AN INVESTIGATION OF CONSTRAINTS AND OPPORTUNITIES IN SETTING UP HYGIENE STANDARDS IN SOMALIA MEAT EXPORT INDUSTRY

By

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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 parents who have championed that hard work bears fruit;

To my wife Liliana and my children Mattia and Cecilia who have been very patient, supportive and encouraging during some difficult time and long absence from home.

To my colleagues and friends Graham Farmer, Sergio Innocente, Luca Alinovi, Rodrigue Vinet, Roberta Canulla, Giovanni Simonelli, Wamalwa Kinyanjui, Solomon Munyua, Sophycate Njue and George Matete for their continuous support and friendship.

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Glossary

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

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

Chemical residues:-Residues of veterinary drugs and pesticides that may be found in meat

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

Competent authority:-The official authority charged by the government with the control of meat hygiene, including setting and enforcing regulatory meat hygiene requirements.

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

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

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

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

Meat hygiene:-All conditions and measures necessary to ensure the safety and suitability of meat at all stages of the meat value chain.

Risk-based:-Containing performance and/or process criteria developed according to risk analysis principles.

Sanitation standard operating procedures (SSOPs):-A documented system for assuring that personnel, facilities, equipment and utensils are clean and where necessary, sanitized to specified levels prior to and during operations.

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

Abbreviations

AM:-Ante-Mortem

BCR:-Benefit Cost Ratio

BHI: Brain Heart Infusion

BGA:-Brilliant Green Agar

CAC: - Codex Alimentarius Commission

CBPP:-Contagious Bovine Pleuropneumonia

CCP:-Critical Control Point

CCPP:-Contagious Caprine Pleuropneumonia

CDC:-Centre for Disease Control

CFU:-Colony Forming Unit

EMBA: -Eosin Methylene blue Agar

EU:-European Union

FAO: - Food and Agriculture Organization of the United Nations

GCC:-Gulf Cooperative Council

GHP: -Good Hygienic Practice

GMP:-Good Manufacturing Procedures

GSM: - General Secretariat of Municipalities

HACCP:-Hazard Analysis Critical Control Point

HuCVs:-Human Calicivirus

IFC: -International Finance Corporation

IMVIC:-Indole, methyl red, voges-proskauer and citrate

ITCZ:-Inter–Tropical Convergence Zone

KEBS: - Kenya Bureau of Standards

LIA:- Lyazine Iron Agar

MPN:-Most Probable Numbers

NPV:- Net Present Value

NRA: -National Registration Authority

OIE:-World Organization of Animal Health

PL:-Puntland

PM:-Post-Mortem

PPR:-Peste des Petit Ruminants

RP:-Rappaport-Vasilliadis

RRA: - Rapid Rural Appraisal

RVF:-Rift Valley Fever

SC:-Selenite Cystine

SL:-Somaliland

SMA:-Sorbitol MacConkey Agar

SPS:-Sanitary and Phytosanitary Standards

SSOP:-Sanitary Standard Operating Procedures

TSA:-Tryptone Soya agar

TSI:- Triple Sugar Iron

TVC: - Total viable counts

U.S.:-United States

UAE:-United Arab Emirates

UK:-United Kingdom

US FDA:-United States Food and Drug Administration

VP: - Voges-Proskauer

WB:-World Bank

WHO:-World Health Organization

WTO:-World Trade Organization

XLD:-Xylose Lysine Desoxycholate

Abstract

The study, intervention, data collection and analysis lasted nearly five years from mid 2008 upto the end of 2012. It examined practices that should normally be undertaken to ensure hygiene production of meat. These include the design and layout of slaughterhouses, types of equipment used in slaughtering process and compliance with quality assurance systems, including Good Hygiene Practices (GHP), Sanitary Standard Operating Procedures (SSOPs) and Hazard Analysis and Critical Control Point (HACCP) Principles.

The overall objective of this study was to investigate constraints and opportunities for introducing hygiene standards in export slaughterhouses in two administrative regions of Somalia (Somaliland and Puntland states).

Data collection methodology involved quantitative and qualitative data collection which included swabbing of carcass surfaces, administration of a pre-tested questionnaire, transect-walks, organoleptic inspection and observations to assess the hygiene status of two slaughterhouses, (i.e. H- Foods in Somaliland and Mubarak II in Puntland states of Somalia) and carcasses produced. Additional data was obtained from secondary sources such as the internet and government documents.

A total of 500 samples (250 from each slaughterhouse) were first collected from randomly selected carcasses of small ruminants (sheep and goats) from the two slaughterhouses, using a wet and repeated with a dry non-absorbent cotton wool swabbed in an area of 50 cm^2 delineated by a sterile aluminium template. The swabs were later analyzed for total

viable counts (TVC), *E. coli* counts and presence of *Salmonella* species, within 24-48 hours of sampling. Serotyping for the presence of *E. coli* 0157 sero-group was carried out on all *E. coli* isolates. Biochemical analysis of all suspected *Salmonella* species isolates was done for confirmation purposes.

The second round of sample collection was only carried out from H-Foods export slaughterhouse whereby a total of 85 samples were collected. These were analyzed against TVC and *E. coli* only.

Furthermore, a pre-tested questionnaire made up of 32 questions was administered to collect data on hygiene slaughtering and meat handling practices to identify meat contamination risk factors and critical control points (CCPs) during slaughtering process, meat storage and transportation to airstrips.

