"ASSESSMENT OF HYGIENE OF MEAT PRODUCED IN SELECTED LOCAL SLAUGHTER FACILITIES IN SOMALILAND"

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university

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DEDICATION

This work is dedicated to my wife Aziza Okaghe Wamalwa who believes that hard work bear fruit;

To my sons, Michael Wamalwa, Collins Wamalwa and Mother, Rispa Nakhungu who were very supportive and encouraging during the entire study period;

To all meat producers of Somaliland local slaughter facilities under the study

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GLOSSARY

Ante-mortem inspection:-Any procedure or test conducted by a competent person on live animals for the purpose of judgement of safety and suitability and disposition.

Carcass:-the body of an animal after slaughter and dressing.

Cleaning:-It is the removal of soil, food residue, dirt, grease or other objectionable matter

Disinfection: - Reduction by means of chemical agents and/ or physical methods, of the number of micro-organisms in the environment, to a level that does not compromise food safety or suitability

Sterilize: - use of physical or chemical procedures to destroy all microbial life, including highly resistant bacterial endospores

Condemned:-Examined and judged by a competent person, or otherwise determined by the competent authority as being unsafe or unsuitable for human consumption and requiring appropriate disposal

Contaminant:-Any biological or chemical agent, foreign matter or other substance not intentionally added to food that may compromise food safety or suitability

Contamination:-The introduction or occurrence of a contaminant in food or food environment

Evisceration:-Removal of the internal organs from the abdominal and thoracic cavity of a carcass

Good hygienic practice (GHP):-All practices regarding the conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain

Hazard Analysis Critical Control point (HACCP):-A system that identifies, evaluates and controls hazards that are significant for food safety

Hazard:-A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect

Meat hygiene:-All conditions and measurers necessary to ensure the safety and suitability of meat at all stages of the food chain

Post-mortem inspection:-Any procedure or test conducted by a competent person on all relevant parts of slaughtered animals for the purpose of judgement of safety, suitability and disposition

Sanitation Standard Operating Procedures (SSOP):- refer to sanitation procedures taken to prevent product contamination or adulteration.

ABBREVIATIONS AND ACRONYMS

AM:-Ante-Mortem

BGA:-Brilliant Green Agar

CAC: - Codex Alimentarius Commission

CDC:-Centre for Disease Control

CFU:-Colony Forming Unit

DFD: - Dark, Firm, Dry

EMBA: - Eosin Methylene Blue Agar

EU:-European Union

FAO: - Food and Agriculture Organization of the United Nations

FSANU:-Food Security Analysis and Nutrition Unit

GHP: - Good Hygienic Practice

GMP:-Good Manufacturing Procedures

HACCP:-Hazard Analysis Critical Control Point

IFC: - International Finance Corporation

KEBS: - Kenya Bureau of Standards

MPN:-Most Probable Numbers

OIE:-World Organization of Animal Health

PM:-Post-Mortem

PSE: - Pale, Soft, Exudative

RP:-Rappaport-Vasilliadis

RRA: - Rapid Rural Appraisal

SC:-Selenite Cystine

SMA:-Sorbitol MacConkey Agar

SSOP:-Sanitary Standard Operating Procedures

TSA:-Tryptone Soya Agar

TVC: - Total Viable Counts

U.S.:-United States

UAE:-United Arab Emirates

UK:-United Kingdom

US FDA:-United States Food and Drug Administration

WB:-World Bank

WHO:-World Health Organization

XLD:-Xylose Lysine Desoxycholate

ABSTRACT

The hygiene of slaughter, in a broad sense, embraces a variety of considerations such as design, layout and maintenance of buildings, systems of control of Good Hygiene Practice (GHP), Sanitary Standard Operating Procedures (SSOP) concept and Hazard Analysis Critical Control Point (HACCP) principles. These include inspection (AM and PM) and hygiene of personnel, equipments and structures as well as the level of dirt on livestock meant for slaughter, parasites and micro-organisms the meat contains.

This study describes an analysis of levels of bacterial contamination and suspected risk factors associated with contamination of meat produced in five local slaughter facilities in the Somaliland state of the Republic of Somalia with the aim of making recommendations to improve production of quality meat without loading unrealistic costs and restrictions to operating slaughter facilities. The general objective of the study was to determine the level of contamination and microbial quality of meat produced by some Somaliland local slaughter facilities.

Slaughter facilities under study were purposively selected for carcass sampling. A total of 80 samples were randomly taken from each of the five slaughter facilities by swabbing carcasses using wet cotton wool dipped in buffered peptone water in an area of 50 cm^2 delineated by aluminium template. Swabbing in the same area was repeated with dry cotton wool. The samples were later analyzed for Total Viable Counts (TVC), presence of *Salmonella spp,* total coliforms and faecal *E.coli.*

A questionnaire made up of 18 questions was administered to slaughter facility supervisors in all the five slaughter facilities. This was aimed at collecting data on slaughter practices in order to identify risk factors that influence meat contamination. Additionally, transect walks and observations were discretely carried out in order to detect some of the unclear issues that could not be identified through questionnaire administration. From the questionnaire and observations carried out during slaughter, Hargeisa local slaughter facility personnel and management applied minimum meat hygiene slaughter practices as compared to Berbera, Borama, Burao and Gabiley local slaughter facilities. The latter four were being managed by local authorities while Hargeisa local slaughter facility was being managed by a private company.

Based on EU microbiological TVC levels performance criteria, 66% of carcasses sampled from Berbera local slaughter facility were of an unaccepted grade (>4.3 cfu/cm^2) while 34% were of marginal grade (2.8-4.3 cfu/cm^2). Likewise, 31% of carcasses sampled from Burao local slaughter facility were of unacceptable grade, 58% were of marginal grade and 11% were of acceptable grade (<2.8 cfu/cm^2). From Gabiley local slaughter facility, only 1% was of unacceptable grade, 30% were of marginal grade and 69% were of acceptable grade of TVC levels. From Hargeisa local slaughter facility, only 5% of carcasses sampled were of marginal grade while 95% were of acceptable grade. Finally, 29% of carcasses sampled from Borama local slaughter facility were of marginal grade while 71% were of acceptable grade. All carcasses sampled from Hargeisa and Borama local slaughter facilities were of acceptable to moderate grades.

Based on EU microbiological total coliforms performance criteria with regard to levels of *Enterobacteriaceae,* 25% of carcasses sampled from Berbera local slaughter facility were of unacceptable grade (>1.8 cfu/cm^2) while 59% were of marginal grade (0.8-1.8 cfu/cm^2). From Burao local slaughter facility, only 1% was of unacceptable grade while 5% were of marginal grade. All carcasses sampled from Gabiley, Borama and Hargeisa local slaughter facilities were of acceptable grade (<0.8 cfu/cm^2).

Of the 400 samples analyzed, 116 samples had faecal *E. coli* while none had *Salmonella* spp.

It was observed that apart from Hargeisa local slaughter facility that was managed by a private company, all the other four slaughter facilities lacked the most basic facilities like stainless steel slaughter equipments, protective gear for personnel, adequate lighting, adequate potable water, well structured slaughter facilities management and proper waste and environmental management system. These factors presumably play a vital role in influencing the levels of meat contamination produced from these slaughter facilities.

The study established that slaughter facilities of Berbera, Burao, Gabiley and Borama that were managed by local municipalities had high levels of carcass contaminations as compared to Hargeisa that was being managed by a private company. Therefore, in addition to providing adequate potable water, light among others, privatization appears to be the way forward for improved meat quality.

The outcome of this study will serve as guidelines to set up the standards of hygiene for meat production in the five local slaughter facilities under investigation.

CHAPTER ONE

1 INTRODUCTION

1.1 BACKGROUND

Meat hygiene is defined as all conditions and measures necessary to ensure the safety and suitability of meat at all stages of the meat chain (CAC, 2005). Therefore, the hygiene of slaughter embraces a variety of considerations such as design and layout of slaughter facility buildings, systems of control, hygiene of personnel, chemical residues and micro organisms in meat (Kang'ethe, 1993).

Meat quality and safety have great impact on the storage durability of fresh meat. As meat itself has no intrinsic barriers sufficient to inhibit the growth of micro organisms on or in it, the holistic approach of considering hygiene from farm to fork is essential for the production of meat and meat products that contain low initial amounts of bacteria and/or are pathogen-free (FAO/WHO, 2002a; Bernhard *et al*, 2006).

The growth of undesired or spoilage bacteria such as *Pseudomonas, Lactobacillus*, and coliforms on meat present aesthetic concerns that affect the marketability of meat products. For example, growth of spoilage bacteria creates undesired odours due to bacterial production of certain esters, hydrogen sulphite, nitrogenous compounds, propionic acid, formic acid, as well as other undesirable gases and acids. The growth of such other bacteria also acts to discolour the surface of the meat. This spoilage causes meat to be unacceptable to the consumer (Kang'ethe, 1993, Clayton and Bowling, 2007).

Therefore, there is need to put in place simple and inexpensive mitigation measures to focus on attaining sufficiently high hygiene standards in the meat production chain in accordance with quality control programs like Hazard Analysis Critical Control Point (HACCP) and Sanitation Standard Operating Procedures (SSOPs) (U.S. Department of Health and Human Services, Food and Drug Administration, 2006).

1.2 Problem Statement and Justification

FAO/WB/EU (2004) estimates that in 1996, Somalia produced 46,000 tonnes of beef, 49,000 tonnes of goat and sheep meat giving an estimated availability of 8.2 kg of beef and 8.8 kg of small ruminant meat per person per year in Somalia. Yet due to the collapse of a Central Somalia government in 1991 following the civil war, many services including veterinary public health and related infrastructures collapsed posing a public health risk to meat consumers. Somaliland has established some institutions that can now enforce observation of law and order. The hygiene status of meat and meat production facilities in terms of level of microbial contamination has not been established therefore no mitigation measures have been taken in these slaughter facilities (FAO/WB/EU, 2004).

Consumers of such unwholesome meat may be subjects of risks of food borne diseases that are frequent worldwide. Such illnesses are very common in both developing and industrialized countries (Bernhard *et al*, 2006). Meat and meat products are the cause of many notifiable diseases worldwide (Bernhard *et al*, 2006).

According to the CAC (2005), meat must be safe and suitable for human consumption. It is the responsibility of the establishment operator to produce meat that is safe and suitable in accordance with regulatory meat hygiene requirements. FAO/WHO (2002a) shows that consumers should be able to assume that all food including meat offered for sale is safe for its intended use.

In view of the above, a legal framework about meat hygiene and quality assurance is being drafted by legal experts under the auspices of FAO Somalia. This provided the justification for this research to establish the level of microbial contamination of meat being produced in slaughter facilities in the study areas.

1.3 Overall Objective

The overall objective of the study was to determine the level of contamination and microbial quality of meat produced by Somaliland local slaughter facilities.

1.3.1 Specific Objectives

Specific objectives were to:-

1. Determine the general level of microbial contamination of meat produced by various local slaughter facilities.
2. Determine the level of contamination of the meat with coliforms, faecal *E. coli* and *salmonella* spp.
3. Identify risk factors of meat contamination along the production chain.

1.4 Hypothesis

Meat offered for sale in Somaliland is of low microbial quality and is contaminated by pathogenic and spoilage micro-organisms.

CHAPTER TWO

2 LITERATURE REVIEW

2.1 Meat and its sources

Meat means any portion of animal which is intended for human consumption, whether fresh, chilled, or frozen or otherwise processed by any means whatsoever or included in any article of food for human consumption. Meat animals include Bovine, Ovine, Caprine, Camels and Pigs among others (Kenya Meat Control Act, 1977; CAC, 2005). It is obtained after the slaughtering and dressing operation. It includes carcass, intestines, lungs, brain, liver, kidneys, heart, spleen, stomach and tongue. The carcass is a slaughtered dressed animal composed of muscle, bones, fat, connective tissues and tendons (Cole and Lawrie, 1975).

2.2 Meat composition and quality

Meat is composed of about 75% water, 19% protein or nitrogenous matter, 2.5 % lipids (fats), 1.2% carbohydrates, 2.3% soluble non-protein substances and vitamins (Thornton and Gracey, 1974). The quality and composition of meat is affected by factors such as age, sex, stress, diet, intramuscular fat, moisture content, pre-slaughter conditions and processing variables.

2.2 Some factors which affect meat quality

2.2.1 Stress and pH

The pH of muscle/meat is a measurement of acidity. In a normal living muscle the pH is approximately 7.2. Glycogen is broken down to lactic acid when muscle turns into meat.

The pH of meat can range from 5.2 to 7.0. The highest quality products tend to fall in the pH range of 5.7 to 6.0. Both the rate and extent of post-mortem pH fall will influence meat quality characteristics (Ronald, 2005).

Stress which may result from poor pre-slaughter handling conditions can cause undesirable effects on quality of meat. Stress leads to production of pale, soft, exudative (PSE) meat in pigs and dark, firm, dry (DFD) meat in bovine. Pale, Soft, and Exudative (PSE) pork commonly results from a rapid breakdown of glycogen into lactic acid after slaughter. This rapid pH fall can be seen in pigs carrying the halothane gene (stress gene). The ultimate pH is determined by the extent of the pH decline at 24 hours after slaughter. The variation in ultimate pH influences factors such as colour and the ability of the meat to retain water. A low ultimate pH results in meat proteins having decreased water-holding capacity and a lighter colour. Conversely, a higher ultimate pH will give a darker colour and less drip loss (Ronald, 2005).

DFD is a condition in which the colour of the musculature of freshly killed animals, as a whole or in part, is appreciably darker and drier than normal. It occurs in cattle most frequently subjected to pre-slaughter stress. In post-mortem glycolysis, glycogen reserve in the muscle is broken down into lactic acid and carbon dioxide. In unstressed animals, the final pH is in the region of 5.5-5.8 but in DFD cases, it falls from 7.0 to 6.8 only due to less post-mortem glycolysis following glycogen exhaustion as a result of stress. This kind of meat has a poor keeping quality (Gracey *et al*, 1999).

The acid usually has the effect of retarding the growth of bacteria that have contaminated the carcass during slaughter and dressing. Therefore meat with inadequate acid spoils fast as it provides a good medium for growth of spoilage and pathogenic bacteria. Spoilage causes heavy economic losses while pathogenic bacteria cause serious health risks to meat consumers. Therefore, good quality meat has to come from animals subjected to less stress and no bruises (Falade and Adegoke, 2005; Ronald, 2005).

2.2.2 Bruised livestock

Bruised animals have blood that has bled into muscles. Meat from bruised animals is unacceptable to consumers as it decomposes and spoils rapidly because blood in the meat is an ideal medium for growth of contaminating bacteria (Falade and Adegoke; 2005, Ronald; 2005).

2.2.3 Sex

Bulls can produce tougher meat as compared to steers and heifers, but if grown rapidly and slaughtered comparatively young they will produce meat of acceptable tenderness. A steak from bulls is largest but has the least fat around it. The fat and lean of the bulls is also lighter. Steers have more fat around their steaks which is not significantly affected by eating quality. There is an overall trend for the steer meat to be tenderer, juicy and of better flavour with highest overall acceptability while bulls are least tender and heifers intermediate (Geoff *et al*, 2004).

2.2.4 Diet

Nutrition has great influence on meat quality of all livestock species. Meat from grass-finished animals tends to be slightly tenderer while meat from cereal-finished animals tends to be slightly juicier, meat from grass and silage-finished animals have a slightly stronger flavour. A steak from grass-finished animals is significantly smaller. Cereal-finished animals produce less fat around the steaks. There is no significant effect of diet on texture although the silage-finished animals have the largest numerical value for texture liking. Grass-finished animals produce steaks which are preferred least for juiciness, while silage-finished steaks are preferred most for flavour (Geoff *et al*, 2004).

2.3 Sources of microbial contamination of meat

Animals enter a meat slaughter plant with various foreign materials present on their hair. These may include dirt, manure, mud, and vegetative material. The hair is also contaminated with a multitude of micro organisms some of which are pathogenic to humans. The major sources of meat contamination are heads, legs, hide/skin and viscera removal during slaughter (Kang'ethe, 1993; Bernhard *et al*, 2006; Clayton and Bowling, 2007).

The degree of contamination of the external surfaces of the animal is likely to compromise hygienic slaughter and dressing (CAC, 2005). Therefore, the cleanliness of animals determines the level of microbiological cross-contamination of the carcass and other edible parts during slaughter and dressing. The central aim in hygiene slaughtering is to remove the hide, head, hooves, and alimentary tract in such a way as to prevent their abnormal bacterial load being transferred to meat (Kang'ethe, 1993).

Bernhard *et al* (2006) has shown that handling during slaughter is another great source of contamination. The normal skin flora of the human head is host to approximately 1 million micro organisms per square centimetre, and that of the hands between 100 and 1000 after hand washing. Therefore, personnel can have a considerable influence on the contamination of meat throughout the entire meat production chain (Bernhard *et al,* 2006).

Cross-contamination of carcasses when they come in contact with other carcasses and personnel during slaughter is a major risk factor for the transmission of bacteria from the living animal to the slaughter equipment or personnel and ultimately to meat. Additionally, during transportation, animals can be contaminated by faecal discharges (Bernhard *et al*, 2006; CAC, 2005).

Furthermore, Bernhard *et al* (2006), has shown that stress during transport can lead to breakdown of the intestinal barrier, so that bacteria from the bowel content can pass the barrier and invade the blood or lymph.

Other sources of bacterial contamination to meat can be during pithing if they gain entrance into blood, flaying if the skin or hide comes in contact with meat, evisceration and opening of cavities if regurgitation may occur and cause contamination or if accidental puncture of the stomachs and intestines can occur, if meat comes in contact with surfaces like floor, walls or other dirty equipments, if carcasses are split using unhygienic equipments, washing carcasses with non-potable water. Furthermore, other

sources of contamination include unhygienic slaughter personnel who operate with dirty protective clothing or are physically dirty, presentation of dirty animals for slaughter, and cross movement of personnel between dirty and clean areas. Poor drainage system can cause effluent to splash on and contaminate meat, irregular cleaning of slaughter facility. Delayed scrubbing and inadequate cleaning/washing can lead to accumulation of dirt which will in turn contaminate meat. Improper control of pests, flies, rodents and carnivores will enhance spread of germs in the slaughter facility. Unhygienic practices of personnel such as inadequate washing of hands with soap before start of work and after visiting toilets, eating and smoking during the slaughter process are other risk factors of meat contamination (Meat Control Act, 1977; Kang'ethe, 1993; Almond Board of California, 2005, Livestock and Meat Industries Act, 2007).

2.4 The major types of micro organisms associated with meat

Meat has traditionally been viewed as a vehicle for a significant proportion of human food-borne diseases. Included are moulds, yeast and bacteria (CAC, 2005).

Bacteria are the major source of contamination. Specific meat-borne pathogens include *E. coli, Salmonella spp., Campylobacter spp., Yersinia enterocolitica, Brucella spp., Leptospira spp., Staphylococcus spp., Streptococcus spp. and Clostridium spp* (CAC, 2005; Bernhard *et al*,2006; Clayton and Bowling, 2007).

Most countries with systems for recording food-borne diseases have reported significant increases in the incidence of diseases caused by pathogenic micro organisms in food over the past few decades. As many as one person in three in industrialised countries may be

affected by food-borne illness each year and it is even worse in developing countries. Meat and poultry eaten cold or pre-warmed is a predominant vehicle of food- borne diseases and poisoning (Gillespie *et al*, 1999; FAO/WHO, 2002b; Bernhard *et al,* 2006). Apart from deaths and human suffering caused by food-borne diseases, the economic consequences are enormous, running into billions of dollars in some countries. For example, in Europe, Bovine Spongiform Encephalopathy (BSE) and contamination of food with dioxins led consumers to lose confidence in the safety of foods on the market, with severe economic consequences (FAO/WHO, 2002).

2.5 Effect of micro-organisms on meat

The shelf life of a meat product is directly related to the initial numbers of spoilage and pathogenic bacteria present on the surface of the meat and meat product. The meat product having a high level of spoilage and pathogenic bacteria on its surface exhibits a relatively short shelf life whereas meat having a low count of spoilage and pathogenic bacteria exhibits an extended shelf life (Kang'ethe, 1993; Bernhard *et al*, 2006; Clayton and Bowling, 2007).

Contamination of meat with pathogenic bacteria or toxin produced by such bacteria can cause illness or disease in humans and animals who consume such meat (Kang'ethe, 1993, Clayton and Bowling, 2007).

2.6 Some Specific Food-borne Pathogens associated with meat

2.6.1 *Salmonella* spp

Salmonellosis continues to be an important public health problem worldwide. The following are serotypes most commonly recovered from foods of animal origin like meat.

S. typhymurium, S. heidelberg, S. thompson, S. enteritidis, and *S. dublin*

These bacteria have been known to cause salmonellosis in man for over 100 years (Flowers *et al*, 1992; CDC, 2006a). Every year, approximately 40,000 cases of salmonellosis are reported in the U.S. The disease affects all age groups. However, young children, the elderly and the immunocompromised are the most likely to have severe infections. It is estimated that approximately 600 persons every year die from acute Salmonellosis in the United States of America (CDC, 2006a).

2.6.2 *Listeria* spp

This is caused by *Listeria monocytogenase*. It is a small Gram positive facultative anaerobic rod-shaped bacterium that is widely distributed in the environment. Animals can carry the bacterium without appearing ill and can contaminate foods (CDC, 2005). The disease affects primarily pregnant women, newborns and immunocompromised adults (CDC, 2005).

2.6.3 *Campylobacter* spp

The disease in humans is caused by *Campylobacter jejuni* and *C. coli.* These are small non spore forming microaerophilic Gram negative bacteria possessing characteristic curved (s-shaped or spiral) morphologies. The bacteria can be transmitted to man and cause disease through consumption of undercooked or raw meat (Clayton and Bowling, 2007).

2.6.4 Coliform Group

The coliform group includes aerobic and facultative anaerobic, gram-negative, non-spore forming rods that ferment lactose, forming acid and gas within 48 hours at 35^0c. Included in this family are coliform group of indicator organisms for faecal contamination like *Escherichia, Klebsiella,* and *Enterobacter* genera that ferment lactose with production of acid and gas (Ira, 1984). The presence of coliforms in processed foods is an indicator of post-sanitization and post-processing (pasteurization) contamination. Practices which permit their presence in such instances are not consistent with good sanitation standards required for food processing operations. Total coliforms are referred to as indicator organisms since a quantitation of their presence in food is used to indicate the potential presence of pathogens. Detection of faecal coliforms indicates faecal contamination of foods (Ira, 1984; FAO, 1992).

2.6.5 Enteropathogenic *Escherichia coli*

These belong to the coliform group in the family of *Enterobacteriaceae*. They are Gram negative non spore forming rod-shaped bacteria that ferment lactose to produce acid and gas within 48 hours at 48^0C. There are five recognised classes of Enterovirulent *E. coli*. These include; Enterohaemorrhagic *E. coli,* Enterotoxigenic *E. coli,* Enteroinvasive *E. coli,* Enteroaggregative *E. coli,* Enteropathogenic *E. coli.*

Enterohaemorrhagic *E. coli* serotype O157:H7 causes haemorrhagic colitis which is characterised by grave, overtly bloody diarrhoea. In addition, afflicted patients often suffer from haemolytic uremic syndrome which may cause permanent kidney damage, necessitating transplant (Read *et al,* 1990; Arimi *et al*, 2000; Agaoglu *et al,* 2000;

FAO/WHO, 2002b; CDC, 2006 b; US FDA, 2006). Enterotoxigenic *E. coli* is involved in traveler's diarrhoea; Enteropathogenic *E. coli* causes infection characterized by fever, vomiting and watery diarrhoea; Enteroinvasive *E. coli* causes dysentery-like disease while Enteroaggregative *E. coli* is associated with chronic persistent diarrhoea (Luis *et al*, 2004).

