect data through semi-structured questionnaires. Detail information related to household characteristics, milking techniques, hygienic milk handling practices, milk collection and distribution, delivery and sale of milk, preparation and serving milk for consumption, traditional milk processing and preservation techniques, milk storage equipment, constraints of milk production, processing and marketing and post-harvest milk losses and its causes were collected.

3.4.2. Observational survey

Personal observation was performed during questionnaire survey. Data related to types of housing, floor, roof, drainage, cleanliness of farm, kitchen and vendor/server, and storage equipment status were recorded on respective format and check lists prepared for specific activity.

3.5. Data Analysis

The primary data collected from household survey through semi-structured questionnaires was processed (data was checked for accuracy, data entries was coded, coded data was entered in to computer). Processed data was analyzed by using Statistical Package for Social Science (SPSS) version 16.0 software. Descriptive statistics such as mean, percentage and frequency were used to analyze the data quantitatively.

3.6. Ethical consideration

Ethical clearance was obtained from Mekelle University College of Veterinary Sciences Research and Community services council before undertaking the research. Verbal consent was also obtained from participants for the questionnaire-based survey.

4. CHAPTER IV: RESULTS AND DISCUSSIONS

4.1. Characteristics of the Respondents

From a total of 160 interviewees, 52.5% of them were females and the rest 47.5% were males (Table 1).The highest age groups of the interviewed were ranged 18-28 years which accounts about 45% and followed by 29-39 years (27.5%), 40-50 years (18.1%), and 51-61 year (6.9%) years and above 61 years (2.5%).

Table 1: Sex, age, marital status and level of education of the respondents

Variables	Frequency (N=160)	Percent
Sex		
Males	76	47.5
Females	84	52.5
Age groups		
18-28	72	45.0
29-39	44	27.5
40-50	29	18.1
51-61	11	6.9
Above 61	4	2.5
Marital status		
Single	53	33.1
Married	100	62.5
Widowed	5	3.1
Divorced	2	1.2
Level of education		
Illiterate	4	2.5
Read and write	11	6.9
Elementary (1-8)	54	33.8
High school(9-10)	43	26.9
Preparatory(11 -12)	7	4.4
Diploma	36	22.5
Degree	5	3.1

N=number of respondents

The highest percent (33.8%) of the interviewed members were attended elementary school (grade 1-8), while (2.5%) of them were illiterates (Table 1). This illiteracy was observed in milk producers but, there were higher literacy in milk vendors and cafeteria as compared to milk producers. From the entire respondents of the study area, 62.5% have got married. The rest 33.1%, 3.1% and 1.2% were single, widowed and divorced respectively.

4.2. Milk Production

The total annual national milk production in Ethiopia received from 9.6 million dairy cows and the product is estimated to be 2.9 billion liters which is, 1.69 liters yield per cow per day on average (Ayantu, 2021). According to the current study result in Mekele city, the average milk production per week per household was 123.09 liters/week (Table 2).The highest milk production was observed in Hadnet sub-city (164.85L/wk, 33.5%) ,whereas the lowest milk production was observed in Semien (44.45L/wk, 9%).

Table 2: Weekly milk production in Mekelle city

Sub-city	Mean(liters/week)	N	% of total sum
Adihaki	120.65	20	24.5%
Semien	44.45	20	9.0%
Hadnet	164.85	20	33.5%
Hawelti	162.40	20	33.0%
Average	123.09	80	100.0%

N=number of respondents

4.3. Hygienic Milk Handling Practices

4.3.1. Type of housing and cleaning practices

According to the current study, about 60% of housing (barn) type of dairy farm was semi – opened and the rest 40% was a closed type (Table 3). While the floor and the roof of the barn were concrete (66.2%) and metal sheet (96.2%) respectively. Maintaining the sanitary condition of barn is important for the production of good quality milk. Clean, dry and comfortable bedding condition is important to minimize the growth of pathogenic microorganisms (Gurmesa, 2015).

In the present study showed that 83.8% of the respondents clean the barn once a day, while the rest 16.2% clean their barn three times a week (Table 3). However, proper and clean housing

environment is a prerequisite to produce milk and milk products of acceptable quality (Gurmesa, 2015).

Table 3: Types of housing and cleanliness of the farm

Variables	Frequency(N=80)	Percent
Housing type		
Closed type	32	40
semi-open	48	60
Floor type		
Concrete	53	66.2
Stone	13	16.2
Muddy	14	17.2
Roof type		
Metal sheet	77	96.5
Grass	2	2.5
Plastic	1	1.2
Drainage		
Good	10	12.5
Satisfactory	51	63.8
Poor	19	23.8
Cleaning frequency of the barn		
Once a day	67	83.8
Three times a week	13	16.2
Farm cleanliness		
Excellent	13	16.2
Satisfactory	60	75
Poor	7	8.8
Storage condition of the hay and concentrate		
Excellent	11	13.8
Satisfactory	62	77.5
Poor	7	8.8

N=number of respondents

4.3.2. Hygienic condition of cows and milker

In the study area, all the interviewed milk producers practice hand milking. In addition to that these all milk producers wash their hand before milking, milk their cows twice a day during the morning and evening times as well as wash the cow's udder before milking (Table 4). This result contradicted with (Abebe *et al*. ,2012) who reported that all respondents did not use udder

washing before milking in Gurage Zone, Ezha district, southern Ethiopia. Cleaning of the udder of cows before milking is one of the most important hygienic practices required to ensure clean milk production. This is important since the udder of the milking cows could have direct contact with the ground, urine, dung and feed refusals (Zelalem, 2010; Saba, 2015).