H-foods export slaughterhouse complied with 92% of meat contamination risk factors while Mubarak II export slaughterhouse complied with only 46%. There was a statistical difference in the level of non compliance with the guidelines set for export slaughterhouses in Somalia. Based on these results, only 8% of the guidelines were not met in H-foods while in Mubarak II, the level of non compliance was 54%. This difference in level of non-compliance with export guidelines was statistically significant with $Z = 4.92$ which is higher than 1.96 for a normal distribution curve at, p-value < 0.05.

Based on Gulf Cooperative Council (GCC) standards, meat contamination levels were graded either as: -1) Excellent, 2) Good, 3) Fair, 4) Poor or 5) Very Poor for TVC and *E. coli* and Present or Absent for S*almonella* species and *E.coli* 0157 sero-group.

According to GCC standards, basing on TVC levels, only 0.4% of carcasses sampled from H-Foods export slaughterhouse were in poor grade, and therefore could have been potentially rejected in this study. Otherwise, 48.8% were in excellent grade, 48.0% were in good grade and only 2.8% were of fair grade. These could have been accepted in the GCC countries. On the other hand, no carcass from Mubarak II export slaughterhouse was of excellent grade, 11.6% were of good grade, 30.8% were of fair grade, 19.2% in poor grade and 24.4% in very poor grade.

Based on *E. coli* counts, no sample from H-Foods export slaughterhouse could have been rejected. About 96.8% of the carcasses sampled were of excellent grade, 2.8% were of good grade and only 0.4% was of fair grade.

From Mubarak II export slaughterhouse, 19.6% were of excellent grade, 21.2% were of good grade, 25.2% were of fair grade, 12.8% were of poor grade and 21.2% were of very poor grade. Furthermore, 13% of the 250 carcass samples collected from Mubarak II export slaughterhouse tested positive for *salmonella* species, but none from H-Foods export slaughterhouse was positive. The results proved true to the good hygiene meat handling practices (meat contamination risk factors) in H-Foods slaughterhouse and poor hygiene

meat handling practices in Mubarak II slaughterhouse. None of the 500 samples were positive for *E. coli* 0157 sero-group.

None of the 160 excision liver samples collected and analyzed for antibiotic (tetracycline) residues tested positive.

Inferential analysis was done using general logistic regression. Carcasses from Mubarak II slaughterhouse were 264.4 (P-value < 0.001) times more likely to be contaminated as compared with carcasses slaughtered in H- foods slaughterhouse that were swabbed on second round of sample collection. Total viable counts (TVC) were 1.69 (P- value < 0.001) times more likely to contaminate carcass samples when compared with *E. coli*. However, none of the sampled sites had significantly higher level of contamination.

In H-Foods export slaughterhouse, identified CCPs included carcass shrouding, chillers and transportation to airstrip whereas in Mubarak II export slaughterhouse, CCPs were found to be all along the livestock slaughter chain process including livestock receiving and holding in pens, slaughter (sticking), flaying, evisceration and storage in freezer transport trucks where carcasses were hanged on dirty re-used ropes.

An overall net profit of USD 0.9 millions from H-foods was realized over a period of 6 years of operation and USD 0.64 millions was realized from Mubarak II export slaughterhouse over a period of 5 years it operated. The two slaughterhouses were still closed during the time of compiling this thesis.

The study established that a cost of USD 20,000 and 85,000 respectively, was required to in-cooperate HACCP compliance facilities and personnel training for H-Foods and Mubarak II export slaughterhouses respectively.

Cost-benefit analysis showing a benefit cost ratio (BCR) of 1.06 and 1.05 for H- Foods and Mubarak II slaughterhouses respectively revealed that rehabilitation of these establishments and training of personnel would be economically beneficial; further, it would take less than one year for H-Foods export slaughterhouse and more than one year for Mubarak II export slaughterhouse to recover their investment if the management incorporates HACCP compliant facilities and trainings of personnel.

Opportunities of high demand of Somalia small ruminant carcasses in the Gulf Cooperative Countries was found remarkable. However, export of chilled carcasses face several challenges and constraints including stiff competition of meat by stronger exporters (e.g. Australia and Ethiopia), stiff competition from export of live animals from Somalia, poor animal body conditions due to cyclic drought and ban of cargo export from Somalia to GCC countries after some explosives were found on two cargo planes bound for America from Yemen.

Training needs assessment revealed that abattoir workers required trainings in good hygiene meat handling and production practices, standard operating procedures, slaughterhouse waste management and environmental hygiene, sanitary standard operating procedures, and HACCP principles. On the other hand, the management and meat

inspectors should be taken through human resource management training. The meat inspectors need training on meat inspection procedures, disease surveillance, detection and management at slaughterhouses as part of relevant identified trainings.

Several interventions in the two export slaughterhouses were conducted during the study, including training of non-technical and technical workers on good hygiene practices (GHP) and sanitary standard operating procedures (SSOP) as well as standard operating procedures (SOP), which are pre-requisite requirements for establishment of a HACCP system. However, the HACCP system was not implemented as the two slaughterhouses stopped operating due to *force majeure*.

A recommendation of a total overhaul of the slaughterhouses' infrastructure facilities to incorporate physical components that will promote more compliance with implementation of SSOP and HACCP system requirements is advisable. Personnel training in food safety system including GHP, SSOP, SOP, HACCP system, slaughterhouse environmental hygiene and waste management, human resource management with a focus to improve hygiene operation and standards in both slaughterhouses should be regular to mitigate high proportions of natural attrition and improve meat quality.