The bacteria are a normal flora of intestines of all animals including man. When meat contaminated with *E. coli* O157:H7 is consumed raw or undercooked, it causes disease. The presence of *E. coli* on meat is an indication of faecal contamination and indicates poor hygiene practice during meat handling e.g. at slaughter (Arimi *et al*, 2000; US FDA, 2006; CDC, 2006b; Mashood *et al*, 2006). Mashood *et al* (2006) showed Enterohaemorrhagic *E. coli* O157:H7 as an important food-borne pathogen that has emerged globally. *E. coli* O157:H7 infections have been reported world wide, but most frequently in developed countries. Laboratories in many African countries do not routinely test for *E. coli* O157:H7, hence many infections may go unrecognised (Mashood *et al*, 2006).

2.7 Sample collection methods

2.7.1 Wet and dry swabbing method

The procedure involves swabbing of the neck, lateral brisket, flank and rump for cattle and lateral brisket, thorax lateral, flank and breast for sheep and goats. Swabs are moistened in sterile peptone salt diluents prior to sample collection. The sampling area for swabbing should cover 100 cm^2 for cattle and horses, 50 cm^2 for pigs, sheep and goats per sampling site. The swab is moistened for at least 5 seconds in the diluent and rubbed

initially vertically, then horizontally, then diagonally for not less than 20 seconds across the swab site. As much pressure as possible should be applied in the process. Swabbing is repeated using a dry swab at the same site. Samples collected from the four sampling sites of each carcass may be analysed separately or may be pooled in the same container for later microbiological examination. All samples must be placed aseptically into a sample container or plastic dilution bag at the slaughter facility and transferred to the laboratory in a cool box (Kang'ethe, 1993, Amendment to the Fresh Meat Hygiene and Inspection regulations Northern Ireland, 1997).

2.7.2 Excision method

The procedure involves obtaining tissues from the neck, brisket, flank and rump or liver for cattle and flank, thorax lateral, brisket and breast for sheep and goats. Four tissue samples representing a total of 20 cm^2 are obtained from each carcass. Pieces of tissue organ are obtained using a sterile cork borer (2.5 cm diameter) or by cutting a slice of 5 cm^2 and maximum thickness of 5 mm off the carcass with a sterile instrument. Samples from the four sampling sites of each tested carcass may be analysed separately or may be pooled in the same container before examination. The samples must be placed aseptically into a sample container or plastic dilution bag at the slaughter facility and transferred to the laboratory in a cool box (Amendment to the Fresh Meat Hygiene and Inspection regulations Northern Ireland, 1997).

2.8 Methods for microbiological analysis of meat

2.8.1 Plate Count Agar (PCA)

Plate Count Agar (appendix I) is suitable for estimating total number of aerobic bacterial population in food samples. A series of dilutions of the food sample homogenate is mixed with an agar medium and incubated at 37^0C for 24-48 hours. It is assumed that each visible colony is the result of multiplication of a single cell on the surface of the agar (FAO, 1992; Robert, 2005). The procedure involves thoroughly mixing the food sample using a vortex mixer or mechanical blender. A portion (1 ml) of the sample homogenate is then transferred to a sterilized tube containing 9 ml of sterilized normal saline. From this, serial dilutions into subsequent labelled sterilized tubes containing sterilized 9 ml normal saline is done upto 10^{-6} or 10^{-10} depending on the estimated level of food contamination. One millilitre (1) ml of each dilution is pippeted seperately into sterilized and appropriately marked petri plates in duplicates. To each plate, 10-15 ml of the PCA cooled to 44-46^{0}C is added. Immediately, the sample dilutions and agar medium are thoroughly mixed to make distribution of micro-organisms in the medium uniform. The agar is allowed to solidify and petri plates incubated promptly for 24 hours at 37^0C. After incubation colonies are counted in duplicate plates having 25-250 colonies using a colony counter (FAO, 1992; Robert, 2005).

2.8.2 Presumptive test for Total Coliforms

These are determined using the most probable numbers (MPN) method. The procedure involves thoroughly mixing a food sample using a mechanical mixer. A portion (1 ml) of the homogenate is asseptically transferred into a sterile test tube containing 9 ml peptone water using a sterilized pipette. From this, serial dilutions are made into subsequent labeled sterile test tubes containing 9 ml of sterile peptone water upto 10^{-3} or 10^{-4}

depending on the estimated level of food contamination with coliforms (FAO, 1992). One millilitre portion from each tube is transferred into 3 or 4 labeled sterile tubes containing 9 ml of lauryl tryptose broth and Durham tubes. Lauryl tryptose inoculated tubes are incubated for 24-48 hours at 37^0C. The tubes are examined after 24 hours for gas production that collects in Durham tubes and for increased turbidity of the broth. Negative tubes can be re-incubated for an additional 24 hours. Gas production and turbidity of the broth is an indication of coliforms (FAO, 1992).

2.8.3 Confirmation test for coliforms from presumptive positive tubes

Each gassing lauryl tryptose broth tube is gently agitated and a loopful of suspension transferred to tubes containing 5 ml brilliant green bile broth. The inoculated tubes are incubated for 24 hours at 37^0C. The tubes are examined for gas production and results recorded. The MPN of total coliforms is calculated based on the combination score of lauryl tryptose broth for the three consecutive dilutions (FAO, 1992).

2.8.4 Confirmed test for faecal *E. coli*

Each gassing lauryl tryptose tube is gently agitated and a loopful of each suspension transferred to a tube containing 5 ml tryptone water. The inoculated tryptone water tubes are incubated for 24 hours at 37^0C. After 24 hours, a few drops of Kovacs reagent are added to each tube. Development of pink coloration is indicative of a positive result for indole production. There will be no colour change for the tube that is negative. The MPN of faecal coliforms is then calculated based on the proportion of confirmed pink tubes for three consecutive dilutions (FAO, 1992).

2.8.5 Characterization of *E. coli*

Loopfuls of suspension from each gassing lauryl tryptose tube are streaked to Levine eosin methylene blue agar. The plates are then incubated for 24 hours at 37^{0}C. They are then examined for colonies with typical metallic sheen, characteristic of *E. coli*. A Gram stain was then performed on both colonies displaying metallic sheen and those not because some *E. coli* do not display metallic sheen colonies characteristic of *E. coli* culture. Cultures appearing as Gram-negative, short rods or cocci are characterized further by Indole, Voges-Proskauer, Methyl Red and Citrate (IMVIC) test (FAO, 1992). This involves test for indole production, test for voges-proskauer and methyl red reactive compounds as well as utilization of citrate as source of carbo. Test for indole production involves inoculation of a tube of tryptone water is incubating it for 24 hours at 35^{0}C. After incubation, test for indole is done by adding 0.2-0.3 ml Kovacs' reagent. Appearance of distinct red colour in the upper layer indicates a positive test (FAO, 1992; Bridson; 1998). Most *E. coli* produce indole, however, a few *E. coli* strains do not.

Test for Voges-Proskauer (VP) reactive compounds involves inoculation of a tube of MR-VP medium is incubated for 24 hours at 37^{0}C. After incubation, 0.6 ml alpha-naphthol solution and 0.2 ml 40% KOH are then added and mixed well. A few crystals of creatine are added, mixed and let to stand for 2 hours. Development of eosin pink colour indicates a positive VP test (FAO, 1992; Bridson, 1998).

Test for Methyl-red (MR) reactive compounds involves inoculation of MR-VP tubes and incubating them for 24 hours at 37^{0}C. After incubation, 5 drops of methyl-red solution is

added to each tube. Development of a red colour indicates a positive MR test (FAO, 1992; Bridson, 1998).

Test for utilization of citrate involves inoculation of a tube of Simon's Koser Citrate Agar and incubating it for 24 hours at 37^0C. A colour change from green to blue is a positive test indicating utilization of citrate as sole source of carbon. *E coli* do not utilize citrate; therefore the colour of the medium remains green (FAO, 1992; Bridson, 1998).
IMVIC results ++-- or -+-- indicate presence of *E. coli.*

2.8.6 Isolation of *salmonella* spp

Isolation of *Salmonella* species involves initial use of enrichment media such as selenite cystine (SC) or tetrathionate (TT) broth. One ml of mixed food samples are inoculated in 9 ml of each enrichment broth and incubated at 37^0C for 24 hours. A loopful from each of the overnight broth culture is then streaked onto *Salmonella* selective media like bismuth sulphite (BS) agar or xylose lysine desoxycholate agar (XLD) and incubated at 37^0C for 24 hrs. Typical *salmonella* spp appear as brown, gray, black or sometimes as metallic sheen on BS colonies whereas it will appear as pink colonies with or without black centers on XLD (FAO, 1992).

CHAPTER THREE

3 MATERIALS AND METHODS

3.1 Republic of Somalia

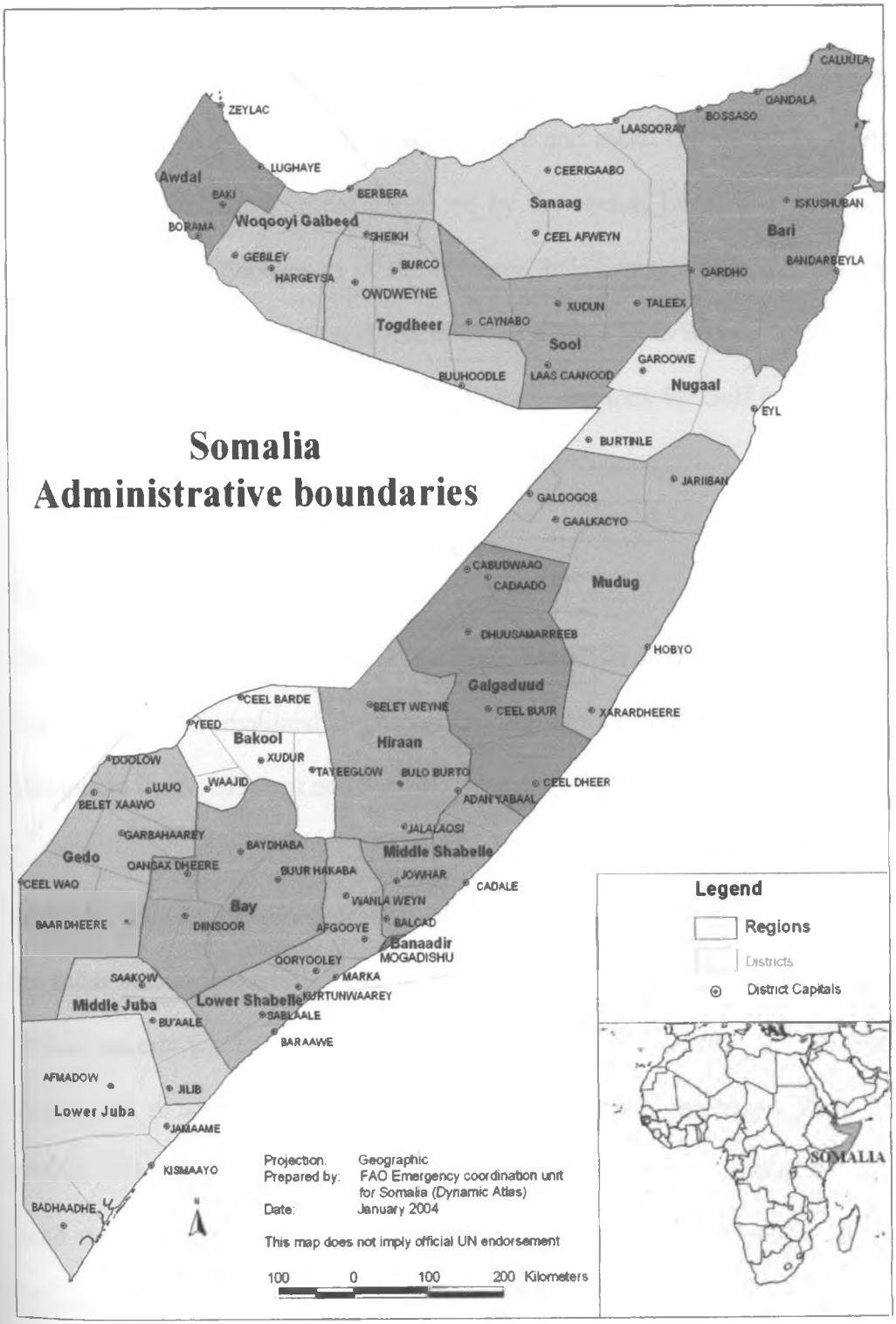
The unified Somalia (Map 3.1) covers an area of 640,000 km^2 which stretches from the shores of the Indian Ocean towards the Ethiopian plateau in the Northwest and the West, in the South it extends towards the plains of Kenya. It stretches from roughly 2^0 South to 11^0 North latitudes and lies between 40^0 and 53^0 East longitudes (Thadis, 1971; FAO/WB/EU, 2004).

3.1.1 Climate

The climate is arid or semiarid. Very small elevated areas have an annual average rainfall of 500-600mm but most of the country has an average rainfall that is only 100-200mm. In the wettest regions there are typically 40-60 rainy days each year with daily rainfall of the order of 5-15mm (FAO/WB/EU, 2004).

3.1.2 Topography

The landmass is dominated by arid and semiarid rangelands for which pastoralism is the most appropriate form of land use. Of the total landmass, 55% is classified as rangeland, 14% as forest, 12% suitable for cultivation and 19% as other land (FAO/WB/EU, 2004). Eighty percent (80%) of the rangelands are used for rearing livestock, which accounts for over 80% of agricultural activity, and this directly and indirectly, involves up to 80% of the population (FAO/WB/EU, 2004).



Map 3.1 Map of Somalia (FSNAU, 2007)

3.1.3 Economy

Livestock supports all levels of the economy; families benefit directly from milk through household consumption and from sale of milk and meat. Communities benefit from the local income and employment generated by the sector. Local and national institutions levy taxes on various aspects of the industry. It is a major source of foreign exchange through export of livestock and livestock products (FAO/WB/EU, 2004). An embargo imposed in the year 2000 on imports of Somali livestock by Gulf countries has deprived the country of a key source of revenue (Mark, 2008).

3.1.4 Study area-Somaliland

The exercise was carried out in Somaliland (Map 3.2) state of the Republic of Somalia. The republic of Somaliland share borders with Djibouti and Gulf of Aden to the North, Ethiopia to the South-west and Somalia's Puntland to the East (Mark, 2008).

Located on the northern edge of the Horn of Africa, Somaliland has emerged as one of the most stable democratic state in the Horn, and in 2006 could boast of a popularly elected government and a political system with democratic credentials to rival any in the region and most Muslim states. As such, Somaliland challenges the image of war, disaster and social regression that has been associated with this part of the Horn of Africa since the early 1990s when the central government of the entire Republic of Somalia collapsed (Mark, 2008). Much of the urban infrastructure, municipal services and systems of education, health, livestock and many others that were destroyed during the war have been re-established. The government is levying taxes, issues currency, exercises some

control over its borders, manages some public assets etc that enable it render some services to its citizens (Mark, 2008).

3.1.5 Human population

In 2005, Somalia as a country had an estimated population of about 7.7 million people. Of these, Central Somalia had 4.9 millions, Puntland had 1.1 millions and Somaliland 1.7 millions with an average density of 10 persons per kilometre square (FAO/WB/EU, 2004 and UN/WB, 2006).

3.1.6 Livestock population

The study area (Somaliland) had cattle-435,890, camels-1,347,700, sheep-3,448,720 and goats- 7,096,180 giving a total of 12,328,490 livestock (FAO/WB/EU; 2004).

3.1.7 Infrastructures

The road network in the study areas is all weather and telecommunication network coverage is available in all the five towns covered (Mark, 2008).

3.2 Data collection on risk factors of meat contamination

This involved both qualitative and quantitative approaches.

3.2.1 Rapid Rural Appraisal (RRA)

RRA technique was used to gather information on community resources and needs for use in literacy and community development programs. It includes use of semi structured

questionnaires (appendix IV), interview; focus group discussions and transect walks (Okuthe *et al*, 2003; Okuthe *et al*, 2006). Secondary data from the relevant local authorities on livestock slaughter figures, slaughter facility personnel among others was collected and summarised. A checklist was developed to guide the researcher during the RRA interviews with facility supervisors and personnel. This gathered information on how much they knew about minimum meat hygiene handling practices when they carry out slaughter of livestock in addition to hygiene of personnel and slaughter facility surrounding environment. Transect walks/drive was done in selected areas of slaughter facilities to probe, triangulate and confirm some of the unclear issues from the discussions like the hygiene of the slaughter facilities and their environments.

The researcher accompanied by an interpreter administered a pre-tested questionnaire. Questions to slaughter facility supervisors included:-structure and location of facility, number of personnel, and provision of slaughter equipments and hygiene of the facilities. Facility personnel were questioned on use of protective clothing, health status and observation of minimum hygiene standards during slaughter among others.

3.2.2 Sampling

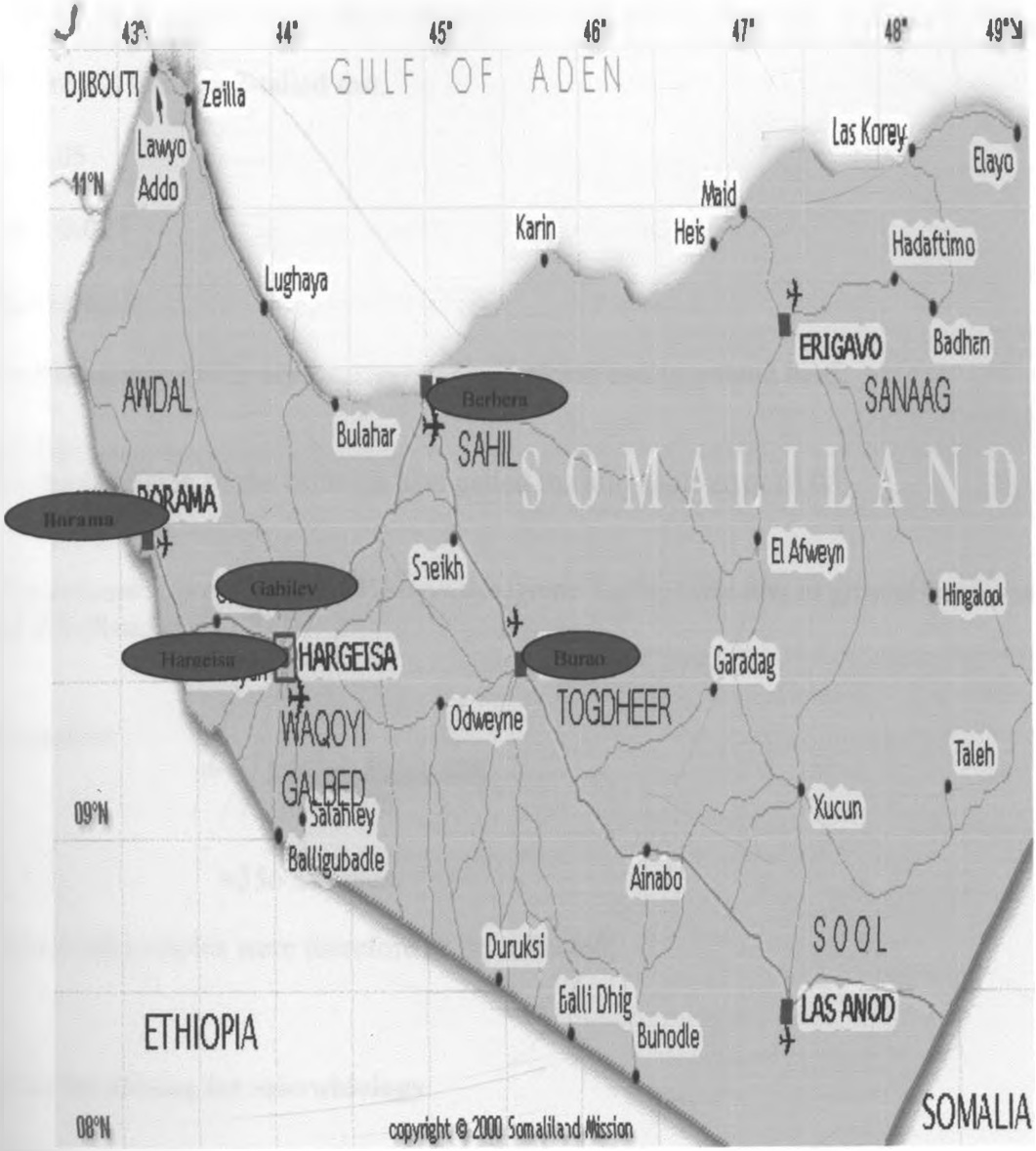
The study units were local municipal slaughter facilities stratified into five districts that had high daily kill. They were selected conveniently based on logistical considerations such as accessibility, security and daily slaughter of small stock.

A two stage sampling strategy was used with the primary units being the local Municipal slaughter facilities and secondary units the carcasses within the slaughter facilities. A

systematic sampling method was used to select the carcasses that were subsequently swabbed with non-absorbent cotton wool moistened with buffered peptone water for bacteriology.

Since the slaughter figures were not known a *priori*, a constant proportion of carcasses were sampled in each slaughter facility. For every trip, only fourty five to fifty goats/sheep were sampled because of the capacity that could be analyzed at Analabs at a given time and the swabbing and transport logistics.

Five local slaughter facilities selected were Hargeisa, Gabiley, Borama, Berbera and Burao based on convenience, accessibility, security and daily through put (Map 3.2).



Map 3.2 Map of Somaliland showing study areas (FSNAU, 2007)

3.2.3 Sample size determination

The sample size for swabs to be taken from carcasses was based on the formula of Dohoo *et al* (2003): The estimated prevalence of Verocytotoxigenic *Escherichia coli* was based on the study of Read *et al* (1990) in ground beef which was 36.4% from randomly selected meat processing plants in South-western Ontario, Canada.

Where Z_α; this is a 2-tailed test.

α=0.05

$\alpha/_2$=0.025

$Z_{\alpha/}$=1.96

P= Prevalence of *Verocytotoxigenic Escherichia coli* in ground beef.

q= 1-p
L= the precision of the estimate also called the allowable error (0.05)

The estimated prevalence of *Verocytotoxigenic Escherichia coli* in ground beef was *36.4%* (Read *et al* 1990).

Therefore

$$n = \frac{1.96^2 \times 0.364 \times 0.636}{0.0025}$$

=356 samples.

356 swab samples were therefore to be collected;

3.2.4 Swabbing for microbiology

Swabs were taken from small ruminants (sheep and goats). The swabs were taken from the lateral brisket which was randomly selected using cards. These sites are recommended because of being mostly prone to contamination during slaughter (Kang'ethe, 1993; Amendment to the Fresh Meat hygiene and inspection regulations (Northern Ireland, 1997). For the purpose of this research, lateral brisket was randomly chosen using cards for swabbing in the whole exercise.

Wet and dry swabbing was applied. Fifty square centimetres ($50cm^2$) from each site was delineated using a sterile aluminium template. A swab moistened for at least five seconds in buffered peptone water was rubbed initially vertically, then horizontally and finally diagonally for not less than twenty seconds across the delineated swab site. Much pressure as possible was applied. Swabbing was repeated with a dry swab at the same site (Kang'ethe, 1993; Amendment to the Fresh Meat hygiene and inspection regulations Northern Ireland, 1997). Both wet and dry swabs from the site of each carcass were then placed in one sample bottle containing 5ml of buffered peptone water and put under refrigeration in cool boxes with ice (2-4^{0}C). Samples were being taken as early as from 11.00 pm in Hargeisa and Burao since slaughter ran from 11.00 pm to 5.00 am, while in Berbera, Gabiley and Borama, slaughter used to run from 2.00-8.30 am latest. Sampling was done within this time. Additionally, sampling was done on days when there was to be a flight to Nairobi, Kenya where the samples were taken to Analabs for microbiological analysis.