The use of individual towel and following essential cleaning practices during milking is crucial for the production of quality milk (Saba, 2015). In Mekelle city from the total respondents of milk producers, 51.25 % use individual towels to dry udder before milking (Table 4). However, about 27.5% of the milk producers do not use towels or just use hands for udder drying, whereas the remaining 21.25% use collective towels. (Zelalem, 2010; Saba, 2015) reported that carefully cleaning of the udder followed by drying with a clean cloth was effective in reducing the number of bacteria in milk contributed from soiled teats.

Table 4: Hygienic condition of cows and milkers

	Milk Producers (N=80)	
Variables	Frequency	Percent
Washing hands before milking		
Yes	80	100
When do you wash your hand?		
Before milking only	10	12.5
Before and after milking	70	87.5
Washing udder before milking		
Yes	**80**	**100**
Towel used for drying udder		
Collective towel	17	21.25
Individual towel	41	51.25
Just with hands	22	27.5
Milking methods		
Hand milking	80	100
Milking frequency/day		
Twice	80	100

N=number of respondents

4.3.3. Types of milking containers used for milking, storage and transportation

In the current study, about 95% of the interviewed milk producers used plastic container and only 5 % of the interviewed used stainless steel as milking, storage and transportation vessels (Table 5). This report agreed with the finding of (Gashaw and Gebrehiwot, 2018) who reported that about 88.13% of respondents used plastic utensils and only 11.87% of respondents used metallic utensils. The main types of plastic containers used to handle milk were plastic jerry cans (recycled cooking oil containers, of capacity 3 to 20 liters). These were used because they were cheap, light weight and better suited for transport in vehicles. The equipment used for milking, storage and transportation determine the quality of milk and milk products. Milk storage and transportation are aimed at having good quality milk available where and when needed for processing (Gurmesa, 2015; Walstra *et al*., 1999). Therefore, producers need to pay particular attention for the type as well as cleanliness of milk equipment.

The use of plastic containers can be a potential source for the contamination of milk by bacteria, because it allows the multiplication of bacteria on milk contact surfaces during the interval between milking. Unlike metal containers, plastic containers are less expensive hence easily affordable by majority of farmers. They are also easy to replace when taken away by regulatory bodies. Plastic containers were linked to poor milk quality due to the inability to fully clean and sterilize them (Ndungu, 2019).

4.3.4. Cleaning methods of milk handling equipment

This survey results revealed that cleaning of milk handling equipment is common in all respondents. According to this survey, 61.2% of the producers, 85% of the milk vendors and 87.5% of milk cafeteria used detergents and hot water to wash milk handling equipment whereas only 2.5%, 7.5, 10% and 18.8% of the milk producers cleaned their milk vessels with cold water, hot water, cold water and soap, hot water and soap respectively. All respondents in this survey study reported that they washed and rinsed their milk containers before and after every use (Table 5).

4.3.5. Source of water used for cleaning

For production of quality milk a good supply of clean water is essential. Water used for washing and rinsing milk equipment during milk handling must be the same safety and purity as drinking water (Saba, 2015). Milk producers in Mekelle city used different water sources for cleaning purpose. According to the current study results, the water source for milk producers were piped water (46.2%) followed by piped and river water (23.8%), hand dug well (22.5%), and piped and hand dug well (3.8%) (Table 5). Water from non-tap sources used for different purposes can definitely contribute to poor quality milk and milk products. Therefore, it is important that producers should at least filter and heat treat it before use (Zelalem, 2010).

Table 5: Types of milk storage, sources of water and methods of cleaning milk containers

Variables	**producers(n=80)**	**vendors(n=40)**	**cafeteria(n=40)**
Types of milk storage (%)			
Plastic container	95	95	97.5
Stainless steel	5	5	2.5
Water source for cleaning (%)			
Piped water	46.2	100	100
River	3.8		
Hand dug well	22.5		
Piped water and river	23.8		
Piped water and hand dug well	3.8		
Methods of cleaning milk containers (%)			
Cold water	2.5		
Hot water	10		
cold water and soap	7.5		
hot water and soap	18.8	15	12.5
detergent and hot water	61.2	85	87.5
Frequency of washing milk containers (%)			
Before and after every use	100	100	100

N=number of respondents

Figure 1: Ddifferent types of plastic milk storage containers of milk vendor at Hadnet sub-city

Figure 2: Traditional milk processing/churning equipment

4.3.6. Smoking practice of milk containers

The entire household in the study area were washed and smoked their milk containers. According to the study results, the main purposes of fumigation (smoking practice) were improving flavor (28.8%, 27.5% and 32.5% for milk producers, vendors and cafeteria respectively), increasing shelf life (22.5%,22.5% and 5% for producers, vendors and cafeteria respectively), and both improving flavor and increasing shelf life (48.8%,50% and 62.5% for producers, vendors and cafeteria respectively) (Table 6). In the study area, all milk vendors and cafeteria were fumigated their milk containers before every use. However, 57.5%, 17.5% and 25% of the milk producers were smoked the milk utensils before every use, after every use and before and after every use respectively (Table 6).

