MICROBIOLOGICAL AND COMPOSITIONAL QUALITY OF RAW MILK DELIVERED BY SMALL SCALE DAIRY FARMERS TO THE MILK COLLECTION CENTRES IN HAI DISTRICT, TANZANIA

By

Mboya Neema John

(BSc. Animal Science, SUA, Morogoro, Tanzania)

A dissertation submitted in partial fulfilment of the requirements for the degree of Master of Science in Dairy Science and Technology

Department of Animal Science

Faculty of Agriculture

University of Zimbabwe

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DECLARATION

BY THE CANDIDATE

I hereby declare to the University of Zimbabwe that this thesis ***MICROBIOLOGICAL AND COMPOSITIONAL QUALITY OF RAW MILK DELIVERED BY SMALL SCALE DAIRY FARMERS TO THE MILK COLLECTION CENTRES IN HAI DISTRICT TANZANIA*** submitted for the Master of Science degree at the University of Zimbabwe is my original work and has not been previously submitted to any other institution of higher education. All sources of cited literature are acknowledged and referenced.

Neema John Mboya June 2016

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BY SUPERVISORS

This work has been submitted for examination with our approval as University supervisors.

Dr. P.T Banda (Co-Supervisor)

Department of Animal Science

Faculty of Agriculture

University of Zimbabwe

Prof. Lusato Kurwijila (Associate-Supervisor)

Department of Animal Science

Faculty of Agriculture

Sokoine University of Agriculture

ABSTRACT

Microbiological and physical-chemical quality of raw milk delivered at milk collection centres in Hai District, Tanzania

By

Neema John Mboya

A total of 310 milk samples were collected from 180 small scale dairy farmers who brought their milk to Milk Collection Centres and 30 vendors in the study area. The bacteriological quality, physicochemical parameters and milk adulteration with Sulphonamides and Tetracycline drug residues were assessed. Microbiological quality evaluation was done based on Total Bacterial Count, Total Coliform Count, *E.coli* and pathogenic *E.coli* (O157: H7). For sake of comparisons milk 60 samples from Turiani and Mlandiz were added for antimicrobial residues analysis. In addition, a survey with the use of semi-structured questionnaires was conducted to assess the knowledge of farmers on clean milk production in the study area. Microbiological analyses were carried out using standard cultures, physicochemical properties by use of Automatic Milk Analyser and antibiotic residues using Charm EZ technique. Interviews revealed that 91% of respondents dried cows' udders after washing, 75% cleaned milk containers with hot water and 86.7% used plastic containers to transport milk. The mean bacterial counts were within acceptable limits as per East African Community standards. About 54% of *E.coli* was detected, but none for the pathogenic strain. Physicochemical properties of milk were within acceptable ranges for processing. Up to 25% of milk samples from farmers were positive for Tetracycline and Sulphonamides drug residues whilst the vendor samples were negative. More quality tests such as iodine and alcohol tests are recommended to ensure freedom of milk from adulteration with other materials apart from water.

DEDICATION

To my beloved family for their moral support throughout this study and commitment they have made in my academic life.

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Thank you all.

SYMBOLS AND ABBREVIATIONS

COMESA	Common Market for Eastern and Southern Africa
DALDO	District Agriculture and Livestock Development Officer
EAC	East African Community
EAS	East African Community Standard
HACCP	Hazard Analysis and Critical Control Points
iAGRI	Innovative Agriculture Research Initiative
MCC’s	Milk Collection Centres
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
SMAC	Sorbitol Mac Conkey Agar
SUA	Sokoine University of Agriculture
SUALISA	Sokoine University of Agriculture Laboratory for Interdisciplinary Statistical Analysis
TBC	Total Bacteria Count
TCC	Total Coliform Count
TBS	Tanzania Bureau of Standards
TDB	Tanzania Dairy Board
TFDA	Tanzania Food and Drugs Authority
UHT	Ultra-High Temperature

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CHAPTER ONE

1 INTRODUCTION

Small-scale dairying has a significant role in poverty alleviation and nutrition improvement in Tanzania (Mdegela *et al*, 2009). The sector provides employment to rural society and also is an important mean of life improvement. The employment can be in a form of milk selling, input supply and others are employed to attend dairy animals.

Small-scale dairy farmers are the major suppliers of milk in the informal milk market in Tanzania (Msuya, 2012). Of all the milk produced from small-scale dairy farmers about 90% of the milk is marketed informally (Mwakalinga, 2010). In spite of the significant contribution of informally marketed milk to the total milk supply little is known about the quality of the milk.

The bulky nature of milk and its nutritious characteristics attract microbes which contribute largely to the perishability of milk (Orregård, 2013) This creates a need to ensure clean milk production by small-scale farmers. Clean milk production depends on milking environment, the milker hygiene, cleanliness of udder, teats and containers that are used to store the milk. Contamination of milk after leaving the farm gate is largely due to poor milk handling practices and milk adulteration (Street and Bogor, 2013).

Milk produced in the informal sector is poorly handled (Omore *et al*, 2005). Unclean milk containers that are commonly used by milk vendors in informal milk marketing contribute a lot to milk contamination along the value chain. This is because milk vendors, as well as farmers use plastic jerry cans with narrow openings in handling milk hence making it very difficult for thorough cleaning (Swai *et al*, 2010). There is a need to make sure that milk is kept clean by avoiding all sources of contamination. This can be achieved by maintaining a high level of hygiene on milk handling (Debela, 2015).

Microbiological quality of milk plays an important role in ensuring safety to the consumer and profit to producers (Rejeev *et al*, 2012). Milk microbiological quality is of public health concern due to zoonotic diseases which are milk-brne such as tuberculosis, brucellosis, shigellosis and salmonellosis. There are also emerging pathogens of public health importance such as *E. coli* O157: H7, *Campylobacter jejuni*, *Yersinia enterolitica*, *Listeria monocytogenes* and *Salmonella sp* (Swai and Schoonman, 2011). Due to the fact that milk-borne diseases are of public health importance, there is a need to screen the milk in informal market for the sake of consumer health protection.

Antibiotic residues in the milk predispose consumers to health hazards such as allergies and bacterial resistance (Jones, 2009). The major cause for this problem is prolonged treatment of the lactating animals and failure to comply with the recommended withdrawal period of the drug. Due to poor record keeping, farmers may unknowingly sell the milk from the animal on treatment, further contributing to the problem. Apart from health hazards milk with antibiotic residues cannot be used in making fermented milk products because the starter culture used in making these products cannot survive in milk with antibiotic residues (Adetunji, 2011).

This study aimed at assessing the microbiological quality, physicochemical and adulteration status of milk from small-scale farmers and vendors in Hai District to trace the possible sources of milk contamination. The results from the study will be used to generate information showing the factors that influence the quality of milk in the study area. Such information is useful to farmers when looking for more profitable markets for their milk and also informing the stake holders in the dairy sector.

1.1 Problem Statement

There is little published information on the quality of milk produced by small-scale farmers in Tanzania. While studies were done in Arusha, Morogoro and Njombe (Mdegela *et al*, 2009;Karimuribo *et al*, 2015; Ngasala *et al*, 2015) in which the animal kept is of indigenous breeds, little is known about the milk quality produced by crosses of improved dairy breeds that are kept by most farmers in Hai District, Kilimanjaro region.

1.2 Justification

Microbiological, chemical and physical composition qualities of milk are among the important public health issues for milk consumers (Mansouri-Najandi and Sharifi, 2013). Apart from health issues, it helps to persuade processors to buy from small-scale farmers. For this reason, it is essential to make sure that milk consumers are paying for the safe dairy products. The assurance can only be guaranteed after research studies have been conducted. This study intends to provide information on the safety and quality of milk in the study site and hence helps stakeholders when formulating the policy concerning dairy industry. The study also will provide information to the extension agents in the study area on the important practice to be taught to farmers to ensure clean and high -quality milk production by small-scale dairy farmers.

1.3 Objectives

The main objective of this study was to assess the factors influencing the milk quality from small-scale dairy farmers in the Hai District in Tanzania.

1.3.1 Specific objectives

The specific objectives of the study were to:

a) Assess the knowledge of farmers on quality milk production and dairy animal management practices under small-scale dairy production conditions.

b) Evaluate microbiological quality of milk from farmers and vendors.

c) Assess the milk composition wholesomeness and freedom from drug residues from farmers and vendors.

1.4 Hypotheses

H_0: There is no difference in the milk microbiological quality from farmers and vendors in Hai District.

H_0: There is no difference in milk composition, wholesomeness and amount of drug residues in milk from farmers and vendors in the study area.

CHAPTER TWO

2 LITERATURE REVIEW

2.1 Introduction

The dairy sector is one of the important livestock components in Tanzania. It contributes about 3.8% of Gross Domestic Products from the livestock sector which is one-third of the 4.6% contributed by livestock sector (Njombe, 2011). The sector is dominated by small-scale dairy farmers. The scenario is also the same with Sub-Saharan countries (Uddin *et al*, 2012) with the exception of Zimbabwe, South Africa and Namibia. In this chapter, the work that has been done on the contribution of smallholder dairy farmers in the Sub-Saharan Africa and Tanzania to national milk production is reviewed. Production, marketing and policy issues that influence milk composition as well as hygienic quality were assessed. Lastly, the problem of antibiotic residues in milk was reviewed.

2.2 Contribution of Small-Scale Dairy Farmers in Tanzania

2.2.1 Improved Nutrition

Milk production in Tanzania is estimated to be 2.5 billion litres per year with a population of 45 million the per capita consumption is therefore about 50 litres per person per year (Kaush *et al*, 2015). This amount is less than the per capita consumption in Kenya which is 100 litres per person per year (Muriuki, 2011) and the world average which is 108 litres per person per year and the amount recommended by FAO of 200 litres per person per year (Kim *et al*, 2009). The low milk production is due to low milk yield due to few improved dairy cattle estimated to be about 680 000 cattle against the desired number of 3 000 000 improved dairy cattle (Njombe, 2011). In addition, more than 90% of milk from small-scale dairy farmers is marketed informally (Njombe, 2011).

Due to the high nutritive value of milk, it is essential to increase the consumption level so as to improve the nutrition status especially for children and infants less than 5 years of age. Since infants are vulnerable to protein-energy malnutrition this requires that milk provided to this group must comply with the standard nutritive value for milk to form an important component of their diet (Nwankwo *et al*, 2015). Milk supplies high-quality protein, minerals and vitamins (Achchuthan and Kajananthan, 2012).

2.2.2 Improved Livelihood

Small-scale dairying can be a viable tool in poverty and malnutrition alleviation in low-income societies (Uddin *et al*, 2012). Sales obtained through selling milk help farmers to earn money that is used to pay for other important services. Small-scale farmers combine crops and livestock. Manure from the animals is used to fertilise their farms and contribute to crops productivity. Dairy production acts as an extra source of income to rural populations which depend only on crops (Amarja, 2013).

2.2.3 Employment

Dairy production has been considered as a potential means of alleviating large scale unemployment, especially in rural areas (Marichamy *et al*, 2014). There is employment creation along the milk value chain. People are in dairy input supply business, production of milk, marketing of milk and processors. Dairy helps people in increasing the income through selling raw milk and processing of dairy products in small-scale basis which is commonly run by women groups.

2.3 Constraints Faced by Small Scale Dairy Farmers

2.3.1 Seasonal and Low-Quality Feeds

There are plenty of feeds during the rainy season and are in deficit in the dry season. This causes milk productivity to fluctuate depending on the feed availability. A study by (Kivaria, 2006) in Dar-es-Salaam Tanzania showed that during the rainy season the distance to forage source was half a kilometre but during the dry season the average distance travelled was over 20 kilometres.

The additional milk produced during the rainy season when feed is in abundance can be processed into high-value products which have longer shelf life and are of high microbiological as well as nutritional quality. Examples of such products include sterilised milk, UHT milk and milk powders. Products with long shelf life are available to consumers during the dry season when feed is scarce and milk yields are low.

2.3.2 Unreliable Milk Marketing

The milk produced by small-scale farmers is not formally marketed in most developing countries including Tanzania. It is possible to formalise the sector provided that there is a good policy concerning dairy production**.** A study done in Kenya by (Muriuki, 2011) on the performance of informal milk marketing sector, shows the advancement of the sector by tripling the amount of milk the informal dairy sector was handling from 144 million litres in 2002 to 423 million litres in 2007. The increased production was supported by the presence of conducive policy environment for the dairy sector as well as a large number of dairy cattle i.e 3 000 000 improved cattle from improved breeds (Muriuki, 2011). Formalising the milk marketing will help in providing the correct figures on milk productivity in small-scale dairy farmers. The formalisation success supported by a number of on-going milk projects, one of them is Irish project under "**MilkIt**" programme which is establishing a modern milk marketing of milk for small-scale dairy farmers as explained by (Muchichu, 2014). Also, there is support from Bill and Melinda Gates Foundation that is supporting small-scale dairy farmers in the southern highlands regions (Iringa and Mbeya) to increase milk production and access better market for their milk (EADD, 2010).

2.3.3 Lack of Incentive

The price for milk in Tanzania is done on a flat rate basis and not on a quality basis. This discourages the small scale farmers from producing clean and high-quality milk. The introduction of bonuses for clean milk and penalties for poor quality milk will motivate farmers to produce clean milk. The price incentive system is practised in countries like Zimbabwe and Zambia (Alemayehu *et al*, 2012). The introduction of this system will attract processors into buying milk from small-scale farmers because the milk quality will be ensured.