3.3 Analytical tests

3.3.1 Total viable counts

Samples were examined within 24-48 hours of sampling. They were mixed thoroughly using a vortex mixer. Serial dilutions before plating were carried out in tenfold step in buffered peptone water up to 10^{-6} for total viable counts. One ml of each dilution was transferred to a sterilized marked 90mm diameter petri dish. Ten mls of PCA tempered at 48^{0}C was poured into each of the 6 petri dish plates. Each plate was swirled in figure 8 to mix. The plates were incubated at 37^{0}C for 24 hours. Plates that had 250 or less colonies

were selected for colony enumeration using colony counter. The total number of colonies was determined by multiplying the enumerated colonies with the dilution factor of each plate. When two dilutions were in appropriate range, an average count for each dilution was determined before averaging the two dilution counts that were in close range to obtain total viable counts. The counts were divided by the total surface area of swabbing per carcass to give the colony forming units (cfu) per cm^2.

3.3.2 Coliform Counts

Coliform count was estimated using the Most Probable Numbers (MPN) index and 95% confidence limits for various combinations of positive results when various numbers of tubes were used. Serial 10-fold dilutions of the sample homogenate were used in a 3- tube MPN series (Inocula of 0.1, 0.01, and 0.001). Serial tenfold dilution in buffered peptone water was prepared up to 10^{-3} as per the anticipated coliform density. One ml aliquots of each dilution were transferred to each of the three tubes containing Lauryl Tryptone Broth and Durham tubes. The tubes were incubated at 37^0C for 18-24 hours. Gas production which collected in Durham tubes was positive for the test. The MPN technique was used at this level to estimate the density of viable coliforms in the sample. The combination acquired or generated was used to interpret the number of viable coliforms organisms in the sample using the MPN table (appendix III).

3.3.3 Determination of faecal *E. coli*

A loopful of the inoculate from the tubes positive for *E. coli* were inoculated into sterilized tubes containing 9 ml of lauryl tryptose broth containing Durham tubes using

sterilized wire loops. These were incubated in a water bath at 44.5 ± 0.5^{0}C for 24 hours. All tubes that developed turbidity and gas collected in Durham tubes were regarded as positive for faecal *E. coli.*

3.3.4 Confirmatory test for faecal *E. coli*

One ml from each positive tube was sub-cultured into each tube containing 3ml Tryptone water. These were incubated at 44^{0}C for 24 hours. After 24 hours, a few drops of Kovac's Indole reagent were added to all the sub-cultured tubes. Positive tubes developed a pink layer at the top of the media while negative ones displayed a cream golden layer at the top of the media.

The inoculated tubes of MR-VP medium were incubated for 24 hours at 37^{0}C. One ml of the culture was transferred to a sterilized test tube and mixed well. 0.6 ml alpha-naphthol solution and 0.2 ml 40% potassium hydrxide were then added and mixed well. A few crystals of creatine were added, mixed and let stand for 2 hours. Positive tubes for *E. coli* developed eosin pink colour.

Similarly, the inoculated MR-VP tubes were incubated for 24 hours at 37^{0}C. Five (5) drops of methyl-red solution was added to each tube after incubation period. Tubes that developed red colour were counted as positive for *E. coli.*

Tubes of Simon's Koser Citrate Agar were lightly streaked with the same isolates and incubated for 24 hours at 37^{0}C. All the tubes that had no colour change from green to blue were counted as positive for *E. coli.*

MVIC results of ++-- or -+-- are the ones that were regarded as positive for *E. coli*.

3.3.5 *Salmonella* spp detection

After thoroughly mixing the swab samples using a vortex mixer, 1 ml was transferred into a tube containing 9 ml of buffered peptone water and mixed thoroughly. The sample mixture was incubated at $37^0C \pm 1^0C$ for 24 hrs with the tube being securely capped.

1 ml of the pre-enrichment buffered peptone water was then transferred to 10 ml of Selenite Cystine (SC) broth which was incubated at 37^0C for 24 ± 2 hours. After incubation period, approximately 2 mm loopfuls of incubated SC broth was streaked onto prepared Brilliant Green Agar (BGA) and onto Xylose Lysine Desoxycholate (XLD) agar plates. The plates were incubated at $37^0C \pm 1^0C$ for 24 hrs.

3.4 Meat contamination risk factors

Many factors influence the level of meat contamination during slaughter process of livestock. Some of meat contamination risk factors probed for through the questionnaire, transect walks and observation were; location of the slaughter facility, if slaughter facilities had carcass hoisting equipments during bleeding, skinning and evisceration, if there was demarcation between dirty and clean areas, whether heads, skins, white offal are removed immediately and if there was provision for offal handling rooms. Other factors were provision of adequate light, availability of condemnation disposal pits, whether floors and walls were impervious, without cracks and are washed immediately after slaughter, availability of good drainage system, provision of stainless steel slaughter

equipments like knives, hooks and receptacles among others and whether the equipments are cleaned thoroughly immediately after slaughter. Equally searched for were provision of adequate potable cold/hot water, provision for washing dirty animals before slaughter, whether personnel put on protective gear and wash their hands with soap before start of slaughter, whether they avoid unhygienic practices like smoking, chewing, wearing jewellery during slaughter, whether they go for medical check up and if they had had any training in minimum meat hygiene handling practices and what they do when carcasses are contaminated with ingesta.

3.5 Level of significance of meat contamination risk factors

Statistical analyses of data was carried out by use of one way analysis of variance (ANOVA) using scientific package for social scientist (SPSS). Various factors were identified as risk factors influencing different levels of meat contamination from the five slaughter facilities after visual observation and administration of a questionnaire as stated before.

CHAPTER FOUR

4 RESULTS

4.1 Risk factors of meat contamination

As indicated in table 4.1 below, compliance with hygiene meat production practices was quite varied. All the five local slaughter facilities surveyed complied (100%) with proper location of slaughter facilities and having carcass hoisting facilities during bleeding, flaying and evisceration and washed their carcasses whenever they came in contact with ingesta.

However, out of the five slaughter facilities in the study, only Hargeisa local slaughter facility complied with observing the following meat contamination risk factors:- demarcation between dirty and clean areas, immediate removal of skins, heads and offal, having separate offal, heads and skin handling rooms, availability of lockable carcass/organs condemnation disposal pit, provision of stainless steel slaughter equipments, provision of adequate cold/hot potable water, ensuring clean equipments before start of slaughter, personnel putting on protective gear and washing hands before start of slaughter and after visiting toilet. Therefore compliance with regard to these risk factors by the five local slaughter facilities was only 20%.

There was 0% compliance with washing of dirty livestock before slaughter and personnel getting medical check up in all the five slaughter facilities under study.

Compliance with having good drainage system, impervious walls and floors of slaughter facility and personnel having had training in minimum meat hygiene handling practices

was by four slaughter facilities (Hargeisa, Burao, Borama and Gabiley) giving 80% compliance.

Finally, compliance with having adequate light whether artificial, natural or both was observed by Hargeisa, Borama and Gabiley giving 60% compliance.

Table 4.1 below shows compliance and non compliance by the five slaughter facilities regarding various meat contamination risk factors.

S. No	Risk factors	Slaughter facility practices:- correct (C) or wrong (W)					
		Berbera	Burao	Borama	Gabiley	Hargeisa	Compliance (%)
1	Location of slaughter facility	Correct	Correct	Correct	Correct	Correct	100
2	Hoisting facilities	Correct	Correct	Correct	Correct	Correct	100
3	Demarcation-dirty & clean area	wrong	wrong	wrong	wrong	Correct	20
4	Immediate removal of heads, skins, intestines & stomachs	wrong	wrong	wrong	wrong	Correct	20
5	Offal handling room	wrong	wrong	wrong	wrong	Correct	20
6	Adequate light	wrong	wrong	Correct	Correct	Correct	60
7	Condemns disposal pit	wrong	wrong	wrong	wrong	Correct	20
8	Impervious walls & floors	wrong	correct	Correct	Correct	Correct	80
9	Good drainage system	wrong	Correct	Correct	Correct	Correct	80
10	Stainless steel slaughter equipments	wrong	wrong	wrong	wrong	Correct	20
11	Adequate cold/hot potable water	wrong	wrong	wrong	wrong	Correct	20
12	Dirty animals washing provision	wrong	wrong	wrong	wrong	wrong	0
13	Clean equipments before slaughter	wrong	wrong	Wrong	wrong	Correct	20
14	Personnel in protective gear	wrong	wrong	wrong	Wrong	Correct	20
15	Hands washing after toilets visit	wrong	wrong	wrong	wrong	Correct	20
16	Had any training in slaughter	wrong	Correct	Correct	Correct	Correct	80
17	Regular medical check for personnel	wrong	wrong	wrong	wrong	wrong	0
18	Wash carcass if in contact with feces	Correct	Correct	Correct	Correct	Correct	100
Total C/W		C-3 W-15	C-6 W-12	C-7 W-11	C-7 W-11	C-16 W-2	

Table 4.1 Meat contamination risk factors

4.2 Swab sample analysis results

Eighty (80) swab samples from goats/sheep carcasses were collected from each slaughter facility. Therefore, a total of 400 swab samples were collected from all the 5 local slaughter facilities and analyzed at Analabs for total viable counts (TVC), coliforms and *Salmonella spp.* Meat from these slaughter facilities displayed different levels of bacterial contamination (TVC).

4.2.1 Interpretation of laboratory results

The total viable counts and coliform counts of meat contamination were converted to $\log_{10}$ cfu/cm^2 in order to make an interpretation basing on European Union microbiological performance criteria as indicated in table 4.1 below

Count	Sampling method	Acceptable (log cfu/cm^2)	Marginal (log cfu/cm^2)	Unacceptable (log cfu/cm^2)
Total viable counts	Swab	‹2.8	2.8-4.30	›4.30
Enterobacteriacea	Swab	‹0.8	0.8-1.8	›1.8

Table 4.2:-EU microbiological performance criteria
McEvoy *et al;* 2004

Total viable counts (TVC)

Based on EU microbiological TVC performance criteria, out of the 400 carcass samples collected and analyzed, 79 (19.75%) were of unacceptable grade, 154 (38.5%) were of marginal grade and 167 (41.75%) were of acceptable grade

Total coliforms

Based on total coliform counts as per EU microbiological performance criteria, of the 400 swab samples collected and analyzed for total coliforms, 345 (86.25%) were of acceptable grade), 34 (8.5%) were of marginal grade and 21 (5.25%) were of unacceptable grade.

4.3 Effect of risk factors on meat contamination

4.3.1 Average Total Viable Count (TVC) from the five local slaughter facilities

Berbera local slaughter facility which did not comply with many of the hygiene slaughter practices, produced meat that was heavily contaminated followed by Burao then Borama and Gabiley while Hargeisa local slaughter facility displayed minimal meat contamination levels. In comparison, on taking the average or mean of the grades of meat contamination with TVC when converted to $\log_{10}$ cfu/cm^2 of the 80 carcasses sampled from each of the five slaughter facilities, carcasses from Berbera facility had a mean grade of 4.4 cfu/cm^2 (unacceptable grade), Burao had a mean grade of 3.7 cfu/cm^2 (marginal grade), those from Borama slaughter facility had a mean grade of 2.9 cfu/cm^2 (marginal grade), those from gabiley facility had a mean grade of 2.8 cfu/cm^2 (Marginal grade), and those from Hargeisa facility had a mean grade of 1.9 cfu/cm^2 (acceptable grade) .

On using the EU microbiological TVC performance criteria and mean grade, all carcasses sampled from Berbera local slaughter facility were unacceptable and therefore could have been entirely rejected.

Carcasses sampled from Burao, Borama and Gabiley local slaughter facilities were of moderate grade of TVC. Based on the EU microbiological performance criteria and obtained mean grade, these could have been regarded as of marginal grade. The difference in contamination levels from the three local slaughter facilities is not statistically significant. All carcasses sampled from Hargeisa local slaughter facilities were of acceptable grade according to EU microbiological performance criteria as can be seen (chart 4.1).

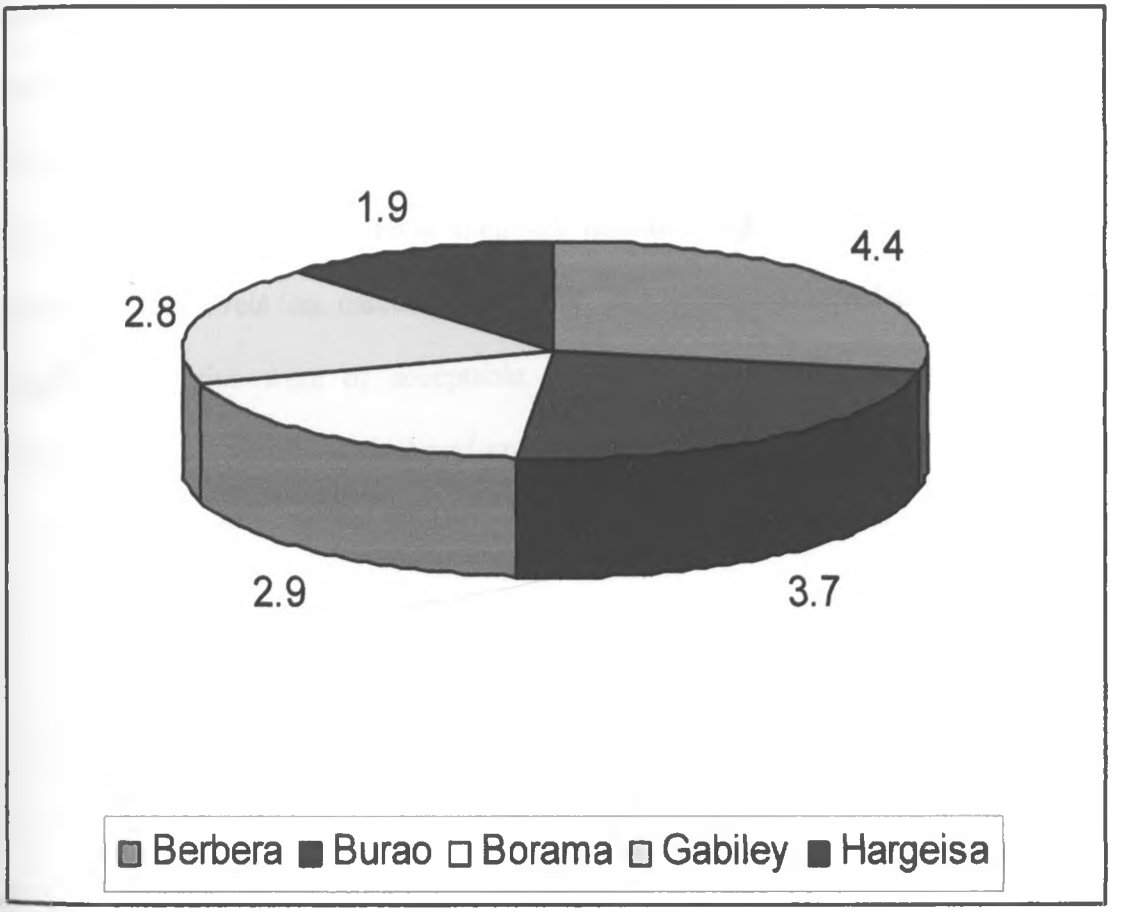


Chart 4.1 Average Total Viable Count from the 5 slaughter facilities

Key (log_{10} cfu/cm^2)

Acceptable –< 2.8 cfu/cm^2

Marginal -2.8-4.3 cfu/cm^2

Unacceptable->4.3 cfu/cm^2

4.3.2 Average coliform counts from the five slaughter facilities

Based on EU microbiological performance criteria, Berbera local slaughter facility on average had the highest levels of meat contamination with respect to coliform counts from carcasses sampled. The carcasses had mean grade of 1.2 cfu/cm^2 of the 80 samples analysed. Therefore based on mean grade, all carcasses sampled from this slaughter facility were of marginal grade.

Carcasses sampled from Burao local slaughter facility had a mean grade of -0.2 cfu/cm^2, those from Borama local slaughter facility had a mean grade of -0.05 cfu/cm^2 while those from Gabiley and Hargeisa local slaughter facilities had an average of 0% coliforms contamination levels on carcasses sampled. All carcasses sampled from these four slaughter facilities were of acceptable grades based on *Enterobacteriaceae* family according to EU microbiological performance criteria (chart 4.2).

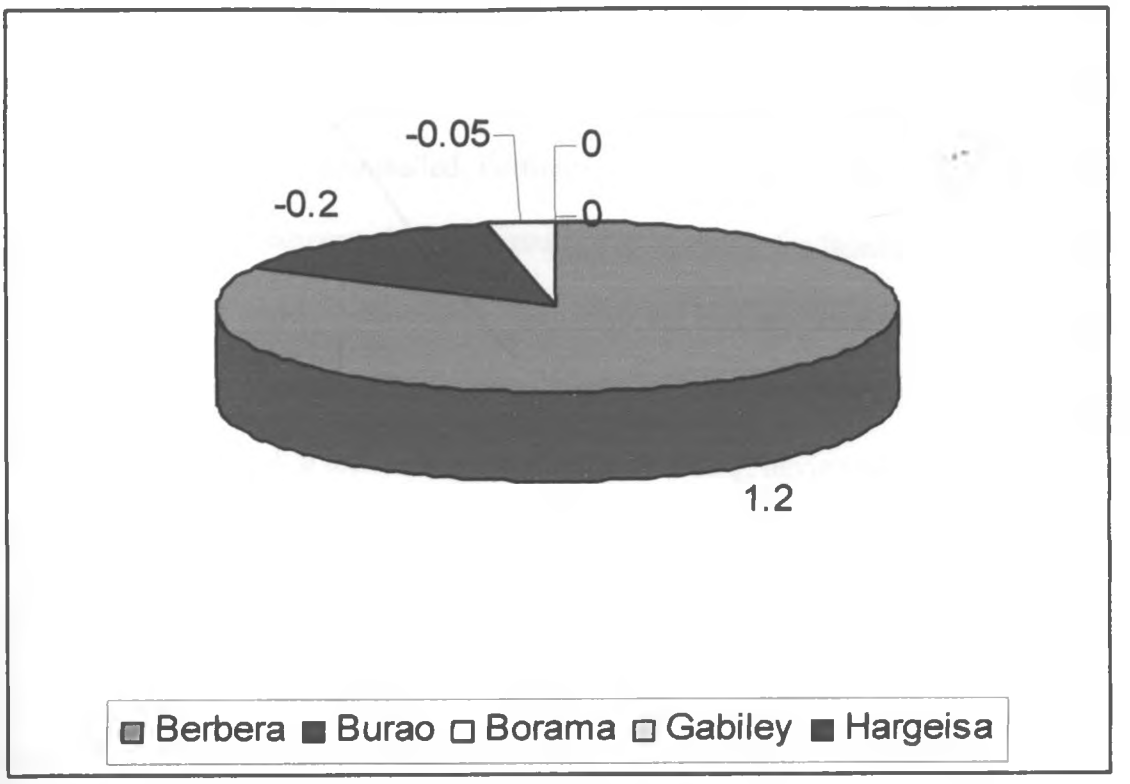


Chart 4.2 Average total coliforms from the 5 slaughter facilities

Key (log_{10} cfu/cm^2)

Acceptable –< 0.8 cfu/cm^2

Marginal -0.8-1.8 cfu/cm^2

Unacceptable- >1.8 cfu/cm^2

4.4 Individual slaughter facilities and meat contamination levels

4.4.1 Berbera municipal slaughter facility

Berbera slaughter facility is a municipal local slaughter facility. Average daily slaughter is between 70-80 shoats and 1-2 camels. The council has employed 10 personnel on permanent basis who work in and around the slaughter facility. Slaughter starts at 2.00am and ends at around 5.30am. The slaughter facility has no electricity; therefore slaughter personnel simply use torches fitted on their heads.

It has no demarcation between dirty and clean areas. Personnel and butcher men simply move in any direction uncontrolled. Furthermore, slaughter personnel have no protective gear. Many use old tattered clothes as protective covering for themselves against blood, ingesta and waste water. Additionally, they have not had any training on minimum meat hygiene handling practices like washing hands before start of work and after visiting toilets, touching the skin then carcass, coughing, sneezing, having jewellery like watches, rings, bungles during slaughter and being involved in slaughter when ill from communicable diseases or having open wounds.

Compounding the situation, equipments being used for slaughter like knives, hooks and matchets were not made of stainless steel materials easy to wash and sanitize. They were made by local blacksmiths from scrap metals.

The slaughter facility hall was damaged with very loose gates. This provides an entry point sometimes for dogs and birds to access the killing floor picking leftover meat trims thereby contaminating the floor. In addition, the floor was full of cracks posing a difficult task for those who are to keep it clean by washing. This leads to waste accumulation in these cracks thereby becoming a source of meat contamination.

The drainage system was damaged thus enhancing chances of contaminating meat. Waste water, blood and some manure accumulate in the cracks making it difficult to clean and wash it thoroughly. In addition, the exit of the drainage system from the slaughter facility

had no grease traps making it an entry point for cats that further contaminate the slaughter facility.

Water was supplied by the municipal council truck which empties it into a tank that is rarely emptied and washed, compromising its potability. Additionally, the water supplied was inadequate, compromising thorough washing of the slaughter facility and equipments after slaughter process.

Environmental management was poor. Heaps of manure, bones and other wastes could be seen in the vicinity of the slaughter facility posing a public health hazard as it causes environmental pollution in addition to increasing chances of contaminating meat. Luckily, there was no encroachment on the slaughter facility.

Immediately after slaughter, carcasses were hoisted onto stainless steel fixed metal pipes by their lateral briskets. Bleeding, skinning and evisceration were done when the carcass is in this position. Personnel who do skinning and evisceration are fairly careful. Puncture of the stomach and intestines was rare.

Total viable counts (TVC)

Out of 80 samples collected from carcasses and analysed, no carcass was of acceptable grade. Twenty seven (34%) of the samples collected were of marginal grade while 53 (66%) of the carcasses sampled were of unacceptable grade according to EU microbiological performance standards (chart 4.3).

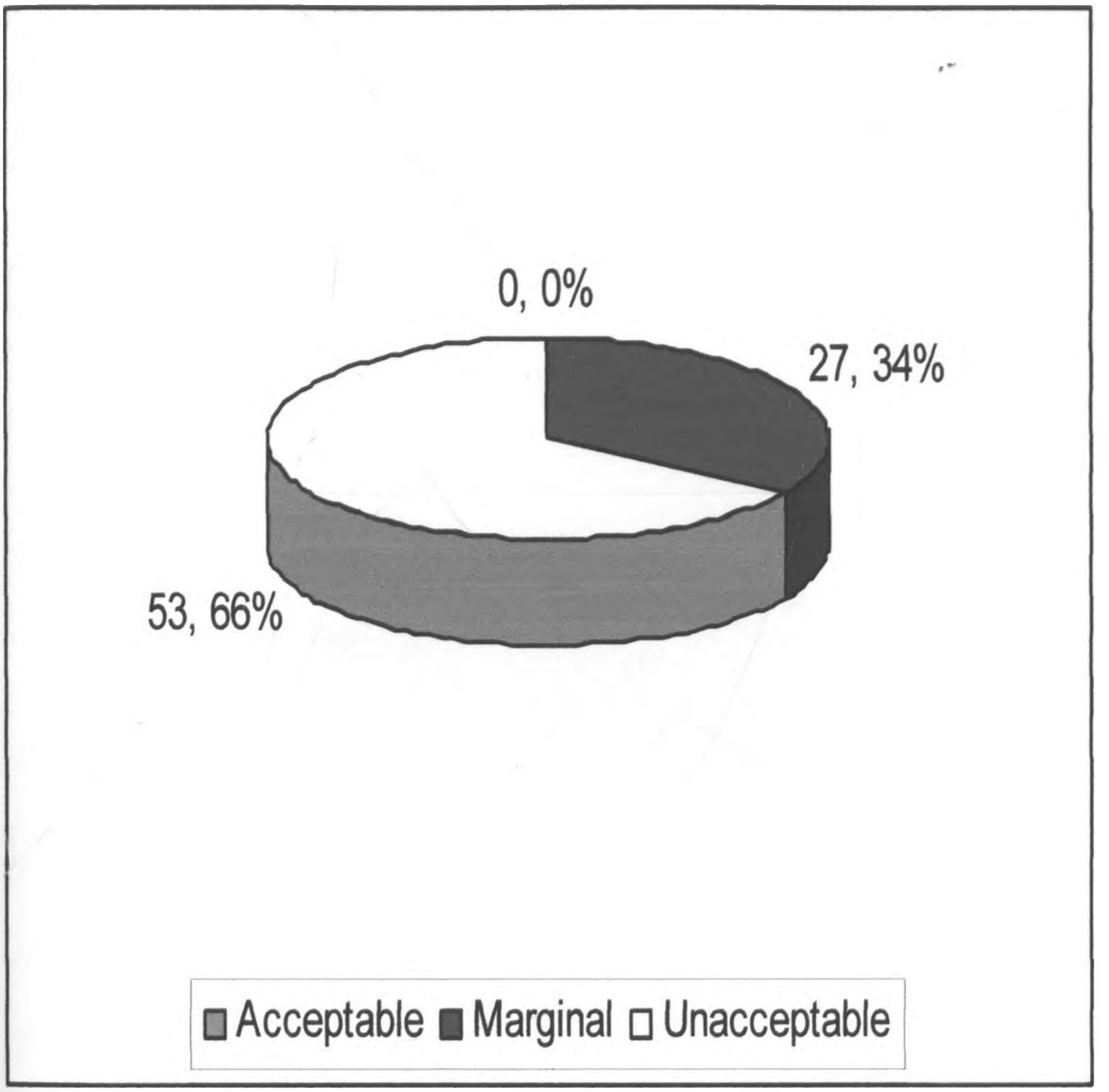


Chart 4.3 Total Viable Count levels-Berbera slaughter facility

Key (log_{10} cfu/cm^2)

Acceptable –< 2.8 cfu/cm^2

Marginal -2.8-4.3 cfu/cm^2

Unacceptable->4.3 cfu/cm^2

Coliform count

Out the 80 samples collected from carcasses slaughtered in Berbera local slaughter facility, 29 (36%) were of acceptable grade, 31 (39%) were of moderate grade and 20 (25%) were of unacceptable grade (chart 4.4).