The milk containers were fumigated with smoke from burned wood of specific tree species such as *Olea africana (*Awlie), *Acacia nilotica (*Seraw*)*, *Dodenea anguistifolia (*Tahses*)*, *Euclea schimperi (*Kliewo*)* and *Solanum incanum* (Qorenet) (Table 6). The milk containers were fumigated by inverting them over smoking chips until the smoke died out (about 5 to 10 minutes). The residual charcoal pieces were brushed out with special twigs, followed by rinsing with water (Wayua, 2012).

According to the local understanding, smoking of milk containers imparted special taste and flavour to the milk, and disinfected the containers, thus reducing the numbers of microorganisms and thereby extending the shelf life of milk (Wayua, 2012). Similarly, Endrias (2019) reported that the purpose of smoking was to facilitate fermentation and to bring good taste or aroma to the dairy product.

Table 6: Practice, reason, frequency and plant used for smoking

Variables	**Milk producers(N= 80)**		**Milk vendors($N = 40$)**		**Milk cafeteria($N = 40$)**	
	Frequency	Percent	Frequency	Percent	frequency	Percent
Smoking						
Yes	80	100	40	100	40	100
Reason for smoking						
Improving flavor	23	28.8	11	27.5	13	32.5
Increasing shelf life	18	22.5	9	22.5	2	5
Improving flavor and shelf life	39	48.8	20	50	25	62.5
Smoking frequency						
Before every use	46	57.5	40	100	40	100
After every use	14	17.5				
Before and after every use	20	25				
Plant used for smoking						
Olea africana (Awlie)	11	13.8	9	22.5	2	5

Acacia Bussei (Seraw)	38	47.5	17	42.5	14	35
Solanum incanum (Qorenet)	3	3.8	5	12.5	2	5
Dodenea Anguistifolia (Tahses)	3	3.8	4	10	6	15
Euclea schimperi (Kliewo)	10	12.5			4	10
Olea Africana and Acacia Bussei	13	1.5	1	2.5	4	10
Olea africana , Acacia Bussei and qorenet			1	2.5		
Acacia Bussei and qorenet	2	2.5	3	7.5	8	20

N = number of respondents

Table 7: Mode of transportation for milk vendors and producers

	Milk producers(N=80)		**Milk vendors(N=40)**	
Variables	Frequency	Percent	Frequency	Percent
on foot	34	42.5	14	35
Bicycle	23	28.8	10	25
on foot and bicycle			10	25
Cart	15	18.8	1	2.5
motor cycle	3	3.8		
Vehicle	5	6.2	5	12.5
Total	**80**	**100.0**	**40**	**100**

4.3.7. Mode of milk transportation

The means of milk transportation used by majority of the respondents in the study area for milk producers were on foot (42.5%) , bicycle (28.8%),cart (18.8%), motor cycle (3.8%) and public transport vehicle (6.2%), while the milk vendors were used on foot (35%), bicycle (25%), on foot and bicycle (25%) and the remaining were cart (12.5%) and public transport vehicle

(12.5%)(Table 7). This result agreed with Shiga (2013) who reported that means of delivery milk was done on foot (56.9%), by bicycle (13.8%) and motorcycle (4.6%).

4.4. Milk Marketing Channels

There are many milk marketing channels through which smallholder dairy farmers sell their dairy products. However, most of the dairy farmers in the study area preferred to sell their milk through informal chain where they get high price per litre of milk (Debele and Verschuur, 2013). As indicated in Figure 3, milk producers' in the current study area were sold their raw cow milk to milk vendors (42.5%), individual households (18.2%), and cafeteria (6.2%). In other hand, the milk cafeterias collect their 77.5% milk from urban and peri-urban milk producers (Figure 4). Tsegaye (2016) has also reported that milk produced in Bona district, Southern Ethiopia was sold to consumers (68%) and traders (32%).

Marketing channels are routes through which products pass as they are moved from the farm to the consumer (Winrock, 1989). Marketing outlet is the final market place to deliver the milk product, where it may pass through various channels. In the study area, milk was sold for the consumers through tracing of different channels and outlets.