Chapter 1: Introduction

1.1 Republic of Somalia

The entire central government of the Somali Republic collapsed in 1991 following the ousting of President Mohammed Siad Barre after two decades of dictatorship. Upon its collapse, the country descended into civil war and has remained without an effective central government since 1991 (UN/WB, 2006[1]). However, Somaliland (North West region) which unilaterally declared independence from Somali Republic in 1991 as the Republic of Somaliland, and Puntland (North East region) which followed suite by declaring itself an autonomous regional state of Somalia in 1998, have achieved a significant level of economic and political stability (UN/WB, 2006[1]). Relative peace and stability have encouraged businesses like export of livestock through Bossaso and Berbera ports which have played a key role in stabilizing both Puntland and Somaliland respectively (UN/WB, 2006[1]; FSAU, 2008; FSNAU, 2012).

1.1.1 Topography and climate

Somalia is a resource-rich country with abundant livestock, two rivers, and fertile lands for agriculture, extensive fishery resource base, and some forests in the south. Despite the prolonged instability and insecurity, there has been a dynamic market economy supporting private sector engagement in services, transport and trading (Bradbury, 2008; FSNAU, 2012).

The country's climate ranges from arid to semi-arid and equatorial, characterized by a binomial but highly irregular pattern of rainfall, which is the principal constraint on

agriculture and livestock production. The agricultural zones like the Shebelle and Juba river valleys, the Bay-Bakool regions (Central/Southern Somalia) receive an annual rainfall of about 400-600mm. Major parts of Somalia receive much lower amounts of rainfall at the range of 100-300mm annually (Bradbury, 2008).

The landmass is characterized by arid and semi-arid rangelands dominated by acacia woodlands and scrub grassland, which are more suited to the livelihood of nomadic pastoralism than agriculture (UN/WB, 2006[1]). Rain tends to fall in isolated and heavy storms following an erratic pattern. In the wettest regions, there are typically 40–60 rainy days each year with daily rainfall of the order of 5–15 mm (Bradbury, 2008). Open water evaporation usually far exceeds rainfall and is in the range of 1,600–2,400 mm per year in the south of the country. The mean monthly temperatures range from 15–25°C in the northern mountains to 25–35°C in the south (Bradbury, 2008).

1.1.2 Economy

In Somalia, 80% of the rangelands are used for rearing livestock, which accounts for 80% of agricultural activity (UN/WB, 2006[1]; Bradbury, 2008). Families benefit directly from milk for household consumption and from the income derived from sales of milk and meat, as well as live animals in the internal and export markets (UN/WB, 2006[1]; Bradbury, 2008). Thus livestock is a key local consumption commodity for household food security. It is a basis of social cohesion in Somali society. Animal wealth is linked with key events such as birth, marriage, reconciliation, conflict resolution and peace making. Livestock are cherished assets and their products, especially milk and meat, are associated with peace and prosperity. In times of conflict, escape with livestock is easy as compared to agricultural

products (UN/WB, 2006[1]). Exports of livestock and their products account for 80 percent of exports in normal years **(**UNDP, 2001; Bradbury, 2008, Castiello *et al,* 2011)**.**Livestock are exported to the Kingdom of Saudi Arabia and to the Middle East countries of Gulf Cooperative Council in millions through the ports of Berbera and Bosasso on a large scale (Castiello *et al*, 2011). A few others are exported through the ports of Kisimayo and Mogadishu even though these have adversely been affected by the ongoing war (Holman 2002, Castiello *et al*, 2011). Substantial cattle trade also takes place through Garissa market to serve the Kenyan meat market.

1.1.3 Livestock population

The livestock population of south central Somalia, Puntland and Somaliland was estimated at about 4.6 million cattle, 19 million goats, 11.8 million sheep and 6.3 million camels, giving a total of 41.7 million (Somali Livestock Statistics, 1988/1989; Department of Planning and Statistics, Mogadishu/Somalia, 1989; UN/WB, 2006[2]). However, these population figures are about 10 years old and current figures are not available.

1.1.4 Human population

The human population of south central Somalia, Puntland and Somaliland was estimated at 7.7 million in 2006 and it was projected to rise to 7.9 million in 2007, 8.2 million in 2008 and 8.4 million in 2009 (UN/WB, 2006[2]).

1.2 Food safety

Food safety is defined as an assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use (FAO, 2004). Food safety plays a significant role in the national economic and health development by safeguarding the

health of the nation, enhancing tourism, national and international trade for production, distribution and consumption of safe food, preventing avoidable losses and conserving natural resources. Thus countries with well established food safety assurance systems can export and trade their products without any barriers and become competitive in global trade (FAO/WHO 2005[1]).

Food safety in developing countries and especially in Africa is weak, unable to protect human health. Because of stringent food safety laws of developed nations, many African countries are unable to export their potential raw or processed food. These nations not only lose foreign exchange earnings, they also overstretch the national health services as a result of preventable food borne illnesses and death. As many as one in three persons in industrialized countries, may be affected by food borne illnesses each year (CAC, 2005). This situation is however worse in the developing countries (FAO/WHO, 2002[1]; CAC, 2005; 2009).