2.3.4 Poor Infrastructure

In Tanzania, infrastructure especially roads are very poor (Opiyo and Wambugu, 2011). Most roads are not all weather roads hence make it difficult to access milk producing areas during the rainy season. This makes it difficult during the rainy season to transport milk to the market. The travelling time of a farmer to a collection centre is between 30 minutes and 3hours (Scanagri, 2005). The time taken depends on the mode of transport i.e on foot, bicycle, motorcycle, oxcart or motor vehicle depending on the condition of the road. The source of energy to many small-scale dairy farmers is another obstacle which makes it difficult for them to cool milk soon after milking (Nell *et al*, 2013). Dairy farming in

Tanzania is done in the cooler part of the country i.e Northern and Western Zones. These areas are characterised by enough rainfall annually hence make it easy for adequate water availability all the year round for animals to drink and cleaning purposes.

2.4 Opportunities for Small Scale Dairy Farmers

2.4.1 Availability of Internal Market

In Tanzania, the population is growing at a rate of 3% annually (Amanor *et al*, 2013). This translates to growth in food demand in the country. There is an emerging segment of middle income earning people which have more purchasing power and is demanding quality milk for the money paid. This increases the market opportunity for milk production and processing in the country (Msuya, 2012a). Success in controlling milk quality will allow small-scale farmers to sell their milk to this market.

2.4.2 Increased Supply of Milk to Large Processors

There is underutilization of most of the milk processing plants in Tanzania. A study done by (Kurwijila, 2012) shows that processing plants utilisation in the country is only at 30% which is equivalent to 167 000 litres per day (Kaush, 2015). The underutilization is partly due to low supply of raw milk to these processing plants. The milk supply to the processing plants can be increased through allowing milk from small-scale dairy farmers to be collected and sent to the processing plants. The barrier to this is that the quality of milk produced by small-scale dairy farmers is not well known. There are few studies done in other parts of Tanzania on milk quality. One of the studies on milk quality produced by small-scale dairy farmers done by (Mdegela *et al,* 2009) in Njombe District, found that the microbiological quality of milk from the small scale dairy farmers was in the acceptable ranges as per East Africa Community Standards.

2.4.3 Value Addition

Milk production in Tanzania is constrained by seasonal fluctuation with high production during the rainy season and low production in the dry season. Processing milk into various milk products helps in improving livelihoods of farmers as well as increasing the availability of milk products in the developing countries (Hahlani and Garwi, 2014). The Tanzania government is encouraging this small-scale dairy farmers into engaging in value addition to their milk so as to get more income. Most of the processing groups are found in the Northern part of the country i.e Arusha and Kilimanjaro (Pim *et al*, 2009). These groups act as a market for milk produced by small-scale farmers found around their area because they process the products at a small volume compared to large scale processing (Pim *et al*, 2009). Small-scale processors create jobs to more people than when milk is sold in its raw form.

2.5 The Dairy Sector in Tanzania

Figure 2.1 shows the major stakeholders in the dairy industry. These include producers, middlemen, processors and consumers.

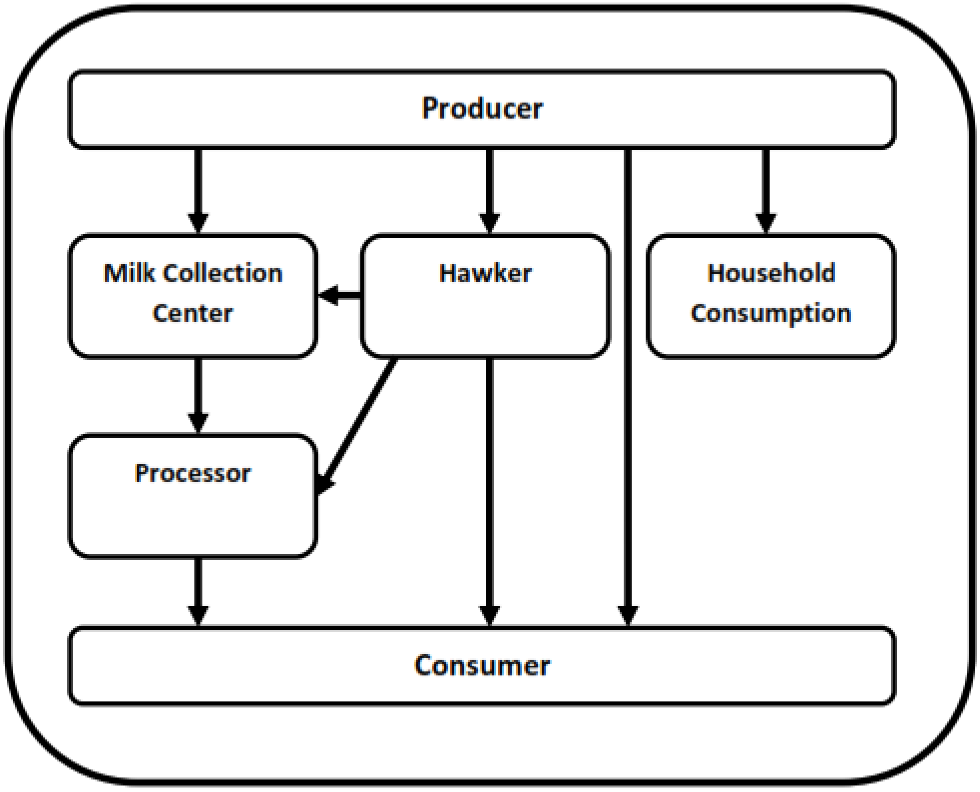

Figure 2.1 Informal milk marketing sector in Tanzania Source: Msuya (2012)

2.5.1 Input Suppliers

They are veterinary shops which are privately owned. They supply drugs and animal feed especially concentrates and mineral lick. There are also extension workers which specializes in animal health and production. Extension staffs are employed by the Government under the Ministry of Livestock Development and Fisheries. These extension officers are assigned to perform all livestock services needed by the farmers. They usually provide farmers with the required knowledge on the proper keeping of their animals. In Tanzania, there are no subsidies provided for small-scale dairy farmers. The government contribution to dairy sector development is through employing extension workers who are responsible for attending to matters regarding dairy cattle management.

2.5.2 Producers

The dairy sector is comprised of small and large scale dairy farmers, with small-scale dairy farmers dominating the sector. There are about 680,000 improved dairy cattle in Tanzania (Njombe, 2011). The small scale dairy farmers are concentrated in the cooler part of the country (Arusha, Kilimanjaro, Mbeya, Iringa and Kagera Regions) (Njombe, 2011).

These farmers own an average of 1-5 dairy cattle per farmer. Average productivity is 7-10 litres of milk per cow per day (Swai *et al*, 2005). Animals are kept under zero grazing system. About 90% of the produced milk by small-scale dairy farmers is marketed in a raw form in informal milk markets (Mwakalinga and Leif, 2010).

2.5.3 Processors

This group comprises of both large scale and small scale processors. Large scale processors include Tanga Fresh, ASAS in Iringa, Musoma Dairies, Azam in Dar-es-Salaam and Mara milk processors. These processing plants source their milk from their own farm and from the surrounding livestock keepers that are on contract. For Tanga Fresh, the processing plant collects the milk from dairy farmer cooperatives in Tanga and Chalinze areas.

The report by (Kaush *et al*, 2015) shows that about 180 million litres of milk is annually processed in the country into pasteurised milk, UHT milk, cultured products, ghee, butter, cheese and cream. These are sold in the domestic market (Njombe, 2011). The most common processed milk products in Tanzania are UHT milk, Ice cream, pasteurised milk, fermented milk (*mtindi*), yoghurt and others. The proportion of these processed products are as follows:

UHT milk 30%, Ice cream 7%, pasteurised milk 31%, fermented milk 16%, yoghurt 8% and others is 7% (TechnoServe, 2012). These dairy products are consumed in the country.

The amounts of imported milk in 2010 were 30-40million litres per year. The imported milk products include UHT milk, infant formula, milk powder, ice-cream and cheese. At present, the quantity of processed local milk is more or less the same as the quantity of imports (Nell *et al*, 2013). This large amount is contributed by a decline in the amount of locally processed dairy and dairy products in the market due to lack of enough raw milk supply into home processing plants.

Figure 2.2 shows the location of processing plants in Tanzania. Most of these processing plants are located in Arusha, Tanga, Kilimanjaro, Mara and Kagera regions. The reason is because these areas are suitable for dairying because the temperature is low. Also, there is a market for the processed dairy products due to the presence of big cities that is Dar es Salaam and Mwanza. Arusha is amongst the big cities so it serves as a market for the dairy products processed in the Region.

2.5.4 Distributors

This group is made up of wholesalers and retailers. The wholesalers group is made up of large processors. The large processors in Tanzania are Tanga Fresh, Azam milk, Musoma Dairies and ASAS Dairies. The processed milk products from these large processors are usually sold in urban and peri-urban areas especially in big cities like Arusha, Dar es Salaam and Mwanza. The major market for the Tanga Fresh, ASAS and Azam milk products is in Dar es Salaam while for Musoma Dairies is the Lake Zone Regions. Retailers are supermarkets, retail shops, restaurants and milk kiosks.

2.5.5 Consumers

This is the last and ultimate player in the chain. Consumers may be households in the urban area, or an institution such as schools, universities, colleges and hospitals.

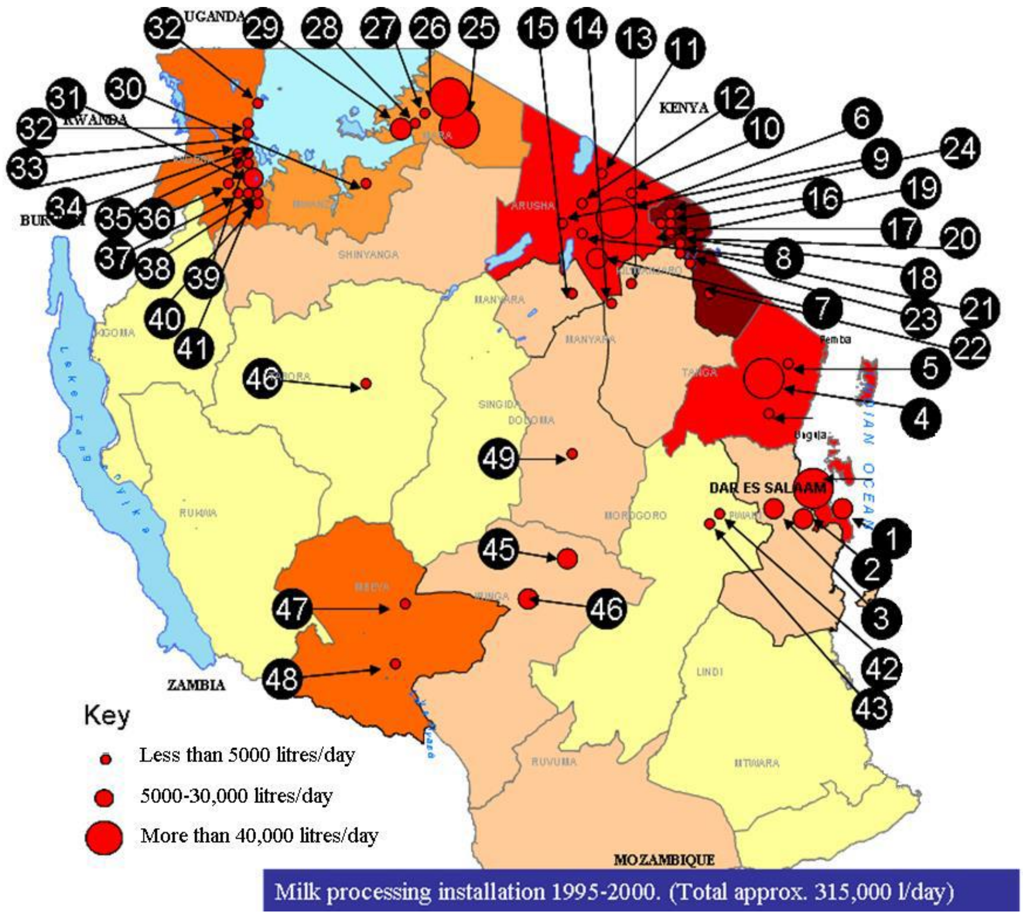

Figure2.2 Location of Dairy Processing Plants in Tanzania Source: Kurwijila *et al* (2012)

2.6 Informal Milk Marketing in Tanzania

Informal milk marketing in Tanzania is mainly composed of producers, vendors/hawkers and consumers. These hawkers buy milk direct from farmers and transport it by use of motorbikes and bicycles in plastic jerry cans to consumers in urban areas (Schooman and Swai, 2011). The consumers include restaurants, hotels, milk bars and individual households. Farmers keep some of the milk for home consumption and sell milk directly to consumers at the farm gate. Above 86% of milk from the small-scale, dairy farmers in this area are sold as raw fresh milk and very little in processing form (Ngasala *et al.*, 2015).

2.6.1 Producers

In this type of market, the main producers are small-scale dairy farmers. Small-scale dairy farmers milk their animals in open areas. They usually use wide mouth containers when milking (Schooman and Swai, 2011).This exposes the milk to contamination by the bacteria. Cooling facilities in most small-scale dairy farmers do not exist (Orregård, 2013b). Milk is transported by bicycles in narrow-mouthed jerry cans and is difficult to clean and sanitise

(Omore *et al*, 2004). There is no literature showing how farmers prepare their animals before milking them in Tanzania and it is not officially known if farmers follow any standardised milking procedures to ensure clean milk production.

2.6.2 Vendors

Most of the time vendors buy milk directly from the producer or milk collection centres in their areas. They are the middlemen between the producer and the consumer (Ngasala *et al*, 2015). The commonly used mode of transport of milk by vendors are motorbikes. Milk is transported in plastic containers rather than stainless cans (Omore *et al*, 2004). This poor milk handling subjects the consumer to health risks due to the high possibility of contamination (Lubote *et al*, 2014). Little is known about the reasons for small-scale farmers selling their milk to vendors instead of established processors.