Producers-consumers

Producers' → vendors→ Consumers

Producers' → vendors→cafeteria →Consumers

Producers' → cafeteria→ Consumers

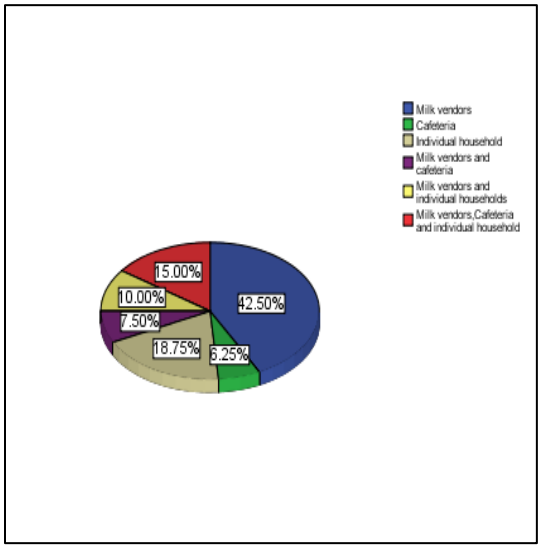


Figure 3: Marketing channel of milk producers

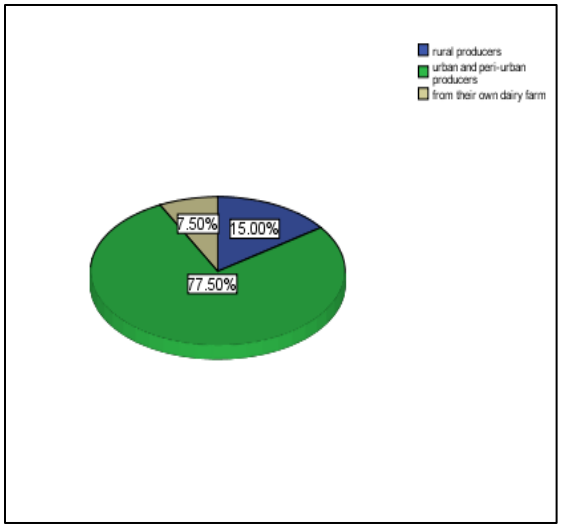


Figure 4**:** Marketing channel of milk cafeteria

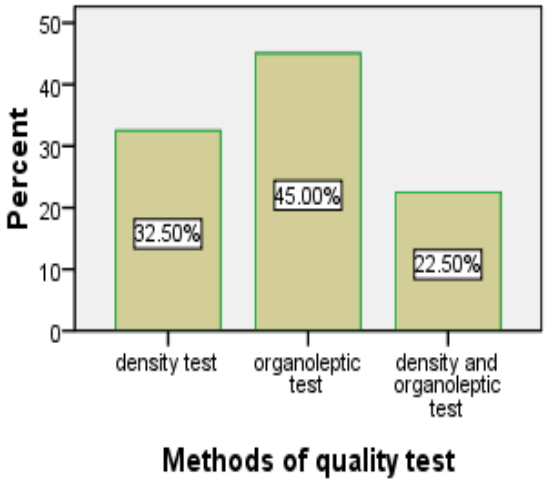


Figure 5: Methods of milk quality test used by milk vendors

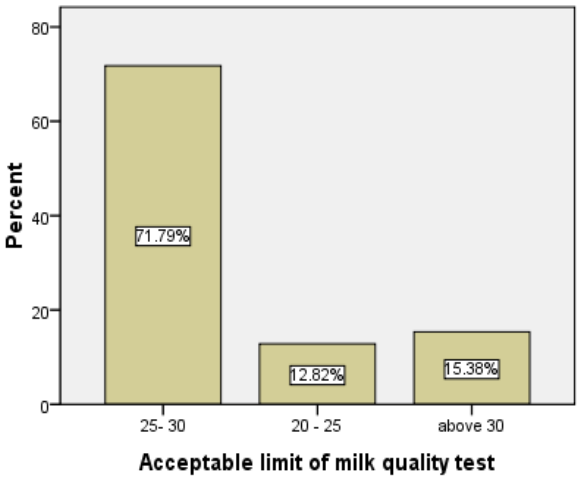


Figure 6: Acceptable limit of milk quality test

4.5. Methods of milk quality test

The milk vendors in the current study area were tested the quality of milk by using organoleptic and density test. Testing milk for organoleptic characteristics is often called sensory testing and done using the normal senses of sight, smell and taste in order to know the overall quality. The density of milk, among others, is usually used for quality test mainly to check for addition of water to milk or removal of cream. Addition of water to milk minimizes milk density, while removal of cream increases it.

As indicated in Figure 5, about 45% of the milk vendor respondents used organoleptic test followed by density test (32.5%) and by both organoleptic and density test (22.5%).The acceptable limits of milk quality tested by milk vendors using a lactometer (milk density) in the study area was 12.82% for lactometer reading 20-25, 71.79% for 25-30 and 15.38% for lactometer reading was above 30 (figure 6). Normal milk has a density of 1.026 -1.032 g/ml (or 26 - 32 on the lactometer reading). If water has been added, the lactometer reading will be below 26. If any solid such as flour has been added, the reading will be above 32.

4.6. Traditional Milk Processing

In Ethiopia, milk processing is generally based on Rg'o (Ethiopian naturally fermented milk) without any defined starter culture. This is due to a number of reasons including high ambient temperatures, small daily quantities of milk, consumer preference and increased keeping quality

of sour milk. Milk processing is an important measure for the preservation of food constituents as sources of nutrients and cash for many people in the world (Abebe *et al*., 2014).