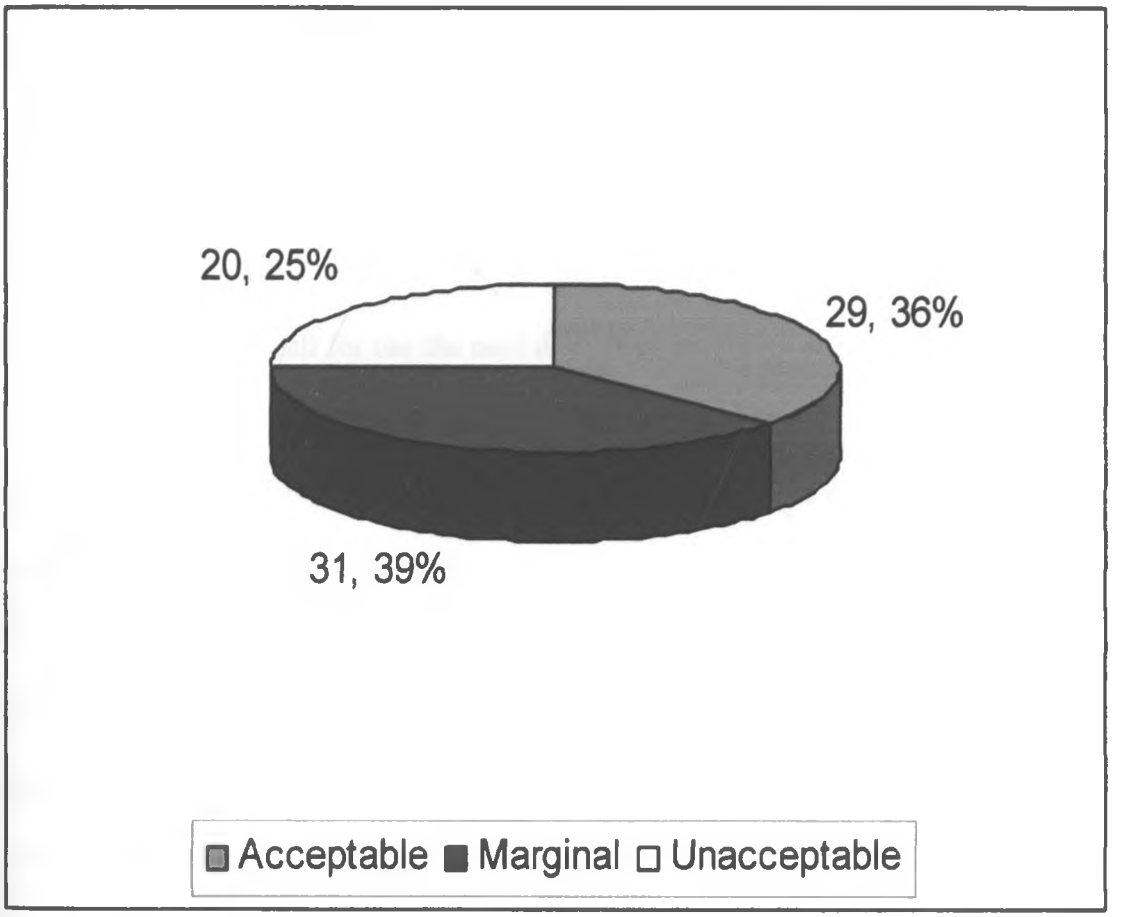


Chart 4.4 Coliform counts-Berbera slaughter facility

Key (log_{10} cfu/cm^2)

Acceptable –< 0.8 cfu/cm^2

Marginal -0.8-1.8 cfu/cm^2

Unacceptable- >1.8 cfu/cm^2

4.4.2 Burao municipal local slaughter facility

The slaughter facility is managed by Burao Municipal council which has employed 9 workers on permanent basis. These maintain the general cleanliness of the slaughter facility both inside and the surrounding environment. The average daily slaughter is between 450-500 shoats and 5-10 camels. Slaughter starts at 11.00 pm ending at around 5.00am. There was no electricity light in the slaughter facility. The whole slaughter process takes place under very poor lighting conditions with torches tied on heads of slaughter personnel for those who can afford. Furthermore, personnel had no protective gear. Their old tattered clothes used for self protection against ingesta and blood were kept in the slaughter hall for use the next day. They are rarely washed and cleaned.

Equipments being used for slaughter like knives and hooks are made by local blacksmith from scrap metals. Moreover, there is no demarcation between dirty and clean areas. Personnel move freely in any direction. Compounding the situation is the inadequate and irregular supply of water by municipal council trucks. The water was stored in storage tanks that are hardly washed and cleaned making it most likely not potable. It could be a source of contamination of equipments during washing and carcasses even though carcasses are rarely washed at the final stages of slaughter. The scarcity of water further compromises the washing of the slaughter facility at the end of slaughter. Some sections of the slaughter facility had accumulated dirt raising chances of meat contamination.

The surrounding environment was full of accumulated rubbish heaps, manure and polythene bags, an indication of poor environmental management system and hygiene.

However, personnel were trained in minimum meat hygiene handling practices by FAO Somalia.

The slaughter facility had well maintained wall and gates that were always locked after slaughter. This prevents access to the slaughter facility by vultures, dogs and any other carnivores during non-working hours. Accessibility of dogs and cats into the slaughter facility cause contamination of the killing floor which can easily be passed onto meat during slaughter period. In contrast, the slaughter facility floor and walls are made of impervious material easy to wash. They have very few cracks thus accumulation of dirt minimum.

The drainage system is fairly well maintained. It was intact and always cleaned alongside cleaning of the slaughter facility after slaughter. The slaughter facility had adequate and well fixed metal pipes used as carcass hoisting facilities before bleeding, skinning, evisceration and splitting. This greatly minimised carcass contamination.

Total viable count

Out of 80 swab samples collected from slaughtered carcasses in Burao local slaughter facility, 9 (11%) were of acceptable grade for TVC, 46 (58%) were of marginal grade and 25 (31%) were of unacceptable grade (chart 4.5).

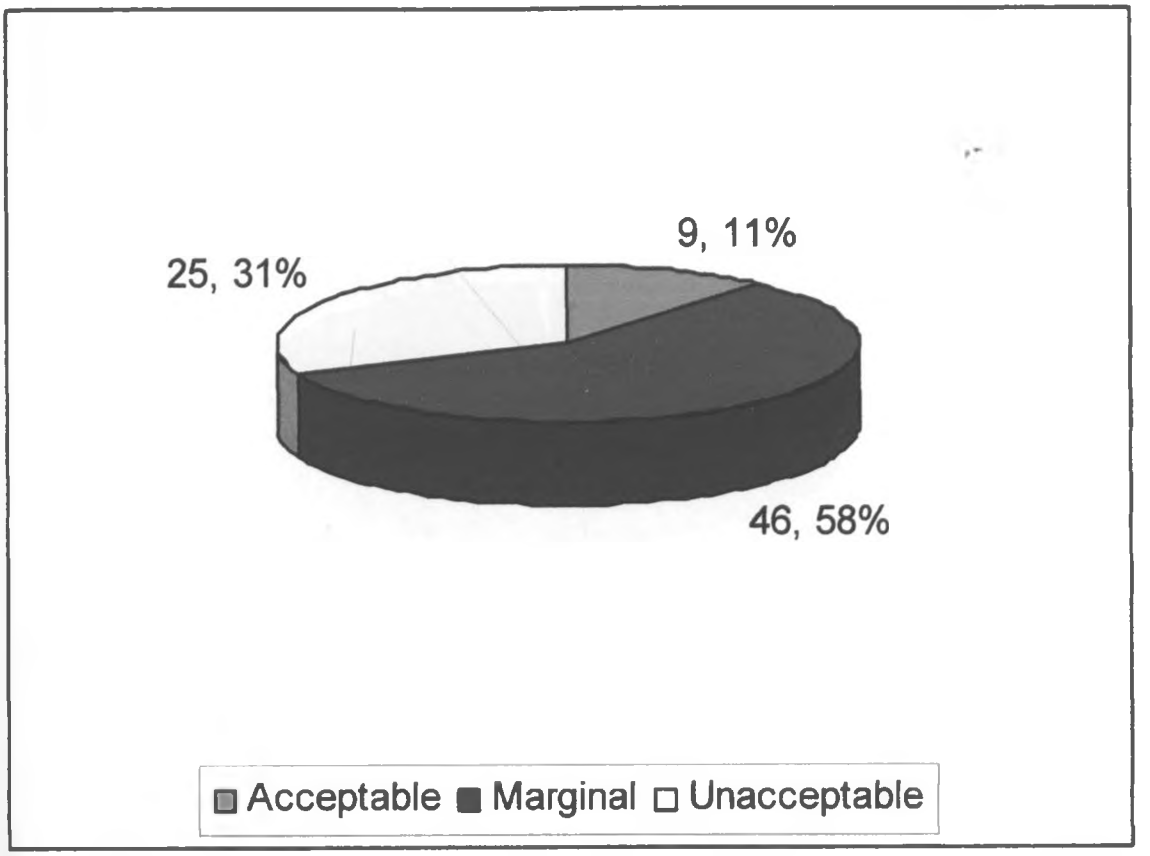


Chart 4.5 Total Viable Count-Burao slaughter facility

Key (log_{10} cfu/cm^2)

Acceptable –< 2.8 cfu/cm^2

Marginal -2.8-4.3 cfu/cm^2

Unacceptable->4.3 cfu/cm^2

Coliforms count

As per EU standards, of the 80 samples collected, 75 (94%) were of acceptable grade, 4 (5%) were of marginal grade and only 1 (1%) was of unacceptable grade. Only 1% of carcasses may be rejected from this slaughter facility (chart 4.6).

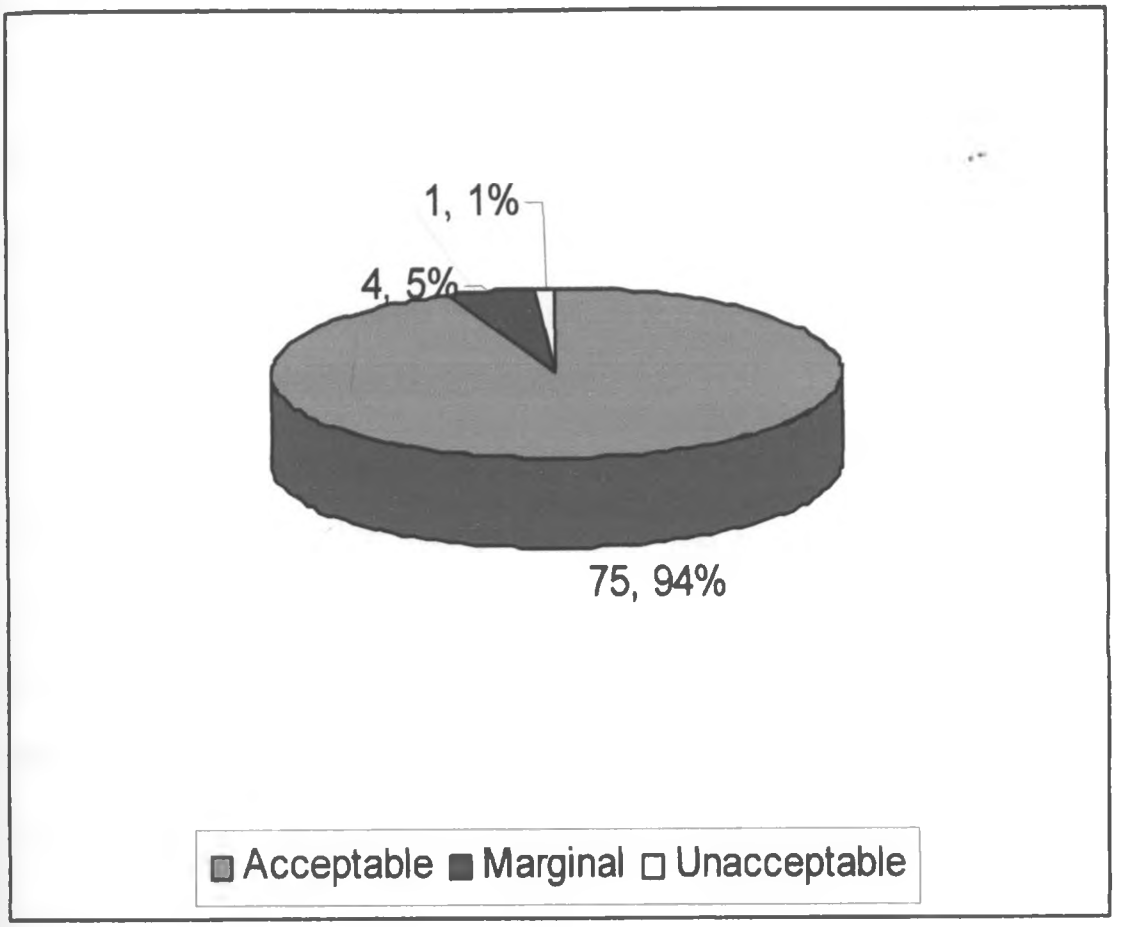


Chart 4.6 Coliform counts-Burao slaughter facility

Key (log10 cfu/cm^2)

Acceptable –< 0.8 cfu/cm^2

Marginal -0.8-1.8 cfu/cm^2

Unacceptable- >1.8 cfu/cm^2

4.4.3 Gabiley and Borama municipal local slaughter facilities

These slaughter facilities had similar conditions and almost the same meat contamination levels. They are managed by Gabiley and Borama municipal councils respectively and by extension, the government. Daily slaughter is between 110-130 shoats, 2 camels and 7-9 cattle for Gabiley slaughter facility and 230-250 shoats, 10-15 cattle and 3-5 camels for

Borama slaughter facility. The councils have permanently employed some council workers who are charged with maintaining cleanliness in and around the slaughter facilities in addition to ensuring proper sanitation at the meat markets. Slaughter was carried out as from 5.30 to 8.00 am in both slaughter facilities, under adequate natural light which is initially dim at the start of slaughter. Like in Berbera and Burao slaughter facilities, slaughter personnel had no protective gear. There was no demarcation between clean and dirty areas. Slaughter personnel and the public freely move in any direction. The slaughter facilities had very porous walls and very loose gates. These allow carnivores like dogs and cats access to the slaughter floor, thus contaminating the slaughter facility. In the environs were accumulated rubbish heaps, manure and polythene bags, an indication of poor environmental management and hygiene. If not taken care of, it can easily turn into an environmental health hazard to the public.

Water supply was scanty. The inadequate of water strained free use of it to wash carcasses and equipments. Carcasses were rarely washed at the end of the slaughter process. Furthermore, scarcity of water compromised thorough washing of the equipments and the slaughter facility after the slaughter process. However, slaughter process started when it was almost day time under adequate natural light. Under adequate light, visibility was proper thus minimizing contamination of carcasses. Personnel were trained in minimum meat hygiene handling practices by FAO Somalia. Carcasses are hoisted immediately after slaughter or sticking for bleeding, flaying, evisceration and splitting. This greatly minimised contamination.

TVC levels-Borama slaughter facility

Out of 80 swab samples collected from carcasses and analysed from Borama slaughter facility, 57 (71%) were of acceptable grade and 23 (29%) were of marginal grade. No carcass was in unacceptable grade and therefore none could have been rejected according to EU standards (chart 4.7).

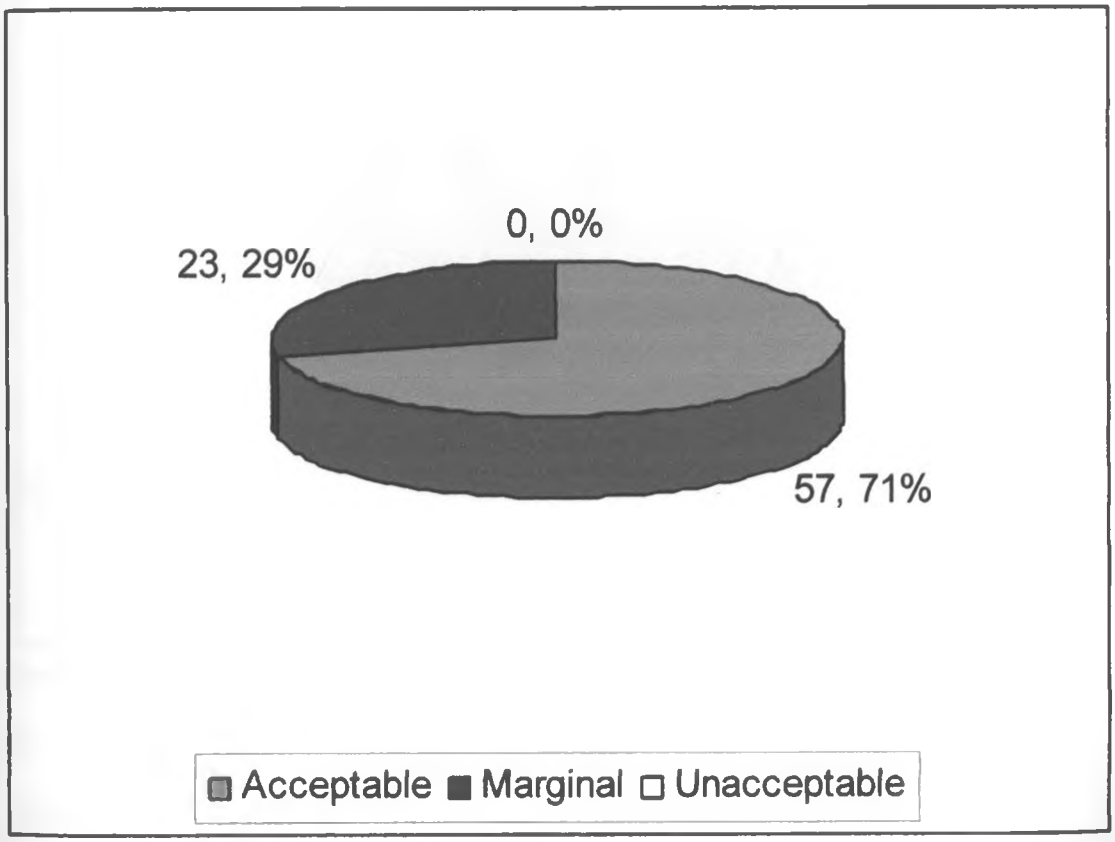


Chart 4.7 TVC levels-Borama slaughter facility

Key (log_{10} cfu/cm^2)

Acceptable –< 2.8 cfu/cm^2

Marginal -2.8-4.3 cfu/cm^2

Unacceptable- >4.3 cfu/cm^2

Coliform counts-Borama slaughter facility

All the 80 (100%) samples analysed were of acceptable grade. No carcass could have been rejected on account of coliform counts (chart 4.8).

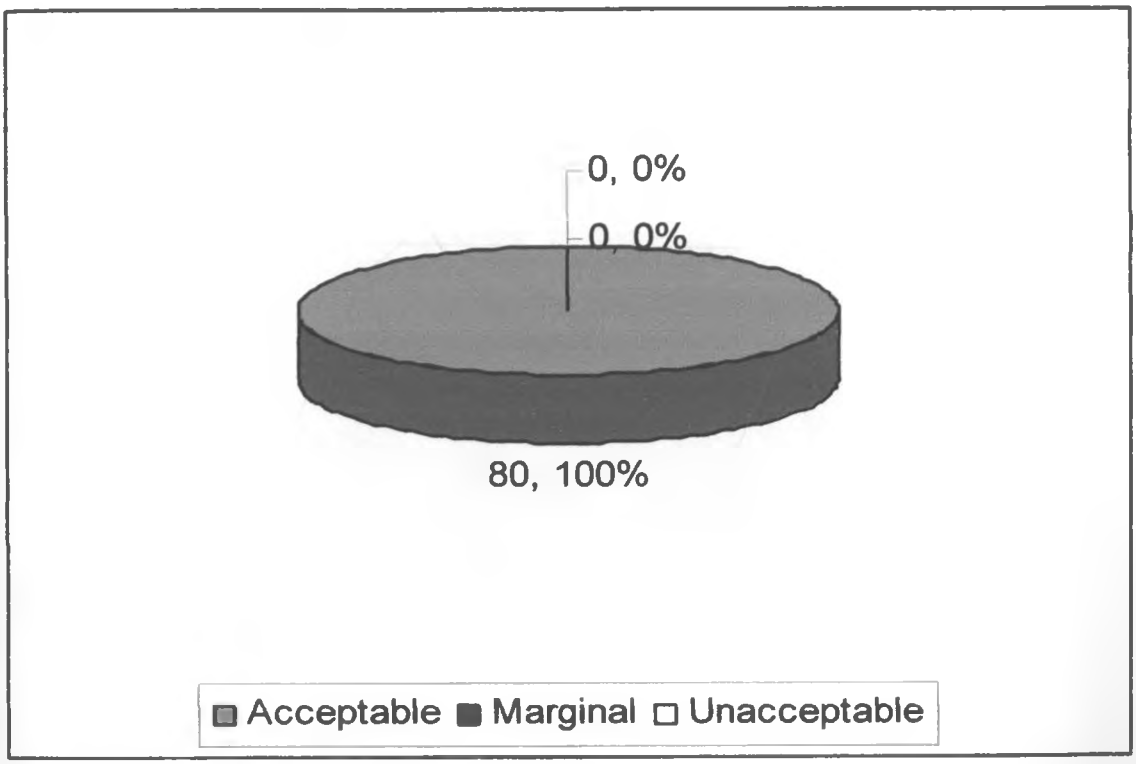


Chart 4.8 Coliform counts-Borama slaughter facility

Key (log10 cfu/cm^2)

Acceptable –< 0.8 cfu/cm^2

Marginal -0.8-1.8 cfu/cm^2

Unacceptable- >1.8 cfu/cm^2

TVC levels-Gabiley slaughter facility

Of the 80 samples analysed, 55 (69%) of the carcasses sampled were of acceptable grade, 24 (30%) were of marginal grade while only 1 (1%) was of unacceptable grade. Only 1 carcass could have been rejected from Gabiley slaughter facility (chart 4.9).