2.6.3 Consumers

Consumers include hotels, restaurants and households in urban areas. A study that was done in Arusha by (Ngasala *et al*, 2015) shows that consumers are aware of the quality of milk they want and the risk associated with consumption of contaminated milk.

2.7 Factors Affecting the Quality of Raw Milk

2.7.1 Physical-chemical Properties of Milk

Milk and milk products are excellent high-quality foods providing both nutritional and culinary values (Anderson *et al*, 2011). This is due to the fact that milk does have distinct physical, chemical and biological characteristics and its colour, odour, taste, consistency, freezing point (- 0.55°C), pH (6.6) and specific gravity (1,032) and these characteristics remain particularly constant (Lues *et al*, 2010). The addition of any foreign material will disturb the milk content hence causing loss to processors and it is cheating to consumers of milk and their products because the consumer needs a quality product for the paid price.

2.7.2 Type of Feed and Cattle Breed

The type of feed given to animals as well as the breed of cattle, they have an effect on both milk composition and milk yield. It is well known that Holstein breeds have the highest milk yield than other breeds but this milk has the lowest fat content (3.64%), and Jersey has the highest fat content (4.64%). This is contributed by interests shown by the breeders with some on the yield and others on milk composition. Nutrition has been reported to affect the milk yield and composition (Agena *et al*, 2003) with the increased dry matter intake contributing to increased milk yield and composition of the animal. Milk fat and protein is easily affected by the nutrition because it is greatly influenced by the diet of the animal. It is recommended to feed animals at 40:60 concentrate to roughage ratio in order to improve the level of milk composition percentage and yield as the food provides precursors for milk synthesis (Salamon, 2006). The dry matter content of the feed is the determinant for the nutrient supply so they must be fed to the ratio of 3-4% of the animals' body weight. For the aim of protecting milk from adulteration, there is a standard table showing the compositional quality of raw milk from the cow. This table provides the basis for checking on any changes in milk composition. The normal milk density according to COMESA/East Africa Cow Raw milk standard (2006) used in Tanzania is 1.028g/l-1.032g/l equivalent to Lactometer reading of 28-32 at a temperature of 20°C (EAC, 2006).

Table 2.1 Standard Physical Composition for Raw Milk From the Cow

Component	**Percentage**
Protein	3.3
Lactose	4.8
Fat (%)	3.8
SNF (%)	7.8

Source: www.disknet.com (Accessed 11/05/2016)

2.7.3 Intentional and Accidental Adulteration of Milk

Adulteration of milk refers to the addition of foreign matter such as flour, margarine and water into the milk (Karimuribo *et al.*, 2015). Adulteration of milk can negatively affect its microbial quality, taste and market value (Omore *et al.*, 2005). The adulteration may be done intentionally or accidentally. Accidental milk adulteration might be caused by leaking in the cooling facilities or use of milk containers that are not properly cleaned.

Adulteration is not acceptable because it causes milk contamination; disqualify milk processing into other dairy products by lowering butterfat and protein content. It is not fair to the consumer because they are not receiving the quality product for the price paid. Adulterated milk leads to a loss for processors and consumer. Because milk goes from the farm to the consumer without being tested for quality, the risk of accidental or intentional contamination with foreign matter can be high and go unnoticed.

Intentional adulteration with water and starch can be done to increase the volume or alter the properties of milk. The most common milk adulteration is the addition of water. Adulteration can also be done by adding other substances such as starch, flour and margarine. Water is added with the intention of increasing the volume of the milk (Karimuribo *et al*, 2015). Starch, flour and margarine are added so as to increase the density and butterfat content of the milk (Karimuribo *et al*, 2015).

There is little information on the quality of milk consumed in most parts of Tanzania. In a study done by (Orregård, 2013b) in Kenya, results showed increased levels of adulteration as the milk was moved from the farmer to the consumer. This creates a need to find out the extent of milk adulteration problem in Hai District Tanzania.

2.7.4 Antibiotic Residues in Milk

Although milk is such an important source of nutrition to people in different age categories, it sometimes contains an unacceptable high level of antibiotic residues so causes problems to consumers of such milk and its products (Muhammad, 2014). Antibiotic residues in milk originate from various sources namely residue of herbicides on feedstuffs, drugs given to cow orally, by injection or as an intramammary infusion for the treatment of mastitis (Jahed, 2007). This problem has led to the development of various techniques to check the level of antibiotic residues in milk to name few DelvoTest and CharmEZ methods. Drug residues in milk apart from other hazardous effects it also affects negatively the health of the consumer of milk with high level of antibiotic residues. These effects include allergic reactions and bacterial resistance in the body of humans (Muhammad, 2014).

There are ongoing studies aiming at developing the baseline information to help in Hazard Analysis and Critical Control Point implementation to ensure the improvement of the milk quality produced in the developing countries (Grimaud *et al*., 2009). The HACCP approach has an important role in preventing and controlling of chemical contamination in milk and dairy products especially antibiotics in raw milk transported from the producer (Jahed, 2007). The HACCP concept is dealing with hazard and risk identification, process decomposition, designation of critical control points, documentation and verification of the programme, is an alternative to the ISO system (Noordhuizen, 2005) so as to ensure standardised qualified products. This programme starts at the very early stage of production for dairy products all the way to when the product reaches consumer's hands. The critical control points are defined by the producers depending on the structure of their production units.

The use of drugs in dairy cattle farms is common, being used for treatment as well as feed additives (Navrátilová, 2006a; Karimuribo *et al*, 2015). The frequent use of antibiotics may result in drug residues that can be found at different concentration levels in products from animal origin, such as milk or meat (Khaskheli *et al*, 2008). In lactating cows, antimicrobial agents are used mostly for the therapy of mastitis but also of other diseases (e.g. laminitis, respiratory diseases, metritis) (Navrátilová, 2006b). Also on other farms they use antibiotics as prophylaxis i.e giving animals' low dosage of the drug so as to prevent animals from falling sick (Abebew, 2008).

Mastitis is also the problem for dairy cattle in Tanzania. This forces dairy farmers in Tanzania to use antibiotics to treat their animals against this disease as well as other diseases (Mdegela *et al*, 2009). The common drugs used in dairy farming are β-Lactams such as penicillin, Tetracyclines such as Oxytetracycline and Sulphonamides such as Sulfamethazine (Jahed, 2007). A study done by (Navrátilová *et al*, 2009) in the Czech Republic finds a low level of Tetracycline residues in milk. Residues of these drugs in milk may be caused by overdosing the animal or changing the route of administration. An example is giving Fluxinin intramuscularly instead of intravenously and lack of adherence to the withdrawal period (NMPF, 2011). In most developing countries record keeping for animals is not well practised (Orregård, 2013b). This creates a need for rapid methods for testing the presence of antibiotics in raw milk to guarantee its quality (Kivirand *et al*, 2015).

The legislative framework for monitoring drug residues in milk is not strong enough in Tanzania. There is a lack of expertise and equipment for the tests (Kifaro, 2011). This subjects consumers to high risks through milk consumption which may contain drug residues. A study done by (Karimuribo *et al*, 2015) showed the presence of antibiotic residues in milk sold in Kilosa District.

2.8 Effects of Antibiotic Residues in Milk

2.8.1 Health Effects

The frequent presence of antibiotic residues in food and feed can cause allergy problems to consumers. It can lead to the development and spread of antibiotic-resistant strains of human pathogens such as *Salmonella typhimurium* which has been documented in transferring the resistance from animals to people (Clau *et al*, 2013). The resistance renders antibiotics ineffective in the treatment of disease once a person falls sick. In countries that are silent about drug residues in milk, exposes consumers for products with antibiotics into the great risk of adverse health effects (AbdulSamad *et al* 2014). In America, the problem of drug residues in milk was very minimal. Among the 357 milk samples analysed for drug residues, only one sample had β-Lactam violative residues. This was contributed by immediate and severe penalties at milk collection centres (FDA 1999). Consumers need to be protected from eating food with an unaccepted level of antibiotic residues in developing countries. In order to protect consumers of milk and milk products, research work needs to be done to assess the level of antibiotic residues on the food especially those of animal's origin including milk.

2.8.2 Economic Effects

The resulting decrease in milk quality and supply negatively impacts processors and consumers along the dairy value chain (Doyle *et al*, 2015). Processors dealing with the production of fermented products are the most affected. Antibiotics are known to interfere with the manufacture of these dairy products through inadequate curdling of milk and partial or total inhibition of starter culture growth in making fermented dairy products (Jones *et al*, 2009) These products require use of starter cultures which are living bacteria and the presence of antibiotics in the milk will negatively affect flavour of the product. Milk that contains antibiotic residues causes problems of acidification and ripening of cheese which leads to loss to the processor. A study by (Adetunji, 2011) in Nigeria proves the failure of cheese making by the processors due to the presence of microbial inhibition by antibiotics in the milk used as raw materials in cheese making. The residues cause the production of poor products that were discarded and hence were a loss to the processor.

2.8.3 The Microbiological Quality of Milk

Microbial quality of milk refers to the cleanness of milk. This is defined by a number of bacteria present in milk. The high bacterial count as well as the presence of pathogenic bacteria in milk not only degrades the milk quality and shelf-life of milk or milk related products but also poses a serious health threat to consumers (Yuen *et al*, 2012). Milk being a wholesome food with high nutritive value is often prone to early contamination and spoilage if not handled properly (Minj and Behera, 2012). The fewer the number of micro-organisms in milk the higher the quality of milk. The microorganism may originate from the cow or the environment. Examples of these are lactic acid bacteria and mastitis causing bacteria. The lactic acid bacteria convert milk sugar i.e lactose into lactic acid. The common spoilage bacteria in milk multiply at the temperature range of 20°C - 25°C. The rate of multiplication for microorganisms can be slowed down through cooling the milk and keeping it at the temperature of 4°C and below.

The microbiological quality of milk is affected by storage temperatures and time taken in milk transporting. The longer the time taken to transport the milk, the more likely the milk is going to spoil. The rate of cooling and milk handling procedures during and after milking are also important in determining the quality of milk. Tanzania uses the standards as described by the Tanzania Bureau of Standards and by the East African Standards and COMESA (EAC, 2006). These state that quality of raw milk is poor if it has a coliform count of more than 50 000 CFU/ml and a total bacterial count of more than 2 million CFUs/ml.

In ensuring adherence to clean milk production and consumption, there are set standards of legal limits of bacteria in milk for each country. In Tanzania standards used for grading milk are as per East Africa Community Standards (EAS 2007). The legal limits are very important to be observed as it provides protection to the health of consumers for milk and other dairy products. The standards are universal with the difference in legal limits. In setting these standards technological level and economic constraints of the region is taken into consideration (Jensen *et al*, 2010). The EU countries are the leading with the highest microbiology quality standard of (<100,000 CFU/ml) for TBC in raw milk (Bytyqi *et al*, 2011 ; Berry, 2004) of which this is contributed by the presence of all the required resources for clean milk production when compared to the developing countries.

Many types of bacteria live harmlessly in the digestive systems of people and animals. For example, *E.coli* is one of them, but some strains of *E.coli* such as *E.coli* O157:H7, produce toxins that can cause serious illness (Pennington, 2005). Studies on milk quality have been conducted in several parts of Tanzania: Arusha (Ngasala *et al*, 2015), Njombe (Mdegela *et al*, 2009), Morogoro (Karimuribo *et al*, 2015) and Tanga(Swai and Schoonman, 2011). This study aimed to add to the available information so as to establish the status of milk quality all over the country hence allow stake holders in developing the strategies for improvement in the dairy sector.

In a study by (Mdegela *et al*, 2009) in Tanzania, milk microbiological quality i.e coliforms and lactic acid bacteria from small-scale farmers in Mvomero and Njombe Districts was found to be between 1.1 million and 2 million CFUs/ml which was within acceptable levels. In another study by (Omore *et al*, 2004) levels of contamination were found to be high in milk samples collected in Mwanza and Dar es Salaam Regions. The reason for this was a high level of milk contamination due to milk adulteration in Mwanza and Dar-es-Salaam Regions.

2.9 Foodborne Pathogens in Milk and Public Health Implications

2.9.1 Milk-Borne Pathogens

As milk is among the most valuable and nutritious food commodities for humans and young mammals, it also provides an excellent growing medium for bacteria, which once they get access to milk will multiply rapidly and spoil the milk or render it unsafe for human consumption or unfit for further processing (Welearegay *et al*, 2012). The presence of the micro-organisms in milk is contributed by unhygienic handling of milk and milk products. Microbial contamination of milk not only causes spoilage but can lead to illness as a result of foodborne pathogens (Ngasala *et al*, 2015). A study by (Mdegela *et al*, 2009) showed the presence of *Campylobacter jejuni* in milk samples collected from small-scale dairy farmers in Njombe and Mvomero District in Tanzania. *Campylobacter jejuni* causes gastroenteritis in humans.

There are a number of other microorganisms that are of public importance to the human health. They are summarised in table 2.2 with their public significance to the consumer's health. These health risk micro-organisms can be prevented through milk pasteurisation so as to protect the health of consumers. Coliforms enter milk through faecal and environmental contamination. Some like *E.coli* can be pathogenic.

2.9.2 Escherichia Coli

This bacterium is classified under the family Enterobacteriaceae. They are normal flora in the guts of human, cattle and sheep where it produces vitamin K and protects the host animal from digestive infection by suppressing and preventing growth and colonisation of the gut by pathogenic bacteria. *E.coli* is able to live with or without Oxygen and can use different sources for food requirements (Theodor, 1982). Contamination of the milk and other food is done through faecal-oral route. A study was done in Indonesia by (Street and Bogor, 2013) and in Khartoum by (Yuen *et al*, 2012) shows a high load of contamination of milk and milk products by *E. coli*. This imposes high health risk to the consumers of milk since there is an evidence of the presence of pathogenic *E coli* strain. Another study by (Kumar and Prasad, 2010) in India found the highest level of contamination of milk samples collected from vendors (26%) followed by the dairy farm (20%) and lastly house milk (6.6%), this may be due to unhygienic handling of milk along the value chain.