In industrialized countries fresh cow's milk is usually extensively processed to be safe for human consumption, to meet consumer requirements and also to prolong its shelf life. After harvesting, milk is immediately cooled and transported to milk factories. The raw milk is subjected to different processes to inactivate pathogenic microorganisms such as bacteria, spores, yeast, molds, and viruses, which can cause health problems in humans (Geiselhart *et al*., 2021).

Milk processing is usually designed to remove water from milk or reduce the moisture content of the product. Milk producers, vendors and cafeteria in the current study area, processed fresh whole milk into sour milk prior to churning. Out of the total weekly milk produced, most of it was sold (73.61%), 19.16% was processed while the left was consumed within the household (6.63%). Out of the milk bought by milk vendors, 53.49% and 46.26% was sold and processed respectively. Whereas out of the milk bought by milk cafeteria, 57.52% and 41.76% was sold and processed respectively (Table 9). In the current study area milk was converted traditionally in to yoghurt (*Rg'o*), butter (*Tesmi*), buttermilk (*Awso*), Ethiopian cottage cheese (*Ajbo*), ghee (*Fluh tesmi*) and whey (*Maycheba*) (Figure 7).

In the study area, only traditional milk processing equipments were used for all processing activities. The traditional milk processing is generally time consuming, varieties of products was limited. Naturally fermented milk is the basis of diversified milk products such as butter, ghee, yoghurt, cheese, buttermilk and whey manufacturing. The traditional milk processing equipment and its problem is summarized in (Table 8).

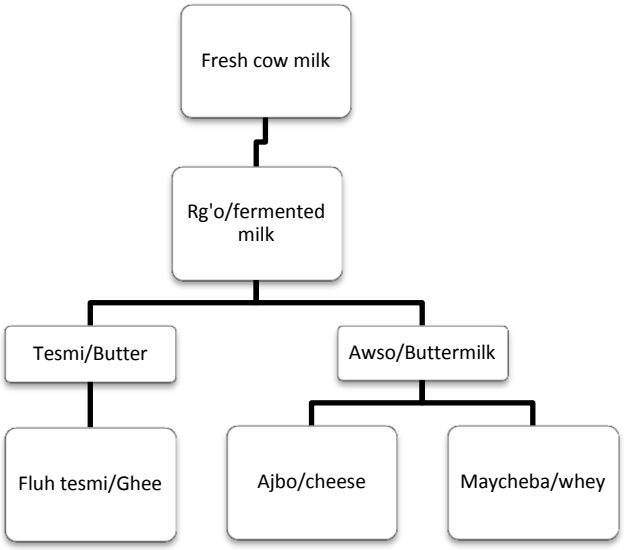


Figure 7: Process flow of traditional milk processing and utilization

4.7. Milk Utilization

Milk is utilized in different forms in the study area: as fresh liquid milk, as fermented milk (*Rg'o*), butter (*Tesmi*), cottage cheese (Locally called *Ajbo*), buttermilk (*Awso/Hquan*) and whey (*Maycheba*). Milk in the studied area was sold to local markets, processed to different milk products and used for family consumption. The remaining considered as milk post-harvest losses. The current study revealed that about 8.231 liters of fresh whole milk was consumed per week (Table 9). According to the result, the majority of the milk produced was sold to local markets and processed to fermented milk. This finding was opposed to Tsedey and Bereket (2016) who reported that the majority of the milk produced in Southern Ethiopia was used for home consumption and that is in the form of fresh whole milk.

Table 8: Traditional milk processing equipment and its problems

Variables	Producers(N=80)		Vendors(N=40)		Cafeteria(N=40)	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Traditional milk processing equipment						

Clay	1	1.2				
Hamham	1	1.2			1	2.5
Plastic containers	78	97.5	40	100	39	97.5
Problems of using traditional milk equipment						
Difficult for cleaning	16	20	2	5	12	30
Easily broken	2	2.5			3	7.5
Difficult for handling	50	62.5	16	40	18	45
Difficult for cleaning and easily broken	2	2.5				
Difficult for cleaning and handling	10	12.5	22	55	6	15
Easily broken and difficult for handling					1	2.5
Milk serving equipment						
Clay cup/Wancha					33	82.5
Plastic cup					2	5
Ceramic cup					3	7.5
Glass cup					2	5

N=number of respondents

Table 9: Milk utilization and estimated milk post-harvest losses

Variables	Milk producers		Milk vendors		Milk cafeteria	
	N	Mean	N	Mean	N	Mean
Milk produced L /wk	80	124.14				
Milk bought L/wk			40	634.73	40	188.52
Milk sold L/wk	80	91.38	40	339.5	40	108.45
Milk consumed L/wk	80	8.23	40			
Milk processed L/wk	80	23.79	40	293.65	40	78.74
Milk post-harvest losses L/wk	80	0.74(0.6%)	40	1.58(0.25%)	40	1.33(0.7%)

N=number of respondents

4.8. Sources, Sales and Condition of the Milk Premise in Milk Vendors and Cafeteria

Most of the milk vendors and cafeteria in the present study area responded that they bought their milk from rural and, urban and peri-urban producers. As indicated in (Table 10), all milk types were sold by all milk vendors. Whereas 62.5% of the milk cafeteria respondents sold all types of milk, 10% sold boiled milk only and the rest 27.5% of the respondents were sold raw and fermented milk only. All the milk selling area (premise) of the milk vendors was closed area; however 17.5% of the milk cafeteria was semi-opened; the left 82.5% was closed area. Cleanliness of the storage equipment, floor, server and kitchen were summarized in Table 10.