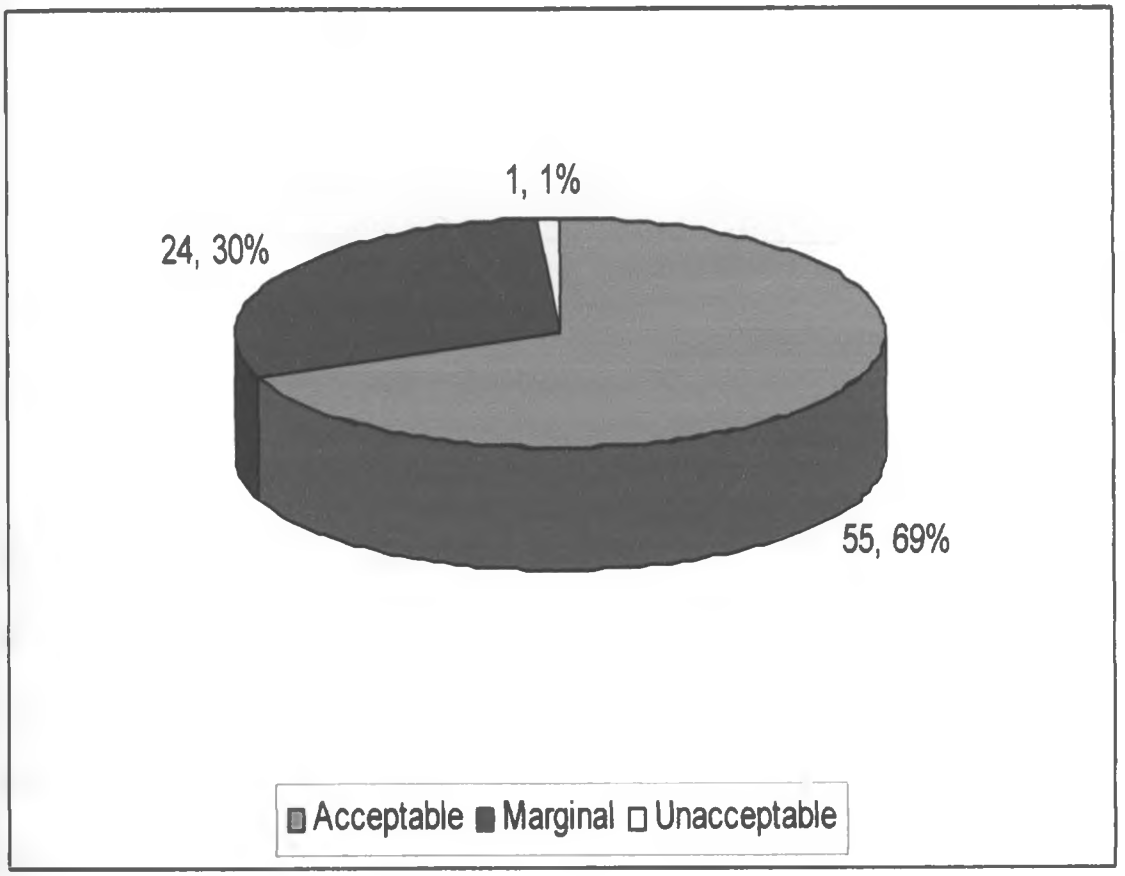


Chart 4.9 TVC levels-Gabiley slaughter facility

Key (log_{10} cfu/cm^2)

Acceptable –< 2.8 cfu/cm^2

Marginal -2.8-4.3 cfu/cm^2

Unacceptable->4.3 cfu/cm^2

Coliform counts from Gabiley slaughter facility

All the 80 (100%) sampled carcasses were of acceptable grade (chart 4.10).

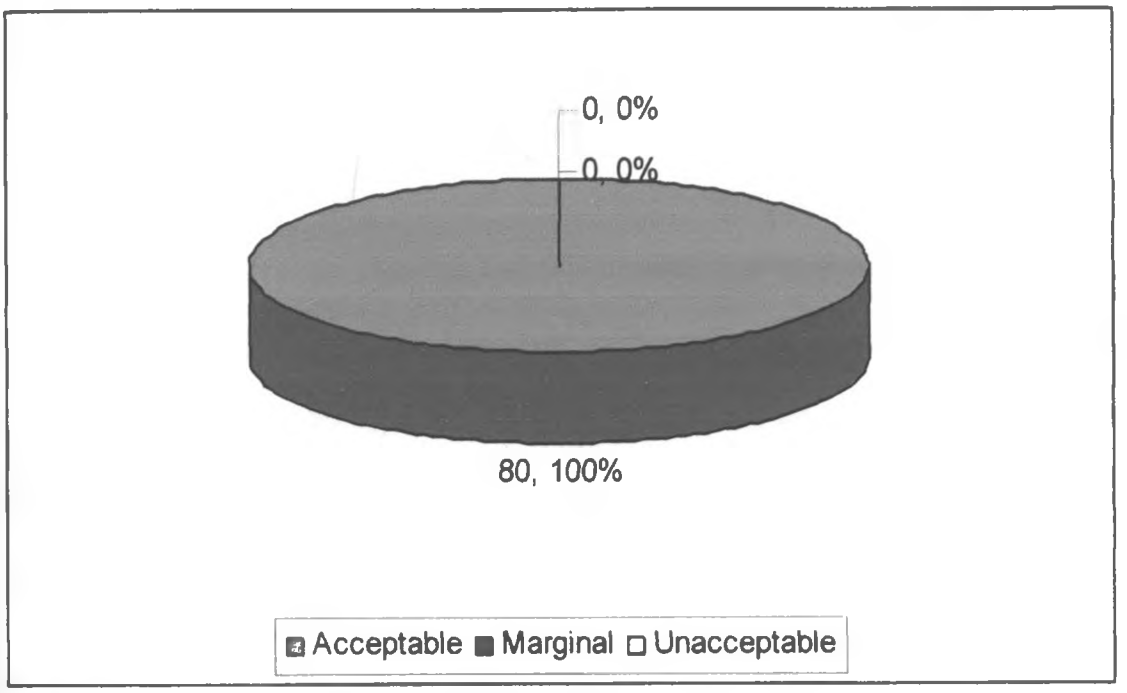


Chart 4.10 Coliform counts-Gabiley slaughter facility

Key (log10 cfu/cm^2)

Acceptable –< 0.8 cfu/cm^2

Marginal -0.8-1.8 cfu/cm^2

Unacceptable- >1.8 cfu/cm^2

4.4.4 Hargeisa slaughter facility

The slaughter facility management is under Maandeq Company. The company took over the running of the facility from January 2006 after not being operational for many years. The daily throughput is between 900-1000 shoats, 28-30 camels and 28-30 cattle. The company has employed 86 workers on permanent basis. They maintain the cleanliness

and sanitation of the slaughter facility in addition to being involved in the actual slaughter process. Slaughter begins at 10.30 pm ending at about 5.00 am under adequate electricity light. Immediately after slaughter, carcasses are hoisted onto stainless steel fixed metal pipes by their lateral briskets. Bleeding, skinning and evisceration are carried out when the carcass is in this position.

Personnel who perform the skinning and evisceration were very careful. Puncture of the stomach and intestines was rare. Moreover, personnel were trained in minimum meat hygiene handling practices by FAO Somalia. Furthermore, all personnel working in the slaughter facility put on clean protective gear before start of work. The protective gears were only used during working hours and they are washed immediately after work.

The slaughter facility was properly enclosed with a permanent wall and roof denying all vultures and carnivores any access. The slaughter floor and walls are made of hard impervious materials (tiles) easy to wash and disinfect immediately after slaughter.

The drainage system is adequately constructed and well maintained. It empties into well constructed soak away pits that are lockable. The slaughter facility has a well constructed lockable condemnation pit for all condemned meat and carcasses. There is a clear demarcation between dirty and clean areas. There was no free movement of personnel between these areas. Additionally, the public are not allowed into the slaughter facility.

All slaughter equipments like hooks, knives, hoisting pipes are made of stainless steel materials that are easy to wash and sanitize. There is plenty of potable borehole water for final washing of carcasses and immediate washing of equipments and slaughter facility at the end of the slaughter process. Additionally, washing and removal of solid waste was done continuous during slaughter. Heads, skins and legs were immediately removed during slaughter.

Slaughter facility management personnel strictly adhered to minimum meat hygiene handling practices as per the training they received. The surrounding environment had no rubbish or any pollutants. The environment was well maintained as per the guidelines of International Finance Corporation and World Bank of 2007.

TVC levels

Hargeisa local slaughter facilities very strictly apply minimum meat hygiene handling practices during slaughter. Out of 80 swab samples collected and analysed, 76 (95%) were of acceptable grade and only 4 (5%) were of marginal grade (chart 4.11).

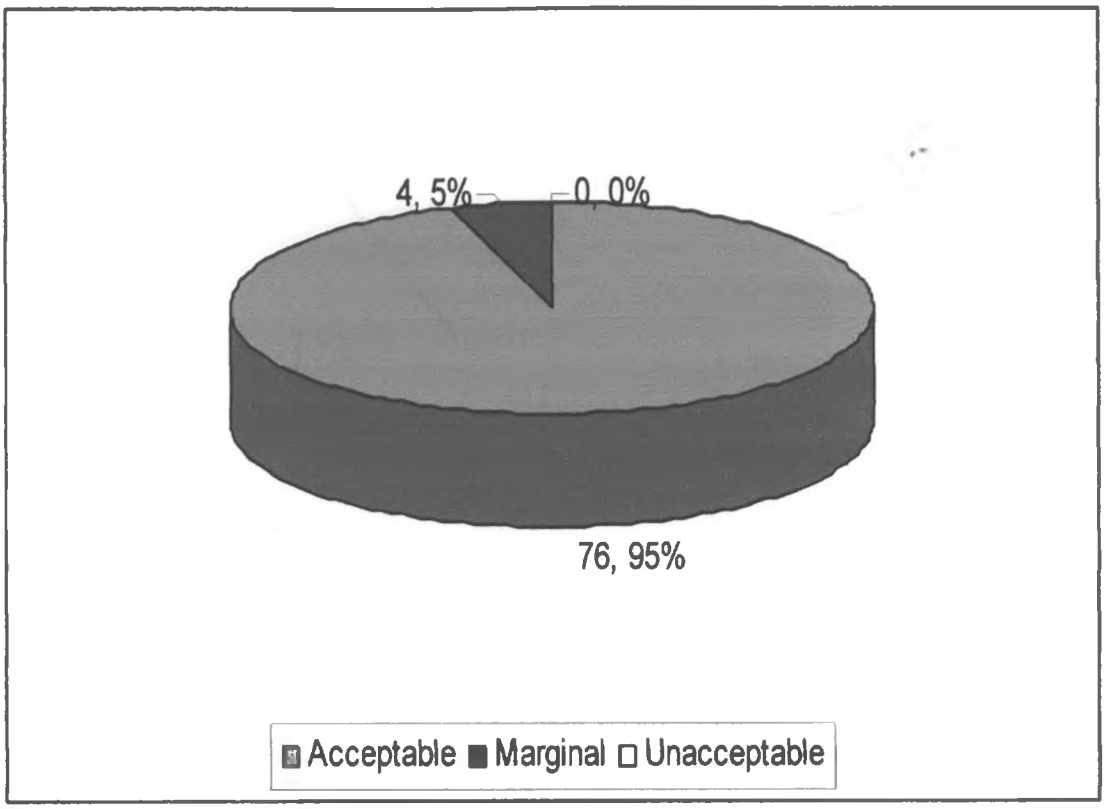


Chart 4.11 TVC levels-Hargeisa slaughter facilty

Key (log_{10} cfu/cm^2)

Acceptable –< 2.8 cfu/cm^2

Marginal -2.8-4.3 cfu/cm^2

Unacceptable->4.3 cfu/cm^2

Coliform counts

All the 80 (100%) samples collected and analysed were of acceptable grade (chart 4.12).

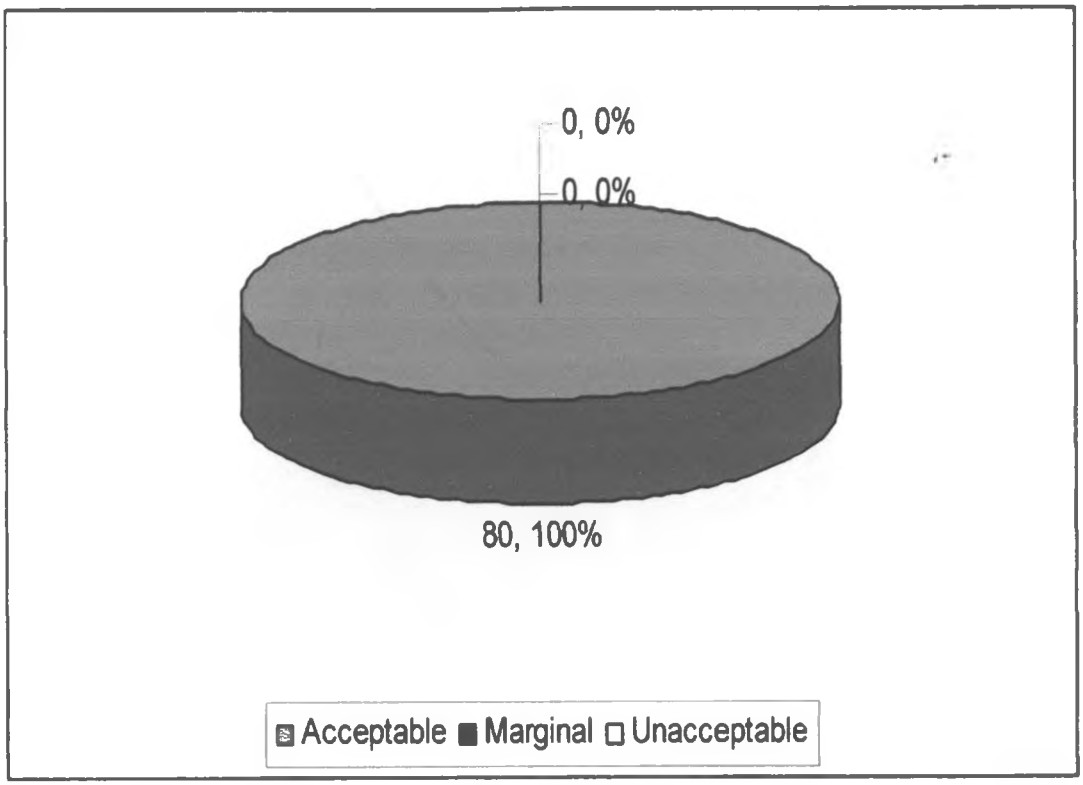


Chart 4.12 Coliform counts-Hargeisa slaughter facility

Key (log10 cfu/cm^2)

Acceptable –< 0.8 cfu/cm^2

Marginal -0.8-1.8 cfu/cm^2

Unacceptable- >1.8 cfu/cm^2

4.5 Detection of faecal *E. coli* from the five local facilitys

Out of the 400 samples collected and analysed for total coliforms, only 116 were positive for faecal *E. coli*.

Of the 116 faecal *E. coli* isolates determined, 69 (60%) were from Berbera, 20 (17%) from Burao, 14 (12%) from Gabiley, 8 (7%) from Borama and 5 (4%) from Hargeisa local slaughter facilities had ≥ 0.3 cfu/cm^2 of *E. coli* (chart 4.13).

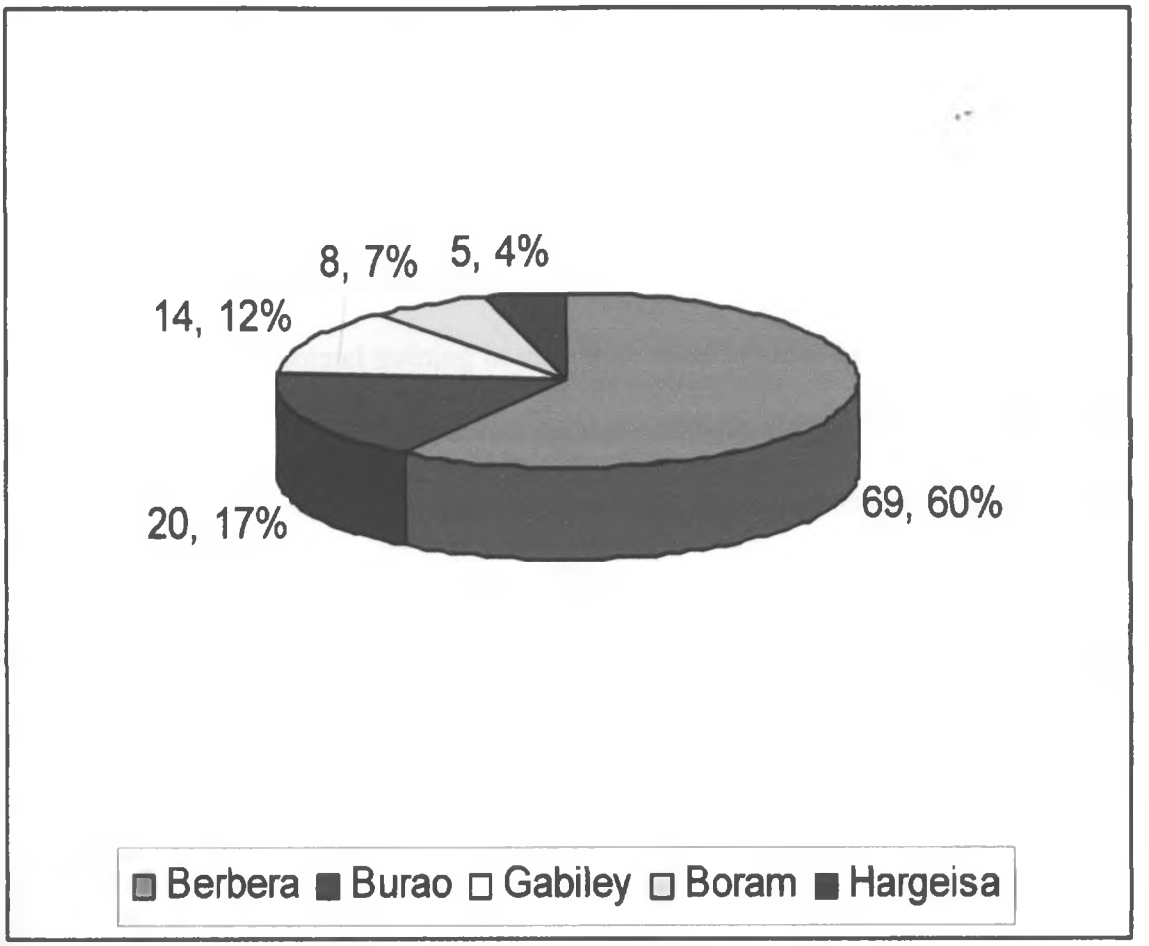


Chart 4.13: Number of samples positive for *E. coli* from the 5 slaughter facilities

4.6 Detection of *Salmonella* spp

None of the 400 swab samples analysed for *salmonella* spp was positive.

CHAPTER FIVE

5. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

Level of significance of risk factors

Adequate light and personnel training in minimum meat hygiene handling practices were very significant meat contamination risk factors. Berbera slaughter facility that lacked both had very high levels of contamination followed by Burao slaughter facility which missed adequate light among others during slaughter.

The significance level was followed by availability of adequate water, clean equipments before start of work, washing hands before start of work and after visiting the toilet, putting on clean protective gear before start of work, washing dirty livestock presented for slaughter, clean equipments, impervious floors, demarcation between clean and dirty areas and hoisting facilities.

From the levels of significance, adequate light and personnel training in minimum hygiene meat handling practices appeared to have great influence on levels of meat contamination. The other factors like provision of adequate potable water, use of clean equipments, washing hands before start of slaughter and after call of nature by personnel, putting on clean protective gear by personnel, washing dirty livestock before slaughter, impervious floors, demarcation between clean and dirty areas and carcass hoisting before bleeding, flaying and evisceration appeared to have ubstantial influence on levels of meat contamination. Other factors like location of slaughter facility, drainage system,

availability of lockable condemnation disposal pits and medical check up for slaughter personnel had little influence on levels of meat contamination.

Hygiene slaughtering

The hygiene of slaughter embraces a variety of considerations such as the design and layout of buildings, systems of control, inspection, hygiene of personnel besides the parasites and micro-organisms which the meat contains (Roberts, 1980). The floors, walls, ceilings (if any), partitions, posts, doors and other parts of all structures should be of such materials, construction and finish as will make them capable of being readily and thoroughly cleaned and disinfected immediately after slaughter. The floors should be kept water tight. Additionally, it should have well constructed and maintained drainage system which empties into well constructed soak away pits that are lockable. The slaughter facility should be properly enclosed with a permanent wall and roof denying all vultures and carnivores any access (Meat Control Act, 1977). This underscores the reasons why samples collected from Berbera and Burao local slaughter facilities had high levels of TVC and coliform counts because of not meeting this requirement.

Apart from aesthetic considerations, the objective of hygienic practices is to reduce meat contamination. For example, the physical separation of unclean from clean areas is intended to diminish contamination of the meat from the soil, hides, gut contents etc (Roberts and Pharm, 1980; Kang'ethe, 1993). The main hygienic objective in slaughtering is to remove the hide and hooves, head and the alimentary tract in such a way as to prevent their enormous contamination being transferred to the carcass. Even

brief contact with faecal material can produce high level of contamination upto 10^7 cfu/cm^2 enough to contaminate 10 succeeding carcasses at the level of 10^6 cfu/cm^2 of area touched (Roberts and Pharm, 1980; Kang'ethe, 1993; Gill *et al*, 1999). Therefore, the design and layout of the slaughter facility is an important factor in ensuring hygienic slaughter process. There should be clear separation of clean and unclean areas to minimise transfer of dirt and micro-organisms from unclean to clean areas (Kang'ethe, 1993). This further explains why swab samples analysed from Berbera and Burao slaughter facilities had high levels of TVC and coliform counts. These slaughter facilities lacked separation between unclean and clean areas. Personnel and the public could be seen moving in any direction during the slaughter process, thus transmitting dirt or soil from unclean to clean areas thereby contaminating carcasses. The same situation was observed in Borama and Gabiley local slaughter facilities. The situation was different for Hargeisa local slaughter facility which had put control measures and restrictions against free movement from unclean to clean areas. Samples collected from carcasses slaughtered in this slaughter facility had minimal TVC and coliform counts.

Training in meat hygiene handling practices is very handy in this aspect in order to produce high quality meat with low levels of bacterial contamination. According to FAO (2004), training of slaughter personnel is a fundamental requirement in achieving or attaining high quality meat. This explains why despite the fact that apart from Hargeisa local slaughter facility which has nearly all basic required equipments for production of high quality meat with low level contamination, Burao, Borama and Gabiley local slaughter facilities had moderate TVC levels. Personnel from the three slaughter facilities

were trained in minimum meat hygiene handling practices by FAO Somalia. The training stressed the need to avoid some unhygienic practices like eating, chewing, smoking, unprotected sneezing and coughing while handling meat meant for human consumption. Washing of their hands with water and soap before start of slaughter and after visiting the toilet were adequately emphasized in the training. Additionally, the training helped them appreciate the need of being careful when flaying so that one does not touch the skin, then the carcass with contaminated hands. Emphasis for care during evisceration to avoid puncturing the intestines and stomachs so that their contents do not spill on meat was made (Kerri and Jeff, 2003). There was a big contrast in levels of carcass contamination witnessed in samples from Berbera local slaughter facility whose personnel had not been trained. Meat produced from this slaughter facility was heavily contaminated.