Studies have proved that not all types of *E coli* are good anymore, there is the presence of a pathogenic strain of *E.coli* that is (*E. coli* 0157:H7) with a worldwide spread in almost all continents and is of public health importance (Mertz, 2003). This pathogenic strain was identified in 1975 and seven years later i.e in 1982 was found to cause bloody diarrhoea infection in human (Theodor, 1982). The disease caused by this strain has the incubation period ranging from 1-16 days and is common in young, elderly and immune-compromised people (University, 2009). The disease is associated with the consumption of contaminated and unpasteurised milk. In Washington it was found that 44% of identified cases were laboratory confirmed to be associated with *E. coli* 0157:H7 infection due to consumption of raw milk (CDC, 2007). Also, the study done in Pakistan by (Hussaina *et al*, 2014) shows the *E. coli* counts of Dahi (yoghurt) were amazingly higher counted up to $212.16 \pm 17.54 \times 10^3$ and $189.35 \pm 3.42 \times 10^3$ for the poor and better sanitation areas, respectively. This creates the need for the further studies in Tanzania to establish the status of milk contamination levels as milk is commonly consumed by young and people who are immune-compromised.

2.10 Sources of Contamination of Milk

Milk as a nutritious food is prone to microbial contamination and many milk-borne epidemics of human are spread through contaminated milk (Nonga *et al.*, 2015). This is true especially in developing countries where milk and milk products production and handling takes place under unhygienic environment and poor production practices. The major source of milk contamination occurs during milking, from the udder, milking equipment or milking personnel. Furthermore, contamination occurs during transportation and storage of the milk. Under any of these conditions, microorganisms get into the milk and multiply (Adugna *et al*, 2013). Therefore, producers need to pay particular attention to the type as well as the cleanliness of milk equipment (Debela, 2015) and ensure hygienic milk handling practices on the household level.

Table 2.2 Examples of Diseases Caused by Consumption of Contaminated Milk

Organism	Disease	Symptoms
Campylobacter jejuni	Gastroenteritis	Diarrhoea
		Abdominal pain
		Fever
Coxiella burnetti	Q Fever	Chills
		Fever
		Weakness
		Headache
Eschrichia coli 0157:H7	Gastroenteritis	Diarrhoea
	Haemolytic Uremic Syndrome	Abdominal pain
		Bloody diarrhoea
		Kidney failure
		Possible death
Listeria monocytogenes	Listeriosis	Flu-like symptoms
		Miscarriage for pregnant women
		Stillbirths
		Spontaneous abortion
Mycobacterium tuberculosis	Tuberculosis	Lung disease
		Weakness
		Fever
Salmonella sp	Gastroenteritis	Diarrhoea
	Typhoid fever	Nausea
		Fever
Brucella sp	Brucellosis	Fever
		Headache
		Back pain
		Physical weakness
		Joint pain
		Fatigue

Source (Marcotty *et al.*, 2009).

2.10.1 The Cow

Milk from a healthy cow has a low bacterial count. A cow sheds microorganisms into milk when it is sick. Examples of microorganisms include *Streptococcus agalactiae* and *Staphylococcus aureus* which are found in the infected udder of mastitic cows. Milk from a sick cow should not be mixed with the one from healthy cows and sick cows should be milked last to avoid contamination of the clean milk.

2.10.2 The Milker

Milkers can transmit contagious diseases such as Tuberculosis and Brucellosis. They can transmit these diseases through their hands, hair, clothing and aerosols from sneezing or coughing. To avoid contamination through contact with hands milkers should wash their hands with detergent and dip them in disinfectant after milking each animal.

2.10.3 The Milking Environment

This includes the skin of the animal, feeds, containers and water facilities. It is important to keep the environment around the dairy animals as clean as possible. Also, bedding materials must be kept dry and clean at all times (Maunsell and Donovan, 2008).

2.10.4 Milk containers

When containers used to store milk after milking are not thoroughly cleaned they harbour pathogens and spoilage microorganisms which will contaminate the milk.

2.11 The Regulatory Framework for Dairy Products in Tanzania

These are Tanzania Bureau of Standards (TBS), Tanzania Dairy Board (TDB) and Tanzania Food and Drugs Authority (TFDA) (Goodluck .C Mchau, 2011)and these authorities work together in inspecting the imported dairy products in the country. The Tanzania Bureau of Standards (TBS) and Tanzania Food and Drugs Authority (TFDA), ensures alignment with the quality and laws set for imported dairy products (Msuya, 2012).The products are inspected for wholesomeness by three authorities. The law states that imported products must be free from pathogenic microorganisms. There is no reported disease outbreak in Tanzania caused by consumption of contaminated milk.

The law prohibits informal milk marketing, but due to weak institutional support, people are not adhering to this law (Kim *et al*, 2009 ; Kifaro, 2011). Milk in Tanzania is commonly sold in raw and in an unpasteurised form (Kurwijila and Mtenga, 2011). There are both pasteurised and unpasteurized milk products in the milk market. Unpasteurized milk products are commonly sold in street kiosks. Pasteurised milk is sold in supermarkets and big shops.

2.12 Informal milk marketing in India

This is an example of the successful story of informal milk marketing. Being dominant in the dairy sector in India and still perform well to the extent of making India the world's largest milk producer. Small-scale dairy farmers dominate the dairy sector in most developing countries including Tanzania (Njombe, 2011; Radder and Bhanj, 2011) India is currently the largest world milk producer in an environment that is dominated by small scale producers (Radder and Bhanj, 2011). The dairy sector in India is a major source of employment catering for about 27.2 million people (Nwankwo *et al*, 2015). Milk from small-scale dairy farmers is marketed informally. Local vendors handle 72 % of all the milk produced in the country (Garcia *et al*, 2006). There is, however, an emerging segment of consumers who are demanding quality processed dairy products. The use of quality premium schemes provides an incentive for farmers to produce clean milk. This was proved in a study done by (Torsten, 2005) where farmers were willing to produce clean milk after the introduction of quality premium schemes.

2.13 Conclusion of Literature Review

The microbiological quality of milk, physicochemical properties of milk and the dairy sector in Tanzania have been reviewed. The review has indicated that the dairy sector is growing exponentially hence possibly serve as the potential source of economic growth and livelihood improvement for dairy farmers and rural society. The challenges affecting the sectors have been identified to allow further decisions aiming at the improvement of the sector. The sector has been found to be monopolised by informal milk marketing of which more than 90% of milk sold from small-scale farmers is through vending. The processing plants have been found underutilising their capacity due to the fluctuation of raw milk availability and poor milk quality from the farmers. Training to livestock keepers will be helpful in improving the milk quality so as to increase the processing capacity in Tanzania.

CHAPTER THREE

3 KNOWLEDGE OF SMALL SCALE DAIRY FARMERS ON CLEAN MILK PRODUCTION AND MANAGEMENT IN SELECTED VILLAGES OF HAI DISTRICT, TANZANIA.

ABSTRACT

Milk handling practices in 5 villages in Hai District, Tanzania were characterised through interviews of 180 farmers and 30 milk vendors. These villages were Nkuu Ndoo, Lyamungo Kati, Wari, Foo and Nronga from Hai District. Data was captured by using the structured questionnaires through interviews done in October and November 2015. Simple random sampling technique was applied to dairy farmers and vendors so as to select the participants for an interview. Data from the survey were analysed by the use of SPSS software for all variables. All respondents (100%) were washing and drying the udder before milking. Ninety percent were using normal cooking oil as an alternative to milking salve, 85% had a protected source of water and only 15.6% of the respondents used aluminium cans in sending milk to collection centres. The study shows that 16.1% of farmers kept records and 11% kept animal treatment record. More than ninety percent of vendors were using plastic containers to store milk when transporting to the collection centres. There was no cold chain maintenance by vendors when transporting milk since the majority of them were using public transport. In Lyamungo Kati, the results showed that the majority of the farmers were using cold water to clean milk containers.

3.1 INTRODUCTION

Studies have shown that below standard hygienic practices in milking by small-scale dairy farmers together with ineffective farm management lead to spoilage and cause great economic loss to the industry (Yuen *et al*, 2012). Since small-scale dairy farmers are primary sources of milk production in most developing countries (Kurwijila, 2012), there is a need to prevent or minimise the entry and subsequent growth of microorganisms in milk (Weleareggay *et al*, 2012). The prevention measures should start from the very first point of production. Prevention and minimisation of milk contamination with the bacteria can be attained through observing the provided standard management procedures for dairy animals as well as proper milking and milk handling practices.

In Tanzania the recommended practices are udder cleaning with clean warm water, drying of the udder with clean dry disposable towel, foremilk stripping for mastitis testing and removal of bacteria that were inside the teat canal, application of milk salve, milking and post-milking teat dipping to protect the teats from infection as the teat canals remains open soon after milking.

Interviews conducted show that most farmers do not follow these standard procedures. In pastoralists society as reported (Brown, 2015) farmers were not cleaning the udder because of lack of knowledge. This resulted in high levels of bacteria in their milk. In a similar study in Tanga (Hyera, 2014), small-scale dairy farmers were cleaning the udder before milking but they were not following the instructed standard procedures for milking such as fore striping, mastitis testing and post teat dipping after milking the animals. Farmers in the study area were cleaning the udder with clean water as the water supply was not a problem all year round and none of them reported that they carry out mastitis testing and post-milking teat dipping.

Proper milk production and handling are important so as to maintain nutritional quality and safety (Keskin and Gulsunoglu, 2012). Since milk requires extra care in handling at all points along the value chain, this study was carried out to establish the status on the milk production and handling knowledge from small-scale dairy farmers so as to create a platform for improvements and so ensure that milk produced is of highest hygienic quality.

3.2 MATERIALS AND METHODS

3.2.1 Study Site

The study was carried out in Hai District in Kilimanjaro Region which is located in the northern part of Tanzania. The study area was purposively selected because it has many small scale dairy farmers than other Districts (Huka *et al.*, 2014). The area lies between latitude 2°50’ and 3°29’ South and longitude 30°30’ and 37°10’ East. The district is divided into three zones namely: upper zone, a middle zone and lowland zone. The upper zone receives 1250-1750 mm of rain per annum. Then the lowland and middle zone receive 500-700 mm and 700-1250 mm rainfall respectively. There are two rainy seasons. The long rainy season starts in March and ends in June whilst the short one lasts from November and ends in December. The maximum temperature in warm season is 35°C and the range for the minimum temperature is 18°C to 20°C. (Source: Hai District profile).

The major agricultural activity is mixed farming. Farmers keep livestock as well as cultivating food and cash crops. The farmers in Hai District also keep local chickens, sheep and goat. The main crops grown include maize, beans, bananas and coffee. Coffee is a cash crop while banana is both food and cash crop. Figure 3.1 shows the location of the study area in Tanzania.

Figure 3.1 Map of Tanzania showing the location of Hai district

Source https://www.google.co.zw/maps/place/Tanzania (Accessed on 30 April 2016)

3.2.2 Study Design

Five villages included in this study were Nkuu Ndoo, Lyamungo Kati, Wari, Foo and Nronga. A total of 180 farmers and 30 vendors were interviewed and data were collected from the participants included the study. Simple random sampling was carried out to select farmers and for the vendors, the available ones were included in the study.

3.2.3 Secondary Data and Other Documents

Secondary data concerning a number of dairy cattle per ward was collected from the Livestock Office at District Headquarters. For the prevalence of diseases, the data was extracted from the monthly report submitted to the office of the District Veterinary Officer at District Headquarters in 2014/2015 year period. Data from the Department of Health was reviewed to assess the prevalence of milk-borne diseases in the District. This was helpful in providing important information that farmers might lack and also in cross checking the validity of collected data. Due to the fact that most people in the study area understand Kiswahili language, then the questionnaires was translated into Kiswahili for effective data collection.

3.2.4 Key Informant Interviews

Key informants involved in the study were extension officers at the District, ward and village levels, dairy input suppliers, village leaders and milk products processors so as to help in generating overview information concerning the title of the study in the study area.

3.2.5 Focus Group Discussions

Successful dairy farmers in the selected villages were interviewed. The identification of these farmers was successfully done with the help from extension staff employed by the Ministry of Fisheries and Livestock Development in the selected villages. Only those participants who were willing to provide the required information were interviewed.

3.2.6 Sampling Strategy

Purposive random sampling was used to select wards with highest milk production. Thereafter villages with milk collection centres were selected. Milk vendors and selling point that buy milk from the interviewed farmers were included in the study. Sample size determination was adopted from http://www.raosoft.com/samplesize.html. With the assumption of 5% margin error, 95% confidence interval, 3654population size and 85% response of distribution, a sample size of 180 farmers was arrived at. Vendors have selected according to their availability in the study area and 30 of them participated. The total sample size for the study was therefore 210.

3.2.7 Data Collection

Table 3.1 summarises the questions that were posed to the farmers. A semi-structured questionnaire was used to extract the required information from the participants. Information collected includes milking procedures preparations, milking facilities availability, use of drugs and hygienic milk handling practices. The questionnaire used is attached at appendix section.

3.2.8 Data Management and Analysis

Quantitative data from questionnaires were analysed by using SPSS Version 16.0. Descriptive statistics especially frequencies and percentages were used to determine the magnitude and distributions of variables. Data cleaning, checking and capturing in the questionnaires was done by use of SPSS 16.