1.3 Problem statement and justification

The collapse of the Somalia central government in 1991 and the subsequent civil war resulted in the destruction of key private and public assets that supported development and regulation of the livestock sector. These triggered the resurgence of major epizootic livestock diseases like Rift Valley Fever and Peste des Petit Ruminants (PPR), among others. Following the outbreak of Rift Valley Fever in 1998 and 1999 after the “el Niño” rains, the Kingdom of Saudi Arabia (KSA) and the United Arab Emirates (UAE), the major importers (95%) of Somali livestock, imposed a ban on live animal export in 2000 from Somalia. However, export of chilled carcasses was not affected as it was considered that

export of meat carried comparatively less risk compared to live animals; hence six modern export slaughterhouses were put up for the purpose of meat export by private Somali investors. To maintain the export of Somalia meat, the agreement was that Somali export slaughterhouse facilities were to improve their capacities with respect to meat inspection, certification and hygiene standards. This has not been fully implemented, thus posing a significant risk to the United Arab Emirates (UAE) and the Kingdom of Saudi Arabia authorities that can easily place a ban on meat export (FAO/WB/EU, 2004; UNDP, 2006).It is possible to establish and maintain regionally acceptable meat quality standards, despite the prevailing social, political and economic conditions in Somalia and the absence of a food safety and quality assurance system. This study endeavors to establish contamination points and training needs for hygienic slaughter in the Somalia regions.

Overall objective

The overall objective of this study was to investigate constraints and opportunities for introducing hygiene standards in export slaughterhouses in the two administrative regions of Somalia

Specific objectives

The specific objectives were to:

1. Determine the level of microbial contamination of meat processed in selected export slaughterhouses.
2. Identify the risk factors associated with contamination of meat along the meat production value chain.
3. Establish the presence of antibiotic residues and determine conformity to maximum residue levels standards.

4. Identify Critical Control Points (CCPs) and recommend mitigation measures to improve hygiene standards along the entire meat production value chain.
5. Identify training needs for slaughterhouse personnel on good hygiene practices and meat quality control programs which will enable operationalization of quality assurance standards along the meat production value chain.
6. Assess the costs and benefits of instituting Hazard Analysis and Critical Control Point (HACCP) system and Sanitary Standard Operating Procedures (SSOPs).

Chapter 2:- Literature Review

2.1 Foods of animal origin and disease causing agents

Foods of animal origin have continued to be important or significant vehicles in the transmission of emerging, re-emerging and chemical residue diseases (FAO/WHO, 2002[1]; FAO/WHO, 2005[1]; FAO/OIE, 2006[1]). Thus, there is a strong food safety element in most of these diseases making food safety an essential public health issue in all countries (WHO, 2002; FAO/OIE, 2006[1]). Bacteria that contaminate meat mostly are the direct cause of food-borne diseases and represent a potential cause for drug resistance of human pathogenic agents (Schlegelová *et al*, 2008). Hazards like veterinary drug residues, pesticides and other chemicals like heavy metals and other environmental contaminating agents are additional pollutants that are as important as biological factors.

Therefore, observing hygiene along the line of food production to consumption chain is vital and needs renewal of outlook from government agents, producers and industries (WHO, 2002; FAO/WHO, 2002[2]; FAO/WHO, 2005[2]; FAO/OIE, 2006[2]).

2.2 Drug residues in livestock and their products

A chemical residue can be defined as the presence of a chemical in one or more tissues of the body at some time after administration or exposure, particularly at the time of slaughter or as a veterinary chemical substance administered to or applied in a situation to eradicate a pest infestation, or treat or cure a disease or a condition. Veterinary chemicals include among others vaccines, antibiotics, anesthetics, deworming products and external parasite treatments (ectoparasiticides) (Avcare, 2005; Canadian Food Inspection Agency, 2006; Ellin, 2006; European Food Safety Authority, 2010). Antibiotics are widely used in animal health practice. In Somalia, as in many other countries, antibiotics may be used

indiscriminately for the treatment of bacterial diseases of domestic animals. When laymen administer such drugs, correct dosages are unlikely to be observed as well as advice on withdrawal period before slaughter especially when administration takes place in an uncontrolled environment. Other sources may include failure to recommended label directions or dosage, administering too large a volume at a single injection site resulting in the formation of a depot (especially when long-acting substances are administered), use of drug-contaminated equipment, or failure to properly clean equipment used to mix or administer drugs.

This misuse of antibiotics is a potential hazard to human health. Improper dosages of tetracycline, especially sub-therapeutic doses may lead to the emergence of resistant bacteria like strains of *Salmonella* species., *Campylobacter* species., *Staphylococci* species., Coliforms, *Bacilli*, *Pneumococci*, *Haemolytic Streptococci*, strains of *Haemophilus Influenza* and *Clostridium Welchi* which have been noted (Muriuki *et al*, 2001; Ellin, 2006; Duong *et al*, 2006; Canadian Food Inspection Agency, 2006).

Moreover, forbidden chemical compounds may be added to feeds for illegal administration to farm animals for promoting increased muscle development or increased water retention and thus obtain an economical benefit. The result is a fraudulent overweight of meat, but what is worse, residues of these substances may remain in meat and may pose a real threat to the consumer either through exposure to the residues, transfer of antibiotic resistance or allergy risk (Ellin, 2006; Milagro and Fidel, 2007; European Food Safety Authority, 2010).

