ASSESSMENT OF MICROBIAL CONTAMINATION IN BEEF FROM ABATTOIR TO RETAIL MEAT OUTLETS IN MOROGORO MUNICIPALITY, TANZANIA

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ABSTRACT

The aim of this study was to assess microbial contamination in beef production chain from abattoir to retail meat outlets in Morogoro municipality. A total of 102 water, meat and surface swab samples from evisceration tables, walls, floors, meat van floors and knives in abattoir were collected and analyzed for Total Viable Counts (TVC), Total Coliform Counts (TCC) and Total Faecal Coliform Counts (TFC). Meat and surface swabs from weighing balances, knives, meat chopping tables, wood cutting blocks in 14 retail meat outlets were also collected and analyzed for the same microbial contamination parameters. The mean values for TVC, TCC and TFC in abattoir were highest in meat samples from neck regions with 7.72, 6.92 and 6.73 log Colony Forming Unit per gram (CFU/g) respectively. The lowest TVC were on knives being 4.13 log CFU/cm^2. There was no growth for TCC and TFC in water samples. In beef retail outlets the highest mean values for TVC, TCC and TFC were in meat samples being 7.24, 5.55 and 5.27 log CFU/g respectively. The lowest TVC mean values were in weighing balances being 5.77 log CFU/cm^2. The lowest mean values for TCC and TFC were observed on meat chopping tables being 4.13 log CFU/cm^2 and 3.47 log CFU/cm^2 respectively. There were higher mean values for TVC, TCC and TFC in abattoir compared to retail meat outlets. Results revealed that practices for personal and environmental hygiene were not adhered. Microbial contamination in beef from abattoir to retail meat outlets indicated low hygienic standards on meat produced in the area. Policies, regulations and procedures for hygienic slaughtering practices and handling of meat along the meat production chain should be adhered and enforced by relevant agencies/authorities in order to ensure that the meat produced is wholesome and safe for human consumption.

DECLARATION

I, Pius Daniel Ntanga, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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Date

The above declaration is confirmed by:

Prof. R.H. Mdegela
(Supervisor)

Date

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DEDICATION

This research is dedicated to my wife Yosepher Damian Mapunda and our children Victor, Ernest, Baraka and Jenifer who supported my education and tolerated my absence during my academic life.

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LIST OF ABBREVIATIONS AND SYMBOLS

CFU	Colony Forming Unit
cm^2	Centimetre square
E	East
FAO	Food Agriculture Organization
Fig	Figure
g	Gram
g/l	Gram per litre
H_0	Null hypotheses
H_1	Alternative hypotheses
HACCP	Hazard Analysis of Critical Control Point
ICMSF	International Commission of Microbiology Specification for Food
km	Kilometre
ml	Millilitre
n	Number
^oC	Degrees Celsius
p	Value
S	South
S.D	Standard Deviation
Sq. km	Square kilometres
TCC	Total Coliform Count
TFC	Total Faecal Coliform Count
TFDA	Tanzania Food Drugs and Authority
TVC	Total Viable Count
URTNC	United Republic of Tanzania National Census
%	Percentage
<	Less than
>	Greater than
±	Plus or Minus

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

In 2012, the population of Morogoro municipality was estimated to be 315 866 (URTNC, 2012), with an estimated increase at 2.4% per year. Most of the people living in Morogoro municipality depend much on beef processed at Morogoro municipal abattoir as the main source of animal derived protein. The production and consumption of meat has increased in parallel with increased human population. For example, in 1986 the average number of cattle slaughtered per day at Morogoro municipal abattoir was 20 and in 2006, 20 years later, the number increased to 60 (Nonga *et al.*, 2010). Such steady increased in number of animals slaughtered per day with the same facility, has compromised adherence to food safety standards.

Food safety is a matter of great concern and of public health importance in particular when the environment in which the food is handled is heavily contaminated (Soyiri *et al.*, 2008). Most of fresh food especially that of animal origin like beef is highly vulnerable to microbial invasion and food poisoning since meat is an ideal medium for growth of a number of microorganisms due to its nutritive value (Soyiri *et al.*, 2008). The main constituents of meat are water and protein. In addition, fat, phosphorus, iron and vitamins are also found in meat. The major primary unit of meat is carcass which represents the ideal meat after removal of head, hide, intestines and blood. The edible parts of a carcass include lean flesh, fat flesh and edible glands or organs which include the heart, kidney, liver, brain and tongue (Ukut *et al.*, 2010). Tissues from healthy animals are normally sterile, but can be contaminated by microorganisms from the exterior of the animal and its intestinal tract during slaughter, dressing and cutting (Ukut *et al.*, 2010).

Contamination of meat can occur in multiple steps along the food production chain including production, processing, distribution, retail marketing and handling or preparation (Zhao *et al.,* 2001). The abattoir environment and slaughtering processes play a vital role in the wholesomeness and meat safety. Unhygienic practices in abattoirs and post-process handling are associated with potential health risk to consumers due to presence of pathogens in meat and contaminated equipments (Abdullahi *et al*., 2006). Effluent from slaughterhouses are known to contribute in contamination of both surface and groundwater since during processing in abattoir blood, fat, manure, urine and meat tissues are discharged to the wastewater streams (Bello and Oyedemi, 2009). For hygienic reasons abattoir use large amount of water in processing operations which in turn produce large amount of wastewater. The major environmental problem associated with abattoir wastewater is the large amount of suspended solids and liquid waste as well as odour generation (Gauri, 2006). After animals are slaughtered and inspected in the abattoir, meat is transported by meat van to different retail meat outlets for selling to consumers. During selling in retail meat outlets further contamination can occur through contact with handling equipments (tables, logs, hooks, balances and knives), insects, air, personnel and even consumers (Mtenga *et al*., 2000).

Microbial contamination of meat and meat products must not exceed levels which could adversely affect the shelf life of meat products and renders it unwholesome and unfit for human consumption. Under tropical conditions, food of animal origin tends to deteriorate more rapidly and become an important vehicle for gastrointestinal infections, thereby endangering consumers' health (Akinro *et al*., 2009). The microbes cause biochemical and microbiological changes in the meat which lead to production of noxious substances resulting into increased incidences of illnesses and other fatal human diseases (Soyiri *et al.*, 2008). This might be due to poor meat handling practices and lack of knowledge on

sources of microbial contamination of meat. Mukhopadhyay *et al*. (2009) reported that fresh raw meat like beef is implicated for a number of meat borne infections and intoxications. In several countries such illnesses cause increased costs of treatments and inability of people to work. Therefore, there is a need to initiate and implement the Hazard Analysis of Critical Control Point (HACCP) system and food safety education at different stages from farm to fork.

1.2 Problem Statement and Justification of the Study

In spite of the increased consumer demand on food safety standards for beef in Morogoro municipality there are still poor hygiene and sanitary practices along the food production chain which contribute to unacceptable level of microbial load in meat. This poses a health risk to consumers. Although several studies have been conducted to assess the degree of meat losses due to contamination of carcasses and offals (Mtenga *et al*., 2000), detection of zoonotic conditions through post mortem inspection (Komba *et al.,* 2012) and occurrence of Thermophilic *Compylobacter* spp in cattle slaughtered at Morogoro municipal abattoir (Nonga *et al.*, 2010), limited studies have been conducted to assess microbial contamination of beef along the production chain from the abattoir to retail meat outlets. In order to minimize public health risks, there is a need to assess microbial contamination of beef along the production chain and point out the main contaminated points that would require interventions through a HACCP system and education for different actors on beef enterprise.

1.3 Objective of the Study

1.3.1 General objective

The overall objective of the study was to determine the extent of microbial contamination and associated risk factors in beef production chain from abattoir to retail meat outlets in Morogoro municipality.

1.3.2 Specific objectives

i) To identify risk factors contribute to microbial contamination of beef from the abattoir to retail meat outlets.

ii) To establish the main beef microbial contamination points from the abattoir to retail meat outlets.

iii) To determine the extent of microbial contamination of beef along the production chain from the abattoir to retail meat outlets.

1.3.3 Hypotheses

i) H_0: There are no risk factors that contribute to contamination of beef from abattoir to retail meat outlets.

ii) H_1: There are risk factors that contribute to contamination of beef from abattoir to retail meat outlets.

iii) H_0: There are no microbial contamination points along the production chain of beef from the abattoir to retail meat outlets.

iv) H_1: There are microbial contamination points along the production chain of beef from the abattoir to retail meat outlets.

v) H_0: There is no microbial contamination along the production chain of beef from the abattoir to retail meat outlets.

vi) H_1: There is microbial contamination along the production chain of beef from the abattoir to retail meat outlets.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Indicator Organisms on Meat

The safety of raw meat products can be estimated based on indicator organism including TVC, TCC and TFC counts of mesophilic (Barros *et al*., 2007). Their presence indicate the possibility of finding pathogenic bacteria. TVC gives a quantitative idea about the presence of microorganisms such as bacteria, yeast and mould in samples. The coliform bacteria group consists of several genera of bacteria within the family *Enterobacteriaceae*. Total coliforms are a group of bacteria that are widespread in nature. All members of the total coliforms group can occur in human faeces, but some can also be present in animal manure, soil, sub-merged wood and in other places outside the human body. The usefulness of total coliforms as an indicator of faecal contamination depends on the extent to which the bacteria species found are faecal and human in origin. Faecal coliforms are good indicator of contamination from human or other animal waste products and they indicate greater risk of exposure to pathogenic organisms than total coliforms (Moore and Griffith, 2002). Control measures that reduce the number of bacterial load will reduce the risk of pathogenic bacteria on meat.

2.2 Common Microbial Present in Meat and Meat Products

Microorganisms of relevance with regard to meat hygiene include helminths, moulds, bacteria and viruses. Within these groups, bacteria play the most important role. Parasites are of insignificant value in meat which has passed meat inspection, or where efficient internal parasite control programmes or measure are in place. The most frequently identified bacterial pathogen associated with consumption of beef products are *Salmonella* spp, *Compylobacter* spp, *Staphylococcus aureus, Escherichia coli, Listeria*

monocytogenes, Clostridium perfringens, Yersinia enterocolitica, *Bacillus cereus and Vibrio parahaemolyticus* (Biswas e*t al.,* 2011). *Compylobacter* spp*, Salmonella* spp and *Escherichia coli* are often present in fresh meat and poultry (Zhao *et al.*, 2001). Ali *et al.* (2010) reported the foodborne pathogens isolated from meat samples in retail meat shops. They included *Escherichia coli* O157:H7, *Listeria* spp, *Salmonella enteritidis* and *Shigella* species while in meat handling equipments in retail shops were *Staphylococcus* and *Shigella* spp. Soyiri *et al.* (2008) isolated *Staphylococcus aureus, Bacillus cereus, Clostridium perfringens* and *Escherichia coli* in beef samples from butchers. Moreover, the faecal coliforms such as *Escherichia coli* are generally considered as indisputable indicators of faecal contamination from warm blooded animals (Yousuf *et al*., 2008).