Use of stainless steel equipments like knives, hooks, hoisting pipes are better than the ones made by local blacksmith from scrap metals. The latter have many grooves that could still hold some meat particles after cleaning with warm/cold water and soap. These become a source of meat contamination during slaughter (Mwangi, 2002). According to Sanitary Standard Operating Procedures (SSOP) of good manufacturing practices (GMP) (Almond Board of California, 2005), such slaughter equipments should be made of stainless steel since it is easy to wash with warm water and detergent and sterilize them in hot water or sanitize them in acceptable chemical solution of proven strength that it can readily kill most bacteria like *Salmonella, E. coli* among others in order to be ready for next use. The equipments and chemical contact time must also be known and observed (Meat Control Act, 1977; FAO, 2004 and Almond Board of California, 2005). Only

Hargeisa slaughter facility had stainless steel equipments and thus produced meat with very low bacterial contamination as compared to the other four.

The slaughter process should take place under sufficient natural and or abundant artificial light for proper slaughter operations and conduct of inspection (Meat Control Act, 1977). This was not the case in Berbera and Burao local slaughter facilities. Improper lighting was a significant risk factor of meat contamination leading to high levels of TVC and coliform counts witnessed in the two slaughter facilities.

Slaughter facilities should have ample supply of hot (82^0C) and cold potable water for cleaning and washing. According to SSOP and Hazard Analysis Critical Control point (HACCP) (USDA, Food Safety and Inspection Services, 1999 and Almond Board of California, 2005), water is a very important source of contamination of carcasses if not potable. Carcasses and equipments will be contaminated when washed with dirty water (Meat Control Act, 1977; USDA, Food Safety and Inspection Services, 1999 and Almond Board of California, 2005). Cleaning of slaughter facility and equipments should be done immediately after the slaughter process. This was not the case in Berbera, Burao, Gabiley and Borama slaughter facilities where washing was done in the afternoon long after end of slaughter. Samples from these slaughter facilities had higher levels of TVC as compared to Hargeisa local slaughter facility which was being washed and cleaned immediately after slaughter.

Slaughter personnel and any other visitors should put on protective gear of light colour and of such material as to render them easily cleaned. Additionally, personnel should be free from communicable diseases before they handle meat (Meat Control Act, 1977; Food Safety and Inspection Services, 1999). Only Hargeisa local slaughter facility had enough protective gear for its staff.

Heaps of manure, bones and other wastes could be seen in the vicinity of Berbera, Burao, Borama and Gabiley slaughter facilities. This poses a public health hazard as it causes environmental pollution in addition to increasing chances of contaminating meat. It is an indication of poor environmental management. Solid wastes should be regularly removed and incinerated to prevent or control odor (IFC and WB, 2007).

5.2 Conclusion

Unsatisfactory slaughtering techniques cause high levels of meat contamination which may lead to various losses and food-borne diseases. Meat produced under unhygienic conditions is of low quality as it will be heavily contaminated with spoilage and pathogenic micro-organisms like total viable counts, coliforms, faecal *E. coli* and *Salmonella* spp. This kind of meat will have reduced shelf life as it quickly deteriorates due to high levels of bacterial contamination resulting in losses. Out of the five slaughter facilities under investigation, those that had no light and whose personnel had not been trained on minimum meat hygiene handling practices such as Berbera and Burao had high levels of carcass contamination with TVC and coliforms. This was an indication of poor hygiene standards during meat production. However, none of the carcasses sampled from the five slaughterhouses was positive for *Salmonella* spp.

Furthermore, slaughter facilities that lacked adequate potable water, stainless steel slaughter equipments, protective gear for staff, demarcation between clean and dirty areas, hand washing facilities, separate rooms for offals and heads, skins/hides such as Berbera, Burao, Borama and Gabiley had fairly high levels of bacterial contamination on carcasses sampled. On the other hand, Hargeisa slaughter facility that avoided most of the meat contamination risk factors produced high quality carcasses with very low levels of bacterial contamination.

Therefore, to guarantee adequate hygienic standards of slaughter facilities for production of good quality meat, it calls for sound hygienic conditions at all levels right from slaughter facility design, layout and operations. Cleaning and removal of solid and liquid waste should be continuous during slaughter. Additionally, use of clean equipments before start of work, physically clean and healthy personnel in clean protective gear during the entire slaughter process, use of clean potable water and clean surrounding environment among others contribute to production of high quality meat with low levels of contamination. Furthermore, training of slaughter personnel is a prerequisite requirement to obtaining high quality meat with low levels of bacterial contamination.

5.3 Recommendations

After establishing the possible sources of meat contamination from the slaughter facilities under study, there is an urgent need to put in place mitigation measures to raise hygiene

standards of these slaughter facilities in accordance with the minimum hygiene meat handling practices. These may include but not limited to:-

- ❖Regular training of personnel in these slaughter facilities on minimum meat hygiene handling practices.
- ❖ Encouraging the management of Berbera, Burao, Borama and Gabiley local slaughter facilities to provide sufficient protective gear to their workers.
- ❖ Installation of generators for provision of adequate light or encourage daytime slaughter for Berbera and Burao slaughter facilities.
- ❖ Provision of adequate potable hot and cold water by municipal councils or digging of shallow wells.
- ❖ Constant repair of slaughter facility structures like walls, floors, drainage systems, fences and toilets.
- ❖ Regular removal and safe disposal of solid wastes to avoid breeding ground for rodents and flies and prevent occurrence of a public health hazard.
- ❖ Provision of slaughter equipments that are easy to wash and sterilize such as stainless steel knives, receptacles, hooks.
- ❖ Provision of adequate and easy to wash and maintain hoisting pipes in slaughter facilities that do not have adequate numbers (e.g Berbera slaughter facility).
- ❖ Provision of facilities to wash dirty animals.
- ❖ Construction of condemnation pits that are lockable.
- ❖ Provision of stainless steel or disposable dust bins for disposing in dirt during slaughter.

- Encourage the government and donor organizations and UN agencies to hire qualified meat inspectors for these slaughter facilities to carry out AM and PM meat inspection and ensure that slaughter facility personnel observe the minimum meat handling hygiene requirements.
- The way forward for quality meat production is privatization of slaughtering activities as exemplified by Hargeisa slaughter facility that is managed by a private company.
- Further studies of whether these high levels of meat contamination from municipal managed slaughter facilities exposes meat consumers to health risks should be conducted.

REFERENCES

Agaoglu S., Yavuz M.T., Berktas M. and Guducuoglu H. (2000): Detection of Escherichia coli 0157:H7 in Retail Ground Beef, Raw Ground Beef Patties and Raw meat Balls sold in Van. Eastern Journal of Medicine 5 (2): 73-75.

Almond Board of California (2005):-Sanitation Standard Operating Procedures; http://us.mc520.mail.yahoo.com/mc/show message?

Amendment to Fresh Meat Hygiene and Inspection Regulations (Northern Ireland):-1997.http://www.uk_legislation.hmso.gov.uk/sr/sr1997/Nisr_19970493_en_8.htm_10k

Arimi, S.M., Koroti E., Kang'ethe E.K., Omore A.O., McDermott J.J., Macharia J.K., Nduhiu J.G., and Githua A.M. (2000):- Risk of infection from *E. coli* 0157:H7 through informally marketed raw milk in Kenya. Paper for oral presentation at the 3rd all Africa conference on animal agriculture 6th-9th November 2000. www.smallholderdairy.org/publications/Conference/

Bernhard. N, Katharina.S. Guenter. K and Theda V. M. (2006):- Trends in the Production and Storage of Fresh Meat-the Holistic Approach to Bacteriological Meat Quality. International Journal of Food Science and Technology 2006, **41**, 303-310.

Bridson. E. Y. (1998):- The Oxoid Manual, 8th Edition.
www.public.iastate.edu/~mariposa/MarinaMesopotamica/2002/pdf/1701pp023030.pdf

CAC (2005):-Code of Hygienic Practice for Meat;
2005.www.codexalimentarius.net/download/standards/0196/CXP.058e.pdf

CDC (2005):- Divisions of Bacterial and Mycotic Diseases (Listeriosis).
http://www.cdc.gov/ncidod/dbmd/diseaseinfo/listeriosis.g.htm

CDC (2006a): - Divisions of Bacterial and Mycotic Diseases (Salmonellosis).
http://www.**cdc**.gov/travel/contentDiseases.aspx-42k-

CDC (2006b):- Questions and answers: sickness caused by *E. coli*. http://www.CDC.go/.

Clayton. R. P. and Bowling. R. A., (2007):- Method for treating a food processing facility to control microbial contamination of food products.
http//www.freepatentsonline.com/20070054008.

Cole, D, J.A. and Lawrie, R.A. (1975):- meat, 1st Ed. Avi publishing Co. Incs, Westport Connecticut.

Dohoo I., Martin. W and Henrik S. (2003):-Veterinary Epidemiologic Research book pp. 39-42

Falade K.O. and Adegoke G.O (2005):- Quality of Meat: Journal of Food, Agriculture and Environment (2005), **3** No 1, 87-90.
FAO (1992): Manuals of Food, Quanlity Control. 4. Microbiological Analysis

FAO (2004):-Good Practices for the Meat Industry

FAO/WB/EU (2004):- Somalia. Towards a livestock sector strategy. Siteresources.worldbank.org/SOMALIAEXTN/Resources/so_LS_final_rpt.pdf-

FAO/WHO (2002a):- Integrated Approaches to the Management of Food Safety Through the Food Chain. Global Forum of Food Safety Regulators, Marrakesh, Morocco, 28th-30th January 2002.

FAO/WHO (2002b):- *E. coli* O157:H7 Outbreak in Scotland in 1996/97; FAO/WHO Global Forum of Food Safety Regulations. Marrakesh, Morocco, 28th-30thJanuary.

Flowers R.S., Andrews W., Donnelly C.W. and Koenig E. (1992):- Pathogens in Milk and Milk Products. Book: Microbiological Tests for Milk and Milk Products by Marshal T. (Chapter 5).

Food safety and inspection services; US (1999): Overview of Food Safety and Inspection Services and Food and Drug Administration Expenditures. *www.gao.gov/cgi-bin/getrpt?GAO/T-RCED-00-300 -*

FSNAU (2007):- Maps of the Republic of Somalia and Somaliland state

Geoff S., John. V., Richardson I., Geoff N, Sandra E., Tony H. and Tim B (2004):- Meat Eating Quality – A Whole Chain Approach; Factors Affecting Beef Eating Quality; www.scotland.gov.uk/Resource/Doc/30859/0014456.pdf

Gill C.O, McGinnis J.C and M. Badoni (1999):-Use of Total or E. coli Counts to Assess the Hygienic Characteristics of a Beef Carcass Dressing Process. International Journal of Food Microbiology, **31**, Issues 1-3, pages 181-196

Gillespie I, C. Little and R. Mitchell (2000):- Microbiological Examination of Cold Ready to Eat Sliced Meats from Catering Establishments in the United Kingdom. Journal of Applied Microbiology 2000, **88**, 246-474

Gracey J.F, David S. C, Robert J. H (1999):- Causes of dirty livestock and Sources of Meat Contamination. Meat hygiene; 10th Ed. pp 62, 166, 222-225

IFC and WB (2007):-Environmental, Health and Safety Guidelines for meat processing. www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/gui

Ira J. M. (1984):- Coliforms, Fecal Coliforms, Escherichia coli and Enteropathogenic E. coli. Book: Compendium of Methods for the Microbiological Examination of Foods. 2nd Edition chapter 25 pp 265-284.

Kang'ethe E.K. (1993):- Hygienic Status of Bovine Carcasses from three Slaughter facilities in Nairobi, Kenya: The Kenya veterinarian vol. **17** pp 9-12.

Kerri B. H. and Jeff W. S (2003):- Best practices for Beef Slaughter; haccpalliance.org/sub/food-safety/**Best**Pracslaught1103.pdf

Livestock and Meat Industries Act (2007):-Livestock and Meat Industries (Meat Inspection and Control of Red Meat Facility) Regulations; Botswana

Luis M. de la Maza, Marie T. pezzlo, Janet T. Shigei and Ellena M. Peterson (2004):- Colour Atlas of Medical Bacteriology; Book pgs 92

Mark B. (2008):-African Issues; Becoming Somaliland; pages 1-8.

Mashood A. R., Uswege. M. and Robert M. (2006): Current Epidemiological Status of *Enterohaemorrhagic Escherichia coli* O157:H7 in Africa. Chinese Medical Journal, 2006, **119** No.3; 217-222.

McEvoy J.M., Sheridan J. J, Blair I. S and McDowell D.A (2004):- Microbial Contamination on Beef in relation to Hygiene Assessment based on criteria used in EU Decision 2001/471/EC. International Journal of Food Microbiology **92** (2004) 217-225.

Meat Control Act (1977) Meat Control Act: Kenya Government Printers. Interpretations.

Mwangi A. W (2002):-Establishment of Critical Control Points of Informally Marketed Raw Milk in Kiambu and Nairobi Districts based on Microbiological safety; Thesis

Okuthe O.S., Kuloba K., Emongor R.A., Ngotho R.N., Bukachi S., Nyamwaro S.O., Murila G., and Wamwayi H.M. (2006):- National Agricultural Research Systems, Experiences in the use of Participatory Approaches to Animal Health Research in Kenya. www.future-agricultures.org/farmerfirst/files/T3c_Catley.pdf

Okuthe O.S., Mcleod A., Otte J.M., Buyu G.E., (2003):- Use of Rapid Rural Appraisal and Cross-Sectional Studies in the Assessment of Constraints in Smallholder Cattle Production Systems in the Western Kenya Highlands; Journal of Veterinary Research, **70**: 237-242

Read .S.C., Gyles .C.L., Clarke. R.C., Lior .H. and McEwen.S (1990):- Prevalence of Verocytotoxigenic Escherichia coli in Ground Beef, Pork, and Chicken in South western Ontario. Epidemiology and Infection, Vol. **105**, No.1 (Aug., 1990), pp.11-20.

Robert T. M. (2005):-Standard Methods for the Examination of Dairy Products; 16th edition pp 213

Roberts T.A. and B. Pharm (1980):-Contamination of Meat; The effects of Slaughter Practices on the Bacteriology of the Red Meat Carcass; rsh.sagepub.com/cgi/content/refs/100/1/3

Ronald. K (2005):- Influence of Ultimate pH on Meat Quality and Consumer Purchasing Decisions; www.thepigsite.com/Featured**red**Article/Default.asp?Display=1506 - 30k -

Thadis W. B (1971): Nomadism and Land Use in Somalia. Economic Development Cultural Change, Volume **19**, Number 2 (January 1971), pp 222-228.

Thornton. H and Gracey. J. F (1974): Textbook of Meat Hygiene; 6th Edition, chapter 4, pp 72-119

UN/WB (2006): Somali Reconstruction and Development Framework. Deepening peace and Reducing Poverty; Volume I. www.somali.jna.com

US Department of Health and Human Services; Food and Drug Administration, Centre for Food Safety and Applied Nutrition (2006):-Managing Food Safety: A Manual for the Voluntary Use of HACCP Principles for Operators of Food Service and Retail Establishments; www.cfsan.fda.gov/~dms/hret2toc.html - 12k

US FDA (food and drug administration 2006): Food-borne pathogenic micro organisms and natural toxins handbook *E. coli* O157:H7. http://www.cfsan.fda.gov/~mow/chap15.html

USDA, Food Safety and Inspection Services (1999):-Generic HACCP Model for Beef Slaughter; www.fsis.**usda**.gov/OPPDE/nis/outreach/**models/HACCP**-13.pdf -

APPENDICES

APPENDIX 1: TYPES AND CONTENTS OF MEDIA AND BROTHS USED

Lauryl Tryptose Broth (Lauryl sulphate broth)
Typical formula (gram\litre):- Tryptose 20.0, Lactose 5.0, Sodium chloride 5.0, Di-potassium hydrogen phosphate 2.75, Potassium dihydrogen phosphate 2.75 and Sodium lauryl sulphate 0.1
pH 6.8± 0.2 at 25^0c
Add 35.6 g to 1 litre of distilled water and distribute into containers with fermentation Durham tubes. Sterilize by autoclaving at 121^0c for 15 minutes. It is a selective medium for the detection of coliform organisms in water, dairy products and other foods.

Plate count agar (Tryptone glucose yeast agar)
Typical formula (gram\litre):-Tryptone 5.0, Yeast extract 2.5, Glucose 1.0 and Agar 9.0
pH 7.0± 0.2 at 25^0c
Suspend 17.5 g in 1 litre of distilled water. Dissolve by bringing to the boil with frequent stirring, mix and distribute into final containers. Sterilize by autoclaving at 121^0c for 15 minutes.

Eosin Methylene Blue Agar (Levine)
Typical formula (gram\litre):-peptone 10.0, Lactose 10.0, Di-potassium hydrogen phosphate 2.0, Eosin Y 0.4, Methylene blue 0.06 and Agar 15.0
pH 6.8± 0.2 at 25^0c
Suspend 37.5g in 1 litre of distilled water. Bring to boil to dissolve completely. Sterilize by autoclaving at 121^0c for 15 minutes. Cool to 60^0c and shake the medium in order to oxidize the methylene blue (i.e. restore its blue colour) and to suspend the precipitate which is an essential part of this medium.

Sorbitol MacConkey Agar
Typical formula (gram\litre):-Peptone 20.0, Sorbitol 10.0, Bile salts No. 3 1.5, Sodium chloride 5.0, Neutral red 0.03, Crystal violet 0.001 and Agar 15.0
pH 7.1± 0.2
Suspend 51.5 g in 1 litre of distilled water. Bring to the boil to dissolve completely. Sterilize by autoclaving at 121^0c for 15 minutes. This is a selective and differential medium for the detection of *E. coli* O157.

Rappaport-Vasilliadid Enrichment Broth
Formula (gram\litre):-Soya peptone 5.0, Sodium chloride 8.0, Potassium dihydrogen phosphate 1.6, Magnesium chloride $6H_2O$ 40.0 and Malachite green 0.04
pH 5.2± 0.2
Add 30g to 1 litre of distilled water. Heat gently until dissolved completely. Dispense 10 ml volumes into screw-capped bottles or tubes and sterilize by autoclaving at 115^0c for 15 minutes.

Selenite Cystine Broth

Formula (gram\litre):-Tryptone 5.0, Lactose 4.0, Disodium phosphate 10.0 and L-Cystine0.01

pH 7.0 ± 0.2

Dissolve 4g of sodium biselenite L121 in 1 litre of distilled water and then add 19g of Selenite Cystine Broth base CM699. Warm to dissolve and dispense into containers to a depth of at least 60 mm. Sterilize by placing in free flowing steam for 15 minutes. Do not autoclave.

Brilliant Green Agar

Formula (gram\litre):-Proteose peptone 10.0, Yeast extract 3.0, Lactose 10.0, Sucrose 10.0, Sodium chloride 5.0, Phenol red 0.08, Brilliant green 0.0125 and Agar 12.0.

pH 6.9 ± 0.2

Suspend 50g in 1litre of distilled water. Bring to the boil to dissolve completely. Sterilize by autoclaving at 121^0c for 15 minutes.

Xylose Lysine Desoxycholate

Formula (gram\litre):-Yeast extract 3.0, L-Lysine HC1 5.0, Xylose 3.75, Lactose 7.5, Sucrose 7.5 Sodium desoxycholate 1.0, Sodium chloride 5.0, Sodium thiosulphate 6.8, Ferric ammonium citrate 0.8, Phenol red 0.08 and Agar 12.5.

pH 7.4 ± 0.2

Suspend 53g in 1litre of distilled water. Heat until the medium boils to dissolve. DO NOT OVERHEAT. Transfer immediately to a water bath at 500c. Pour into plates as soon as the medium has cooled.

It is a selective medium for isolation of Shigella and Salmonella from foods. Salmonella utilizes Xylose and decarboxylates the lysine, thus altering the PH to alkaline mimicking the Shigella reaction. Salmonella colonies appear red with black centre.

Tryptone water

Formula (gram\litre):-tryptone 10.0, sodium chloride 5.0

pH 7.5 ± 0.2

Dissolve 15g in 1 lt of distilled water and distribute into final containers. Sterilize by autoclaving at 121^0c for 15 minutes.

Description: - Tryptone water is a good substrate for the production of indole because of its high content of tryptophan and it is more reliable than peptone water for this purpose.

Methyl-red and voges-proskauer (MRVP)

Test for the differentiation of the coli-aerogenes group.

Formula (gram\litre):-Peptone 5.0, Glucose 5.0, and Phosphate 5.0

pH7.5 ± 0.2

Directions

Add 15g to1litreof distilled water. Mix well, distribute into final containers and sterilize by autoclaving at 121^0c for 15 minute.

This test, now known as the MR , distinguishes those organisms able to form large amount s of acid from glucose so that the pH falls below 4.4 and those organisms which cannot produce a low pH level.
The difference in PH value is visualized by adding MR to the culture, (<pH 4.4 red: pH 5.0-5.8 orange: >pH 6.0 yellow).

Simmon's citrate agar
It is an agar for differentiation of Enterobacteriaceae based on the utilization of citrate as the sole source of carbon
Formula (gram\litre):-Magnesium sulphate 0.2, Ammonium dihydrogen phosphate 0.2, Sodium ammonium sulphate 0.8, Sodium citrate, tribasic 2.0, Sodium chloride 5.0, Bromothymol blue 0.08 and Agar 15.0
pH7.0 ± 0.2
Directions
Suspend 23g in 1 litre of distilled water. Bring to the boil to dissolve completely. Sterilize by autoclaving at 121^0c for 15 minutes.

IMVIC test
Transfer sterilized 5 ml of tryptone water into 3 sterilized tests. Into each tube, add a selected colony of positive *E. coli* from Sorbitol MacConkey Agar or EMBA. Add the same colony by stabbing the citrate slant. Incubate the four tubes at 37^0c for 24-48 hours. After the incubation period add indole into tube 1, methyl-red into tube 2, voges-proskauer into tube 3 and observe for colour changes. Positive E. coli should be red, red, and colorless and no colour change for citrate.
IMVIC + + - -

APPENDIX II: LABORATORY REPORT

Samples taken from Berbera Slaughter House.