3.3 RESULTS

3.3.1 Focus Groups and Key Informants Discussions Results

Discussion with the two groups of people indicates that majority of farmers in Hai District were knowledgeable on clean milk production and proper management of dairy animals. The supply of concentrates, extension and veterinary services were ensured because there were extension officers at all villages who provide veterinary and other services were easily available to farmers whenever in need. Treatment administration was done by extension officers and farmers were instructed to adhere to the withdrawal period before start selling milk from animals on treatment. Milk processing units were checking milk quality through the use of lactometer to check for adulteration with water, they were not doing any other test on milk like alcohol, Resaruzin and Clot-On Boiling tests.

3.3.2 Farmers

3.3.2.1 Social Demographic Characteristics of Respondents Farmers

The study involved 210 respondents of which 180 were farmers and 30 were vendors. Farmers interviewed were those that sell their milk in the milk collection centres available in the respective villages. Results from questionnaires showed that majority of the participants were female (77.8%), married (86.1%) with primary school level of education (65.0%). Their age was between 31-40 years (34.4%) and they were staying at their own houses (88.9%).

The data shows that most of the time women were the ones responsible for taking care of the family and dairy animals. (Table 3.2)

3.3.3 Types of Livestock and the Management System Used by Respondents

Table 3.3 summarises milking practices by farmers in the Hai District. Nearly 16% of the dairy farmers used aluminium cans for storing and transporting raw milk and almost 97% reported that they treat their animals when they fall sick. Seventy percent of farmers who treat their animals use recommended dose as instructed by the manufacturer. Record keeping was practised by only 16.1% of respondents and records kept were about calving dates 12.8% and treatments 11.1%.

Table 3.4 summarises the types of livestock kept and management systems practised by farmers. Seventy percent of farmers interviewed had at least one milking cow at the time of survey 31.7% owned goats and 88.3% kept an indigenous chicken. The number of goats kept is lower than the national average of 8 goats per household (MLFD, 2011) the reason being land scarcity in the Hai District which forces farmers to adopt zero grazing system. This grazing system does not encourage goat keeping because goats prefer free range grazing system.

3.3.4 Milking Practices

Eighty-five percent of the respondents reported that they were using water from the protected source and about eighty-six percent of the respondents were using hot water to clean the udder before they start milking. Udder drying by the use of individual towel was used by eighty-five percent of the interviewed respondents. A small percent of respondents 9.4% were using milking salve during milking to lubricate animal teats the remained ninety percent were using normal cooking oil as teats lubricants. (Table 3.5)

3.3.5 Use of Antibiotics and Clean Milk Production by Farmers

All interviewed farmers reported that they never sell milk from animals on treatment. About 78.9% threw away milk from animals on treatment and the remaining 21.1% mix into other animal's feeds such as in poultry and pet feed. Ninety percent of the respondents were milking their animals twice a day while 86.7% of the farmers used plastic containers to transport milk to the MCC's. Most of the plastic containers were kept on the floor before being transported to the collection centre they sell them soon after milking (Table 3.6).

Table 3.1 Summary of the Information that was Collected by Use of Questionnaire

Variable	Description	Purpose
House hold information	Family type, household size, household demography	Identify type of households and the influence on dairy practices aspects
Milking procedures	What is usually being done by a farmer before milking, source of water used by the farmer, milking salve used, how does they wash and dry the udder of the cow.	To find out knowledge and adherence of farmers to the recommended milking procedures.
Milking facilities	Where does the farmer milk their animals, what facility is in place, any regulations concerning milking facilities availability to small dairy farmer.	To trace the source of milk contamination at farm level and adherence to regulations.
Health records	Knowledge on antibiotic residues in milk, adherence to withdrawal period of the drug, type of diseases common in the area, who attend the animal when sick	To find out the source of antibiotic residues in milk and adherence to regulations.
Hygienic milk handling	Where do farmers store their milk before selling, type of containers used to keep milk, time taken for milk selling to buyer, the distance from the farmer house to the selling point, type of transport for to carry milk to the buyer	To establish whether or not farmers follow recommended practices.

Table 3.2 Socio-Demographic Characteristics of Respondents

Demographic information	Category	N	%
Gender	Male	40	22.2
	Female	140	77.8
Age	21-30	14	7.8
	31-40	62	34.4
	41-50	44	24.4
	More than 50	60	33.3
Marital status	Single	7	3.9
	Married	155	86.1
	Widow	18	10.0
Level of Education	Primary	117	65.0
	Form Four	29	16.1
	Form Six	2	1.1
	College	32	17.8
Occupation	Worker	37	20.6
	Farmer	143	79.4
Residence	Owned	160	88.9
	Tenant	20	11.1
Type of family	All parents alive	157	87.2
	Mother is alive	14	7.8
	Father is alive	5	2.8
	Mother who never married	4	2.2

Table 3.3 Milking Practices by Farmers in the Hai District

Parameter	Category	N	%
Using aluminium cans	Yes	28	15.6
	No	152	84.4
Record keeping	Yes	29	16.1
	No	151	83.9
Amount of milk produced	Yes	1	0.6
	No	179	99.4
Heat period	Yes	15	8.3
	No	165	91.7
Calving dates	Yes	23	12.8
	No	157	87.2

Table 3.4 Types of Livestock and Management System Used by Respondents in Hai District in Tanzania

Parameter	**Category**	**N**	%
Number of Milking Cows	One	126	70.0
	Two	41	22.8
	Three	13	7.2
Keeping Goat	Yes	57	31.7
	No	123	68.3
Keeping Local chicken	Yes	159	88.3
	No	21	11.7
Animal on treatment	Yes	1	0.6
	No	179	99.4
Ever treated animals	Yes	174	96.7
	No	6	3.3
No of injections given	One	13	7.2
	Two	41	22.8
	Three	126	70.0
Treated when fall sick	Yes	174	96.7
	No	6	3.3
Treated after three months	Yes	18	10.0
	No	162	90.0
Treated annually	Yes	0	0.0
	No	180	100.0
On feed costs	Yes	3	1.7
	No	177	98.3
On treatments	Yes	20	11.1
	No	160	88.9

Table 3.5 Milking Practices by Small Scale Dairy Farmers in Hai District in Tanzania

Parameter	Category	N	%
Source of Water	Protected source	153	85.0
			15.0
Drying udder after cleaning	Yes	164	91.0
	No	16	9.0
Method used to dry udder	Using individual towel	153	85.0
	Towel shared among the animals	27	15.0
Use of Milking Salve during milking	Yes	17	9.4
	No	163	90.6
			85.6
Type of Water Used	Hot water	154	
	Cold water	26	14.4

Table 3.6 Use of Antibiotics and Milk Hygiene Practices by Small Scale Farmers at Hai District in Tanzania

Parameter	**Category**	**N**	%
What do you do with milk from	Throw away	142	78.9
treated animals	Mix in other animal feeds	38	21.1
Milk mixing from different cows	Yes	54	30.0
	No	126	70.0
Milking frequency	Twice	178	98.9
	Thrice	2	1.1
Containers used for milk storage	Plastic container	156	86.7
	Aluminium cans	24	13.3
Cleaning of containers	Cold water	44	34.4
	Hot water	136	75.6
Milk storage	In the fridge	18	10.0
	On the floor	162	90.0
Milk selling time	Soon after milking	157	87.2
	12 hours after milking	23	12.8
Attendance to any course on clean	Yes	10	5.6
milk production			94.4
Do farmers know the source of	Yes	156	86.7
contamination to milk			13.3

3.3.6 Quality of Milk from Vendors

A total of 30 vendors were interviewed in the study. Eighty percent of vendors got their milk from farmers and the rest from milk collection centres. In transporting milk 53.3% used jerry cans, 40% bucket and 6.7% Aluminium cans. In ensuring containers cleanness 76.7% of vendors used hot water and the rest used cold water to clean their containers. Ninety percent of vendors were using public transport to carry their milk to the consumers hence, there was no cold chain maintenance. Use of plastic buckets and plastic jerries containers on transporting milk to the selling points was the common practise to the vendors in the study area. (Table 3.7)

Table 3.7 Summary of Responses by Vendors to How they Handle Milk

Parameter	Category	N	%
Source of milk you sell	Farmers brought milk to vendors	26	86.7
	Bought from milk collection centre	4	13.3
Number of farmers supplying milk to vendors	1-10	9	30.0
	11-20	15	50.0
	21-30	2	20.0
Milk storage containers	Plastic buckets	12	40.0
	Plastic jerries	16	53.3
	Aluminium cans	2	6.7
Milk containers cleanness	Washing milk containers with hot water	23	76.7
	Washing milk containers with cold water	7	23.3
Type of transport used	Public	27	90.0
	Private	3	10.0
Time taken to finish selling the milk	One hour	14	46.7
	Two hours	11	36.7
	Three hours	5	16.7
Litres sold per day	Less than fifty litres	7	23.3
	Fifty litres	8	26.7
	More than fifty litres	15	50.0
Measures for adulterated milk	Warning the farmer	26	86.7
	Reporting to collection centres	4	13.3

3.4 DISCUSSION

The results of the current study show that the majority of the farmers were aware of the requirements for clean milk production. Dairy farming in this area has been practised for more than hundred years and also clean water supplies were not a limiting factor to dairy production. Clean water is a major requirement for clean milk production (Perkins *et al.*, 2009). Water is required for different operations in dairying including for animal to drink, cleaning of animal houses, cleaning of the udder and cleaning of milk containers. The knowledge of dairy cattle management has been passed from one generation to the next with little input from extension services from the government. A source of support for the extension services could be the milk collection centres and mini-processing centres for different dairy products that have an interest in providing knowledge to farmers on how clean milk is produced. These collection centres are farmer's owned and they process different dairy products such as cheese, butter, yoghurt and fermented milk.

The use of plastic containers for milk storage by farmers and vendors can compromise milk quality since plastic can easily crack and these cracks harbour spoilage bacteria and are difficult to clean. Stainless steel and aluminium cans are advised in milk storage as they are easily cleaned. The large proportion of farmers who were in the active working age group is a good sign of effective industry since dairying has high labour requirements for feeding animals, calf/heifer management, milking and marketing.

Udder washing with warm water from protected source and then drying the udder with disposable paper towels ensures clean milk production. Since farmers are not paid on the basis of mastitis, they were not practising fore milking mastitis testing and post teat dipping practices. There are no regulations concerning special milking facilities such as holding structures that would be compulsory to the farmer as a regulatory requirement. Farmers had no milking facilities like separated milking parlour to milk their animals from and instead they were milking their animal in barns where animals are kept. Lack of milking facilities exposes milk into contamination with manure and other dirties that might be in animal barns during the milking time. The feeding system used is zero grazing.

The use of plastic containers to store milk without cooling it and the use of public transport means that the cold chain is not maintained by vendors. This increases the rate of microbes multiplying in the milk because the temperature higher than 4°C is favourable for multiplication of the bacteria in milk. This lowers the milk quality, keeping quality and increase the rate of spoilage counts. The collected milk must be kept in a cold chain at a temperature of 4°C from the point of production to the consumer so as to keep it's nutritional and bacteriological quality (Keskin and Gulsunoglu, 2012).

Proper cleaning of utensils and equipment used in the dairy requires scrubbing in a hot water with a detergent solution, followed by rinsing with clean hot water and sterilisation using wet heat in a steam cabinet. Since farmers and vendors clean their utensils but do not sterilise them, there is a risk of bacterial build up and the contamination of subsequent consignments of milk. Efficient cleaning by using the right detergent at the recommended strength is essential for keeping microbial contamination of the products to a minimum (Welearegay *et al.*, 2012).

3.5 CONCLUSION

Generally, farmers were aware of important milk handling procedures such as availability of clean water supplies, cleaning the udder before milking, drying the udder, washing of utensils and separating milk from sick animals. They were practising these important procedures. The risks to clean milk production that were identified includes the use of plastic containers to store and transport milk, lack of cooling facilities after milking and during transportation and lack of sterilisation facilities for utensils on the farm. Milk was not tested for mastitis on the farm. Farmers were not dipping teats in an iodine based tincture post-milking to protect animal udder from bacterial infection since the teats canals are open soon after milking. These issues are of concern since they are sources of milk contamination in the study area and if improved can lead to significant increases in milk quality.

CHAPTER FOUR

4 EVALUATION OF MICROBIOLOGICAL QUALITY OF MILK COLLECTED FROM SMALL SCALE DAIRY FARMERS AND VENDORS IN THE HAI DISTRICT IN TANZANIA

ABSTRACT

A study was carried out to determine the Total Bacteria Counts, Total Coliform Counts, *E.coli* and *E.coli* the O157:H7 content of milk samples from 180 farmers and 30 vendors in the Hai District in Tanzania. Total bacterial count, Total Coliform Count *E Coli* and *E.coli* (O157:H7) were estimated by the use of standard agar methods. There was a significant difference ($P<0.05$) of the mean TBC and TCC from vendors and farmers with vendors having the higher counts compared to farmers. The milk samples tested were positive for *E.coli* but not *E.coli* (O157:H7). In all the samples analysed about 66% was found to be in grade I, 24.9% was in grade II and 9.1% was grade III milk. The milk was observed to be in the acceptable ranges of grade II for both vendors and farmers based on East African Standards for Milk and Dairy Products (EAS 2007). The higher bacterial counts in milk samples from vendors can be explained by the lack of cold chain use by vendors when transport milk to the selling points since temperature above 4°C increases the rate of microbial multiplication in milk. The presence of *E.coli* in some of the samples is an indicator of possible contamination with faecal materials.