2.2.1 Adverse Effects of Veterinary Drug Residues

Veterinary drug residues in meat have been reported to cause toxic or allergic reactions in humans although such reports are uncommon. A few reports indicate that sensitive individuals may experience allergic reactions to antibiotic residues, particularly Penicillin residues in meat. Anaphylactic reactions have been reported to result from consumption of beef or pork containing Penicillin. It is possible that some minor reactions, such as skin rashes may also occur (Ellin, 2006). Additionally, other health problems resulting from intake of sub-chronic exposure levels of tetracycline include gastrointestinal disturbances, poor fetal development, hypersensitivity and other toxic effects. Tetracycline in meat may potentially stain teeth of young children (Muriuki *et al*, 2001).

2.2.2 Control of drug residues in meat

To safeguard human health, FAO/WHO has set standards for acceptable daily intake (ADI) and maximum residue limits (MRL) in foods *inter alia*. These limits apply to both the parent drug or chemical and its metabolites that may accumulate and be deposited or stored within the cells, tissues or organs following the administration of the compound (FAO/WHO, 2006; European Food Safety Authority, 2010). The acceptable maximum residue limit for tetracycline as recommended by the joint FAO/WHO Expert Committee on Food Additives, is 200 µg/kg, 600 µg/kg and 1200 µg/kg for beef, liver and kidney respectively (Muriuki *et al*, 2001).The AD1 is 0-30 µg/kg/BW based on a safety factor of 100 for Tetracycline like Oxytetracycline, Chlortetracycline, and Tetracycline (FAO/WHO, 1998).

2.3 Food-borne disease causing agents

Food-borne diseases are caused by the consumption of contaminated foods or beverages. Bacteria, viruses, parasites, harmful toxins or chemicals can cause contamination. These microbes or toxins when consumed can cause symptoms like nausea, vomiting, abdominal cramps and diarrhea (CDC, 2005). The most commonly recognized food-borne infections are those caused by bacteria such as *Campylobacter* species; *Salmonella* species; *E.coli* O157:H7; *Listeria* species and *Streptococcus aureus*. Other pathogens include a group of viruses called *Calicivirus* (*Norwalk* and *Norwalk-like* viruses) (CDC, 2005). Other infections include *Shigella species.*, *Hepatitis A virus*, *Giardia lamblia* and *Cryptosporidium* species., *inter alia* have occasionally been transmitted through foods (CDC, 2005).

In addition to diseases caused by direct infection, some food-borne diseases are caused by the presence of toxin in the foods. For example, the bacterium *Staphylococcus aureus* can grow in some foods and produce a toxin which causes intense vomiting. Botulism is also a type of intoxication and it occurs when the bacterium *Clostridium botulinum* grows and produces a powerful paralytic toxin in foods. These toxins can cause illness even if the bacteria which produced them are no longer present in the foods (CDC, 2005).

2.4 Specific Viral and Bacterial pathogens associated with foodborne infections and intoxication

2.4.1 *Calicivirus*:

Human *Calicivirus* (HuCVs), especially Noroviruses, are a major cause of food- and water-borne outbreaks in industrialized countries. It is an extremely common cause of food-borne illness, though it is rarely diagnosed, because the laboratory test is not widely available. It causes an acute gastrointestinal illness, usually with more vomiting than diarrhea that resolves within two days. The symptoms of Norovirus illness usually include nausea, vomiting, diarrhea and stomach cramps. Sometimes, people have a low-grade fever, chills, headache, muscle aches and a general sense of tiredness. Unlike many food-borne pathogens that have animals as reservoirs, it is believed that Norwalk-like viruses spread primarily from one infected person to another. Infected kitchen workers can contaminate a salad or sandwich as they prepare it, if they have the virus on their hands. Infected meat handlers have contaminated meat as they slaughtered livestock or prepared meat for human consumption (CDC, 2005 and CDC, 2008).

The first outbreaks of Norwalk virus gastroenteritis in Minnesota were confirmed in 1982. Since then, Norwalk-like *Calicivirus* have been recognized to be the most common cause of food-borne disease outbreaks, accounting for 41% of all confirmed food-borne outbreaks in Minnesota from 1981-1998 (Deneen *et al*, 2000).

2.4.2 Hepatitis A Virus (HAV)

Hepatitis A virus causes an inflammatory disease of the liver. HAV is a non-enveloped, single stranded RNA virus which belongs to the Picornavirus family; genus *Hepatovirus* (Centre for Disease Protection, 2006). The virus can be present in food and cause large outbreaks. Shellfish, especially the bivalves, are considered as high-risk food associated with hepatitis A infections (Centre for Disease Protection, 2006).

Human is the only reservoir of HAV. The virus targets primarily hepatocytes (liver cells). It has no cytolytic activity, but the cell mediated response causes damage to the liver. The disease is usually self-limiting but varies in clinical severity from a mild illness lasting 1 to 2 weeks to a severe disease lasting several months. Onset of illness is abrupt and symptoms may include fever, malaise, nausea, anorexia, abdominal discomfort, dark urine, and jaundice (Centre for Disease Protection, 2006).

2.4.3 *Campylobacter* species

Campylobacter is a bacterial pathogen that causes fever, diarrhea and abdominal cramps. It is the most common bacterial cause of diarrheal illness in the world. The bacterium lives in the intestines of healthy birds and most raw meat can potentially carry it. Eating undercooked chicken or red meats contaminated with juices dripping from raw chicken is the most frequent source of this infection (Cuiwei *et al*, 2001; CDC, 2005). Only low numbers of *C. Jejuni* (2-3 cfu/ml) are needed to produce symptoms of gastroenteritis in humans (Flowers *et al*, 1992).