2.3 The Effects of Bacteria in Meat and Meat Products

Food animals are useful as they supply quality protein and revenues to man, but on the other hand they serve as vehicles of disease pathogens. Raw meat remains an important and probably the major source of human food borne infection with pathogenic bacteria. In spite of decades of effort to control them, it has been difficult to obtain food animals free of pathogenic bacteria (Wilfred and Fairoze, 2011). The effects that microbial contaminants cause on meat include spoilage of the meat, food poisoning and condemnation of carcasses which results into reduction of income to farmers as well as meat sellers. Consumers and meat handlers may acquire bacterial diseases such as Anthrax, Q-fever, Campylobacteriosis, Ornithosis, Botulism, *Staphylococcus* food poisoning, Salmonellosis, Brucellosis, Erysipelas, Streptococcosis, Tetanus, Yersiniosis, Clostridiosis, Listeriosis, Glanders, Leptospirosis and Tuberculosis due to poor handling of food animals and meat (Adeyemo, 2002).

2.4 Incidences of Microbial Load in Meat, Handling Equipments and Facilities

The microbiological profile in meat products is the key criteria for determining quality and safety of fresh produce. Ideally, meat should be considered as wholesome when pathogens of concern are absent or if present should be at low number depending on their toxin or metabolites produced (Biswas *et al*., 2011). Bhandare *et al*. (2009) reported TVC at 5.8 ± 0.17 log CFU/cm^2 and 6.05 ± 0.25 log CFU/cm^2 in modern Indian and traditional meat shops respectively. In abattoir, the highest TVC were observed on floor 7.19 ± 0.18 log CFU/cm^2 and the lowest values in water 3.90 ± 0.07 log CFU/cm^2 , while in retail meat shops the highest were observed on floor 7.45 ± 0.46 log CFU/cm^2 and the lowest on the plastic bags 3.08 ± 0.24 log CFU/cm^2. Barros *et al*. (2007) reported contamination level by mesophilic aerobe count in samples from retail establishments and slaughterhouse equipments at 4.68 log CFU/cm^2, Total Coliforms at 2.55 log CFU/cm^2 and that of *Escherichia coli* at 1.8 log CFU/cm^2 respectively.

In other studies Nouichi *et al*. (2009) reported microbial load as indicated by TVC, TCC and TFC in bovine carcass slaughtered at El-Harrach slaughter house in Algeria at 4.48 ± 0.63, 2.92 ± 0.43 log CFU/cm^2 and 2.60 ± 0.32 log CFU/cm^2 respectively. Kumar *et al.* (2010) found a high total aerobic plate count of 75.91 % in beef produced and marketed in some parts of Tigray region with high percentage of unsatisfactory quality. Ukut *et al*. (2010) reported microbial load on fresh meat sold in Calabar Metropolis markets at 2.24 x 10^4- 5.01 x10^4 CFU/g and 1.05 x 10^3 - 3.72 x 10^3 CFU/g for TVC and TCC respectively.

2.5 Source of Beef Contamination

Unless the animals are infected the meat of freshly slaughtered animals are generally sterile. The presence of microorganisms on post slaughtered carcasses is due to

contamination occurring immediately before, during and after slaughter. The microbial contaminations of carcasses occur mainly during processing and manipulation during skinning, evisceration, processing at abattoir and retailers establishments (Gill, 1998). The main sources of meat contamination include; animal/carcasses source, on farm factors, transport factors, abattoir and butchers facilities, parasites and wild animals, meat van, abattoir and retail meat outlet workers.

2.5.1 Animal/carcasses source

Faecal matter is a major source of contamination and can reach carcasses through direct deposition as well as by indirect contact through contaminated carcasses, equipments, workers, installations and air (Borch and Arinder, 2002). Faeces as well as soil adhering to animals are carried into abattoir on hair, hides, hooves and tail of animals. Contact between carcasses and hides allow a mixture of microorganisms to be introduced on the carcasses. These contaminating microorganisms are derived from the animal's pre slaughter environment that may be of faecal, soil, water or feed origin (Bell, 1997). Infected body fluid such as urine, milk, blood, mucus, rumen fluid, intestinal fluid and fluid from excised abscess can be another source of carcasses contamination (Galland, 1997).

2.5.2 On farm factors

Body condition may affect the pathogens load. Weak animals lie down more often than healthy ones, thereby increasing the likelihood of contaminating hides. Contacts between animals at auction barns may increase the pathogen load (Galland, 1997). The exterior of the animals harbours large number and different types of microorganisms from soil, water, feed, manure as well as its natural flora (Mtenga *et al*., 2000).

2.5.3 Transportation of slaughter animals

The transport factors such as the type and cleanliness of transport facility, distance travelled and duration of journey, harshness of ride, overpopulation of animals in the conveyance and frequency of stops, may affect and contribute to pathogen load (Galland, 1997).

2.5.4 Abattoir and butchers facilities

The abattoir and beef retail outlet environments play important roles in contamination of meat. Site selection and availability of good quality portable water are important factors to consider when selecting site for constructing abattoir or retail meat outlets since it affects the quality of meat. Meat contamination in abattoirs and retail meat outlets result from the use of contaminated water, unhygienic practices like poor handling, use of contaminated tables to display meat intended for sale and the use of contaminated knives and other equipments in cutting operations (Fasanmi *et al.*, 2010).

The length of time animals are held at the abattoir before slaughter can affect the pathogen load by increasing the probability of exposure and infections. Sanitation of walk ways, pen floor, railings, feed and water affect the pathogen load (Galland, 1997). Dirt, soil, body discharges and excreta from animals in holding pens or lairages are primary sources of contamination of carcasses in the later stages of the operation. This happens irrespective of whether or not the animals are fit and have passed ante mortem inspection.

Adzitey *et al*. (2011a) reported the possible sources of contaminations arising from the cutting knives, intestinal contents, chopping boards, hides, meat handlers, containers, vehicle for transporting carcasses and the meat selling environment. It has been reported

by Ali *et al.* (2010) that knives, wooden boards and weighing scales from retail shops are sources of bacterial contamination particularly *Staphylococcus aureus* and *Shigella* species. Akinro *et al.* (2009) reported that with inadequate slaughtering and disposal facilities, the abattoir becomes a source of infection and pollution, attracting domestic and wild carnivores, rodents and flies, which are vectors of diseases. Refrigerator or freezers are essential storage facilities used to prevent spoilage of meat following prolonged storage at room temperature and hence keep meat safe for long period of time.

2.5.5 Parasites and wild animals

With inadequate slaughtering and disposal facilities attracting flies, domestic animals, wild carnivores and rodents, abattoir/slaughter houses become among the important sources of microbial contamination (Adeyemo, 2002).

2.5.6 Meat van

The vehicles used to transport meat from abattoir to retail meat outlets may act as sources of contamination since often lack regular cleanliness and are not well covered leading to contamination by dusts, insects and flies. Sulley, (2006) reported contamination of meat resulting from other means of transport such as motor-bikes and bicycles due to insufficient vans and trucks. On the other hand, the few transport available were not properly cleaned and thus contained high microbial loads (Sulley, 2006).

2.5.7 Abattoir and retail meat outlet workers

The hygienic condition of the abattoir and retail meat outlet workers has potential to contribute contamination in beef before and after processing. Adetunde *et al.* (2011) reported that unclean slaughter men's hands, butcher arms, clothing and equipment used in carcass dressing process accounted for the microbial contamination and also the study

of Jeffery, (2003) revealed that the worker hands and their equipments were among the main sources of meat contamination.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

This study was carried out in Morogoro municipality which is situated on the lower slopes of Uluguru Mountains whose peak is about 500 to 600 metres above sea level. It lies at latitude 5.7 to 10 °S and longitude 35.6 to 39. 5°E. The municipality is located at about 195 km to the West of Dar es Salaam City and has a total land area of 531 sq. km. It is divided into 29 administrative wards and 272 streets with estimated population of 315 866 (URTNC, 2012). It has temperature ranging between 27°C to 33.7°C in the dry/ warm seasons and 14.2°C to 21.7°C in cold/wet season. According to Tanzania Meteorological Agency the Municipal experiences a sub-humid tropical climate with a bimodal rainfall pattern which characterized by two rainfall seasons in a year with a dry season separating the short rains (October to December) and long rains (from March to May/June).

3.2 Study Design

A cross sectional study design was employed whereby a simple random sampling of retail meat outlets was carried out. Meat, water and surface swab samples from retail meat shops handling equipments and abattoir were collected aseptically, processed and analyzed. The knowledge and awareness of contamination of beef along the production chain from abattoir to retail meat outlets were assessed using a structured questionnaire which was administered to retail meat shop keepers and workers in the abattoir. The field study was carried out from February to May 2012.

3.3 Sample Size Determination for Microbial Examination

The sample size was determined using formula of a known population described by Kothari (2009) as follows:

$n= N X Z^2XSD^2/ (N-1) X d^2 + Z^2 X SD^2$,

Where n = estimated sample size, Z = student's t value for an expected confidence interval (1.96), SD = Standard deviation (0.1), d = selected accepted errors (0.05), N= Known population (The total numbers of retail meat outlets present in Morogoro Municipal is 117 as showed on list of retail meat shops in Morogoro municipal (Appendix 1). Using the above formula the calculated sample size was 14 retail meat outlets.

3.4 Sampling and Sampling Procedure

3.4.1 Questionnaire

Questionnaires were administered to 40 selected retail meat outlet workers and 20 abattoir workers. The information collected included source of cattle slaughtered, species of animals slaughtered/meat sold, means of transporting meat, availability of meat storage facility, frequency of check up healthy for workers, hygienic status of abattoir and retail meat outlets, availability and accessibility to clean and safe water (Appendices 3 and 4).

3.4.2 Sample selection

In order to get 14 retail meat outlets, fourteen wards were first randomly selected out of 29 wards located in Morogoro Municipal and then from each selected ward namely Kihonda, Sabasaba, Mwembesongo, Mji Mkuu, Kichangani, Uwanja wa Taifa, Kilakala, Uwanja wa Ndege, Bigwa, Mazimbu, Mafiga, Boma, Kingo and Mji Mpya, one retail

meat outlet was randomly selected from the list of total retail meat shops present in the ward (Appendix 1).

3.4.3 Sampling technique

3.4.3.1 Surface swabs from retail meat shops and abattoir handling equipments

The surface swabs from retail meat outlets handling equipments and abattoir were collected aseptically using sterile moistened cotton wool swabs by rubbing firmly over the predetermined surface area using parallel stroke lines with slow rotation with respectively chosen template surface area to be swabbed.

In the retail meat shops the moistened sterile cotton wool swabs were used to swab surface area in the template of 20 cm^2 from weighing pans, butcher knives, meat chopping tables and meat wood cutting blocks whereas in abattoir the moistened sterile cotton wool swabs was used to swab 60 cm^2 from evisceration tables, walls, floors, meat van floors and 20 cm^2 surface swabs from knives (Appendix 2). The swabs were transferred to the respective capped sterile tubes containing 10 ml normal saline and labelled. The swabs were agitated up and down in the tubes to aid on rinsing the bacteria from the surface of the swabs. Samples were packed in cool box and transported to laboratory for microbiological analysis.