Table 10: Condition of the premise, sources and sales of milk

Variables	Milk vendors (N=40)		Milk cafeteria (N=40)	
	Frequency	**Percent**	**Frequency**	**Percent**
Sources of milk				
rural producers	4	10	6	15
Urban and peri- urban producers	34	85	31	77.5
From their own dairy farm	2	5	3	7.5
Types of milk sold				
Boiled milk only			4	10
Raw and fermented milk only			11	27.5
Raw, boiled and fermented milk	40	100	25	62.5
Serving milk to customers				
By immersing a cup in to the large container/cooking pan	40	100		
Hot from a thermal flask and put in a cup			1	2.5
Hot from the cooking pan and put in a cup			39	97.5
Types of containers used to fetch from large containers				
A cup with handle	40	100	40	100
Storage equipment status				
Very clean	24	60	22	55
Clean	16	40	18	45
Covering storage equipment				
Yes				
Cleanliness of the server				
Very clean	21	52.5	17	42.5
Clean	19	47.5	23	57.5
Condition of the premise				
Open area			7	17.5
Closed area	40	100	33	82.5
Cleanliness of the kitchen				
Very clean			28	70
Clean			12	30
Cleanliness of the floor				
Very clean	30	75	25	62.5
Clean	10	25	15	37.5

N= numbers of respondents

4.9. Post-Harvest Losses of Milk

Farm losses in Ethiopia were quantified at 1.3 per cent and this was mainly due to spillage during milking and transportation, and spoilage caused by poor hygiene and use of inappropriate containers for milk storage. However, farm losses represent only a partial loss in value since in many cases unsold fresh milk that goes sour is sold later at a lower price. Off-farm losses were largely due to spillage during transportation and at retailers' premises due to poor handling and use of inappropriate containers. Transporters delivering milk from farms to private processors reported spillage losses of up to 2 percent of milk handled. Informal sector transporters who usually deliver milk door-to-door reported 1.5 per cent of milk lost through spillage (Lore *et al*., 2005).

The estimation of postharvest losses of milk in the current study was assumed only milk that is rejected from sale and milk dumped due to different reasons. The estimated post-harvest losses

of milk in the study area were 0.6%, 0.25% and 0.70% for milk producers, vendors and cafeteria respectively. These results obtained by dividing milk post-harvest losses to weekly milk produced for milk producers and to weekly milk bought for vendors and cafeteria (Table 9). The major reasons for facing milk post-harvest losses and milk rejection problems were summarized in (Table 11).

Table 11: Reasons for facing milk post-harvest losses and milk rejection problems

Variables	Milk producers (N= **80**)		Milk vendors (***N* = 40**)		Milk cafeteria (***N* = 40**)	
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Milk post-harvest losses						
Yes	65	81.2	40	100	28	70
No	15	18.8	-	-	12	30
Total	**80**	**100**	**40**	**100**	**40**	**100**
Causes of milk losses						
Spoilage	4	6.2	1	2.5	20	71.4
Spillage	3	4.6	-	-	-	-
Lack of market	58	89.2	18	45	7	25
Spoilage and spillage	-	-	-		1	3.6
Spoilage and lack of market	-	-	21	52.5	-	-
Total	**65**	**100**	**40**	**100**	**28**	**100**
Facing milk rejection problems						
Yes	63	78.8	12	30	20	50
No	17	21.2	28	70	20	50
Total	**80**	**100**	**40**	**100**	**40**	**100**
Reason for rejection						
Poor milk handling practices	26	41.3	9	75	13	65
Long distance to market	2	3.2	1	8.3	-	-
Use of inappropriate containers	15	23.8	-	-	-	-
Lack of cooling facilities	11	17.5	-	-	1	5
Cleaning problems	9	14.3	2	16.7	-	-
Adulteration with water			-	-	6	30
Total	**63**	**100**	**12**	**100**	**20**	**100**

4.10. Gender Participation in Milking, Processing and Marketing of Milk

Labor division among family members concerning dairying activities such as milking, milk processing and milk marketing in the study area are shown in the (Table 12). From milk

producer's respondents, 62.5% of the milking activity was done by males, 27.5% by both male and female and the remaining 10% by female only (Table 10). This result was contradicted with a research done in Toch district, Southern Ethiopia by Endrias (2019) who reported that 88.7% of milking activity is done by women, and the rest 11.3% of the milking activity was done by both genders.