2.4.4 *Listeria monocytogenes*

Listeria monocytogenes is a small gram-positive, facultative anaerobic, rod-shaped bacterium that is widely distributed in the environment. Outbreaks of listeriosis in humans have been epidemiologically associated with consumption of contaminated raw milk and meat (CDC, 1988; Flowers *et al*, 1992; CDC, 2005). The bacteria cause infections mainly during summer months in pregnant women, newborns, and patients with compromised immunity (such as individuals with HIV/AIDS, lymphomas, subjects to organs' transplants and elderly persons). High mortality rates can occur during pregnancy. During gestation, *L. monocytogenes* can lead to amnionitis (infection of the amniotic sac) and infections of the fetus that can result in the termination of pregnancy (Luis *et al*, 2004). In the United States, an estimated 2,500 persons become seriously ill with listeriosis each year (CDC, 2005).

2.4.5 *Yersinia* species

This genus includes *Yersinia pestis, Y. enterocolitica* and *Y. pseudotuberculosis*. They are small gram-negative bacilli, approximately 0.5-0.8μm wide and 1-3 μm long. *Y. enterocolitica* is distributed worldwide and it can be transmitted to humans through contaminated water and food like meat. It can cause enterocolitis in humans and may mimic acute appendicitis because it can result in mesenteric lymphadenitis, which is associated with severe abdominal pain (Luis *et al*, 2004).

2.4.6 *Salmonella* species

Salmonella is a bacterium that is widespread in the intestines of birds, reptiles and mammals. It can spread to humans via a variety of different foods of animal origin.

Salmonellosis has been an important public health problem worldwide. The following serotypes are the most often recovered from raw foods: *S. Typhimurium, S. Heidelberg, S. Thompson, S. Newport, S. Enteritidis and S. Dublin (*CDC, 2007[1]*).*

The bacterium has been known to cause enteritis in man for over 100 years. Salmonellosis causes symptoms that include fever, diarrhea and abdominal cramps. In persons with poor underlying health or weakened immune systems, it can invade the bloodstream and cause life-threatening infections (Flowers *et al*, 1992; CDC, 2005; CDC, 2007[1]). Raw milk and poultry meat are important vehicles for transmission of salmonellosis. Every year, approximately 40,000 cases of salmonellosis are reported in the U.S. Children, the elderly and the immuno-compromised are the most likely to suffer severe infections. It is estimated that approximately 600 persons die every year of acute salmonellosis (Holt *et al*, 2003; Sonja *et al*, 2004; CDC, 2007[1]).

2.4.7 Enteropathogenic *Escherichia coli*

Enteropathogenic *Escherichia coli* are gram-negative non-spore forming rods belonging to the coliform group. This bacterium has four recognized classes of entero-virulent E. *coli*. These include; 1) Enterohaemorrhagic *E.coli*, 2) Enterotoxigenic *E. coli*, 3) Enteroinvasive E.*coli* and 4) Enteroaggregative *E.coli* (CDC, 2006, 2007[2]).

Enterohaemorrhagic *E.coli* 0157:H7 and more recently 0103, 026:H11 and 0145 have been implicated in human illness causing hemorrhagic colitis. It is characterized by watery or grave overtly bloody diarrhea and vomiting. Patients often suffer hemolytic uremic syndrome, which may cause severe renal failure due to permanent kidney damage necessitating transplant. This occurs mainly in children, the elderly and immuno-

compromised (Flowers *et al,* 1992; Victor *et al,* 1993; Arimi *et al,* 2000; Omisakani *et al,* 2003;U.S FDA, 2006; CDC, 2006, 2007[2]).

Cattle and other ruminants have been established as major natural reservoirs of the bacteria playing a significant role in the epidemiology of human infections. It has been established that upto 4% of United Kingdom cattle are infected at slaughter (Omisakani *et al,* 2003). When food contaminated with *E. coli* 0157:H7 is consumed raw, it may cause the disease. The presence of *E. coli* in food is an indication of fecal contamination indicating poor hygiene during food production like milking, livestock slaughter for meat *inter alia* (Kang'ethe, 1993; Arimi *et al,* 2000; Ifigenia *et al,* 2001; US FDA, 2006; CDC, 2006, 2007[2]; Nafisa *et al*, 2010, Wamalwa *et al,* 2011[2]).

2.5 Control of food-borne diseases/ illnesses

Food must be safe and suitable for human consumption. Therefore, all interested parties including governments, industries and consumers have a role in achieving this outcome (FAO/WHO, 2005[2]). Transmission of food safety hazards of animal health importance via food chain and associated by-products, can result in high economic loss in animal populations. Rapidly increasing trade in food at both local and international level is resulting in increased attention to biosecurity and the potential for the transmission of animal diseases and zoonosis via the food and feed chain (FAO/OIE, 2006[2]; Justyna and Edward, 2007; Codex Alimentarius Commission, 2014).

In order to ensure food safety and good quality, it is necessary to consider the whole food production, distribution and consumption chain from farm to fork as hazards arising in

primary production can often impair safety of the final food product (FAO/OIE, 2006[1]). The primary goal should aim at reducing food-borne risks to human health by preventing, eliminating, reducing or controlling hazards that can arise during the primary processing of food (FAO/OIE, 2006[2]; Codex Alimentarius Commission, 2014).