4.1 INTRODUCTION

Milk, a major constituent of the diet, is a highly perishable commodity, vulnerable to spoilage and consequently health risk to consumers if is not properly handled from production to the consumer in the value chain (Schooman and Swai, 2011). It is an important source of Ca, P, riboflavin, vitamin B12, and high-quality proteins even though not containing all the nutrition requirements needed in human nutrition (Tekinsen *et al*, 2007). Since milk forms an important part of the diet for children and expectant mothers then its quality is considered important for the welfare of the community (Sudhasaravanan and Binukumari, 2015). In order to protect health of consumers, microbiological quality tests are performed for TBC, TCC, *E.coli* and pathogenic *E.coli* (0157:H7) (Shojaei, and Yadollahi, 2008)

Microbial contamination of milk is the major cause of milk spoilage as well as exposing consumers of such milk to health hazards (Ngasala *et al*., 2015). The presence of high a bacteria load in raw milk reduces the keeping quality of the milk as well as the products that will be made from such milk (Minj and Behera, 2012). There are undesirable microbes that can cause spoilage of dairy products and these include Gram-negative psychrotrophs, coliforms, lactic acid bacteria, yeasts, and moulds (Varga, 2007). The microbial spoilage of milk reduces the market value and freshness of the milk hence lower incomes earned by producers and milk vendors (Kaindi *et al.*, 2011). Bacteria such as coliforms are responsible for reducing the diacetyl content of buttermilk, causing the formation of gases in cheese making so lowering the quality of the product (Sperber, 2009) This indicates a loss to processors of dairy products since the quality of the dairy products will be negatively affected (Swai and Schoonman, 2011). The quality of milk determine the keeping quality and the shelf life of the dairy products made from milk and hence disqualifying milk with a high load of bacteria from further processing.

This study was carried out to establish the status of milk quality in selected dairy farmers and vendors in the Hai District in Tanzania. The information generated will be useful in informing stakeholders involved in the dairy sector and public officers in developing the strategies for improvement in small-scale dairy production.

4.2 MATERIALS AND METHODS

4.2.1 Study Site

Details on the study site are provided in section 3.2.1

4.2.2 Sample Collection

Five villages were involved in the study namely Nkuu Ndoo, Foo, Wari, Nronga and Lyamungo Kati. Milk samples were collected from small-scale dairy farmers who brought their milk to collection centres and milk vendors in respective villages. Labelled pre-sterile 30mls bottles were used to collect the milk sample. Milk samples were collected directly from farmers' containers at the milk collection centres. The samples were immediately cooled and transported in cool boxes filled with ice packs to the laboratory for analysis.

4.2.3 Determination of Total Bacterial and Coliform Counts

Standard procedures described by (USDA, 2011) was used for Total Bacterial Count and Coliform Count of the collected milk samples.

Preparation of Diluent

Peptone water was used as the diluent. This was prepared by diluting 15.23 grams of peptone water powder into 1000ml of the distilled water. Then 9mls of this solution was added into clean test tubes. The tubes were stoppered by the use of cotton wools and sterilised at 121°C for 15minutes in an autoclave. After sterilisation the tubes were cooled to room temperature and then stored in the refrigerator ready for use in the next day.

Determination of Bacterial Counts in Milk Samples

For Total Bacteria Count, the media used was Plate Count Agar (HIMEDIA REF M091). Standard Plate Count Agar was prepared by dissolving 23.5grams and in 1000mls of distilled water. The solution was heated on a gas cooker to dissolve the media. Thereafter it was sterilised in an autoclave at 121°C for 15minutes. After sterilisation bottles with Agar were cooled to 45°C in water bath ready for inoculation. For Total Coliform Count, the media used was Violet Red Bile Agar (HIMEDIA REF M049). Red Violet Bile Agar was made by dissolving 41.53grams in 1000mls of distilled water. The solution was then heated to dissolve the agar then cooled in a water bath to 45°C.

4.2.4 Plating

For each milk sample tenfold serial dilution (10^{-1} to 10^{-6}) were made in sterilised test tubes with peptone water. One millilitre each of 10^{-2} to 10^{-4} was used for Total Bacterial count and 10^{-3} to 10^{-5} for Total Coliform Count as well as *E. coli*. Plating was done in triplicate in sterilised petri dishes. Twenty millilitres of agar and the diluted milk sample were mixed thoroughly. Plates were allowed to cool and solidify then they were incubated in an inverted position at 37°C. The incubation time for Total Bacterial Count was 48hours and for Total Coliform Count and 24 hours for *E.coli*.

4.2.5 Plate Counting

4.2.5.1 Total Bacteria Count

Only plates with colonies between 25 and 250 colonies were counted after incubation. After counting, the number of colonies was multiplied by the reciprocal of the dilution factor to give the count per ml of original milk sample, e.g a count of 37 colonies on a petri dish of 10^{-3} means a count of 37 x 10^{3} or 37 000cfu/ml. Lastly, the average of the dilution series was calculated to get CFU/ml number in the milk sample before dilution.

4.2.5.2 Total Coliform Count

After incubation only petri dishes with counts of 15 to 150 colonies were counted as above. The colonies that were considered for Total Coliform Count were only those that were dark red in colour.

4.2.6 Determination of *E.coli*

This was carried out according to the procedures described by ISO 7251:2005(E). For *E.coli* MacConkey Agar HIMEDIA REF M081-500G was used. Agar was prepared by dissolving 51.53grams of the Agar in 1litre of distilled water. The solution was pre-heated to allow dissolving later was autoclaved at 121°C for 15 minutes. It was cooled to 45°C in water bath ready for inoculation.

Milk sample in a collecting bottle was carefully shaken. The sample bottle was aseptically opened then sample dilution series was carried out from 10^{-1} to 10^{-6} while holding the test tubes and sample bottle near a Bunsen burner to avoid contamination. The sterilised pipettes were used in sample taking to avoid contamination. The single sterile pipette was used per each dilution transfer. One ml of each dilution was pipetted into separate, labelled empty petri dishes, opening dish only enough to let the pipette in. This was done near the Bunsen burner.

The plating was done in triplicate. The inoculated dishes were added with 15-20mls of the MacConkeyAgar. The petri dishes were gently moved at figure eight movements to mix the inoculum with the Agar then they were allowed to solidify. The petri dishes were inverted and incubated at 37±1°C for 24 hours. A blank was prepared using the Agar but without the sample. After incubation, all dishes with colonies 15 and 150 were counted. Only colonies that had reddish ring were counted.

4.2.7 Determination of pathogenic *E.coli* (O157: H7)

Standard procedures used were as described by ISO 7251:2005(E). Sorbitol MacConkey Agar (SMAC) HIMEDIA REF M298-500G was the Agar of choice used to check for the presence of pathogenic *E.coli* (O157:H7). It was prepared by suspending 50.03grams of the Agar in 1litre of distilled water. The solution was vigorously shaken and pre heated to allow thorough mixing of particles. Thereafter it was autoclaved at 121°C for 15minutes and later was cooled to 45°C ready to be used for incubation. The milk was diluted as before and transferred aseptically to petri dishes.

Milk sample in a collecting bottle was carefully shaken to mix the sample. One millilitre of milk sample was serially diluted to give dilutions between 10^{-1} and 10^{-6} while holding the test tubes and sample bottle near a Bunsen burner to avoid contamination. The sterilised pipettes were used in sample taking to avoid contamination. The single sterile pipette was used per each dilution transfer. One ml of each dilution was pipetted into a separate, labelled empty petri dishes, opening dish only enough to let the pipette in this was done near the Bunsen burner. The inoculation was done in triplicate. Petri dishes for inoculation were added with 20mls of the Agar gently moved at figure eight movement for thorough mixing, then allowed to solidify. The solidified petri dishes were incubated at inversion position in the oven at 37°C for 24hours. The developed colonies were counted, for the colonies to be counted as *E.coli* pathogenic they were supposed to be colourless and not reddish, purplish or pinkish.

4.2.8 Confirmation of *E.coli* and *E.coli* pathogenic (O157:H7)

The biochemical tests for confirmation were done to confirm the presence of *E.coli* in the milk samples which the organism grows.

4.2.8.1 Gram Staining Test

This test was done on the sterile glass slides and a drop of normal saline was firstly added on a slide then well-isolated colonies were spread on the prepared slides to make smears. These smears were dried on air and then followed by gentle fixing and flaming. Fixed smears were soaked in a crystal violet stain for two minutes then washed with a running tap water. Slides were then soaked in Lugol's iodine for two minutes and then washed with a running tap water. Thereafter these slides were decolorised by using acetone alcohol and washed on running tap water followed by covering of these fixed smears with neutral red for two minutes and then washed on running water. These slides were then dried on a draining rack after drying a drop of oil immersion was added to these slides then examined under a light microscope with 100X objective to examine the morphology of the bacteria. Gram-positive were cocci with pale to dark purple colour while Gram-negative are rod-shaped with pale to dark red colour.

4.2.8.2 Indole Test

Peptone water solution was prepared by diluting 15.23 grams of peptone water powder into 1000ml of the distilled water and then 3mls of this solution was added in a bijou tubes by using a sterile plastic disposable pipete. Fresh sterile plastic loop was used to inoculate the colonies to bijou tubes then these tubes were incubated at 37°C for 48 hours. After incubation 0.5mls of Kovac's reagent (Loba Chemie Pvt. Ltd, Lot LM 01131303) were added to the incubated tubes. Tubes were then gently shaken and examined for red coloured ring formation on the surface of the tube. Formation of this red ring is an indication of positive Indole reaction.

4.2.9 Statistical Analysis

Results of laboratory counts for Total Bacterial Count, Total Coliform Counts, *E. coli* and pathogenic *E. coli* were firstly entered into Ms Excel data sheet. The TBC and TCC in milk samples were compared with (EAC, 2006) specifications. The data were transformed into log10 then the means for Total Bacterial Count, and Total Coliforms Counts and *E.coli* counts for vendors and farmers were analysed by the use of SAS at the 95% confidence interval and 5% level of significance.

4.2.10 Statistical Model

The following statistical model was used in analysing data for the microbiological quality of the milk

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

Where Yij =individual observation for each test

βi =the ith milk source effect (i=1,2)

Eij = the error term

4.3 RESULTS

Table 4.1 shows the milk grading system practised in East Africa with the legal limits, for both of milk samples majority of them falls within the acceptable grades. TBC and TCC for milk samples collected from farmers and vendors were compared using the standards shown in this table.

4.3.1 Descriptive Statistics

The results on the grades of the milk in respective to the source basing on EAC legal limit standards shows that the large proportion of milk falls within the acceptable grades. (Table 4.1)

Results for milk samples from both farmers and vendors show a significant difference in TCC and TBC with farmers having a significantly lower TBC and TCC ($p<0.05$). (Table 4.2)

Table 4.3 shows the mean bacterial counts of milk from farmers in the villages that participated in the study. The highest and lowest counts for TCC were found in Nronga and Lyamungo Kati villages respectively. For TBC mean counts the highest and lowest counts came from samples collected from Foo and Wari villages.

Table 4.4 is showing the mean bacterial counts of milk from vendors in the villages participated in the study. The highest and lowest counts for TCC were found in Nronga and Foo villages respectively. For TBC mean counts the highest and lowest counts came from milk samples collected from Nronga and Foo villages.

Table 4.5 shows that milk samples from both farmers and vendors tested positive for the presence of *E.coli* all samples tested were negative for the pathogenic strains of *E.coli*

Table 4.1 Classification of Microbiological Quality of Raw Milk Samples Collected from Farmers and Vendors in Hai District Compared to EAC Standards (EAC 2006)

Parameter	Grading	Range (cfu/ml)	Farmers	Vendors
TBC	I	<200,000	68 (37.6%)	10(33.3%)
	II	>200,000 – 1,000,000	75 (41.4%)	11(36.7%)
	III	>1,000,000 – 2,000,000	16 (8.8%)	4 (13.3%)
	Reject	More than 2 000 000	21(11.6%)	5 (16.7%)
TCC	I	0-10 000	114 (63%)	24 (82.8%)
	II	10 000- 50 000	48 (26.5%)	4(13.8%)
	Reject	More than 50 000	18 (9.9%)	1 (3.4%)

Table 4.2 Total Coliform Count and Total Bacterial Count (LSM ± SE) for Farmers and Vendors in Hai District

Variable	Farmer	Vendor	p-Value
TCC	$1.5 \pm 0.9 x10^{4a}$	$1.8 \pm 0.8 x10^{4b}$	0.03
TBC	$7.0 \pm 0.2 x10^{5a}$	$1.0 \pm 0.2 x10^{6b}$	0.0001

Means with different superscripts in the same row under the same variable differs statistically ($p<0.05$).

Table 4.3 Total Bacterial Count and Total Coliform Count (LSM ± SE) for Milk Collected from Farmers from Participating Villages in Hai District

	Village					
Parameter	**1**	**2**	**3**	**4**	**5**	**P-Value**
TCC	$2.8 \pm 0.7 \times 10^{4a}$	$0.4 \pm 9.4 x 10^{4b}$	$0.1 \pm 9.4 x 10^{4b}$	$4.8 \pm 0.7 x 10^{4a}$	$1.7 \pm 9.4 x 10^{3b}$	0.03
TBC	$8.4 \pm 1.9 \times 10^{5a}$	$1.5 \pm 0.2 x 10^{6b}$	$5.5 x \pm 2.3 x 10^{5a}$	$6.5 \pm 1.9 x\ 0^{5a}$	$9.1 \pm 2.3 x 10^{5a}$	0.01

Means with different superscripts in the same row under the same variable differs statistically ($p<0.05$).