The highest engagement of females in dairy activity was observed in milk processing (95%, 100%, and 100% of milk producers, vendors and cafeteria respectively). This finding was in good agreement with the observation of Endrias (2019) who reported that 94.89% of milk processing in the Konta special district, Southern Ethiopia was done by women and the rest 5.11% of milk processing was done by both males and females.

Table 12: Gender participation in milking, processing and marketing of milk

Variables	**Milk producers (N= 80)**		**Milk vendors ($N = 40$)**		**Milk cafeteria ($N = 40$)**	
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Milking						
Male	50	62.5				
Female	8	10				
Male and female	22	27.5				
Total	80	100				
Processing						
Male	3	3.8				
Female	76	95	40	100	40	100
Male and female	1	1.2				
Total	80	100	40	100	40	100
Marketing						
Male	7	8.8				
Female	22	27.5	33	82.5	36	90
Male and female	51	63.8	7	17.5	4	10
Total	**80**	**100**	**40**	**100**	**40**	**100**

N=number of respondents

Table 13: Milk production, processing and marketing constraints

Variables	**Milk producers (N= 80)**	**Milk vendors ($N = 40$)**	**Milk cafeteria ($N = 40$)**

	Frequency	Percent	Frequency	Percent	Frequency	Percent
Production constraints						
Low milk yield	8	10				
Shortage and high feed cost	42	52.5				
Lack of veterinary and AI services	18	22.5				
Lack of credit services	3	3.8				
Lack of forage lands	9	11.2				
Total	**80**	**100**				
Processing constraints						
Low milk yield/supply	13	16.2	16	40	1	2.5
Lack of training	15	18.8	9	22.5	2	5
Poor milk infrastructure	19	23.8	5	2.5	1	2.5
Poor milk quality			2	5	13	32.5
Lack of small scale processing equipment	23	28.8	7	17.5	22	55
Lack of credit service	10	12.5	1	2.5		
Expensiveness of house rent					1	2.5
Total	**80**	**100**	**40**	**100**	**40**	**100**
Market constraints						
Low milk yield/supply	7	8.8	6	15	2	5
Low price of milk	8	10				
Poor milk infrastructure	13	16.2	4	10	2	5
Expensiveness of house rent	5	6.2	5	12.5	7	17.5
Lack of linkage	24	30			4	10
Lack of market during fasting period	23	28.8	18	45	20	50
Lack of credit services			4	10	2	5
Poor milk quality			3	7.5	3	7.5
Total	**80**	**100**	**40**	**100**	**40**	**100**

N=number of respondents

4.11. Milk Production, Processing and Marketing Constraints

4.11.1. Production constraints

There are different factors contributing for low production of milk in Ethiopia. The major milk production constraints in the present study areas were shortage and high cost of feed

(52.5%),followed by lack of veterinary and AI services (22.5%), lack of forage land (11.2%), low milk yield (10%), and lack of credit services (3.8%) (Table13). Similarly, Tsedey and Bereket (2016) and Tsadkan and Amanuel (2016) reported that poor milk production and reproduction potential of dairy were associated with feed shortage, unavailability of improved breed, lack of veterinary services and low milk yield.

4.11.2. Processing constraints

There are different determinants contribute for a very poor trend of processing in the studied sub-cities. The result of the current study revealed that the main constraints of milk processing were lack of small scale processing equipment (28.8% and 55% of milk producers and milk cafeteria respectively), low milk supply (40% in milk vendors) and poor milk quality(32.5% in milk cafeteria) (Table 13).

The major challenges in milk processing industries of Ethiopia were milk supply through informal market, shortage of milk in quality and quantity, lack of cold truck vehicles to collect milk from milk producer or collection center and final products to market or consumers, lack of quality and quantity packaging material, interruption of electric power and irregular current flow of electric power, lack of existing original milk processing machine spare parts producing factories, lack of trained man power on machine maintenance or repair, lack of well-equipped laboratory facilities especially in microbiology laboratory and milk consuming habit of the country (Japaro, 2021).

4.11.3. Marketing constraints

The major marketing constraints of milk and milk products in the current study area were summarized in Table 13. Among the milk marketing constraints, lack of linkage (30% in milk producers) and lack of marketing during the fasting period of the Ethiopian Orthodox Church followers (28.8%,45%,and 50% observed in milk producers, vendors and cafeteria respectively) took the lion shares. A research study conducted by Jiregna et al, (2013) reported that fluctuation in demand and supply of dairy products (as a result of feed shortage and different socio cultural reasons), poor infrastructure (Lack of cooling facilities, simple processing equipment and quality testing skills and equipment) and the long time fasting of the members of the Ethiopian Orthodox churches are constraints for marketing.

4.12. Association of Sex, Age and Level of Education with Milk Handling Practices

4.12.1. Association of sex with milk handling practices of milk producers

Among the milk handling practices carried out by milk producers, none of them were significantly ($p>0.05$) associated with the sex of the respondents (Table 14).

4.12.2. Association of age with milk handling practices of milk vendors

Among the milk handling practices conducted by milk vendors, sources of milk, types of milk containers and cleaning agents were significantly ($p<0.05$) associated with the age of the respondents (Table 15).