3.4.3.2 Meat samples

Raw meat samples were collected directly from the carcass and from the retail hanging display of retail meat outlets. About 500 grams of meat cut samples were collected in abattoir from different regions of the carcass, such as flank and neck region and in retail meat outlets hanged piece of meat. All the samples were packed in cool box with ice packs and then transported to laboratory for microbiological analysis (Appendix 3).

3.4.3.3 Water samples

A tape in the abattoir was opened and allowed the fresh water to flow for 2-3 minutes in order to flush out microbial present in the tape. Water sample was collected directly with sterile bottles, labelled, placed in cool box with ice pack then transported to laboratory for microbiological analysis (Appendix 4).

3.5 Laboratory Media Preparation

3.5.1 Nutrient Agar

The nutrient agar base (Laboratorios Conda S.A, PRONADISA$^{(R)}$) contained 5.0 (g/l) of gelatin peptone, 3.0g/l of beef extract and 15.0 g/l of bacteriological agar. The media was prepared by dissolving 23 grams of medium in 1 litre of distilled water. The mixture was agitated and boiled for two minutes until completely dissolved, then sterilized in the autoclave at 121^{o}C for 15 minutes. Cooled at 45^{o}C and poured into sterile petri dishes ready for inoculation.

3.5.2 MacConkey Agar

The MacConkey agar (Laboratorios Conda S.A, PRONADISA$^{(R)}$) was prepared by dissolving 52 grams of the medium in one litre of distilled water. The mixture was agitated and boiled for two minutes until completely dissolved and sterilized in the autoclave at 121^{o}C for 15 minutes. Cooled at 45^{o}C and poured into sterile petri dishes ready for inoculation.

3.5.3 Normal saline preparation

In order to make a Phosphate buffered saline, 8.5grams of sodium chloride was thoroughly mixed with distilled water. Several test tubes were filled with normal saline solution and sterilized in autoclave at 121^{o}C for 15 minutes.

3.6 Sample Preparation and Inoculation

3.6.1 Surface swabs

In the laboratory each test tube and universal bottle with surface swabs and water samples were opened aseptically by flaming of the mouth part of test tubes and universal bottles. The samples were taken using sterile pipette and further diluted serially (10 folds dilution) into 10 test tubes. The diluents were mixed well and then one millilitre of diluted sample were poured into various sterile petri dishes and covered with 20 millilitres of sterile nutrient agar or MacConkey agar. Each plate was swirled gently taking care not to spill its contents and allowed to set. All samples inoculated with nutrient agar were incubated at 37ºC for 24 hours in order to get TVC while samples inoculated in MacConkey agar were incubated at 37ºC and 44ºC for 24 hours for TCC and for TFC counts respectively (Bhandare *et al*., 2009).

3.6.2 Meat samples

Meat sample weighing one gram was grinded to fine particles using mortar and pestles and mixed with the normal saline solution to make 10 millilitres and diluted serially into several test tubes. One millilitre of inoculum was taken from the test tube using sterile pipette and poured into sterile petri dish. Then 20 millilitres of sterile nutrient agar or MacConkey agar was poured into each sterile petri dish, distributed and mixed evenly throughout. The petri dishes with molten inoculated media were allowed to solidify. All samples inoculated in nutrient agar were incubated at 37ºC for 24 hours in order to get

TVC while samples inoculated in MacConkey agar were incubated at 37ºC and 44ºC for 24 hours for TCC and TFC counts respectively (Bhandare *et al*., 2009).

3.6.3 Water samples

A serial dilution of water sample was done into several test tubes. One millilitre of inoculum was taken from the test tube using a pipette and poured into sterile petri dish. Then 20 ml of sterile nutrient agar or MacConkey agar was added into sterile petri dish, distributed and mixed evenly throughout the petri dish and allowed to solidify. All samples inoculated in nutrient agar were incubated at 37ºC for 24 hours in order to get TVC while samples inoculated in MacConkey agar were incubated at 37ºC and 44ºC for 24 hours for TCC and TFC counts respectively (Bhandare *et al*., 2009).

3.6.4. Interpretation of microbial growth

Petri dishes containing 30 - 300 colonies on nutrient agar plate were selected and colonies that appeared pinkish on MacConkey agar plate were considered to be Coliforms. These were counted using colony counter, enumerated and expressed in $\log_{10}$ CFU/g/cm^2 or ml of meat, surface swabs and water samples respectively.

3.7 Data Collection Methods

3.7.1 Questionnaire survey

The study involved a questionnaire survey in order to assess the risk factor contributing to contamination of beef along the production chain from the abattoir to retail meat outlets. A structured questionnaire was administered to selected retail meat outlets and abattoir workers.

3.7.2 Surface swabs, meat and water samples collection

Nutrient and MacConkey agar were used to determine the TVC, TCC and TFC in the surface swab samples collected from, knives, weighing pan, butcher knife, meat chopping tables, meat wood cutting blocks, evisceration table, abattoir floor, abattoir walls, meat van floor, meat and water. The number of microbial colonies that grew on each agar plate were counted by colony counter and multiplied by the "dilution factor" to get the estimated numbers of bacteria in the original sample.

3.8 Data Analysis

Data from questionnaires were entered and stored in Excel Spread Sheet 2007 before being imported to Epi info Statistical Packages version 3.4.3 where by the frequencies and percentages were determined. All bacterial counts were normalized to CFU/cm^2/g or ml and converted into Log_{10} values. Mean and standard deviation were computed using statistical software Stat view while the Analyses of Variances were done using Excel Spread Sheet 2007. Tests for differences between means were computed by Duncan's Multiple Range Test at ($p < 0.05$).

CHAPTER FOUR

4.0 RESULTS

4.1 Social Characteristics of Respondents

4.1.1 Age and sex distribution of respondents

A total of 60 males were interviewed during the study of which 20 were abattoir workers and 40 retail meat outlet workers. Majority of respondents in abattoir and retail meat outlets were males with age ranging between 18-40 years (Fig. 1).

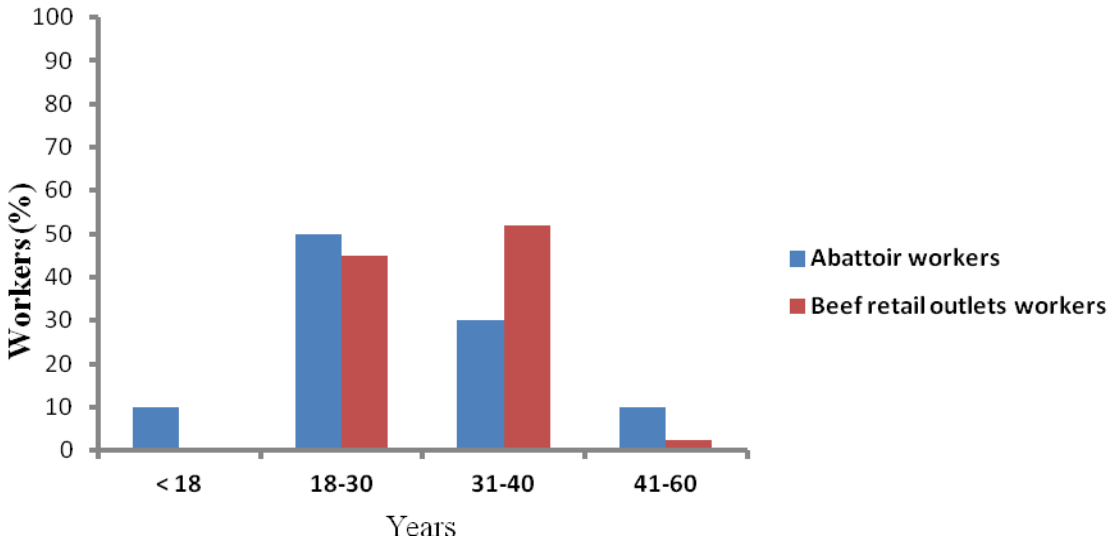

Figure 1: Frequency distribution of abattoir workers (n = 20) and retail meat outlet workers (n = 40)

4.1.2 Distribution of respondents by level of education

Out of 20 abattoir workers interviewed, 35% had informal education and 65% had primary school education. None of respondents had attended any training on meat hygiene and handling. In retail meat outlets, 85% of the respondents had primary school education and 7.5% had informal education (Table 1). Also 92.5% of the retail meat outlet workers had not attended any training on meat hygiene and handling.

Table 1: Frequency distribution of abattoir workers and retail meat outlet workers according to level of education

Level of education	Abattoir workers (%) (n = 20)	Retail meat outlet workers (%) (n = 40)
Informal Education	35.0	7.5
Primary school Education	65.0	85.0
Secondary Education	0.0	7.5

4.1.3 Distribution of respondents according to working experience in abattoir and retail meat outlets

In this study 45% of abattoir workers had working experience of less than four years, 35% had experience of 5-10 years and 20% between 11-20 years. While 37.5% of retail meat outlet workers had working experience of less than four years, 35% had about 11-20 years, 25% between 5-10 years and only 2.5% between 21-30 years (Table 2).

Table 2: Frequency distribution of respondents according to working experience in abattoir and retail meat outlets

Experience (Years)	Abattoir workers (%) (n = 20)	Retail meat outlet workers (%) (n = 40)
0-4	45.0	37.5
5-10	35.0	25.0
11-20	20.0	35.0
21 -30	0.00	2.5

4.2 Practices Contributing to Microbial Contamination of Beef in the Abattoir

4.2.1 Hygienic condition of abattoir workers

Results from this study revealed that 60% of the abattoir workers interviewed were not wearing protective clothes. Seventy percent of the abattoir workers were wearing dirty protective clothes. All workers handled meat with bare hands and 70% of the respondents

reported that water sinks used for washing their hands in the abattoir was in good hygienic condition.

4.2.2 Information on health check up of abattoir workers

Ninety percent of respondents reported to undertake routine check-up of their health condition after every 3-6 months (Fig. 2).

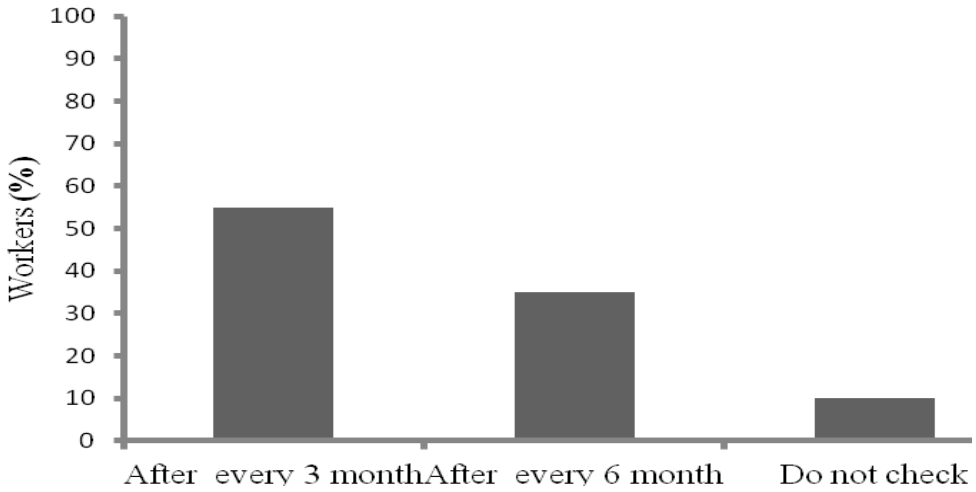

Figure 2: Time interval for health routine check up for abattoir workers (n = 20)

4.2.3 Hygienic condition of abattoir facilities

Eighty percent of the respondents reported that the lairage was deposited with cattle dung that was not removed regularly. Most of the cattle slaughtered were soiled with faeces on their body especially during rainy season and there were a lot of cracks on the outside wall of abattoir and some of the bricks had started to wear out (Fig. 3 and 4).