Analabs Ref No.	Sample Description	Results		Remarks Log mean cfu/cm^2	Inter preta tion (EU)
M0567	Swab- Goat 1 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = <3 MPN index/ml=0.3 cfu/cm^2 *Salmonella* sp = Not detected	30,000 0.3	4.5 0	U A
M0568	Swab – Goat 2 Lateral brisket	TVC = >300,000 cfu/cm^2 estimated Coliforms = 240 MPN index/ml=24 cfucm^2 *Salmonella sp* = Not detected	300,000 24	5.5 1.4	U M
M0569	Swab- Goat 3 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = >1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0570	Swab- Goat 4 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	30,000 0.3	4.5 0	U A
M0571	Swab- Goat 5 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = >1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000	4.5 2.0	U U
M0572	Swab- Goat 6 Lateral brisket	TVC = 13,600 cfu/cm^2 Coliforms = 75 MPN index/ml=7.5 cfucm^2 *Salmonella* sp = Not detected	13,600 7.5	4.1 0.9	M M
M0573	Swab- Goat 7 Lateral brisket	TVC = 13,400 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	13,400 0.3	4.1 0	M A
M0574	Swab- Goat 8 Lateral brisket	TVC = 21,900 cfu/cm^2 Coliforms = 460 MPN index/ml=46 cfucm^2 *Salmonella* sp = Not detected	21,900 46	4.3 1.7	M M
M0575	Swab- Goat 9 Lateral brisket	TVC = 2,064 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2,064 0.3	3.3 0	M A
M0576	Swab- Goat 10 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = >1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0577	Swab- Sheep 11 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = >1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0578	Swab- Sheep 12 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 460 MPN index/ml=46 cfucm^2 *Salmonella* sp = Not detected	30,000 46	4.5 1.7	U M

M0579	Swab – Sheep 13 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 4MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	30,000 0.4	4.5 -0.4	U A
M0580	Swab – Sheep 14 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 28 MPN index/ml=2.8 cfucm^2 *Salmonella* sp = Not detected	,30,000 2.8	4.5 0.4	U A
M0581	Swab – Sheep 15 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = >1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0582	Swab – Sheep16 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0583	Swab – Sheep 17 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 210 MPN index/ml=21 cfucm^2 *Salmonella* sp = Not detected	30,000 21	4.5 1.3	U M
M0584	Swab – Sheep 18 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = >1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0585	Swab – Goat 19 Lateral brisket	TVC =26,600 cfu/cm^2 Coliforms = 450 MPN index/ml *Salmonella* sp = Not detected	26,600 45	4.4 1.7	U M
M0586	Swab – Goat 20 Lateral brisket	TVC >30,000 cfu/cm^2 Coliforms = 132 MPN index/ml *Salmonella* sp = Not detected	30,000 13.2	4.5 1.1	U M
M0587	Swab – Goat 21 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = >1,100 MPN index/ml *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0588	Swab – Goat 22 Lateral brisket	TVC >30,000 cfu/cm^2 Coliforms >1,100 MPN index/ml *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0589	Swab – Goat 23 Lateral brisket	TVC = 21,180 cfu/cm^2 Coliforms = 460 MPN index/ml *Salmonella* sp = Not detected	21,180 46	4.3 1.7	M M
M0590	Swab – Goat 24 Lateral brisket	TVC = 26,300 cfu/cm^2 Coliforms = 75 MPN index/ml *Salmonella* sp = Not detected	26,300 7.5	4.4 0.9	U M
M0591	Swab – Goat 25 Lateral brisket	TVC = 17,727 cfu/cm^2 Coliforms = 264 MPN index/ml *Salmonella* sp = Not detected	17,727 26.4	4.2 1.4	M M
M0592	Swab- Goat 26 Lateral brisket	TVC = 12,820 cfu/cm^2 Coliforms = 3 MPN index/ml *Salmonella* sp = Not detected	12,820 0.3	4.1 0	M A

M0593	Swab- Goat 27 Lateral brisket	TVC = 21,800 cfu/cm^2 Coliforms = > 1,100 MPN index/ml *Salmonella* sp = Not detected	21,800 110	4.3 2.0	M U
M0594	Swab- Goat 28 Lateral	TVC = 15,800 cfu/cm^2 Coliforms = 23 MPN index/ml *Salmonella* sp = Not detected	15,800 2.3	4.2 0.4	M A
M0595	Swab- Goat 29 Lateral brisket	TVC = 21,270 cfu/cm^2 Coliforms = 9 MPN index/ml *Salmonella* sp = Not detected	21,270 0.9	4.3 -0.05	M A
M0596	Swab- Goat 30 Lateral brisket	TVC = 17,730 cfu/cm^2 Coliforms = 9 MPN index/ml *Salmonella* sp = Not detected	17,730 0.9	4.2 -0.05	M A
M0597	Swab- Goat 31 Lateral brisket	TVC >30,000 cfu/cm^2 Coliforms > 1,100 MPN index/ml *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0598	Swab- Goat 32 Lateral brisket	TVC = 15,600 cfu/cm^2 Coliforms = 1,100 MPN index/ml *Salmonella* sp = Not detected	15,600 110	4.2 2.0	M U
M0599	Swab- Goat 33 Lateral brisket	TVC = 29,360 cfu/cm^2 Coliforms = 93 MPN index/ml *Salmonella* sp = Not detected	29,360 9.3	4.5 1.0	U M
M0600	Swab –Goat 34 Lateral brisket	TVC = 1,673 cfu/cm^2 Coliforms = 43 MPN index/ml *Salmonella* sp = Not detected	1,673 4.3	3.2 0.6	M A
M0601	Swab- Goat 35 Lateral brisket	TVC = 25,900 cfu/cm^2 Coliforms = 143 MPN index/ml *Salmonella* sp = Not detected	25,900 14.3	4.4 1.2	U M
M0602	Swab- Goat 36 Lateral brisket	TVC = 1,773 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1,773 0.3	3.2 0	M A
M0603	Swab- Goat 37 Lateral brisket	TVC = 22,655 cfu/cm^2 Coliforms = 403 MPN index/ml *Salmonella* sp = Not detected	22,655 40.3	4.4 1.6	U M
M0604	Swab- Goat 38 Lateral brisket	TVC = 12,445 cfu/cm^2 Coliforms *28* MPN index/ml *Salmonella* sp = Not detected	12,445 2.8	4.1 0.4	M A
M0605	Swab- Goat 39 Lateral brisket	TVC = 19,400 cfu/cm^2 Coliforms = 23 MPN index/ml *Salmonella* sp = Not detected	19,400 2.3	4.3 0.4	M A
M0606	Swab- Goat 40 Lateral brisket	TVC = 28,640 cfu/cm^2 Coliforms = 213 MPN index/ml *Salmonella* sp = Not detected	28,640 21.3	4.5 1.3	U M

M0607	Swab- Goat 41 Lateral brisket	TVC = 28,600 cfu/cm^2 Coliforms = 230 MPN index/ml *Salmonella* sp = Not detected	28,600 23	4.5 1.4	U M
M0608	Swab- Goat 42 Lateral brisket	TVC = 25,900 cfu/cm^2 Coliforms = 23 MPN index/ml *Salmonella* sp = Not detected	25,900 2.3	4.4 0.4	U A
M0609	Swab- Goat 43 Lateral brisket	TVC = 22,100 cfu/cm^2 Coliforms = 43 MPN index/ml *Salmonella* sp = Not detected	22,100 4.3	4.3 0.6	M A
M0610	Swab- Goat 44 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 39 MPN index/ml *Salmonella* sp = Not detected	30,000 3.9	4.5 0.6	U A
M0611	Swab –Goat 45 Lateral brisket	TVC = 17,400 cfu/cm^2 Coliforms = 9 MPN index/ml *Salmonella* sp = Not detected	17,400 0.9	4.2 -0.05	M A
M0612	Swab- Goat 46 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 93 MPN index/ml *Salmonella* sp = Not detected	30,000 9.3	4.5 1.0	U M
M0613	Swab- Goat 47 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = <39 MPN index/ml *Salmonella* sp = Not detected	30,000 3.9	4.5 0.6	U A
M0614	Swab- Goat 48 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 403 MPN index/ml *Salmonella* sp = Not detected	30,000 40.3	4.5 1.6	U M
M0615	Swab- Goat 49 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 43MPN index/ml *Salmonella* sp = Not detected	30,000 4.3	4.5 0.6	U A
M0616	Swab- Goat 50 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 460 MPN index/ml *Salmonella* sp = Not detected	30,000 46	4.5 1.7	U M
M0617	Swab- Goat 48 Lateral brisket	TVC = 16,520 cfu/cm^2 Coliforms = 93 MPN index/ml *Salmonella* sp = Not detected	16,520 9.3	4.2 1.0	M M
M0618	Swab- Goat 51 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 306 MPN index/ml *Salmonella* sp = Not detected	30,000 30.6	4.5 1.5	U M
M0619	Swab –Goat 52 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 73 MPN index/ml *Salmonella* sp = Not detected	30,000 7.3	4.5 0.9	U M
M0620	Swab- Goat 53 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 43 MPN index/ml *Salmonella* sp = Not detected	30,000 4.3	4.5 0.6	U A

M0621	Swab- Goat 54 Lateral brisket	TVC = 2630 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2,630 0.3	3.4 0	M A
M0622	Swab- Goat 55 Lateral brisket	TVC = 14,900 cfu/cm^2 Coliforms = 300 MPN index/ml *Salmonella* sp = Not detected	14,900 50	4.2 1.5	M M
M0623	Swab- Goat 56 Lateral brisket	TVC = 24,000 cfu/cm^2 Coliforms = 93 MPN index/ml *Salmonella* sp = Not detected	24,000 9.3	4.4 1.0	U M
M0624	Swab –Goat 57 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 430 MPN index/ml *Salmonella* sp = Not detected	30,000 43	4.5 1.6	U M
M0625	Swab- Goat 58 Lateral brisket	TVC = 2,950 cfu/cm^2 Coliforms = 4 MPN index/ml *Salmonella* sp = Not detected	2,950 0.4	3.5 -0.4	M A
M0626	Swab- Goat 59 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms > 1100 MPN index/ml *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0627	Swab- Goat 60 Lateral brisket	TVC = 15,000 cfu/cm^2 Coliforms = 210 MPN index/ml *Salmonella* sp = Not detected	15,000 21	4.2 1.3	M M
M0628	Swab- Goat61 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 230 MPN index/ml *Salmonella* sp = Not detected	30,000 23	4.5 1.4	U M
M0629	Swab- Goat 62 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 43MPN index/ml *Salmonella* sp = Not detected	30,000 4.3	4.5 0.6	U A
M0630	Swab- Goat 63 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	30,000 0.3	4.5 0	U A
M0631	Swab – Goat 64 Lateral brisket	TVC = >300,000 cfu/cm^2 estimated Coliforms = 240 MPN index/ml=24 cfucm^2 *Salmonella* sp = Not detected	300,000 24	5.5 1.4	U M
M0632	Swab- Goat 65 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = >1,100 MPN index/ml=110 cfucm^2	30,000 110	4.5 2.0	U U
M0633	Swab- Goat 66 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	30,000 0.3	4.5 0	U A
M0634	Swab- Goat 67 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = >1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U

M0635	Swab- Goat 68 Lateral brisket	TVC = 13,600 cfu/cm^2 Coliforms = 75 MPN index/ml=7.5 cfucm^2 *Salmonella* sp = Not detected	13,600 7.5	4.1 0.9	M M
M0636	Swab- Goat 69 Lateral brisket	TVC = 13,400 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	13,400 0.3	4.1 0	M A
M0637	Swab- Goat 70 Lateral brisket	TVC = 21,900 cfu/cm^2 Coliforms = 460 MPN index/ml=46 cfucm^2 *Salmonella* sp = Not detected	21,900 46	4.3 1.7	M M
M0638	Swab- Goat 71 Lateral brisket	TVC = 2,064 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2,064 0.3	3.3 0	M A
M0639	Swab- Goat 72 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = >1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0640	Swab- Sheep 73 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = >1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0641	Swab- Sheep 74 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 460 MPN index/ml=46 cfucm^2 *Salmonella* sp = Not detected	30,000 46	4.5 1.7	U M
M0642	Swab – Sheep 75 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 4MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	30,000 0.4	4.5 -0.4	U A
M0643	Swab – Sheep 76 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 28 MPN index/ml=2.8 cfucm^2 *Salmonella* sp = Not detected	30,000 2.8	4.5 0.4	U A
M0644	Swab – Sheep 77 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = >1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0645	Swab – Sheep 78 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = Not detected	30,000 110	4.5 2.0	U U
M0646	Swab – Sheep 79 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 210 MPN index/ml=21 cfucm^2 *Salmonella* sp = Not detected	30,000 21	4.5 1.3	U M
M0647	Swab – Sheep 80 Lateral brisket	TVC = >30,000 cfu/cm^2 estimated Coliforms = 4MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	30,000 0.4	4.5 -0.4	U A

Samples taken from Borama local slaughter facility

Analabs Ref No.	Sample Description	Results	Remarks Log mean cfu/cm^2	Interpretation(EU)
M0478	Swab – Goat 1 Lateral brisket	TVC = <100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0479	Swab – Goat 2 Lateral brisket	TVC = 800 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A
M0480	Swab – Goat 3 Lateral brisket	TVC = 700 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A
M0481	Swab – Goat 4 Lateral brisket	TVC = 800 cfu/cm^2 Coliforms = 4 MPN index/ml *Salmonella* sp = Not detected	2.9 0.6	M A
M0482	Swab – Goat 5 Lateral brisket	TVC = <100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0483	Swab – Goat 6 Lateral brisket	TVC = 200 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.3 0	A A
M0484	Swab – Goat 7 Lateral brisket	TVC = 600 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.78 0	A A
M0485	Swab – Goat 8 Lateral brisket	TVC = <100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0486	Swab – Goat 9 Lateral brisket	TVC = 1,400 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.2 0	M A
M0487	Swab- Goat 10 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0488	Swab- Goat 11 Lateral brisket	TVC = 800 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A
M0489	Swab – Goat 12 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A

M0490	Swab – Goat 13 Lateral brisket	TVC = 200 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.3 0	A A
M0491	Swab – Goat 14 Lateral brisket	TVC = 500 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.7 0	A A
M0492	Swab – Goat 15 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0493	Swab – Goat 16 Lateral brisket	TVC = 300 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A
M0494	Swab – Goat 17 Lateral brisket	TVC = 300 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A
M0495	Swab – Goat 18 Lateral brisket	TVC = 300 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A
M0496	Swab – Goat 19 Lateral brisket	TVC = <65 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.8 0	A A
M0497	Swab – Goat 20 Lateral brisket	TVC = 25 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.4 0	A A
M0498	Swab – Goat 21 Lateral brisket	TVC = 300 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A
M0499	Swab – Goat 22 Lateral brisket	TVC = 540 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.7 0	A A
M0500	Swab – Goat 23 Lateral brisket	TVC = 10 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.0 0	A A
M0501	Swab – Goat 24 Lateral brisket	TVC = 50 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.7 0	A A
M0502	Swab – Goat 25 Lateral brisket	TVC = 800 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A

M0503	Swab – Goat 26 Lateral brisket	TVC = 820 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	A A
M0504	Swab – Goat 27 Lateral brisket	TVC = 280 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.4 0	A A
M0505	Swab – Goat 28 Lateral brisket	TVC = 750 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A
M0506	Swab – Goat 29 Lateral brisket	TVC = 320 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A
M0507	Swab – Goat 30 Lateral brisket	TVC = 754 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A
M0508	Swab – Goat 31 Lateral brisket	TVC = 400 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.6 0	A A
M0509	Swab – Goat 32 Lateral brisket	TVC = 160 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.2 0	A A
M0510	Swab – Goat 33 Lateral brisket	TVC = 450 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.7 0	A A
M0511	Swab – Goat 34 Lateral brisket	TVC = 20 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.3 0	A A
M0512	Swab – Goat 35 Lateral brisket	TVC = 350 cfu/cm^2 Coliforms = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	2.5 -0.4	A A
M0513	Swab – Goat 36 Lateral brisket	TVC = 727 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A
M0514	Swab- Goat 37 Lateral brisket	TVC = 740 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A
M0515	Swab – Goat 38 Lateral brisket	TVC = 70 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.8 0	A A

M0516	Swab- Goat 39 Lateral brisket	TVC = 736 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.8 0	M A
M0517	Swab- Goat 40 Lateral brisket	TVC = 190 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.3 0	A A
M0518	Swab- Goat 41 Lateral brisket	TVC = 1,036 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.0 0	M A
M0519	Swab- Goat 42 Lateral brisket	TVC = 1,218 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.1 0	M A
M0520	Swab- Goat 43 Lateral brisket	TVC = 1,973 cfu/cm^2 Coliforms = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	3.3 -0.4	M A
M0521	Swab- Goat 44 Lateral brisket	TVC = 550 cfu/cm^2 Coliforms = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	2.7 -0.4	A A
M0522	Swab- Goat 45 Lateral brisket	TVC = 190 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.3 0	A A
M0523	Swab- Goat 46 Lateral brisket	TVC = 290 cfu/cm^2 Coliforms = 9 MPN index/ml=0.9 cfucm^2 *Salmonella* sp = Not detected	2.5 -0.05	A M
M0524	Swab- Goat 47 Forelimb	TVC = 560 cfu/cm^2 Coliforms = 4 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.7 -0.4	M A
M0525	Swab- Goat 48 Lateral brisket	TVC = 680 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.8 0	A A
M0526	Swab- Goat 49 Lateral brisket	TVC = 330 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A
M0527	Swab- Goat 50 Lateral brisket	TVC = 518 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.7 0	A A
M0528	Swab- Goat 51 Lateral brisket	TVC = 660 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.8 0	M A
M0529	Swab- Goat 52 Lateral brisket	TVC = 470 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 = Not detected in the swab	2.7 0	A A

M0530	Swab- Goat 53 Lateral brisket	TVC = 750 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected in the swab	2.9 0	M A
M0531	Swab- Goat 54 Lateral brisket	TVC = 955 cfu/cm^2 Coliforms = 23 MPN index/ml=2.3 cfucm^2 *Salmonella* sp = Not detected in the swab	3.0 0.4	M A
M0532	Swab- Goat 55 Lateral brisket	TVC = 260 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected in the swab	2.4 -0.5	A A
M0533	Swab- Goat 56 Lateral brisket	TVC = 3,145 cfu/cm^2 Coliforms = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected in the swab	3.5 -0.4	M A
M0534	Swab- Goat 57 Lateral brisket	TVC = 810 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected in the swab	2.9 0	M A
M0535	Swab- Goat 58 Lateral brisket	TVC = 2,164 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected in the swab	3.3 0	M A
M0536	Swab- Goat 59 Lateral brisket	TVC = 260 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected in the swab	2.4 0	A A
M0537	Swab- Goat 60 Lateral brisket	TVC = 905 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected in the swab	3.0 0	M A
M0538	Swab- Goat 61 Lateral brisket	TVC = 110 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected in the swab	2.0 0	A A
M0539	Swab- Goat 62 Lateral brisket	TVC = 460 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected in the swab	2.7 0	A A
M0540	Swab- Goat 63 Lateral brisket	TVC = 450 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected in the swab	2.7 0	M M
M0541	Swab – Goat 64 Lateral brisket	TVC = <100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0542	Swab – Goat 65 Lateral brisket	TVC = 800 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A
M0543	Swab – Goat 66 Lateral brisket	TVC = 700 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A

M0544	Swab – Goat 67 Lateral brisket	TVC = 800 cfu/cm^2 Coliforms = 4 MPN index/ml *Salmonella* sp = Not detected	2.9 0.6	M A
M0545	Swab – Goat 68 Lateral brisket	TVC = <100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0546	Swab – Goat 69 Lateral brisket	TVC = 200 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.3 0	A A
M0547	Swab – Goat 70 Lateral brisket	TVC = 600 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.78 0	A A
M0548	Swab – Goat 71 Lateral brisket	TVC = <100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0549	Swab – Goat 72 Lateral brisket	TVC = 1,400 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.2 0	M A
M0550	Swab – Goat 72 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0551	Swab – Goat 73 Lateral brisket	TVC = 800 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A
M0555	Swab – Goat 74 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0552	Swab – Goat 75 Lateral brisket	TVC = 200 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.3 0	A A
M0553	Swab – Goat 76 Lateral brisket	TVC = 500 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.7 0	A A
M0554	Swab – Goat 77 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0555	Swab – Goat 78 Lateral brisket	TVC = 300 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A
M0556	Swab – Goat 79 Lateral brisket	TVC = 300 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A

M0557	Swab – Goat 80 Lateral brisket	TVC =98 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A

Samples taken from Burao local Slaughter House

Analabs Ref No.	Sample Description	Results	Log mean cfu/cm^2	Interpr. EU guidelines
M0911	Swab – Goat 1 Lateral brisket	TVC = 4,600 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.7 0	M A
M0912	Swab – Goat 2 Lateral brisket	TVC = 400 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	2.6 0	A A
M0913	Swab – Goat 3 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = >1,100 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 2.0	U U
M0914	Swab – Goat 4 Lateral brisket	TVC = 780 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	2.9 0	M A
M0915	Swab – Goat 5 Lateral brisket	TVC = 180 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	2.3 0	A A
M0916	Swab – Goat 6 Lateral brisket	TVC = 6,300 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.8 0	M 0
M0917	Swab – Goat 7 Lateral brisket	TVC = 7,727 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.9 0	M A
M0918	Swab- Goat 8 Lateral brisket	TVC = 820 cfu/cm^2 Coliforms = 3 MPN index/ml *Salmonella* sp = Not detected in swab	2.9 0	M A
M0919	Swab- Goat 9 Lateral brisket	TVC = 1,800 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.3 0	M A
M0920	Swab- Goat 10 Lateral brisket	TVC = 5,800 cfu/cm^2 Coliforms = 23 MPN index/ml *Salmonella* sp = Not detected in swab	3.8 0.4	M A
M0921	Swab- Goat 11 Lateral brisket	TVC = 21,270 cfu/cm^2 Coliforms = 9 MPN index/ml *Salmonella* sp = Not detected in swab	4.3 -0.05	M A

M0922	Swab- Goat 12 Lateral brisket	TVC = 17,730 cfu/cm^2 Coliforms = 9 MPN index/ml *Salmonella* sp = Not detected in swab	4.2 -0.05	M A
M0923	Swab- Goat 13 Lateral brisket	TVC = 10 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	1.0 0	A A
M0924	Swab- Goat 14 Lateral brisket	TVC = 15,600 cfu/cm^2 Coliforms = 1,100 MPN index/ml *Salmonella* sp = Not detected in swab	4.2 2.0	M U
M0925	Swab- Goat 15 Lateral brisket	TVC = 29,360 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	U A
M0926	Swab –Goat 16 Lateral brisket	TVC = 1,673 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.2 0	M A
M0927	Swab- Goat 17 Lateral brisket	TVC = 5,900 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.8 0	M A
M0928	Swab- Goat 18 Lateral brisket	TVC = 1,773 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.2 0	M A
M0929	Swab- Goat 19 Lateral brisket	TVC = 2,655 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.4 0	M A
M0930	Swab- Goat 20 Lateral brisket	TVC = 2,445 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.4 0	M A
M0931	Swab- Goat 21 Lateral brisket	TVC = 9,400 cfu/cm^2 Coliforms = 23 MPN index/ml *Salmonella* sp = Not detected in swab	4.0 0.4	M A
M0932	Swab- Goat 22 Lateral brisket	TVC = 640 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	2.8 0	A A
M0933	Swab- Goat 23 Lateral brisket	TVC = 8,600 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.9 0	M A
M0934	Swab- Goat 24 Lateral brisket	TVC = 5,900 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.8 0	M A
M0935	Swab- Goat 25 Lateral brisket	TVC = 2,100 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.3 0	M A

M0936	Swab- Goat 26 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 39 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0.6	U A
M0937	Swab –Goat 27 Lateral brisket	TVC = 17,400 cfu/cm^2 Coliforms = 9 MPN index/ml *Salmonella* sp = Not detected in swab	4.2 -0.05	M A
M0938	Swab- Goat 28 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 9 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 -0.05	U A
M0939	Swab- Goat 29 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	U A
M0940	Swab- Goat 30 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	U A
M0941	Swab- Goat 31 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 43MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0.6	U A
M0942	Swab- Goat 32 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 460 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 1.7	U M
M0943	Swab- Goat 33 Lateral brisket	TVC = 520 cfu/cm^2 Coliforms = 93 MPN index/ml *Salmonella* sp = Not detected in swab	2.7 0.97	A M
M0944	Swab- Goat 34 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	U A
M0945	Swab –Goat 35 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	M A
M0946	Swab- Goat 36 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 4 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 -0.4	U A
M0947	Swab- Goat 37 Lateral brisket	TVC = 630 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	2.8 0	A A
M0948	Swab- Goat 38 Lateral brisket	TVC = 900 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.0 0	M 0
M0949	Swab- Goat 39 Lateral brisket	TVC = 4,000 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.6 0	M A

M0950	Swab –Goat 40 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	U A
M0951	Swab- Goat 41 Lateral brisket	TVC = 2,950 cfu/cm^2 Coliforms = 4 MPN index/ml *Salmonella* sp = Not detected in swab	3.5 -0.4	M A
M0952	Swab- Goat 42 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 4 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 -0.4	U 0
M0953	Swab- Goat 43 Lateral brisket	TVC = 15,000 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.2 0	M A
M0954	Swab- Goat 44 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 4 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 -0.4	U A
M0955	Swab- Goat 45 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = <3MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	U A
M0956	Swab – Goat 46 Lateral brisket	TVC = 7,600 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.7 0	M A
M0957	Swab – Goat 47 Lateral brisket	TVC = 2,400 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	2.6 0	A A
M0958	Swab – Goat 48 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = >1,100 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 2.0	U U
M0959	Swab – Goat 49 Lateral brisket	TVC = 11,780 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	2.9 0	M A
M0960	Swab – Goat 50 Lateral brisket	TVC = 180 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	2.3 0	A A
M0961	Swab – Goat 51 Lateral brisket	TVC = 6,300 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.8 0	M 0
M0962	Swab – Goat 52 Lateral brisket	TVC = 7,427 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.9 0	M A
M0963	Swab- Goat 53 Lateral brisket	TVC = 1,820 cfu/cm^2 Coliforms = 3 MPN index/ml *Salmonella* sp = Not detected in swab	2.9 0	M A