Table 4.4 Total Bacterial Count and Total Coliform Count (LSM ± SE) for Milk Collected from Vendors from Participating Villages in Hai District

1= Nkuu Ndoo, 2= Foo, 3= Wari, 4=Nronga and 5= Lyamungo Kati

	Village					
Parameter	**1**	**2**	**3**	**4**	**5**	**p-Value**
TCC	$1.8 \pm 0.6 x 10^{4a}$	$2.0 \pm 0.1 x 10^{4a}$	$1.7 \pm 0.7 x 10^{4a}$	$7.3 \pm 2 x 10^{4b}$	$2.8 \pm 2 x 10^{4a}$	0.0009
TBC	$9.5 \pm 0.5 x 10^{5a}$	$9.8 \pm 0.6 x 10^{5a}$	$6.9 \pm 0.5 x 10^{5a}$	$1.6 \pm 0.6 x 10^{6b}$	$1.1 \pm 0.5 x 10^{6b}$	0.02

Means with different superscripts within columns and under the same variable are statistically different ($p<0.05$).

Table 4.5 Proportions of Samples with *E.coli* in Milk Samples Collected from Farmers and Vendors in the Hai District

Actor	n	Samples with *E.coli*	%
Nkuu Ndoo	29	5	17.2
Foo	18	5	27.8
Wari	41	1	2.4
Nronga	11	6	54
Lyamungo Kati	29	4	13.8
Vendors	9	1	11

4.4 DISCUSSION

The low bacterial counts observed could have been due to clean milk handling by the farmers and vendors through proper cleaning of milk utensils, udder and hygiene observation by the milkers. As reported by (Lues *et al*, 2010) in a study conducted in South Africa, freshly obtained milk contain some bacteria and somatic cells, which constitute the biological constituents of the milk, which easily change depending on production conditions, such as the health status of the cattle and hygiene practices during milking as well as keeping and transportation of milk and milk products.

In order to grade milk, the bacteria count is a useful method to determine milk quality (Shojaei and Yadollahi, 2008), and it is measured by the number of colony forming unit per ml of a milk sample after laboratory culture. The lower the bacteria load the better the quality of the milk (Bytyqi *et al*, 2011).

The fact that a large percent of milk samples for TBC and TCC from both farmers and vendors in the study site fall within the standard legal limits as per EAC is an indication of some measures being put in place by farmers and vendors to ensure that clean milk is produced. This can be explained by the fact that this area has a long history of milk production and processing. Knowledge of clean milk production may have been passed on from generation to generation. Clean milk production is also made possible by the supply of clean water all year round.

Based on interviews with farmers and general observation, cleaning of milking barns was done twice in the morning and evening. Removal of dung is important in controlling flies which can spread spoilage microorganism within the premises. Farmers were located close to the milk collection centres with the furthest farmer taking twenty minutes to deliver milk to the collection centre. Milk deliveries were generally made soon after milking. This is because studies have proved that the microbial load of milk is influenced by the distance that milk is transported from point of production to the time it reaches the ultimate consumer (Adugna *et al*, 2013). These factors are important in reducing the period in which bacteria can grow and cause spoilage before chilling because studies have revealed that there is increased multiplication of bacteria in the milk during transportation and storage of milk (Mosu *et al*, 2013). The fact that milk is immediately chilled in collection centre, that vendors buy chilled milk and that the milk deliveries to consumers by vendors are within one hour travelling time using public transport could explain the acceptable quality of milk sold by vendors in the study area. Another reason for this might be hygienic milking, storage and transportation of milk from the farmer to MCC's (personal observation).

The observed number of milk samples that falls within grade III and reject for TBC and reject grade for TCC is of concern because the farmers that are in grade III needs education on proper milk handling so as to improve to better grades. Also, the farmers with reject groups are in the high risk of throwing their milk away in case of introduction of quality scheme payments, so for them to be in a profitable dairying they need to lower the level of TBC and TCC counts in their milk. The observed results in the study are an indication of improper milk handling and hence increase the number of bacterial load in the milk. Improvement of the farmers on milk handling will contribute to the amount milk produced in the country so as to meet the demand for the processing units for fresh milk sourcing and also help farmers in securing the reliable market. The lowered bacterial load in the milk increases the keeping time before milk undergoes spoilage and is a primary determinant of the quality of dairy products processed from such milk.

If a quality premium payment were to be introduced based on microbiological quality, farmer supplying milk with a low bacterial count would get a higher price as an incentive. A study by (Yuen *et al*, 2012) reported that detection of coliform in the milk indicates contamination of milking utensils as well as the water used for cleaning the udder. The presence of coliforms in milk and the effects it can have on milk quality can be used as a way of encouraging farmers to adopt more clean milk production strategies.

Detected *E.coli* in milk is of great health concern as it indicates contamination with the faecal materials. The use of hot water and detergents in washing hands of the milker, cleaning milk utensils with hot water and detergents is the advisable method of avoiding milk contamination as *E.coli* can easily be killed with high temperature and using hot water. Also, farmers with milk in poor grades and with contamination of *E.coli* need to be informed on the possible sources of contamination of their milk like udder with faeces due to uncleaned animal houses so as they will be able to control the milk contamination

.

4.5 CONCLUSION

The average Total Bacteria Counts and Total Coliform Counts for both farmers and vendors in Hai District were within the acceptable ranges as per East African Community Standards. The milk was found to contain *E.coli* of animal origin for milk samples from both farmers and vendors. The presence of coliforms in milk is of public health concern. No pathogenic strains of *E.coli* were identified in all analysed milk samples.

CHAPTER FIVE

5 AN ASSESSMENT OF MILK COMPOSITION, WHOLESOMENESS AND FREEDOM FROM SULPHONAMIDES AS WELL AS TETRACYCLINE DRUG RESIDUES IN MILK SAMPLES COLLECTED FROM FARMERS AND VENDORS IN THE HAI DISTRICT TANZANIA.

ABSTRACT

A study was carried out to assess the physicochemical properties of milk, its wholesomeness, adulteration and the presence of Tetracycline as well as Sulphonamides drug residues. The milk was collected from Foo, Lyamungo Kati and Nronga villages in the Hai District in Tanzania. The physicochemical properties tested were Fat, Solids-Not-Fat (SNF), Freezing Point, Added Water and Density. The analysis was carried out by using Automatic Milk Analyser (Model LM 2, serial number 11673, IndiaMART Company Limited). Results from this analysis show that milk from farmers and vendors had the acceptable standard properties. For farmers Density was 28.18g/l, Fat 3.5%, Freezing Point -0.52, Solids-Not-Fat 7.3% and added water 0.36. For vendors, Density was 27.4, Fat 3.1, Freezing Point -0.54, Solids –Not Fat 7.3% with no added water. Milk samples from Nronga village had the highest Fat content. Tests done using the Charm EZ Techniques for Sulphonamides and Tetracycline drug residues showed that the highest level of Sulphonamides residues was in samples collected from Turiani 53.1% and lowest (25%) in samples collected from Mlandizi. Tetracycline highest level was in milk samples from Turiani (25% of samples), followed by Hai (12.1%) of Hai and then in Mlandizi (6.2%) Milk samples from all vendors tested negative for the two antibiotics drug residues. The presence of antibiotic residues in milk is of public health concern so need measures to be taken in ensuring that farmers will comply with the drug administration requirements to their animals and comply with the regulations of selling antibiotic-free milk.

5.1 INTRODUCTION

Milk composition forms an important aspect of milk quality for both health and processing into different milk products. This also is used as criteria when processors are developing a quality scheme payment to farmers. The components in milk composition considered for assessing the milk quality are butterfat and protein content as they are determinant for butter and cheese making. It is important to measure this content because of milk adulteration practised by dishonest farmers. Adulteration of milk interferes with milk composition and so it is important to measure this parameter for ensuring that the physicochemical properties of milk are maintained to qualify milk for further processing. Milk quality can be analysed basing on physical properties so as to ensure the quality of the product processed from the raw milk (Hadrya *et al*, 2012). In order to accomplish the task, a number of machines have been manufactured and the milk quality is analysed by comparing the values with the standardised values for milk physicochemical properties. Milk demands extra care and attention due to its nature in production, handling and processing to ensure satisfying quality products to consumers.

Studies have revealed that the presence of Tetracycline residues at a higher level than it is accepted in food is a serious public health concern because of its harmful effects to the consumers (Gaurav *et al,* 2014). This study assesses the residue level of Sulphonamides and Tetracycline in milk samples from two townships and one District namely Turiani, Mlandizi and Hai respectively. The presence of antibiotic residues in food is of public health importance so creates the need for research to be carried out to establish the status of drug residues in milk from small-scale dairy farmers in Tanzania. The information from the research will help in coming up with the better plan on how to reduce and if possible eradicate the problem of antibiotic residues in milk in Tanzania.

The physicochemical properties of milk and the presence of antibiotic residues in milk needs strict follow up because they affect milk price. Drug residues affect the health of consumers for milk and milk products. Ignoring of these aspects bring economic losses to processors as the quality of products made from milk are determined by the quality of raw milk that were used as raw material for dairy products processing. Apart from the loss to the processors it also exposes farmers to health problems such as antibiotic resistance and allergic reactions to consumers of milk and milk products made from milk with a higher level of antibiotic than the acceptable. The involved areas for drug residue analysis were selected aiming at comparing drug residue level in two groups of farmers. In Hai District, the participants were dairy cattle keepers and in Mlandizi and Turiani it was pastoralists who had been trained on proper use of antibiotic to lactating animals. The study aimed at establishing the difference in drug residue level in animals from dairy farmers and from trained pastoralists.

5.2 MATERIALS AND METHODS

5.2.1 Study site

The study site and sample collection procedures are described in section 3.2.1.

5.2.2 Data collection

Data collected were physical-chemical properties of milk and analysis for the presence of Tetracyclines and Sulphonamides in milk samples from vendors and farmers in the Hai District as well as Turiani and Mlandizi townships.

5.2.3 Milk Composition Analysis

Milk composition analysis was carried out at Milk Collection Centre using an Ultrasonic Milk Analyser Model LM 2, serial number 11673 IndiaMART Company Limited. The milk constituents measured were butterfat content and solids not fat. The same equipment was also used to measure milk density and freezing point.

Sulphonamide and Tetracycline drug residues in milk were analysed using quantitative Charm EZ technique according to manufacturers' instruction. Tetracycline and Sulphonamides are the most commonly used antibiotics in Tanzania. For Tetracycline, the incubation time was 8 minutes while for Sulphonamides was 4 minutes.

Calibration of the machine was done. The negative control tests were then carried out using milk from animals that had not been treated with antibiotics for at least one month before the day of taking a sample. 30µl of milk was added into the strips and the test was run in the Charm EZ machine and results were recorded. The positive control was done by dissolving a Tetracycline or Sulphonamide antibiotic tablet that was included in the kit. The tablet was dissolved in 1ml of the milk free from antibiotic residues. Then 30µl of this sample was squeezed in a respective strip.

5.3 RESULTS

5.3.1 Physicochemical Properties of Milk

Milk from the participated villages was in the standard level accepted for further processing. The highest fat content was in milk from Foo village (Table 5.1).

Table 5.1 Comparison of Physicochemical Properties of Milk Samples Collected From Selected Villages in the Hai District in Tanzania

1= Nkuu Ndoo, 2 = Foo 3 = Lyamungo Kati

Parameter	Village			
	1(n=30)	2(n=43)	3(n=27)	P-Value
Fat (%)	3.4 ± 0.09[a]	3.8 ± 0.11[b]	3.4 ± 0.09[a]	0.003
Temperature(°C)	19.8 ± 0.3[a]	22.8 ± 0.37[b]	21.14 ± 0.3[c]	0.0001
Density	23.8 ± 0.4[a]	28.9 ± 0.51[b]	28.45 ± 0.42[a]	0.003
Added water	1.3 ± 0.21[a]	0.05 ± 0.3[b]	0.05 ± 0.21[a]	0.0003
SNF (%)	7.5 ± 0.01[a]	6.3 ± 0.02[b]	6.4 ± 0.01[b]	0.0001
Freezing Point	-0.53 ± 0.01[a]	-0.51 ± 0.01[a]	-0.53 ± 0.01[a]	0.42

Figures with different superscript letter in the same row and under the same variable differs ($p<0.05$)

Levels of milk fat were found to be 3.5% and 3.1% for farmers and vendors respectively Milk samples from vendors had no added water but samples from farmers had the 0.36 of added water. Results for the freezing point of milk samples were not different ($p>0.05$) between farmers and vendors (Table 5.2).

Table 5.2 Comparison of Physicochemical Properties of Milk From Farmers and Vendors

Parameter	Farmers	Vendors	p-Value
Fat (%)	3.6 ± 0.1[a]	3.2 ± 0.1[a]	0.5
Temperature(°C)	19.9 ± 0.4[a]	21.6 ± 0.4[a]	0.3
Density	28.7 ± 0.5[a]	27.9 ± 0.7[a]	0.4
Water	0.12 ± 0.08[a]	0.0[b]	0.0001
SNF (%)	7.5 ± 0.02[a]	7.3 ± 0.02[a]	0.7
Freezing Point	-0.54 ± 0.06[a]	-0.53 ± 0.01[a]	0.5

Figures with different superscript letter in the same row means the two groups were statistical different ($p<0.05$).