Figure 3: The wall and floor of lairage covered with cattle dung

Figure 4: Abattoir walls with cracks and well containing water

Majority of abattoir workers (80%) reported that the septic tank had low capacity for storing the abattoir effluents and 85% reported that the septic tank was in poor hygienic condition (Fig. 5)

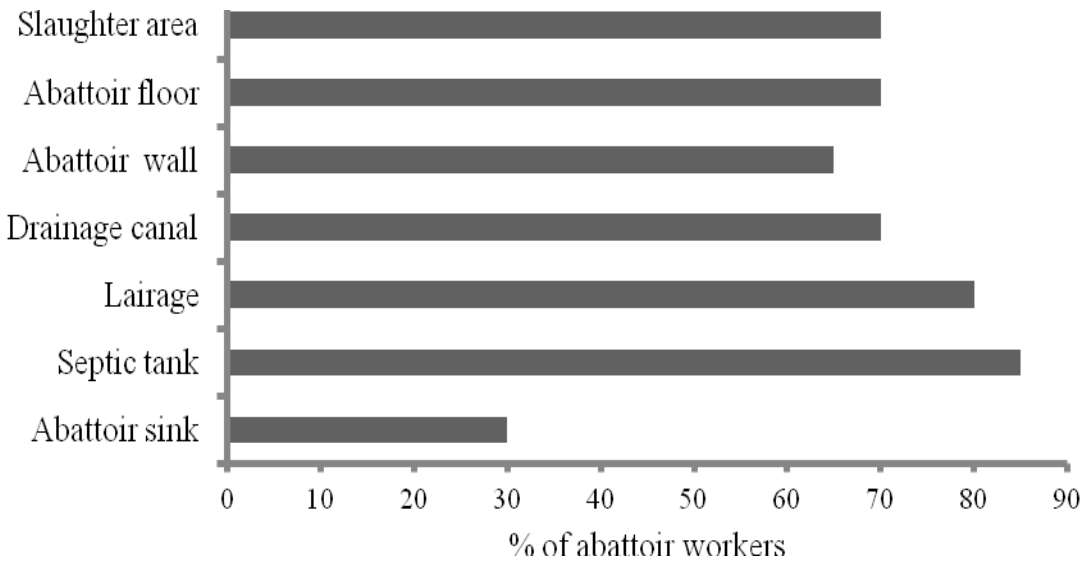

Figure 5: Percentage of abattoir workers (n = 20) who reported abattoir facilities to have poor hygienic condition

Seventy percent of respondents reported that the floor, slaughtering area and drainage canal were in poor hygienic condition. All processes of slaughtering, evisceration and cutting into quarters were done on the floor. Knives used for processing were only washed with unsterilized water. Sometime the carcasses came into contact with floor which predisposes meat to contamination with microbial pathogens (Fig. 6).

Figure 6: Dressing of carcasses on dirty floor

About 92.5% of the beef retail workers reported that the meat vans were in good hygienic condition. In addition 75% of respondents reported the abattoir itself was in poor hygienic condition (Fig.7).

Figure 7: A poor hygienic condition of killing area and drainage canal

In the study 70% of the respondents reported that water was readily available in the abattoir even though the abattoir was in unhygienic condition (Fg. 8 and 9).

Figure 8: Evisceration table with full of dirty

Figure 9: Wearing of trough with broken water tape

4.3 Microbial Contamination of Beef in Retail meat outlets

4.3.1 Information on the hygienic status of retail meat outlets workers

It was observed that 62.5% of workers used dirty protective clothes. About 12.5% and 37.5% of workers were not washing their hand with water and soap before and after sale of meat respectively.

4.3.2 Health check up of retail meat outlet workers

The results of the study revealed that all workers in retail meat outlets had a routine check up of their health status (Fig. 10).

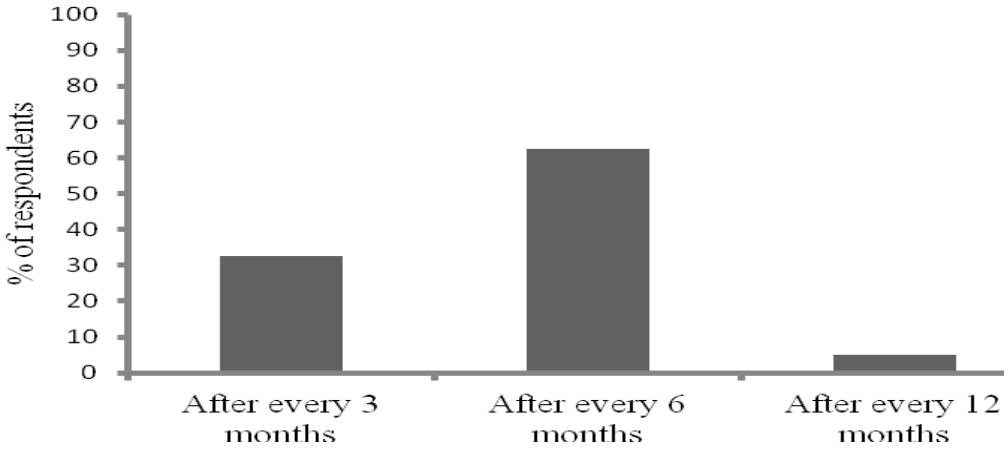

Figure 10: Proportion of respondents (%) who carried out health examination at different time interval in retail meat outlets (n = 20)

4.3.3 Hygienic status of beef in retail meat outlets

Seventy percent of surveyed retail meat outlets had poor hygienic condition despite the daily cleaning of shops with water and soap. All 40 retail meat outlet workers reported to sell unchilled meat and 95% of the workers chopped bony meat with axes on a cutting piece of wood locally known as “Kigogo”. About 73.7 % of the wood cutting blocks present in the shops were in poor hygienic condition (Fig. 11). The majority of retail meat outlets were controlling house/domestic flies in their shops routinely. In order to control

flies 50% of the workers used glass windows and cleaned their shops daily. The remaining 50% of worker used glass window and pyrethrins pesticides known as Rungu® to spray to their retail meat outlets and meat (Fig. 12).

Figure 11: Retail meat outlet with dirty wood cutting block and a dirty environment

Figure 12: Retail meat outlet with dirty wood cutting block and at the corner there is tin of insecticide known as Rungu® (pyrethrins) with dirty environment

Seventy percent of respondents reported to finish selling meat after one day and 67.5% of workers were mixing fresh meat and the one left on previous days. During the study it was observed that 95% of the retail meat outlets sold cattle meat only without mixing with other commodity (Fig. 13).

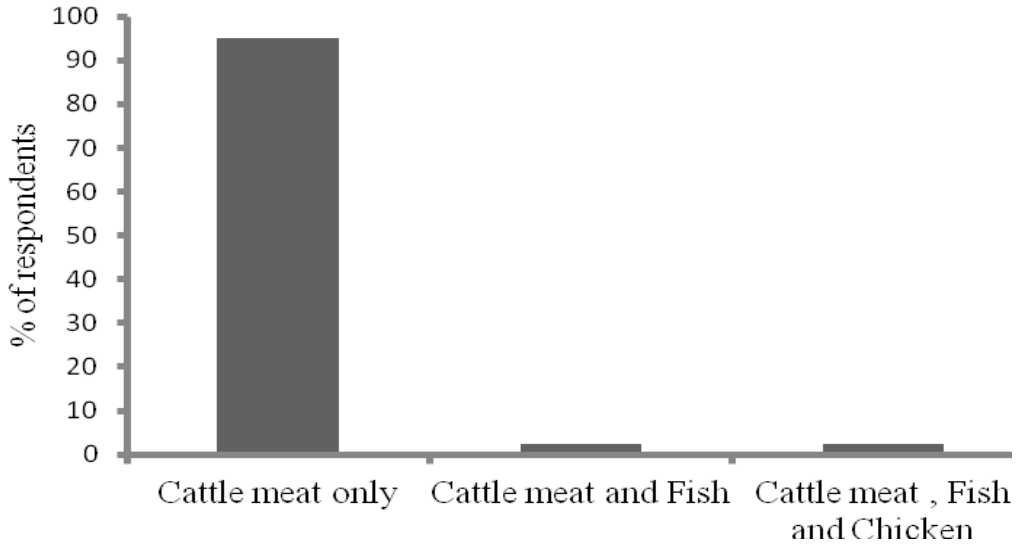

Figure 13: Different types of commodity sold in retail meat outlets (n = 40)

About 72.5 % of retail meat outlets had no refrigerators in their shops and in case meat was left it was transfered from one shop to another where storage facilities were available. Some of meat chopping tables was too dirty with some pieces of meat on it (Fig. 14 and 15).

Figure 14: A deep freezer and a dirty meat chopping table

Figure 15: Some of pieces of meat thrown on meat chopping table in retail meat shop

4.4 Evaluation of Microbial Load in Abattoir and Retail meat outlets

4.4.1 Total Viable Count (TVC)

The results of the study showed that in abattoir the highest mean values of TVC were on meat samples from neck region and lowest on knives with 7.72 ± 0.22 log CFU/g and 4.13 ±0.08log CFU/cm^2 respectively. There were no significant difference between contamination load on evisceration tables, floors and meat from flank region while in walls, water, knives, and meat sample from neck region, levels of contamination was significantly different ($p < 0.05$). In retail meat outlets the highest log mean values of TVC were on meat and lowest on knives with 7.24 ± 1.30 log CFU/g and 6.16 ± 1.25 log CFU/cm^2 respectively. However the difference in microbial contamination between knives, weighing balances, meat chopping tables and wood cutting blocks was not significant at $p > 0.05$(Table 3).