M0964	Swab- Goat 54 Lateral brisket	TVC = 1,800 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.3 0	M A
M0965	Swab- Goat 55 Lateral brisket	TVC = 3,800 cfu/cm^2 Coliforms = 23 MPN index/ml *Salmonella* sp = Not detected in swab	3.8 0.4	M A
M0966	Swab- Goat 56 Lateral brisket	TVC = 41,270 cfu/cm^2 Coliforms = 9 MPN index/ml *Salmonella* sp = Not detected in swab	4.3 -0.05	M A
M0967	Swab- Goat 57 Lateral brisket	TVC = 17,730 cfu/cm^2 Coliforms = 9 MPN index/ml *Salmonella* sp = Not detected in swab	4.2 -0.05	M A
M0968	Swab- Goat 58 Lateral brisket	TVC = 2,310 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	1.0 0	A A
M0969	Swab- Goat 59 Lateral brisket	TVC = 15,600 cfu/cm^2 Coliforms = 1,100 MPN index/ml *Salmonella* sp = Not detected in swab	4.2 2.0	M U
M0970	Swab- Goat 60 Lateral brisket	TVC = 29,360 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	U A
M0971	Swab –Goat 61 Lateral brisket	TVC = 1,673 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.2 0	M A
M0972	Swab- Goat 62 Lateral brisket	TVC = 5,900 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.8 0	M A
M0973	Swab- Goat 63 Lateral brisket	TVC = 1,773 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.2 0	M A
M0974	Swab- Goat 64 Lateral brisket	TVC = 12,655 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.4 0	M A
M0975	Swab- Goat 65 Lateral brisket	TVC = 2,445 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.4 0	M A
M0976	Swab- Goat 66 Lateral brisket	TVC = 9,400 cfu/cm^2 Coliforms = 23 MPN index/ml *Salmonella* sp = Not detected in swab	4.0 0.4	M A
M0977	Swab- Goat 67 Lateral brisket	TVC = 640 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	2.8 0	A A

M0978	Swab- Goat 68 Lateral brisket	TVC = 8,600 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.9 0	M A
M0979	Swab- Goat 69 Lateral brisket	TVC = 15,900 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.8 0	M A
M0980	Swab- Goat 70 Lateral brisket	TVC = 2,100 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	3.3 0	M A
M0981	Swab- Goat 71 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 39 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0.6	U A
M0982	Swab –Goat 72 Lateral brisket	TVC = 17,400 cfu/cm^2 Coliforms = 9 MPN index/ml *Salmonella* sp = Not detected in swab	4.2 -0.05	M A
M0983	Swab- Goat 73 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 9 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 -0.05	U A
M0984	Swab- Goat 74 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	U A
M0985	Swab- Goat 75 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	U A
M0986	Swab- Goat 76 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 43MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0.6	U A
M0987	Swab- Goat 77 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = 460 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 1.7	U M
M0988	Swab- Goat 78 Lateral brisket	TVC = 520 cfu/cm^2 Coliforms = 93 MPN index/ml *Salmonella* sp = Not detected in swab	2.7 0.97	A M
M0989	Swab- Goat 70 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	U A
M0990	Swab –Goat 80 Lateral brisket	TVC = >30,000 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected in swab	4.5 0	M A

Samples taken from Gabiley local slaughter facility

Analabs Ref No.	Sample Description	Results	Remarks Log meac/cm^2	Interpretation (EU)
M0458	Swab – Goat 1 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0459	Swab – Goat 2 Lateral brisket	TVC = 1,100 cfu/cm^2 Coliforms = 93 MPN index/ml=9.3 cfucm^2 *Salmonella* sp = Not detected	3.0 1.0	M M
M0460	Swab – Goat 3 Lateral brisket	TVC = 300 cfu/cm^2 Coliforms = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	2.5 -0.4	A A
M0461	Swab – Goat 4 Lateral brisket	TVC = 3,600 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.56 0	M A
M0462	Swab – Goat 5 Lateral brisket	TVC = 700 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A
M0463	Swab – Goat 6 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	2.0 -0.4	A A
M0464	Swab – Goat 7 Lateral brisket	TVC = 800 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 -0.5	M A
M0465	Swab – Goat 8 Lateral brisket	TVC = 500 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.7 0	A A
M0466	Swab – Goat 9 Lateral brisket	TVC = 1,500 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.2 0	M A
M0467	Swab – Goat 10 Lateral brisket	TVC = 600 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.8 0	A A
M0468	Swab – Goat 11 Lateral brisket	TVC = 1,700 cfu/cm^2 Coliforms = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	3.2 -0.4	M A
M0469	Swab – Goat 12 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = 23 MPN index/ml=2.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0.4	A A
M0470	Swab – Goat 13 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0471	Swab – Goat 14 Lateral brisket	TVC = 400 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.6 0	A A

M0472	Swab – Goat 15 Lateral brisket	TVC = 300 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A
M0473	Swab – Goat 16 Lateral brisket	TVC = 600 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.8 0	A A
M0474	Swab – Goat 17 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = 23 MPN index/ml=2.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0.4	A A
M0475	Swab – Goat 18 Lateral brisket	TVC = 1,500 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.2 0	M A
M0776	Swab – Goat 19 Lateral brisket	TVC = 3,100 cfu/cm^2 Coliforms = <3 MPNindex/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	3.9 0	M A
M0777	Swab – Goat 20 Lateral brisket	TVC = 510 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.7 0	A A
M0778	Swab – Goat 21 Lateral brisket	TVC = 260 cfu/cm^2 Coliforms = 4 MPN index/ml=0.43cfu/cm^2 *Salmonella* sp = Not detected in swab	2.4 -0.4	A A
M0779	Swab – Goat 22 Lateral brisket	TVC = 460 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.7 0	A A
M0780	Swab – Goat 23 Lateral brisket	TVC = 940 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	3.0 0	M A
M0781	Swab – Goat 24 Lateral brisket	TVC = 250 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.4 0	A A
M0782	Swab – Goat 25 Lateral brisket	TVC = 210 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.3 0	A A
M0783	Swab- Goat 26 Lateral brisket	TVC = 200 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.3 0	A A
M0784	Swab- Goat 27 Lateral brisket	TVC = 1,520 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.7 0	A A
M0785	Swab- Goat 28 Lateral brisket	TVC = 1,190 cfu/cm^2 Coliforms = 9 MPN index/ml=0.9cfu/cm^2 *Salmonella* sp = Not detected in swab	2.3 -0.05	A A
M0786	Swab- Goat 29 Lateral brisket	TVC = 780 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.9 0	M A

M0787	Swab- Goat 30 Lateral brisket	TVC = 180 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.3 0	A A
M0788	Swab- Goat 31 Lateral brisket	TVC = 330 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.5 0	A A
M0789	Swab- Goat 32 Lateral brisket	TVC = 3,800 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	3.6 0	M A
M0790	Swab- Goat 33 Lateral brisket	TVC = 60 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	1.8 0	A A
M0791	Swab –Goat 34 Lateral brisket	TVC = 1,145 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	3.1 -0.5	M A
M0792	Swab- Goat 35 Lateral brisket	TVC = 170 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.2 0	A A
M0793	Swab- Goat 36 Lateral brisket	TVC = 140 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.1 0	A A
M0794	Swab- Goat 37 Lateral brisket	TVC = 310 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.5 0	A A
M0795	Swab- Goat 38 Lateral brisket	TVC = 340 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.5 0	A A
M0796	Swab- Goat 39 Lateral brisket	TVC = 2,400 cfu/cm^2 Coliforms = 43 MPN index/ml=4.3cfu/cm^2 *Salmonella* sp = Not detected in swab	3.4 0.6	M A
M0797	Swab- Goat 40 Lateral brisket	TVC = 230 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.4 0	A A
M0798	Swab- Goat 41 Lateral brisket	TVC = 3,220 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.3 0	A A
M0799	Swab- Goat 42 Lateral brisket	TVC = 3,000cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	4.5 0	U A
M0800	Swab- Goat 43 Lateral brisket	TVC = 170 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.2 0	A A

M0801	Swab- Goat 44 Lateral brisket	TVC = 410 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.6 0	A A
M0802	Swab –Goat 45 Lateral brisket	TVC = 260 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.4 0	A A
M0803	Swab- Goat 46 Lateral brisket	TVC = 1,040 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	3.0 0	M A
M0804	Swab- Goat 47 Lateral brisket	TVC = 6,900 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	3.8 0	M A
M0805	Swab- Goat 48 Lateral brisket	TVC = 170 cfu/cm^2 Coliforms = <3MPN index/ml *Salmonella* sp = Not detected in swab	2.2 0	A A
M0806	Swab- Goat 49 Lateral brisket	TVC = 348 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	1.5 0	A A
M0807	Swab- Goat 50 Lateral brisket	TVC = 150 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.2 0	A A
M0808	Swab- Goat 51 Lateral brisket	TVC = 1,360 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.6 0	A A
M0809	Swab –Goat 52 Lateral brisket	TVC = 320 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.5 0	A A
M0810	Swab- Goat 53 Lateral brisket	TVC = 4,800 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	3.7 0	M A
M0811	Swab- Goat 54 Lateral brisket	TVC = 280 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.4 0	A A
M0812	Swab- Goat 55 Lateral brisket	TVC = 320 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.5 0	A A
M0813	Swab- Goat 56 Lateral brisket	TVC = 580 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.8 0	M A
M0814	Swab –Goat 57 Lateral brisket	TVC = 2,190 cfu/cm^2 Coliforms = 4 MPN index/ml=0.4cfu/cm^2 *Salmonella* sp = Not detected in swab	3.3 -0.4	M A

M0815	Swab- Goat 58 Lateral brisket	TVC = 160 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.2 0	A A
M0816	Swab- Goat59 Lateral brisket	TVC = 80 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	1.9 0	A A
M0817	Swab- Goat 60 Lateral brisket	TVC = 130 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.1 0	A A
M0818	Swab- Goat 61 Lateral brisket	TVC = 290 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.5 0	A A
M0819	Swab- Goat 62 Lateral brisket	TVC = 130 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3cfu/cm^2 *Salmonella* sp = Not detected in swab	2.1 0	A A
M0820	Swab – Goat 63 Lateral brisket	TVC = 120 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0821	Swab – Goat 64 Lateral brisket	TVC = 1,000 cfu/cm^2 Coliforms = 95MPN index/ml=9.3 cfucm^2 *Salmonella* sp = Not detected	3.0 1.0	M M
M0822	Swab – Goat 65 Lateral brisket	TVC = 350 cfu/cm^2 Coliforms = 6 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	2.5 -0.4	A A
M0823	Swab – Goat 66 Lateral brisket	TVC = 3,400 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.5 0	M A
M0824	Swab – Goat 67 Lateral brisket	TVC = 800 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	M A
M0825	Swab – Goat 68 Lateral brisket	TVC = 110 cfu/cm^2 Coliforms = 5 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	2.0 -0.4	A A
M0826	Swab – Goat 69 Lateral brisket	TVC = 800 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 -0.5	M A
M0827	Swab – Goat 70 Lateral brisket	TVC = 500 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.7 0	A A
M0828	Swab – Goat 71 Lateral brisket	TVC = 1,500 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.2 0	M A

M0829	Swab – Goat 72 Lateral brisket	TVC = 700 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.8 0	A A
M0830	Swab – Goat 73 Lateral brisket	TVC = 1,700 cfu/cm^2 Coliforms = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	3.2 -0.4	M A
M0831	Swab – Goat 74 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = 23 MPN index/ml=2.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0.4	A A
M0832	Swab – Goat 75 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M0833	Swab – Goat 76 Lateral brisket	TVC = 500 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.6 0	A A
M0834	Swab – Goat 77 Lateral brisket	TVC = 300 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A
M0835	Swab – Goat 78 Lateral brisket	TVC = 800 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.8 0	A A
M0836	Swab – Goat 79 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = 43 MPN index/ml=2.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0.6	A A
M0837	Swab – Goat 80 Lateral brisket	TVC = 1,300 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.2 0	M A

Samples taken from Hargeisa local Slaughter House

Analabs Ref No.	Sample Description	Results	Log mean cfu/cm^2	Interpr. (EU)
M1029	Swab – Goat 1 Lateral brisket	TVC = 140 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.2 0	A A
M1031	Swab – Goat 2 Lateral brisket	TVC = 90 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M1032	Swab – Goat 3 Lateral brisket	TVC = 30 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.5 0	A A
M1033	Swab – Goat 4 Lateral brisket	TVC = 20 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.3 0	A A

M1034	Swab – Goat 5 Lateral brisket	TVC = 1,000 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.0 0	M A
M1035	Swab – Goat 6 Lateral brisket	TVC = 40 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.6 0	A A
M1036	Swab – Goat 7 Lateral brisket	TVC = 360 cfu/cm^2 Coliforms = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	2.6 -0.4	A A
M1037	Swab – Goat 8 Lateral brisket	TVC = <10 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.0 0	A A
M1038	Swab – Goat 9 Lateral brisket	TVC = 50 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.7 0	A A
M1039	Swab – Goat 10 Hind Quarter	TVC = 20 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.3 0	A A
M1040	Swab – Goat 11 Lateral brisket	TVC = 180 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.26 0	A A
M1041	Swab – Goat12 Lateral brisket	TVC = 290 cfu/cm^2 Coliforms = <3MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A
M1042	Swab – Goat 13 Lateral brisket	TVC = 80 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.9 0	A A
M1043	Swab – Goat 14 Hind Quarter	TVC = 110 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M1044	Swab – Goat 15 Lateral brisket	TVC = 11,900 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	4.1 0	M A
M1045	Swab – Goat 16 Lateral brisket	TVC = 718 cfu/cm^2 Coliforms = <3MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	A A
M1046	Swab – Goat17 Lateral brisket	TVC = 1,164 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.1 0	M A
M1047	Swab – Goat 18 Hind Quarter	TVC = 25,200 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	4.4 0	U A

M1048	Swab – Goat 19 Lateral brisket	TVC = 130 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.1 0	A A
M1049	Swab – Goat 20 Lateral brisket	TVC = 30 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.5 0.-	A A
M1050	Swab – Goat 21 Lateral brisket	TVC = 60 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.8 0	A A
M1051	Swab – Goat 22 Lateral brisket	TVC = 230 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.3 0	A A
M1052	Swab – Goat 23 Lateral brisket	TVC = 20 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.3 0	A A
M1053	Swab – Goat 24 Lateral brisket	TVC = 80 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.9 0	A A
M1054	Swab – Goat 25 Lateral brisket	TVC = 90 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.0 0	A A
M1055	Swab- Goat 26 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.0 0	A A
M1056	Swab- Goat 27 Lateral brisket	TVC = 360 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.6 0	A A
M1057	Swab- Goat 28 Lateral brisket	TVC = 200 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.3 0	A A
M1058	Swab- Goat 29 Lateral brisket	TVC = 990 cfu/cm^2 Coliforms = 4 MPN index/ml *Salmonella* sp = Not detected	3.0 -0.4	M A
M1059	Swab- Goat 30 Lateral brisket	TVC = 590 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.8 0	A A
M1060	Swab- Goat 31 Lateral brisket	TVC = 190 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.3 0	A A
M1061	Swab- Goat 32 Lateral brisket	TVC = 90 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.0 0	A A

M1062	Swab- Goat 33 Lateral brisket	TVC = 150 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.2 0	A A
M1063	Swab –Goat 34 Lateral brisket	TVC = 240 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.4 0	A A
M1064	Swab- Goat 35 Lateral brisket	TVC = 50 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.7 0	A A
M1065	Swab- Goat 36 Lateral brisket	TVC = 170 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.2 0	A A
M1066	Swab- Goat 37 Lateral brisket	TVC = 60 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.8 0	A A
M1067	Swab- Goat 38 Lateral brisket	TVC = 70 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.8 0	A A
M1068	Swab- Goat 39 Lateral brisket	TVC = 200 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.3 0	A A
M1069	Swab- Goat40 Lateral brisket	TVC = 70 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.8 0	A A
M1070	Swab- Goat 41 Lateral brisket	TVC = 60 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.8 0	A A
M1071	Swab- Goat 42 Lateral brisket	TVC = 170 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.2 0	A A
M1072	Swab- Goat 43 Lateral brisket	TVC = 90 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.0 0	A A
M1073	Swab- Goat 44 Lateral brisket	TVC = 460 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.7 0	A A
M1074	Swab –Goat 45 Lateral brisket	TVC = 290 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.5 0	A A
M1075	Swab- Goat 46 Lateral brisket	TVC = 230 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.4 0	A A

M1076	Swab- Goat 47 Lateral brisket	TVC = 30 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.5 0	A A
M1077	Swab- Goat 48 Lateral brisket	TVC = 50 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.7 0	A A
M1078	Swab- Goat 49 Lateral brisket	TVC = 860 cfu/cm^2 Coliforms = <3MPN index/ml *Salmonella* sp = Not detected	2.9 0	M A
M1079	Swab- Goat 50 Lateral brisket	TVC = 70 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.8 0	A A
M1080	Swab- Goat 51 Lateral brisket	TVC = 170 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.2 0	A A
M1081	Swab- Goat 52 Lateral brisket	TVC = 610 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.8 0	A A
M1082	Swab –Goat 53 Lateral brisket	TVC = 780 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.9 0	M A
M1083	Swab- Goat 54 Lateral brisket	TVC = 90 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.0 0	A A
M1084	Swab- Goat 55 Lateral brisket	TVC = 190 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.3 0	A A
M1085	Swab- Goat 56 Lateral brisket	TVC = 60 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.8 0	A A
M1086	Swab- Goat 57 Lateral brisket	TVC = 60 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.8 0	A A
M1087	Swab –Goat 58 Lateral brisket	TVC = 70 cfu/cm^2 Coliforms = 4 MPN index/ml *Salmonella* sp = Not detected	1.8 -0.4	A A
M1088	Swab- Goat 59 Lateral brisket	TVC = 1,360 cfu/cm^2 Coliforms = 4 MPN index/ml *Salmonella* sp = Not detected	3.1 -0.4	M A
M1089	Swab- Goat 60 Lateral brisket	TVC = 70 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.8 0	A A

M1090	Swab- Goat 61 Lateral brisket	TVC = 210 cfu/cm^2 Coliforms = 4 MPN index/ml *Salmonella* sp = Not detected	2.3 -0.4	A A
M1091	Swab- Goat 62 Lateral brisket	TVC = 60 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	1.8 0	A A
M1092	Swab- Goat 63 Lateral brisket	TVC = 190 cfu/cm^2 Coliforms = <3 MPN index/ml *Salmonella* sp = Not detected	2.3 0	A A
M1093	Swab – Goat 64 Lateral brisket	TVC = 138 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.2 0	A A
M1094	Swab – Goat 65 Lateral brisket	TVC = 100 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M1095	Swab – Goat 66 Lateral brisket	TVC = 40 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.5 0	A A
M1096	Swab – Goat 67 Lateral brisket	TVC = 20 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.3 0	A A
M1097	Swab – Goat 68 Lateral brisket	TVC = 1,030 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.0 0	M A
M1098	Swab – Goat 69 Lateral brisket	TVC = 40 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.6 0	A A
M1099	Swab – Goat 70 Lateral brisket	TVC = 350 cfu/cm^2 Coliforms = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected	2.6 -0.4	A A
M10100	Swab – Goat 71 Lateral brisket	TVC = <10 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.0 0	A A
M10101	Swab – Goat 72 Lateral brisket	TVC = 60 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.7 0	A A
M10102	Swab – Goat 73 Hind Quarter	TVC = 20 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.3 0	A A
M10103	Swab – Goat 74 Lateral brisket	TVC = 190 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.3 0	A A

M10104	Swab – Goat 75 Lateral brisket	TVC = 290 cfu/cm^2 Coliforms = <3MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.5 0	A A
M10105	Swab – Goat 76 Lateral brisket	TVC = 80 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	1.9 0	A A
M10106	Swab – Goat 77 Hind Quarter	TVC = 110 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.0 0	A A
M10107	Swab – Goat 78 Lateral brisket	TVC = 1000 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.0 0	M A
M10108	Swab – Goat 79 Lateral brisket	TVC = 718 cfu/cm^2 Coliforms = <3MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	2.9 0	A A
M10109	Swab – Goat 80 Lateral brisket	TVC = 1,164 cfu/cm^2 Coliforms = <3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected	3.1 0	M A

APPENDIX III: MPN INDEX TABLE

MPN index and 95% confidence limits for various combinations of positive results when various numbers are used. (Inocula of 0.1, 0.01, and 0.001 g)

3 Tubes per dilution

95% confidence Limits

Combination of positives	MPN index per g	Lower	Upper
0-0-0	<3	<0.5	<9
0-0-1	3	<0.5	9
0-1-0	3	<0.5	13
0-2-0	--	--	--
1-0-0	4	<0.5	20
1-0-1	7	1	21
1-1-0	7	1	23
1-1-1	11	3	36
1-2-0	11	3	36
2-0-0	9	1	37
2-0-1	14	3	37
2-1-0	15	3	44
2-1-1	20	7	89
2-2-0	21	4	47
2-2-1	28	10	150
2-3-0	--	--	--
3-0-0	23	4	120
3-0-1	39	7	130
3-0-2	64	15	380
3-1-0	43	7	210
3-1-1	75	14	230
3-1-2	120	30	380
3-2-0	93	15	380
3-2-1	150	30	440
3-2-2	210	35	470
3-3-0	240	36	1,300
3-3-1	460	71	2,400
3-3-2	1100	150	4,800
3-3-3	>1100	>150	>4,800

APPENDIX IV : QUESTIONNAIRE ON FACILITY HYGIENE PRACTICES

Date: dd/month/year……..

Name of Respondent……sex.....age….

Name of city……..

Ownership……..

Average No. of Slaughter per Day……

Goats……

Sheep……

Cattle ……

Camels……

Others …… ……..

No. of Inspectors……

Government/private……

No. of Employees……

Sanitation Standard Operating Procedures (SSOP)

1. Is the location of the slaughter facility subject to water stagnation, floods, objectionable odours, smoke, dust or other contaminants?
   Yes/No
2. Are there hoisting facilities before skinning and evisceration?
   Yes/No
3. Is there a clear demarcation between the dirty area and a clean area during slaughtering and handling?
   Yes/No
4. Are heads, hides, skins and legs removed immediately after slaughter?
   Yes/No
5. Is there a separate room for handling offal?
   Yes/No
6. Is there adequate natural and or artificial light to enable proper operations?
   Yes/No
7. Do you have a disposal pit for condemns that is lockable?
   Yes/No
8. Are floors and walls made of impervious hard material for easy washing and disinfection?

Yes/No

9. Is there a good drainage system?
   Yes/No
10. Are your slaughter equipments e.g. knives, hooks, receptacles and cleaning table for offals made of easy to clean material like stainless steel?
    Yes/No
11. Is there adequate cold and hot potable water (82^0c) for washing used utensils, floor and walls after slaughter?
    Yes/No
12. Is there a provision of washing dirty animals presented for slaughter before slaughter?
    Yes/No
13. Do you ensure that all the equipments are clean before start of slaughter operations?

    Yes/No
14. Do you ensure that all personnel in the slaughter process have protective and clean covering e.g. aprons, head cap, gumboots, sanitary wears? Yes/No
15. How do you maintain your hands clean after visiting toilet or before start of work?

    Wash with warm water and soap/Wash with cold water and soap
16. Have slaughter facility personnel undergone any training on minimum meat hygiene handling practices? Yes/No
17. Do slaughter facility personnel undergo a regular medical check up every year?

    Yes/No
18. What do you do when carcass meat comes in contact with faeces or intestinal contents?

    Wash thoroughly/ Trim the meat or scrub off the faeces.