2.5.1 Food safety concerns

Food safety is a global concern, not only because of the importance for public health, but also because of its impact on international trade. Globalization of food production and procurement makes food chains longer and more complex and increases the risk of food safety incidents. Effective and harmonized food safety systems shall manage and ensure the safety and suitability of food in each link of the supply chain. This can effectively be achieved through strengthening and building the capacity of public and private sectors and the establishment of public- private partnerships in fragile states recovering from civil instability (Wamalwa *et al*, 2011[1];Wamalwa *et al*, 2012). Public- private partnership under established management systems will ensure sustainability of programs such as meat sector enterprises by enhancing the skills and capacities of slaughterhouse workers and by increasing the public's access to the unique expertise and core competencies of the private sector thereby guaranteeing the consumers of safe products with minimal food-borne pathogens (Wamalwa *et al*, 2011[1]; Wamalwa *et al*, 2012).

2.5.2 Quality assurance

'Quality assurance' refers to all the planned and systematic activities implemented within the quality system and demonstrated as needed to provide adequate confidence that an entity will fulfill requirements for quality while 'Quality system' refers to the

organizational structure, procedures, processes, and resources needed to implement quality assurance (FAO/WHO, 2005[2]).

To ensure that food is safe for human consumption, it should be produced according to the following criteria: it should meet all food safety requirements appropriate to its intended end use, it should meet risk-based performance and process criteria for specified hazards, it should not contain hazards at levels that are harmful to human health (FAO/WHO, 2005[1]) and it should be produced in accordance with Good Manufacturing Practices (GMP), Good Hygiene Practices (GHP),Sanitary Standard Operating Procedures (SSOP), Hazard analysis and critical control point (HACCP) principles. Human capacity building in these areas should be achieved through training of slaughterhouse workers and upgrading meat production facilities, equipment and tools to keep pace with advancing food safety standards (USDA, Food Safety and Inspection Services, 1999; Belk *et al*, 2001; Almond Board of California, 2005; CAC, 2008, Wamalwa *et al*, 2011[2]; International Accreditation Forum, 2014).

2.5.3 Public health hazard mitigation procedures

It is imperative that governments, private and public sectors, consumers and other meat sector stakeholders work in a concerted and synergistic manner in the shared responsibility of assuring meat safety from farm-to-fork. Cooperation and linkages at the national, sub-regional, regional and international levels provide opportunities for synergy and maximized benefits for improved human health and economic development both at local and export levels (Wamalwa *et al*, 2011[1]).

For pragmatic public health hazard mitigation, it will be prudent that Hazard Analysis and Critical Control Point (HACCP) principles approach be applied. Food producers, processors and traders should operate according to the principles of good agricultural/hygienic/manufacturing practices. Food production, processing and all related handling operations should be analyzed with a view to identifying hazards and assessing associated risks. These should lead to the identification of Critical Control Points (CCP) under the establishment of a system so as to monitor production at these points (FAO/WHO, 2002[1]).

The establishment operators should apply the seven HACCP principles namely: (1) Conduct a hazard analysis, (2) Identify critical control points (CCP) (3) Establish critical limits for each CCP (4) Establish CCP monitoring requirements (5) Establish corrective actions, (6) Establish procedures for ensuring the HACCP system is working as intended and (7) Establish record keeping procedures (US-FDA, 1997; US-FDA, 2001; FAO/WHO, 2005[1]; CAC, 2008).

To the greatest extent possible, the HACCP principles should also be applied in the design and implementation of hygiene measures throughout the entire food value chain (US-FDA, 1997; US-FDA, 2001; FAO/WHO, 2005[1]; CAC, 2008; International Accreditation Forum, 2014). As indicated in Figure 1 below, CCPs can be identified along meat process chain depending on hazard control measures put in place for mitigation purposes.

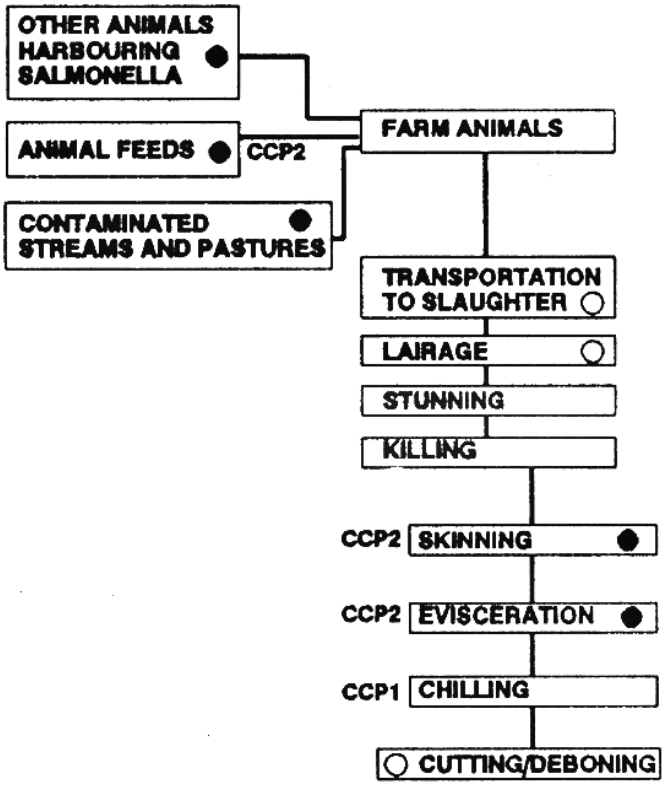

Figure 1: Critical points of bacterial contamination

Diagram showing sources of bacterial contamination (FAO, 1994, modified)

2.5.4 Sanitary Standard Operating Procedures (SSOP)

This is a documented system for assuring that personnel, facilities, equipment and utensils are clean and where necessary, sanitized to specified levels prior to and during operations. They are procedures taken to prevent product food contamination or adulteration (CAC, 2004; Almond Board of California, 2005).