Table 3: Mean values for TVC (log $_{10}$ CFU/cm^2/ml or g) of the samples from abattoir and retail meat outlets in Morogoro municipality

Location	Sample type	Unit	TVC (mean log $_{10}$)	p-value
Retail	Knives	CFU/cm^2	6.16 ± 1.25 ^{b}	
meat	Weighing balances	CFU/cm^2	5.77 ± 1.49^{b}	
outlet	Meat chopping tables	CFU/cm^2	5.88 ± 1.53^{b}	< 0.05
(n = 14)	Wood cutting blocks	CFU/cm^2	6.14 ± 1.21^{b}	
	Meat	CFU/g	7.24± 1.30 ^{a}	
Abattoir	Meat from flank region	CFU/g	6.60 ± 0.37 ^{b}	
(n = 4)	Meat from neck region	CFU/g	7.72 ± 0.22 ^{a}	
	Walls	CFU/cm^2	6.05± 0.11^{c}	
	Water	CFU/ml	5.18 ± 0.25 ^{d}	< 0.05
	Evisceration tables	CFU/cm^2	6.43± 0.11 ^{b}	
	Floors	CFU/cm^2	6.59 ± 0.05 ^{b}	
	Knives	CFU/cm^2	4.13± 0.08 ^{e}	
	Meat van floors	CFU/cm^2	5.00 ± 0.41^{d}	

^{abcdefg} Means with different superscript are significantly different ($p < 0.05$)

4.4.2 Total Coliform Count (TCC)

In Table 4 the highest TCC in abattoir were on meat samples from neck region and lowest on water with 6.92 ± 0.12 $\log_{10}$ CFU/g and 0.00 $\log_{10}$ CFU/ ml respectively. There were no significant difference in microbial load between meat samples from the flank region, evisceration tables and floor. In retail meat outlets the highest log mean value of TCC were on meat and lowest on meat chopping tables with 4.66 ± 1.85 log CFU/g and 4.13 ± 2.21log CFU/cm^2 respectively. There was no significant difference ($p > 0.05$) in microbial load between knives, weighing balances, meat chopping tables and wood cutting blocks in the retail meat outlets.

Table 4: Mean values for TCC (log $_{10}$ CFU/cm^2/g or ml) of the samples from abattoir and retail meat outlets in Morogoro municipality

Location	Sample type	Unit	TCC (mean $\log_{10}$)	p-value
Retail	Knives	CFU/cm^2	4.66 ± 1.85^{a}	
meat	Weighing balances	CFU/cm^2	4.45 ± 1.96^{a}	
outlets	Meat chopping tables	CFU/cm^2	4.13 ± 2.21^{a}	> 0.05
(n =14)	Wood cutting blocks	CFU/cm^2	4.62 ± 1.72^{a}	
	Meat	CFU/g	5.55 ± 2.31^{b}	
Abattoir	Meat from flank region	CFU/g	5.74 ± 0.29^{b}	
(n = 4)	Meat from neck region	CFU/g	6.92 ± 0.12^{a}	
	Walls	CFU/cm^2	4.99 ± 0.31^{c}	
	Water	CFU/ml	0.00 ± 0.00^{f}	< 0.05
	Evisceration tables	CFU/cm^2	5.83 ± 0.44^{b}	
	Floors	CFU/cm^2	5.85 ± 0.22^{b}	
	Knives	CFU/cm^2	3.77 ± 0.34^{e}	
	Meat van floor	CFU/cm^2	4.22 ± 0.23^{d}	

^{abcdef} Means with different superscript are significantly different at $p < 0.05$

4.4.3 Total Faecal Coliform Count (TFC)

The results of the study showed that in abattoir the highest mean values of TFC were on meat sample from neck region and lowest on water with 6.73 ± 0.28 log CFU/g and 0.00 ± 0.00 log CFU/ml respectively. The microbial assay showed a significant difference in microbial load count ($p<0.05$) on meat from neck region, walls, water and meat van but there was no significant difference in microbial load in meat from flank region, evisceration table and floor ($p>0.05$). In the retail meat outlets the highest mean values of TFC were on meat and lowest on meat chopping tables with 5.27 ± 2.38 log CFU/g and 3.47 ± 2.71 log CFU/cm^2 respectively. There were no significant differences in microbial load between knives, weighing balances and wood cutting blocks at $p > 0.05$ (Table 5)

Table 5: Mean values for TFC (mean log $_{10}$ CFU/cm^2/g or ml) of the samples from abattoir and retail meat outlets in Morogoro municipality

Location	Sample type	Unit	TFC (mean log_{10})	p –value
Retail meat outlets (n = 14)	Knives	CFU/cm^2	4.33 ± 2.05^{ab}	
	Weighing balances	CFU/cm^2	3.98 ± 2.42^{ab}	
	Meat chopping tables	CFU/cm^2	3.47 ± 2.71^{b}	>0.05
	Wood cutting blocks	CFU/cm^2	4.19± 2.11^{ab}	
	Meat	CFU/g	5.27 ± 2.38^{a}	
Abattoir (n = 4)	Meat from flank region	CFU/g	5.56 ± 0.17^{b}	
	Meat from neck region	CFU/g	6.73 ± 0.28^{a}	
	Walls	CFU/cm^2	4.93 ± 0.29^{c}	
	Water	CFU/ml	0.00 ± 0.00^{f}	< 0.05
	Evisceration tables	CFU/cm^2	5.66 ± 0.14^{b}	
	Floors	CFU/cm^2	5.83 ± 0.15^{b}	
	Knives	CFU/cm^2	3.60 ± 0.25^{e}	
	Meat van floors	CFU/cm^2	4.20 ± 0.28^{d}	

^{abcdefg} Means with different superscript are significantly different $p<0.05$

The log mean values for TVC in abattoir ranged from 4.13 ± 0.08 to 7.72 ± 0.22 log CFU/g/ml or cm^2 and beef retail outlets from 5.77 ± 1.49 to 7.24 ± 1.30 log CFU/g/ml or

cm^2. The TCC in abattoir ranged from 0 to 6.92 ± 0.12 log CFU/g/ml or cm^2 and in retail meat outlets from 4.13 ± 2.21 to 5.55 ± 2.31 log CFU/g/ml or cm^2. The TFC in abattoir ranged mean values from 0 to 6.73 ± 2.80 log CFU and in retail meat outlets from 4.19 ± 2.11 to 5.26 ± 2.38 log CFU/g/ml or cm^2 (Table 6).

Table 6: Mean log values for TVC, TCC and TFC (log $_{10}$ CFU/cm^2/ml or g ± S.D.) in samples collected from the abattoir and retail meat outlets

Location	Sample type	Unit	Microbial load (mean log 10 CFU/ cm^2/ml or g ± S.D.)			
			TVC± S.D	TCC ± S.D	TFC ± S.D	p-value
Retail meat outlets (n = 14)	Knives	CFU/cm^2	6.16±1.25^a	4.66±1.85^b	4.33±2.05^b	< 0.05
	Weighing balances	CFU/cm^2	5.77±1.49^a	4.45±1.96^{ab}	3.98±2.42^b	
	Meat chopping tables	CFU/cm^2	5.86±1.53^a	4.13±2.21^b	3.47±2.71^b	
	Wood cutting blocks	CFU/cm^2	6.14±1.21^a	4.62±1.72^b	4.19±2.11^b	
	Meat	CFU/g	7.24±1.30^a	5.55±2.31^b	5.27±2.38^b	
Abattoir (n = 4)	Meat from flank region	CFU/g	6.60±0.37^a	5.74±0.29^b	5.56±0.17^b	< 0.05
	Meat from neck region	CFU/g	7.72±0.22^a	6.92±0.12^b	6.73±0.28^b	
	Walls	CFU/cm^2	6.05±0.11^a	4.99±0.31^b	4.93±0.29^b	
	Water	CFU/ml	5.18±0.25^a	0.00±0.00^b	0.00±0.00^b	
	Evisceration tables	CFU/cm^2	6.43±0.11^a	5.83±0.44^b	5.66±0.14^b	
	Floors	CFU/cm^2	6.59±0.05^a	5.85±0.22^b	5.83±0.15^b	
	Knives	CFU/cm^2	4.13±0.08^a	3.77±0.34^{ab}	3.63±0.25^b	
	Meat van floors	CFU/cm^2	5.00±0.41^a	4.22±0.23^b	4.20±0.28^b	

^{ab}Means between the row with different superscript are significantly different $p< 0.05$

Analysis of variances between bacterial contaminations in the abattoir revealed significant differences ($P<0.05$) for TVC, TCC and TFC while in retail meat outlets the TVC showed significant difference ($P<0.05$) except for TCC and TFC which showed no significant difference ($P>0.05$). In general the mean microbial load was significantly different between the abattoir and retail meat outlets ($P<0.05$).

CHAPTER FIVE

5.0 DISCUSSION

5.1 Risk Factors Contributing to Microbial Contamination of Beef along the Production Chain from Abattoir to Retail meat outlets

5.1.1 Age distribution of workers

In the abattoir 50% of workers had an average age 18-30 years, 31-40 years (30%), 10% below 18 years and 41-60 years (10%). Findings from this study are different from what was reported in Ghana by Adzitey *et al*. (2011b) who found 45% of the abattoir workers were within the ages of 41-50 years, followed by 31-40 (23%), 51-60 (16%) and 21-30 (13%). Only one abattoir worker (3%) was 60 years old, and was the head and coordinator of all activities in the slaughter house. In retail meat outlets 45% of workers had an age between 18- 30 years, 31-40 years (52.5%) and 41-60 years (2.5%). Most of workers in abattoir and retail meat outlets were males with age between 18-40 years which falls within an active age group. Adzitey *et al.* (2011b) reported that the butchering activity is more dominated by the youth and middle aged men who are more energetic as the butchering business requires much physical strength.

5.1.2 Level of education

The level of education and training of food handlers about the basic concept and requirements of personal hygiene and its environment plays an important part in safeguarding the safety of products to consumers. During the study it was revealed that, the abattoir and beef retail outlet workers had low level of education and this could make difficult in acceptability of modern slaughtering practices as well as adherence to strict hygienic and standard slaughtering practices that contribute to microbial contamination. From the survey conducted at Makelle City, Ethiopia by Haileselassie *et al*. (2012) it was

found that out of 26 abattoir workers interviewed, 7.7% were illiterate, 61.5% had no any training regarding meat hygiene. Bhandare *et al*. (2009) reported that workers working in the abattoir in most cases in developing countries are untrained and thus, they pay no attention to the hygienic standards and as a result contribute immensely to bacterial contamination.

5.1.3 Practices contributing to microbial contaminations of beef in abattoir

Morogoro abattoir is located within the area which is close to heavy traffic and is surrounded by residential houses that do not allow room for expansion of the abattoir facilities. The area is not fenced hence is easily exposed to vermin and unauthorized people. Bello and Oyedemi (2009) reported that the healthy qualities of residents living in the vicinity of the abattoir are reduced due to effects of pollutants from the abattoir activities. Although this was not investigated, similar challenges might be facing the communities in Morogoro, an issue that require further studies. Majority of cattle slaughtered in Morogoro abattoir were the Tanzania Shorthorn Zebu and boran breeds. Most of them were purchased in the cattle auction markets located at Dumila, Nanenane, Mkata, Dakawa, Mkata, Melela and Misongeni areas. During the study it was reported that about 60-120 cattle are slaughtered at Morogoro municipal abattoir per day and distributed to different retail meat outlets within the municipality for sale.

Findings from this study revealed that most of abattoir workers were not wearing protective clothes which are contrary to Tanzania Food and Drugs Authority (TFDA) ACT of 2003. In order to protect both food products and meat handlers from cross contamination the abattoir and retail meat outlet workers should wear protective clothes while working (Nel *et al*., 2004). It was found that abattoir was often congested with

people who were not direct involved with slaughtering and processing of the carcasses which may contribute to contamination of meat with microbes.