5.3.2 Antimicrobial Residues

Results show that the highest frequency of positive samples of Sulphur residues was in milk samples from Turiani (53.1% of samples) and lowest in Mlandizi samples 25%. Tetracycline highest level was in milk samples from Turiani (25% of samples), and lowest in 6.2% of milk samples from Mlandizi. Milk samples from vendors tested negative for the two antibiotic residues. (Fig 5.1)

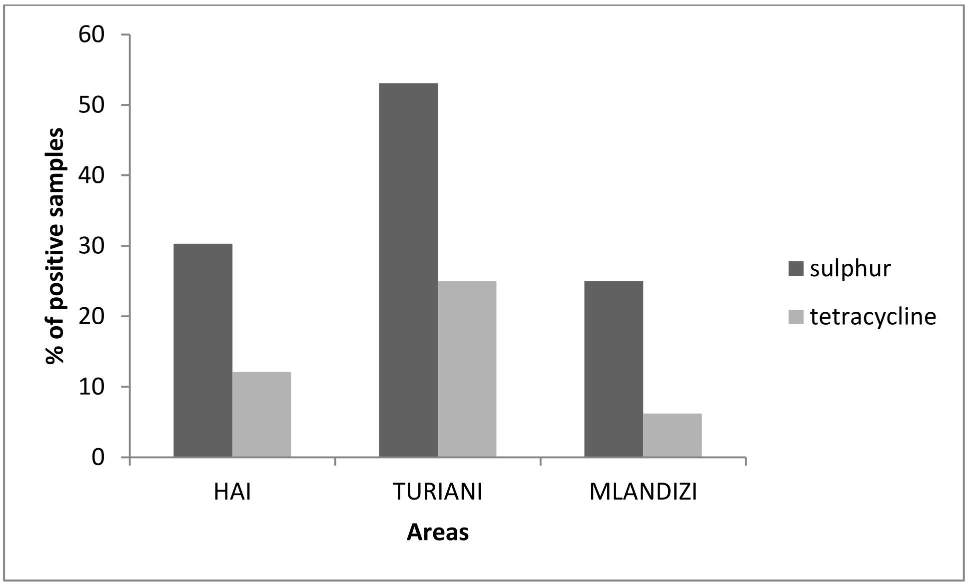

Figure 5.1 Drug Residues in Milk Samples Collected from Hai, Turiani and Mlandizi Areas in Tanzania.

5.4 DISCUSSION

The presence of Sulphonamide and Tetracycline antibiotic residue is of concern in Tanzania. There is risk associated with consumption of milk based products due to the presence of drug residues given that 50% of the tested milk samples contained drug residue. The introduction of a penalty scheme which fines producers who submit milk that tests positive or withdrawal of dairy licences where they are required can act as deterrents. In Europe, the production of organic milk is an incentive for farmers to produce milk that fetches a higher price per litre and is free from antibiotics (Gegner, 2001). With the exception of South Africa, Zimbabwe and Kenya in Sub-Saharan Africa (where payment schemes screen for antibiotic residues), antibiotic residues may be high, exposing milk consumers to undesirable health effects associated with drinking milk with residues of antibiotics.

Some farmers were selling milk from treated animals to collection centres so their milk tested positive for drug residues contrary to their responses in the interviews where they indicated that they observed the withdrawal period. Milk samples from vendors tested negative for drug residues.

The absence of residues in milk from vendors can be explained by the fact that vendors mix the milk from different farmers so there is dilution effect in milk samples from the vendors. If milk containing drug residues is with milk from farmers who are not using antibiotics the test may no longer be sensitive enough to pick up the lower concentration of antibiotic residues as the sensitivity for this test is 0.050ppb at the European Union maximum residue limit.

Physical-chemical properties of milk are important components since they determine both health and processing aspects of milk. They are affected by breed with local breeds having higher fat content of up to 6.3% but in exotic dairy breeds that usually ranges from 3.5-4.8% (Singh and Pratap, 2014). Results from this study show that milk from the farmers and vendors meets the composition standards, this was in agreement with (Séverin, 2013) who found milk with normal physical chemical properties in his study at Côte D'ivoire. The Fat content of the milk in the Hai District was found to be within the range of fat content for *Bos indicus* and *Bos Taurus* cows and is above the minimum of 3% which is required for processing milk (Lues *et al*, 2010). In almost all aspects were the same for both actors and these results can be caused by the milk vending system in Hai District. The vendors had their permanent buyers who were Regional Hospitals, schools and hotel owners in Moshi Town, so they don't adulterate their milk to keep their customers. This different from the study by

(Lubote *et al.*, 2014) in Arusha in which vendors moved to households to sell the milk and they had no permanent customers for their milk. Also from the survey, all respondents said that they were spending only two hours to finish up selling their milk so milk was preserved from deterioration in quality.

5.5 CONCLUSION

The study confirms the presence of Tetracyclines and Sulphur in the milk samples from the study area as well as the two added areas for this aspect. Milk samples from vendors were all negative for the two drugs. This can be caused by dilution effect since these vendors were buying the milk from the bulk tank in the MCC's with milk mixed from all farmers. The presence of drug residues in milk poses threats to consumers' health so this creates the need for the regulatory agencies in the country to enforce farmers comply with the set regulations through improving the policy on milk quality and act according to the laws in place. The milk composition of milk from both farmers and vendors was found to be at acceptable levels for further processing. This gives farmers from Hai District an opportunity to look for a better paying market for their milk because the compositional quality of their milk is assured as it was proved by this study.

CHAPTER SIX

6 GENERAL DISCUSSION CONCLUSION AND RECOMMENDATIONS

6.1 General Discussion

The observed levels of bacteria load for both TBC and TCC in milk from the study area were in the acceptable limits according to EAC Standards because they were below $2x10^6$cfu/ml indicating the improved milk handling by the participants in the study area. There were some few farmers in the study area with mean bacterial count above two million in their milk, the high count in milk samples for these groups of farmers can be explained as the failure of adherence to clean milking and milk production storage and handling as many farmers were using plastic jerry cans to transport their milk to collection centres. The types of containers used were difficult to clean thoroughly. Although the majority of milk samples was within grade II of the milk quality there is need to educate farmers so that quality use of approved milking structures like milking parlours would help in lowering the bacterial counts in milk from farmers in the study area and so the proportion of farmers with high-quality milk increases.

High levels of the total bacterial count of milk from vendors compared to the samples from the farmers can be explained by the lack of cold chain for vendors when transporting milk so increases bacterial multiplication in their milk.

The presence of *E.coli* in some milk samples for both farmers and vendors reflects the contamination of milk with faecal materials. It poses a risk to the health of consumers of raw milk and milk products from such milk. Milk and dairy products should be free from *E.coli* (EAC, 2006). Recovery of *E.coli* from fresh raw milk is an indicator of the possible presence of other pathogenic microorganisms such as Salmonella which are also of faecal origin.

The presence of Sulphonamides and Tetracyclines in milk samples Hai, Turiani and Mlandizi is an indication of lack of adherence to the drug withdrawal period after administration of antibiotics to sick milking animals. This is an indication of dishonesty since from the interviews, farmers admitted that they should not be selling such milk and indicated that they do not sell the milk from animals on treatment. Lack of adherence to the practice can be due to fear of financial losses a farmer will incur due to throwing away the milk.

The fat and total solids content meet the minimum standards required for processing of dairy products. The low levels of adulteration with water could be due to fear of financial loss since most MCC's use the lactometer as the basis for accepting milk from farmers.

In conclusion, information generated from this study on milk quality in this study can be used in the development of strategies to boost the small-scale dairy sector in Tanzania. The information will also be useful to all stakeholders in the dairy sector in Tanzania.

6.2 General Conclusion

The Total Bacterial Count and Total Coliform Count observed results indicate that there is some level of use of hygienic practices among some farmers. While the Coliform Counts in the analysed milk samples were in the acceptable level of raw milk qualities as per EAC. The use of proper containers made of stainless and seamless aluminium cans will reduce this figure even further.

The presence of *E.coli* reflects milk contamination of faecal origin. Even though no pathogenic strains of E.coli were identified, the coliforms are of public health concern and there is a need for the small-scale dairy farmers to introduce additional measures such as cleaning their hands before start milking, avoid contamination of the milk utensils and milk to ensure proper milking and milk handling hence reduce milk contamination. The physical-chemical properties of milk for all the participated villages were in the acceptable quality for processing.

The study confirmed the presence of Tetracycline and Sulphonamide antibiotics residues in milk from farmers but not from vendors in the study area. The source of these drugs is mostly due to lack of compliance to withdrawal period after administering drugs to the sick milking animals. The presence of antibiotic residues in milk is of public health concern.

6.3 Recommendations

Extension of education in all aspects of clean milk production is important in developing awareness among small-scale dairy farmers to follow the set standards procedures for milking and proper milk storage.

The available laws and regulations need to be revised and developed where they are not available to take care of possible sources of spoilage for example replacement of plastic milk storage containers with the use of stainless steel cans for milk storage. These can be easily cleaned and removes the bacteria that build up in milk storage containers and lowers the bacterial counts in milk from the Hai District.

Establishing a system in which milk will be graded and priced according to the quality will involve introducing a quality-based payment system. This will have financial rewards for milk which are clean and penalties for low-quality milk. Such a scheme can screen for antibiotic residues and adulteration with other materials such as flour and butter at MCC's. Other milk tests apart from the use of lactometer at MCC's such as alcohol test, Resazurin test and Clot -On Boiling test can be included as platform tests.

Educational programmes and awareness campaigns should be conducted by all dairy stakeholders to enlighten dairy producers and consumers on dangers posed by drug residues in milk to public health and the dairy processing industry. The existing food regulations and Acts should be reinforced to take care of drug residues in milk and other dairy products. A weak regulatory structure such as the one currently exists allows farmers to sell milk containing drug residues due to fear of financial losses that occur due to the discarding of the milk with antibiotic residues.

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7 Appendix

Questionnaire

I. FARMER

A. House hold details

1. Name ………………………………………………………….
2. Relation to house hold head………………………………
3. House hold demography

Relationship to head of household	Age	Marital status	Sex	Education	Occupation	Residence
	15-20	Single	Male	Primary	School	Residence
	21-30	Married	Female	O' level	Farming	Homestead
	31-40	Divorced		A ' level	Working	Local area
	41-50	Widowed		Tertiary	Others	Nearby town

	Over 50			Others		Others

4. House hold size…………………………………………………..
5. Family type

   a. both parents alive

   b. woman headed widowed

   c. man headed widowed

   d. woman headed man in town

   e. woman headed never married

B. Livestock

1. What types of livestock do you have?

Type	**Number**	**Owned/Rented**
Goats		
Sheep		
Dairy cattle		
Indigenous cattle		
Chicken		
Others		

2. Which of the following farm equipment do you own?

List	**Quantity**	**Duration of use**
Milking machine		

Milking cans		
Milking area		
Handling facilities		
Milk storage facilities		
Others		

C. Antibiotics

1. Do you treat your cows?

   a. Yes

   b. no

2. If yes how often?

   A when they fall sick

   B after three months

   C annually

3. Do you have any cattle on antibiotic treatment recently?

   a yes

   b no

4. Do you keep records for your animals?

   a yes

   b no

5. If yes which among the following

   a. Milk production

   b. Treatment

   c. Heat sign

   d. Feeds

   e. Calving date

6. How many days your cow will be treated when sick?

   A one day

   B two days

C three days

7. Do you sell milk from cow on treatment?

   A no

   B yes

8. If not how long do you wait?

   A one day

   B two days

   C three days

9. If you don't sell the milk what do you do with the milk?...
10. Do you mix the milk from all the milked animals?

    A yes

    B no

D. Milk handling.

1. What do usually do before milking?...

2. How many times do you milk your animal per day?
   a. Twice
   b. Thrice
3. If you wash your hands and udder of the animal what do you use?

   A hot water

   B cold water

4. What is the source of water you use comes from?

   A protected source

   B open source

5. Do you dry your animal before milking?

   A yes

   B no

6. What do you use to dry them?
   a. Individual towel

b. One towel shared among all milked animals
c. Tissue paper
d. Others

7. Do you use milking salve?

A yes

B no

8. If yes which brand do you use?..
9. Do you do teat dipping after milking?

A yes

B no

10. What type of container do you use to keep your milk?
    a. Plastic
    b. Aluminium cans
    c. Others
11. How do you make sure that the container is clean before using it?

A rinsing with clean water before using

B washing with clean water soon after removing milk

12. How do you store your milk?

A keep the fridge

B on the floor

13. When do you sell your milk
    a. Soon after milking
    b. 12 hours after milking
    c. Others

14. Have you attended any course on how to produce clean milk?

A yes

B no

15. Are you able to trace the source of bad milk in your farm?

A yes

B no

E. Quality control

1. Do you have any quality control check on your milk?

   A yes

   B no

2. What parameters do you examine?

   A adulteration with water

   B alcohol test

3. Have you had any of your milk being rejected?

   A yes

   B no

4. If yes why?..................................

5. What did you do to stop the problem from repeating?...................................

II. VENDOR

A. Handling and storage of milk

1. How do you get the milk
   a. Farmers bringing their milk to the vendor
   b. Bought from milk collection centre

2. What type of containers do you use to keep the milk?

   A plastic bucket

   B plastic jerries

   C aluminium cans

3. How do you ensure that containers are clean before using them?

   A rinsing with hot water

   B rinsing with cold water

4. How long does it take from point of collection to the selling point?

   A 1 hour

   B 2 hours

5. What type of transport do you use to carry your milk to selling centre?

   A public transport

   B private car

   C motorcycle

6. What is the time taken to finish selling your milk?

   A 2 hours

   B 3 hours

   C 4 hours

7. How many litres do you sell per day?

   A Zaidi ya lita 50

   B lita 50

   C chini ya lita 50

B. Quality control

1. Do you have any milk quality checks in place?

   A yes

   B no

2. What are they?

   A milk adulteration with water

   B alcohol test

3. How do you handle the detected defects?

   A warning to the farmer

   B penalizing the farmer

   C rejecting the milk

4. Did u have any complaints about quality of the milk you sell from your customers?

   A yes

   B no

5. What was it about?

   A watery milk

   B dirty milk

6. How did you handle the situation?............................

7. Are you able to trace the source of bad milk brought to you by farmers?

   A yes

   B no