4.12.3. Association of level of education with milk handling practices of milk cafeteria

Among the milk handling practices performed by milk cafeteria, milk reception time and reason for milk rejection problems were significantly ($p<0.05$) associated with the level of education (Table 16).

Table 14: Association of sex with milk handling practices of milk producers

Parameters of handling practices	**Sex**	
	X^2	p-value
Towel for drying	0.624	0.732
Source of water	6.768	0.149
Types of milk containers	1.404	0.236
Cleaning agents	2.311	0.679
Mean of transportation	7.775	0.101

Table 15: Association of age with milk handling practices of milk vendors

Parameters of handling practices	**Age**	
	X^2	p-value
Sources of milk	42.987	0.000

Milk delivery time	2.654	0.448
Types of milk containers	40.000	0.000
Means of transportation	20.045	0.066
Cleaning agents	3.331	0.343
Methods of quality test	15.678	0.016
Causes of milk losses	7.603	0.269
Milk rejection problems	5.615	0.132

Table 16: Association of level of education with milk handling practices

Parameters of handling practices	**Level of education**	
	X^2	p-value
Types of milk sold	10.743	0.097
Milk reception time	13.109	0.004
Types of milk containers	1.905	0.592
Milk bought from	4.088	0.665
Facing milk losses	4.319	0.229
Causes of milk losses	3.182	0.786
Facing milk rejection problems	3.254	0.354
Reason for milk rejection	24.654	0.000

5. CHAPTER V: CONCLUSION AND RECOMMENDATION

In the study area, the handling practice and post-harvest losses of milk were assessed. The participation of females in milk handling activities was higher in milk vendors and cafeteria as compared to in milk producers, whereas the involvement of these females with in milk producers

was lower as compared to the males. There were a fewer percentage (2.5%) of illiteracy in milk producers. The ability to read and write would enable the producers to better utilize and adopt technology effectively and efficiently whatever resources exist in their area (Wayua, 2012). About 60% of the housing (barn) type of the dairy cows were semi-opened. This semi-openness of the barn will expose the animal for unwanted hot condition, wind and rain. Half of the milk producers use individual towel for drying the cow's udder. However, some respondents use collective towel and bare hand to dry the udder. The use of collective towel and bare hand for drying udder may result in contamination of the udder. Majority of the milk producers, vendors and cafeteria used plastic containers for milking, storage and transportation purposes. The use of plastic containers can affect milk quality because plastic containers can easily crack, hide spoilage bacteria and are difficult to clean. All milk vendors and cafeterias used pipe water, but the milk producers used river water and hand dug well in addition to pipe water for washing and rinsing milk equipment. Water from non-tap sources used for different purposes can definitely contribute to poor quality milk and milk products. Even if the majority of respondents used detergents and hot water, there were fewer milk producers who used cold water for cleaning the hands, milk utensils and the cow's udder. All interviewed in the study area practiced smoking of milk containers by using different plant species in order to improve the flavor and increase shelf life of the milk. The means of milk transportation used by majority of the respondents in the study area were on foot, bicycle, cart, motor cycle and public transport vehicle .The milk vendors tested the quality of milk by using organoleptic and density test. Fresh cow milk converted in to yoghurt (*Rg'o*), butter (*Tesmi*), buttermilk (*Awso*), Ethiopian cottage cheese (*Ajbo*), ghee (*Fluh tesmi*) and whey (*Maycheba*) by using traditional milk processing equipmet. These equipments' are easily broken, difficult for cleaning and handling. Milk post-harvest losses and rejection problems were faced in majority of the respondents. The main causes of milk losses were spoilage, spillage and lack of market. The major milk production constraints in the present study areas were shortage and high cost of feed , lack of veterinary and AI services, lack of forage land, low milk yield, and lack of credit services. Whereas the main constraints of milk processing were lack of small scale processing equipment, low milk supply, lack of training and poor milk quality and infrastructure.

Depending on the findings, the following recommendations are made:

- Training of milk producers, vendors and cafeteria on hygienic milk handling practices and quality testing can play a great role in lowering milk spillage, contamination and microbial spoilage.
- Awareness should be created among milk producers on the importance of adequate udder preparation, hygienic milking technique, use of clean milk equipment, washing of milk containers and milkers hands using well treated water to improve the milk hygienic quality and shelf life.
- If possible, drinkable water should be available for effective cleaning and sanitizing of milk equipment and udder preparations, otherwise boiled water should be used for such purposes.
- Milking, storing and transporting milk in non-food grade plastic containers are difficult to sterilize and thus their use for milk handling contributes to milk spoilage. For this reason, the regulatory authorities do not approve of/should ban using plastic containers in milk marketing.
- Creating awareness among dairy industry stakeholders on the causes and levels of post-harvest milk loss can contribute towards reducing the amount of milk lost along the market chain, by making available technology and training information to users.
- Improve access to essential veterinary and AI services to maintain the health and productivity of dairy cow.
- Ensure availability of quality feed and fodder at affordable prices and encourage the cultivation of forage crops and green fodder.

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