Most of the meat vans used to transport meat from abattoir to retail meat outlets were pickups which were covered according to TFDA ACT of 2003. The meat brought to the meat van in most cases was carried on shoulders, head and bare head. Sometimes abattoir workers stepped on the meat. This may also contribute to bacterial contamination of meat.

It is important to maintain hygiene in the lairage since such structure can act as source of contamination of carcasses especially during skinning due to the fact that the meat may be soiled with cattle faeces. In the present study the lairage was in unhygienic condition. All processes of slaughtering, skinning, evisceration and splitting the carcasses into quarters were done on the dirty floor which predisposes the meat to contamination with microbes. After the carcasses have been skinned and eviscerated, were hanged up on the slaughter hall before being inspected. However, the heads were left on the floor and inspected onsite, practices that may contribute to contamination of meat from the head as the floor was in poor hygienic condition. These findings are similar to those reported by Adzitey *et al.* (2011b) that 65% of abattoir workers dressed carcasses on bare floor in the abattoir, 16% dressed carcasses on unclean slaughter slabs and 19% on both the slaughter slabs and bare floor in which the slaughter floor and slabs were smeared with blood, rumen contents and other wastes from previous dressed animals which increased the risk of contamination of subsequent carcasses. Adeyemo *et al*. (2009) found that animals were often slaughtered and eviscerated on the floor because of the absence of mechanical or manual hoists a factor which contributed to a major source of contamination. Efforts being made to maintain some level of cleanliness before and after close of work appeared

to be insufficient due to fewer cleaners who also lacked cleaning facilities, poor drainage systems, potable water (in some occasion), also poor monetary motivation scheme including delayed payment of salaries.

Akinro *et al*. (2009) reported that the seepage of the effluents to the well and bore hole constitutes a serious health hazards to the public. It gives offensive odours to the abattoir surroundings accompanied with good breeding site for mosquitoes due to pile up of paunch contents and other solid wastes, faeces, carcasses, horns and scraps of tissues. In this study, the septic tank was in poor hygienic condition and had low capacity for storing the abattoir effluents. Sometimes the effluents spilled out when the septic tank was full. Further observation showed that there was no pit for disposal of faeces; horns and solid wastes. Most of the faeces and other solid wastes were disposed outside near to the abattoir which caused a bad smell as a result of decomposition. This also attracted birds, rodents, flies, dogs and other unwanted insects and animals around the abattoir. Adeyemi and Adeyemo, (2007) reported that inadequate disposal technologies and high cost of waste management were responsible for the build-up of waste with adverse impact on the environment.

In the study done by Haileselassie *et al*. (2012), 53.8% of the respondents reported that sanitary measures in the abattoir were not observed making the quality of meat produced in the study area questionable, a finding which is similar to what was observed in the present study whereby majority of respondents reported that the abattoir was in poor hygienic condition which made poor quality of meat produced.

5.1.4 Practices contributing to microbial contaminations of beef in retail meat outlets

The practice of wearing protective clothes and washing hands before and after sales of meat is important since it helps to reduce the burden of contaminants in meat. In this study most of workers did not wear clean protective clothes during selling of meat in their shops. Although all of them had protective clothes, most of workers in retail meat outlets had no habits of wearing them. It was only during few occasions when visited by Health Officers. Haileselassie *et al*. (2012) found that 71 butcher shop workers interviewed, 11.3% did not use protective clothes and 50.7% did not cover their hair, 47.9% of the butchers handled money while serving food and 78.9% of them had worn jewellery materials which may result into cross contamination of meat with microbes. Nervy *et al*. (2011) reported that handling of carcasses and money with the same unwashed hands could be good sources of contamination. In the present study some of workers had no habits of washing their hands with water and soap before and after sale of meat which contribute to contamination of meat. Desmarchelier *et al.* (1999) recommends that hand-washing alone has no effect on *S. aureus* counts on hands. The reduction of bacteria on hands depends on the mechanical action, the duration and the type of soap and sanitizers being used. Hence same procedures should be advocated as the majority of those who washed hands, did not use soap and sanitizers.

Meat handlers might be sources of contamination of beef with microorganisms. Thus it is important that all possible measures be taken to reduce or eliminate such contamination (Muinde *et al*., 2005). The result revealed that all workers in retail meat outlets had a routine medical examination and regularly inspected by Health Officers (TFDA ACT, 2003). This is important since it helps to control and prevent zoonotic diseases such as Tuberculosis. Nervy *et al.* (2011) reported that careless sneezing and coughing among

butchers may lead to contamination of beef. In order to protect the health of consumers and for aesthetic reasons, meat handlers should stop habit of careless sneezing and coughing when handling it.

Meat wood cutting blocks are commonly used in most of retail meat outlets even though it harbours microorganisms due to absorptive nature. During the study it was revealed that all retail meat outlet workers sold unchilled meat and most of the workers chopped bony meat with axes on a cutting piece of wood locally known as ‘Kigogo’ which was in poor hygienic condition as a result exposed the meat to microbes.

Observation showed that domestic flies were abundant in most of the retail meat outlets. It is important to control flies since they feed on meat and other wastes, where they pick up and transport various disease causing agents with potential to cases such as enteric and eye infections. The majority of retail meat outlets had routine control of flies in their shops, some of the workers used glass window and daily cleaning of the shops, others used glass window and pyrethrin known as’ rungu ‘to spray their butchers which is hazard to human health.

In order to keep beef safe for a long period of time the refrigerators or freezers are the most important storage facilities used. It was observed during the study that most of retail meat outlets had no refrigerators in their shops. Thus a common practice was to transfer the remaining beef from one shop to another where refrigerators were available and meat from different retail meat outlets were mixed together. This might lead to transfer of microbes from one retail meat outlets to another if hygienic condition is not well observed. During the study it was observed that meat sellers in retail meat shops mixed fish, cattle and chicken meat. Similar results was reported by Nonga *et al*. (2010) in

which only 15% of the shops had refrigerators despite the fact that majority of owners were aware with the risk of meat being spoiled following prolonged storage at room temperature.

Most of surveyed retail meat outlets had poor hygienic condition despite of daily cleaning of their shops with water and soap. Ali *et al*. (2010) reported that butchermen lack knowledge of disinfecting and sanitizing, they clean their shops once in 24 hours with detergent and water which is not enough to maintain the hygienic environments in the butcher. Regular cleaning and disinfecting the beef retail outlets is important since it helps to reduce microbial contamination.

Based on findings from this study, the sources of meat contamination originated from the slaughter process in the abattoir are poor hygienic environmental condition and unhygienic handling of meat to the retail meat outlets. Cross contamination from tables, wood chopping blocks, knives and weighing scales is also possible.

5.2 Microbial Load in Abattoir and Retail Meat Outlets

5.2.1 Total Viable Count

To prevent the occurrence of food borne illnesses and possible meat spoilage, it is important to ensure that foods sold are safe and in good hygienic condition. Total plate count was used to measure the general bacteria load on meat and is a useful tool in monitoring food safety. The results may reflect the hygienic level of food handling and retail storage. In the present study the highest mean log values in abattoir were on meat samples from neck region followed by meat samples from flank region, abattoir floor, evisceration table, abattoir wall, water, transporting van floor and the lowest log mean values were on knives. Difference in the bacterial counts between meat from neck and

flank regions could be due to, meat from neck region are at high risk of being spilled or spread of gastric or intestinal contents if good processing practices and good handling practices of meat are not consistent. Bhandare *et al.* (2009) found higher level of environmental contamination in abattoir than what was observed in this study on abattoir floor, transporting van floor, abattoir wall and knives with mean values of 7.19 ± 0.18, 7.10 ± 0.05, 6.22 ± 0.11 and 6.04 ± 0.15 log CFU/cm^2 respectively. Levels were the lowest in evisceration platform and water with log mean value of 5.52 ± 0.03 log CFU/cm^2 and 3.90 ± 0.07 log CFU/ml respectively. Adeyemo *et al.* (2002) found that the TVC of 4.3 logs CFU/ml in water used at the main abattoir in Ibadan was lower than what was found in the present study. The range of the results for TVC in fresh meat samples in abattoir was similar to Nervy *et al.* (2011) who reported contamination at the range of 4.93 – 8.1 log CFU/g. Tarwate *et al.* (1993) reported lower mean values for TVC compared to what was reported in the present study in knives, walls and water that had 3.2, 5.3 and 2.1 log CFU/cm^2 respectively. Higher values of 6.7 log CFU/cm^{2}were found on floor. The differences in microbial load in different studies were due to lack of good processing practices, good handling practices and sanitary standard operating procedures along beef production chain. The high TVC obtained from abattoir floor in this study is an indication of ineffective and inadequate cleaning of floor before commencement of work and at the close of work.

In the retail meat outlets the highest log mean values of TVC were observed on meat samples followed by knives, wood cutting blocks, meat chopping table and lowest mean values were observed on weighing balance. This is due to lack of good handling practices and sanitary standard operating procedures. Some of abattoir workers carried carcass on their shoulders and stepped on meat in the meat van. The values obtained on wood cutting blocks, knives and weighing balance were lower compared to those reported by

Bhandare *et al*. (2009) with the mean values of 7.33 ± 0.20, 6.45 ± 0.26 and 5.93 ± 0.31 logs CFU/cm^2 in wooden log, knives, and weighing balances respectively. The higher levels of TVC in handling equipments in the retail meat outlets are indication of inadequate cleaning and poor disinfection.

There was a marked growth of bacterial contaminants in meat samples collected from abattoir and beef retail outlets with the highest value of isolation in the abattoir suggesting that there were unusual amount of contamination and growth of natural flora. This is due to poor hygienic practiced of handling meat and poor environmental working condition. According to Haileselassie *et al*. (2012) poorly organized farm to table production chain and poor standard sanitary operational procedures practiced by the abattoir personnel that include poor personnel hygiene were some of the risk factors which contributed to the high microbial load. This might be the reason for what was observed in the current study. The values obtained in the current study were lower compared to what was reported by Haileselassie *et al*. (2012) in which the mean values of microbial load of abattoir meat and butcher shops were 5.04 and 5.75 log_{10} CFU/g respectively. In general the results obtained from meat samples, abattoir floor, evisceration table and abattoir wall in abattoir and also those obtained in beef retail outlets from meat samples, knives, and wood cutting blocks are higher exceeding the recommended set standard of less than 6.00 logs per g/cm^2 by the ICMSF (1985). According to FAO (2007) Total viable plate counts exceeding 100 000/g (10^5 per cm^2 or 5.0 log_{10}) on fresh meat are not acceptable and alarm signals on meat hygiene along the slaughter and meat handling chain. There were significant differences in TVC in abattoir and beef retail outlets ($P<0.05$). The presence of TVC in abattoir and retail meat outlets was attributed due to unhygienic slaughtering practices and handling of meat.

5.2.2 Total Coliform Count

The highest mean values were observed on meat samples from neck region followed by meat samples from flank region, floor, evisceration tables, walls, water, meat van floor and the lowest log mean values were on knives. It has been observed that on the abattoir floor and meat, there are higher values of TCC compared to other samples. This could be contributed by several processing activities done on the abattoir floor, unevenly floor, presence of cracks and appreciable large number of people and lack of proper separation between clean and dirty areas at the abattoir. A similar study was done by Tarwate *et al.* (1993) also reported higher values of *Enterobacteriaceae* on knives, floor, walls and water with 5.9, 6.9, 6.2 and 4.4 log CFU/cm^2 respectively. The variations of microbial load observed in different reported studies were due to lack of good processing practices, good handling practices and sanitary standard operating procedures of meat along the beef production chain.

In the retail meat outlets the highest log mean values of TCC was observed on meat samples followed by knives, wood cutting blocks, weighing balances and lowest on meat chopping tables. Adentunji and Awosanya (2011) reported that portable water was an essential requirement in the quality assurances of meat produced at the abattoir. Absence or lower level of microbial in the water in abattoir suggested that water was clean. During the current study there was no growths for TCC in water samples which implied that the source of water supply in abattoir was clean. In general the results obtained from meat samples from the study are higher exceeding the recommended set standard of coliform bacteria counts of less than 3.0 $\log_{10}$ CFU/g by FAO (2007) which is not acceptable and meat hygiene along the production chain must be improved. The results showed that there was a significant difference in TCC in abattoir at ($P<0.05$) while in retail meat outlets there was no significant difference ($P> 0.05$). The presence of TCC in retail meat outlets

originated from the abattoir due to unhygienic practices and as a result contamination transferred to retail meat outlets.

5.2.3 Total Faecal Coliform Count

The presence of faecal coliform is an indicator of poor sanitary condition in the abattoir and retail meat outlets since these microorganisms originate from faecal microbiota. The result revealed the highest log mean values for TFC on meat samples from neck region followed with floor, evisceration table, meat from flank region, wall, meat van floor, knife and the lowest in water. The study revealed higher TFC mean values on the abattoir floor, transporting van floor, evisceration platform, knives and abattoir wall compared to what was reported by Bhandare *et al.* (2009) with corresponding mean values at log of 4.68 ± 0.38, 4.41 ± 0.83, 4.00 ± 0.30, 3.80 ± 0.15 and 3.72 ± 0.43 log CFU/cm^2 respectively. The TFC were not isolated in water which implies that water used in abattoir was clean and had minimum microbial bacterial load. Comparative studies by Tarwate *et al.* (1993) reported higher mean values of TFC on knives, floor, walls and water with 5.7, 7.3, 6.6 and 4.5 log CFU/cm^2 or ml respectively than what was reported in the present study. Adeyemo *et al.* (2002) reported the TFC of 5.18log CFU/ml in water used at the main abattoir in Ibadan. The current findings for TFC in fresh meat samples in the abattoir ranged from 5.84 – 6.73 log CFU/g being higher than what was previously reported Nervy *et al.* (2011) at the range of 1.83 – 4.73 log CFU/g. The presence of higher mean log values for TFC might have been due to several processing activities that are done on the abattoir floor and lack of separation between dirty and clean area.

In the retail meat outlets, the highest mean values of TFC was observed on meat samples followed by knives, wood cutting blocks, weighing balances and on meat chopping tables. The results from this study revealed that the knives and weighing balance were

having higher mean values of TFC compared to results obtained by Bhandare *et al.* (2009) in their study who reported the mean log of 3.45 ± 0.31CFU/cm^2 and 3.96 ± 0.65 log CFU/cm^2 respectively. This could be due to lack of sterilization points, continuous use of a single knife despite contact with dirty or contaminated surfaces and uses of unclean weighing balances. In the wood cutting blocks the values obtained by Bhandare *et al.* (2009) were higher being 4.63 ± 0.54 log CFU/cm^2. The variation of microbial load in different reported studies were due to lack of good animal husbandry practices, good processing practices, good handling practices, standard operating procedures, sanitation standard operating procedures of meat along beef production chain. There was a significant difference in TFC among different points of abattoir and beef retail outlets. The high value of bacterial loads in wood cutting blocks used for chopping meat in beef retail outlets may be contributed by the fact that cutting wood are neither washed after use nor sterilized and they are absorptive in nature. Blood deposit on it also serves as an ideal medium for growth and multiplication of microorganisms. According to FAO (2007) coliform bacteria counts exceeding 1 000/g or cm^2 (3.0 $\log_{10}$) on fresh meat are not acceptable. The results from this study showed that there was higher TFC in meat samples exceeding the recommended set standard by FAO and hence meat hygiene along the beef production chain should be improved. The results showed that there was a significant differences in TFC in abattoir ($P<0.05$) while in retail meat outlets the difference was insignificant ($P > 0.05$). This indicates that the presences of TFC in abattoir were due to unhygienic practices as a result contaminations were transferred from abattoir to retail meat outlets.

5.2.4 Comparison of microbial load in abattoir and retail meat outlets

Observations showed that there were heavy microbial load in beef carcasses in the abattoir that was subsequently sold in retail meat outlets. However all of the equipments

and environmental facilities sampled had higher bacterial load values as demonstrated by TVC, TCC and TFC levels that exceeded to what was proposed by Agbodaze *et al*. (2005). It was found that if the Total Plate count was less than 5.0 log CFU and coliforms count are less than 3.5 log CFU the meat could be classified as having low risk as far as transmission of pathogenic bacteria to consumers is concerned. According to FAO (2007) Total viable plate count numbers exceeding 100 000/g (5.0 $\log_{10}$) and *Enterobacteriaceae* 1 000/cm^2 (3.0 $\log_{10}$) on fresh meat are not acceptable and alarm signals and meat hygiene along the slaughter and meat handling chain must be urgently improved. This standard from FAO was lower compared to the result found in the present study and hence these counts put the consumers at risk.

There was higher microbial load in abattoir compared to retail meat outlets. Such higher microbial counts would be attributed to poor hygienic practices and how the meat was handled in abattoir. Adetunde *et al*. (2011) reported high levels of total and faecal contamination in the slaughter house showing that contamination begins from the slaughter house. However, more contaminants were added when meat was being transported to and at the market to the point of sell. According to the report of Adeyemo *et al*. (2002) meat safety and environmental sanitation measures at Bodija (Ibadan) abattoir were grossly inadequate thereby giving room for contamination and exposure of humans to pathogens.

All points were contaminated with microbial except water where TCC and TFC were not identified. The main contamination points identified in abattoir, in decreasing order were meat, evisceration tables, floor, wall, meat van floor, knives and water while in retail meat outlets were meat, knives, wood cutting blocks, weighing balances and meat chopping tables. The presence of higher number of microbial load in abattoir and beef retail outlets is alarming and special attention should be considered, because their

presence indicate public health hazard and give warning signal for possible occurrence of food borne diseases. This study reveals high microbial contamination in beef production chain from abattoir to retail meat outlets in Morogoro municipality.

In order to produce meat which is safe and wholesome there is a need for use of good animal husbandry practices, good processing practices, good handling practices, standard operating procedures, sanitation standard operating procedures and hazard analysis critical control point system along the beef production chain.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The results obtained from this study shows that there was higher microbial load in abattoir compared to retail meat outlets. This may be due to the low level of sophistications at the abattoir and because the carcasses were dressed on the floor and low level of hygiene and poor abattoir sanitation could also be responsible for the high TVC on the meat. Also contamination arises from animals prior to being brought to the abattoir. The higher microbial log mean values (TVC, TCC and TFC) from the samples tested are an indication of poor meat quality and making it a potential source of food borne infection and food spoilage. From these results it can be deduced that contamination was present right from the abattoir to the retail meat outlets. However, some contaminants are added when meat was being transported to and at the beef retail outlets where they are sold. Thus the meat produced in the study area is contaminated before it gets into the hands of consumers.

Therefore in order to safeguard the health of public against the risks of food borne infections, there is a need to educate and advocate good sanitation and meat handling practices in the abattoir and beef retail outlets.

6.2 Recommendations

Based on these findings, there are challenges of unhygienic meat handling and processing practices in abattoirs and retail meat outlets which could results into production of low quality meat and hence putting consumer at risk. The following recommendations were put forward so as to alleviate the observed prevailing situation:

i) Policies, regulations and guidelines regarding food safety at all levels along the production chain should be adhered to and enforced so as to produce safe and wholesome meat.

ii) Municipal Health Officers, Veterinary Officer and other technical staffs employed by Municipal Executive Director should not be involved in inspecting abattoir and butchery facilities due to conflict of interest and hence other authorities/agencies or institutions should be inspect and enforce the law as per TFDA ACT of 2003.

iii) In order to safeguard the health of public the Municipal authority should reallocate the abattoir to a new site. This is because the area is not fenced, polluted, closed to heavy traffic and surrounded by residential houses that do not allow room for expansion of abattoir facilities.

iv) Provision of training programs to abattoir workers, retail meat outlet workers and all people involved in animal trade on good hygienic practices, handling of animals and meat.

v) The Municipal council should take care and handle all the wastes being generated in the abattoir, including abattoir wastewater treatment and disposal so as to prevent pollution of environment and expose people living nearby the abattoir to health risk.

vi) The use of pyrethrins pesticides known as “Rungu” and other flies repellents on meat in the retail meat outlets should be prohibited. Good hygienic practices should be encouraged at all levels.

vii) The use of wood cutting blocks in retail meat outlets should be discouraged since it harbours microorganisms due to its porous in nature which allow water to infiltrate and accumulate organic matter. Emphasis should be on the use of meat cutting saw which are easy to clean so as to maintain hygiene in retail meat outlets.

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APPENDICES

Appendix 1: List of retail meat shops in Morogoro municipality

s/n	Name of old wards	s/n	Name of new wards	Number of retail meat shops
1	Mji mpya	1	Mji Mpya	9
2	Kingo	2	Kingo	6
3	Mafiga	3	Mafiga	8
4	Kingolwira	4	Kingolwira	3
		5	Tungi	
5	Bigwa	6	Bigwa	2
6	Mazimbu	7	Machimbo	15
		8	Chamwino	
		9	Kihonda Magorofani	
		10	Mindu	
7	Mzinga	11	Mzinga	1
		12	Luhongo	
		13	Kauzeni	
8	Kiwanja cha Ndege	14	K/ ndege	9
9	Uwanja wa Taifa	15	U/Taifa	4
10	Kichangani	16	Kichangani	6
11	Mji mkuu	17	Mji Mkuu	8
12	Boma	18	Boma	3
13	Kilakala	19	Kilakala	7
14	Mbuyuni	20	Mbuyuni	3
		21	Magadu	
15	Mlimani	22	Mlimani	1
16	Kihonda	23	Kihonda	10
		24	Mkundi	
		25	Lukobe	
17	Saba saba	26	Saba saba	12
18	Mwembe songo	27	Mwembesongo	10
		28	Mafiga	
19	Sultani Area	29	Sultani Area	0
	GRAND TOTAL			117

(Source: Health department, Morogoro municipality 2011).

Appendix 2: Sampling points, sample size and surface sampling area in abattoir and retail meat outlets in Morogoro municipal

Origin of sample		**Abattoir**	**Retail meat outlets**	**Total**	**Area/sampling quantity**
		n	n	n	cm^2 or g
Surface swabs from	Knives	4	14	18	20 cm^2
Equipments	Weighing balance		14	14	20 cm^2
	Meat chopping table		14	14	20 cm^2
	Wood cutting Blocks		14	14	20 cm^2
Surface swabs	Meat van floor	4		4	60 cm^2
from environments	Evisceration table	4		4	60 cm^2
	Wall	4		4	60 cm^2
	Floor	4		4	60 cm^2
	Water	4		4	1 ml
Sample from meat	Meat samples		14	14	1 g
	Meat sample from flank region	4		4	1 g
	Meat sample from neck region	4		4	1 g
Total		**32**	**70**	**102**	

Appendix 3: Abattoir workers questionnaire

Title: Assessment of bacterial contamination in beef from abattoir to retail meat outlets in Morogoro municipality.

A. Basic Information

1. Date of Interview ……

2. Questionnaire No……

3. Name of Interviewer……..

4. Name of interviewee……..

5. Residential area of interviewee……....

B. Individual characteristics

1. Sex. i).Male (M)……

ii).Female (F)……

2. What is your age?

a. Below 18 years [ ]

b. 18- 30 years [ ]

c. 31- 40 years [ ]

d. 41 - 60 years [ ]

e. Above 60 years [ ]

3. What is your level of Education?

a. Informal Education [ ]

b.Primary Education [ ]

c.Form Four Secondary Education [ ]

d.Form Six Secondary Education [ ]

e. Other (Specify)…….

4. How long have you been doing this work?

a. 0 - 4 years [ ]

b. 5- 10 years [ ]

c.11 - 20 years [ ]

d. Above 20 years [ ]

5. Why you have decided to choose to do abattoir work……..

6. After you have finished your work in abattoir do you do other activities(**Y**)es or (**N**)o..

7. If "Yes" what type of activities do you do? .....

C. General information on risk factor contributing with contamination of beef in abattoir.

1. Do you have sink for washing hand (**Y**)es or (**N**)o……

2. Do you wash your hand before touching the meat? (**Y**)es or (**N**)o……

3. Do you wash your hand with soap (**Y**)es or (**N**)o……

5. Do you use apron/white coat and or head cover during slaughtering process Yes/No…

6. What is the hygienic condition of apron/white coat and or head cover (**G**)ood or (**P**)oor…….

7. Where are the sources of cattle slaughtered at abattoir.....?

8. What are species of animals slaughtered in Abattoir? ……

9. Is there enough water available in Abattoir to support daily need (**Y**)es or (**N**)o…

10. What are source of water for cleaning, washing equipment and cleaning offals after the animal have been slaughtered?

a. Tape water [ ]

b. Ground water [ ]

c. Others specify…….

11. Do you spray wash the carcass prior to inspection (**Y**)es or (**N**)o……

12. If "Yes" what type of water used to wash the carcases after slaughter……

13. Is there daily cleanliness of Abattoir done after slaughtering process (**Y**)es or (**N**)o……..

14. Do you use detergent /disinfectants for cleaning abattoir (**Y**)es or (**N**)o……

16. Is there routine control of flies and other insect in the Abattoir (**Y**)es or (**N**)o……

17. If "Yes" what are the method used to control flies ……

18. Do the abattoir have enough capacity to slaughter cattle at recommended time (**Y**)es or (**N**)o……

19. What is maximum number of cattle slaughter in the abattoir……...

20. Do the animal after arrival in abattoir are allowed to stay in the lairage before being slaughtered (**Y**)es or (**N**)o……

23. How longer does the animal stay in the lairage before they are slaughter? ……

24. What is the hygienic condition of lairage? (**G**)ood or (**P**)oor……

25. Do they removal the dirty in the lairage(**Y**)es or (**N**)o……

26. If "Yes" at what interval do they remove dirties in lairage……

27. Do the animal before slaughter the hides are soiled with faeces in the lairage. (**Y**)es or (**N**)o……..

28. Is there demarcation between the dirty and clean areas in the Abattoir (**Y**)es or (**N**)o……

29. Do you wash your hands and knives after skinning and evisceration(**Y**)es or (**N**)o…

30. Do you sterilize your knives after skinning and evisceration(**Y**)es or (**N**)o……

31.During removal of hides or skin , is there any possibility of come into contact the outside of the skin/hide and the carcass while the hands and equipment touch the outside of the skin come into contact with the underlying carcass meat(**Y**)es or (**N**)o……

32. Is there enough hooks for hoisting the carcasses after skinning (**Y**)es or (**N**)o……

33. How do you do skinning /dehiding operation after slaughtering ….....**...**

35. Do the carcasses and offal come into contact with floors, walls or soiling during dressing and evisceration? (**Y**)es or (**N**)o……..

36. Do the meat inspector during post-mortem meat inspection, palpation and incision of lymph nodes, infected tissues or tissues with abnormalities they wash hand and sterilize their knives. (**Y**)es or (**N**)o…….

37. Is there sufficient drainage system in the abattoir (**Y**)es or (**N**)o……

38. What is the hygienic condition of drainage systems? (**G**)ood or (**P**)oor……. ……

39. Is there enough sewage tanks for collecting dirty in the abattoir (**Y**)es or (**N**)o….

40. If "No" where do you deposit the dirty after evisceration…….

41. What is the hygienic condition of septic tank in abattoir? (**G**)ood or (**P**)oor…….

42. What is the hygienic condition of sink used to wash hand in abattoir? (**G**)ood or (**P**)oor……..

43. What is the hygienic condition of protective clothes of abattoir workers (**G**)ood or (**P**)oor……..

44. What is the hygienic condition of lairage in the abattoir? (**G**)ood or (**P**)oor……

45. What is the hygienic condition of clothes of abattoir workers? (**G**)ood or (**P**)oor...

46. What is the hygienic condition of slaughtering hall? (**G**)ood or (**P**)oor……..

47. What is the hygienic condition of abattoir floor? (**G**)ood or (**P**)oor……

48. What is the hygienic condition of abattoir walls? (**G**)ood or (**P**)oor……..

49. What is the hygienic condition of the abattoir? (**G**)ood or (**P**)oor……

50. Is there any unauthorized person entering in the abattoir during slaughtering process(**Y**)es or (**N**)o……..

51. If" Yes" what is your opinion for controlling unauthorized persons……

44. Do you check your health status (**Y**)es or (**N**)o…….

45. If "Yes" at what interval do you go to hospital for checking your health status?

a. Once per year [ ]

b. Every after three month [ ]

c. Every after six month [ ]

46.If "No" what is last date when you attended the medical check up.

a. Last month[ ]

b. Three month ago [ ]

c. Six month ago [ ]

d. A year [ ]

47. Have you attend any courses related to your work (**Y**)es or (**N**)o……..

48. If" Yes" what types of courses attended……

49. If "No" do you want to attend any course related to your work so as to increase awareness and improve hygiene status in abattoir(**Y**)es or (**N**)o……..

50. What is your suggestion on how to improve hygiene status in abattoir?.....

Appendix 4: Retail meat outlet workers questionnaire

A. Basic information

1. Date of Interview ……

2. Questionnaire No……

3. Village/Street……..

4. Wards…….

5. Name of Interviewer……

6. Name of interviewee……

B. Individual characteristics

1. Sex. i). Male (M)……

ii). Female (F)……

2. What is your age?

a. Below 18 years [ ]

b. 18- 30 years [ ]

c. 31- 40 years [ ]

d. 40- 60 years [ ]

e. Above 60 years [ ]

3. What is your level of Education?

a. Informal Education [ ]

b. Primary Education [ ]

c. Form Four Secondary Education [ ]

d. Form Six Secondary Education [ ]

e. Other (Specify)…….

4. How long have you been selling meat in retail outlet?

a. 0 - 4 years [ ]

b. 5- 10 years [ ]

c.11 - 20 years [ ]

d. Above 20 years [ ]

C. General information on risk factor associated with contamination of beef on retail meat outlets

1. Where is the source of cattle slaughtered at abattoir…….....

2. What are means of transporting meat from abattoir to the butcher? **.....**

3. What is the hygienic condition of vehicle used to transporting meat from abattoir to the butcher? (**G**)ood or (**P**)oor…….

4. What are types of meat sold in your butcher?

a. Cattle meat [ ]

b. Cattle and goat meat [ ]

c. Cattle meat and fish [ ]

d. Any other specify……

5. Do you have sink for washing hand (**Y**)es or (**N**)o……

6. Do you wash your hand before touching the meat? (**Y**)es or (**N**)o……

7. Do you wash your hand with soap (**Y**)es or (**N**)o……

8. Do you use apron/white coat and or head cover while selling meat (**Y**)es or (**N**)o…

9. What is the condition of apron/white coat and or head cover (**G**)ood or (**P**)oor……

10.Do you use Wood chopping block for cutting meat (**Y**)es or (**N**)o……

11. What is the hygienic condition of Wood chopping block for cutting meat? (**G**)ood or (**P**)oor……

12. How many times do you clean your butchers ……

13. Do you use detergent/disinfectant for cleaning the butcher(**Y**)es or (**N**)o……

14. If "Yes" what types of detergent/ disinfectant do you use…….

15. Do you sterilize your equipments (**Y**)es or (**N**)o……

16. What is the methods used to sterilize the equipment……

17. Are the flies present insides of the butcher(**Y**)es or (**N**)o……

18. Do your have routine control of flies in your butcher (**Y**)es or (**N**)o……

19. If "Yes" what are the method used to control flies

a. Glass window [ ]

b. Insecticides [ ]

c. Glass window and Insecticides [ ]

d. others specify……

20. If "No" how do you do in order to control flies in retail meat outlet……

21. What is the hygienic condition of butcher? (**G**)ood or (**P**)oor……

22. Does the meat in the butcher finished the same day (**Y**)es or (**N**)o……..

23. What is average selling time of meat in your butcher?

a.1 - 4 hours [ ]

b. 5 - 8 hours [ ]

c. 9 -12 hours [ ]

d. More than 12 hours [ ]

24. What are the practices of storages of beef after the end of the day?

a. Transfer of beef from one butcher to another where there is refrigerator [ ]

b. Use of your own refrigerator in the butcher [ ]

c. Any other specify……

25.Is there any attendance of selling the mixing of fresh meat with the meat which have been remaining previous day (**Y**)es or (**N**)o……..……

26. Is there any complaint from the customer (**Y**)es or (**N**)o……..

27. What are their complaint……..

28. Do you check your health status (**Y**)es or (**N**)o……

29. If "Yes" at what interval do you go to hospital for checking your health status?

a. Once per year [ ]

b. Every after three month [ ]

c. Every after six month [ ]

30. If "No" what is last date when your attended the medical check up

a. Last month [ ]

b. Three month ago [ ]

c. Six month ago [ ]

d. A year [ ]

31. Have attended any course related to your work (**Y**)es or (**N**)o……

32. If "Yes" what type of courses attended……

33. If "No" do you want to attend any course related to your work so as to increase awareness and improve hygiene status in the butcher (**Y**)es or (**N**)o……..

34. What is your suggestion on how to improve hygiene and meat quality……

THANK YOU