Abattoir sanitation must address hygiene of its environment, processing equipment, all structures and employees. These procedures or practices must be documented and if possible displayed at key or strategic points in the slaughter facility in a language to be

easily read and understood by all employees. Moreover, documentation is vital for external regulatory agencies where they are legally established and have the legal backing of the law enforcing agencies. There should be written proof for regulatory agencies or inspectors of the abattoirs' cleaning and sanitation procedures. Operations with poor sanitation in any slaughterhouse environment can significantly increase the risk of contaminating meat. Pathogenic microorganisms may be found in the lairage, dirty animals, killing floor, slaughter tools, transport trolleys and meat carriers, the chiller, toilets, personnel *inter alia*. Without good sanitary procedures, any surface that comes in contact with meat is taken as a potential source of microbial contamination (Almond Board of California, 2005).

Sanitation procedures must be documented, describing chemicals to be used and mixing instructions, cleaning procedures for each piece of equipment and contact time required for cleaning compounds and sanitizers by a designated trained sanitarian. Adequacy of cleaning must be evaluated, documented, and verified by a designated supervisor where there is provision for such. Sanitizing agent must have documented evidence that it actually is effective against bacteria such as *Escherichia coli, Salmonella* among others. Time for an equipment to be sanitized is equally important (Almond Board of California, 2005; CAC, 2009).

2.6 Cost benefit analysis of instituting quality assurance system

Food processing firms might be required to implement HACCP systems, with the goal that specific processes will be followed and the resulting products will be safer for consumption. Quality standards can be formulated by public organizations as mandatory (e.g. HACCP in the EU) or private institutions can also propose voluntary adoption. In

general, quality standards composition is a handbook with standard requirements and interpretations, a self-control checklist and an audit checklist; other standards are usually provided only with guidelines. The requirements are in most cases in different hierarchical dimensions (Stephanie and Gerhard, 2006).

To estimate the costs of a quality improvement scheme, three alternative approaches should be considered: engineering analysis approach; accounting approach and econometric estimation approach (Stephanie and Gerhard, 2006). In contrast to quantitative cost estimations, at firm level, the benefits of compliance with quality norms and standards have often been assessed in a qualitative manner. In addition, two further approaches are typically used to estimate the benefits of a quality system or improvements in food safety: the willingness-to-pay-approach and the cost-of-illness method (Stephanie and Gerhard, 2006). In this study, three alternative approaches were used: engineering analysis, accounting and econometric estimation. The intervention through conducting environmental impact audit, trainings and supply of basic equipments were meant to provide a conducive environment for adoption and compliance with HACCP system which could promote processing of high quality carcasses to mitigate losses through heavy bacterial contamination. Further, infrastructural refurbishment and rehabilitation, fixing or construction of slaughterhouse facilities were to be done to install HACCP compliant faculties but closure of the two slaughterhouses mid way the study terminated the system establishment.

2.7 Gulf Co-operative Council (GCC) Standards

Whenever possible and practical, competent authorities formulate food safety objectives (FSOs) and related standards according to risk based-approach so as to objectively express the level of hazard control that is required to meet public health goals. Thus, competent authorities should have the legal power to set and enforce regulatory meat hygiene requirements, and have the final responsibility for verifying that regulatory meat hygiene requirements are met both for local consumption and export purposes (FAO, 2004). In view of this, the United Arab Emirates (UAE) mandated the General Secretariat of Municipalities (GSM) as the authority to set, monitor and control standards of foods including meat from exporting countries like the Republic of Somalia and others. For these countries to continually export to the UAE, they have to meet the following levels of meat contamination criteria. Meat with contamination levels in the categories of poor and very poor are not allowed in their markets (Table 1).

Table 1: GCC Microbiological meat contamination standards, Dubai Municipality Annual report (2008)

Grade	**Grade**	**APC (TVC)**	***E. coli***	***S. aureus***	***Salmonella***
A	Excellent (E)	<200	<3	<2	Absent
B	Good (G)	201-2000	3-10	2-20	Absent
C	Fair (F)	2001-20,000	11-100	21-100	Absent
D	Poor (P)	20,001-200,000	101-1,100	101-500	Absent
E	Very poor (VP)	>200,000	>1,100	>500	Present

2.8 Sample collection methods

2.8.1 Wet and dry swabbing method

Meat surface swabs are collected from the neck, brisket, flank and rump (cattle) and flank, forelimb, brisket and breast (sheep and goats). The procedure for wet swabbing involves moistening non-absorbent cotton wool swabs in 0.1% sterile peptone salt diluents for at least 5 seconds prior to sample collection. The sampling area for swabbing covers 100 cm^2 for cattle and horses, but 50 cm^2 for pigs, sheep and goats per sampling site. The moistened swab is rubbed initially vertically, then horizontally and finally diagonally for not less than 20 seconds across the delineated swab site. As much pressure as possible is applied. Swabbing using a dry non-absorbent cotton wool swab at the same site is repeated. The samples collected from the four sampling sites of each tested carcass may be analyzed separately or may be pooled in one container before examination. The sample is placed aseptically into a sample container or plastic dilution bag at the slaughterhouse for transfer to the laboratory (Kang'ethe, 1993; Nafisa *et al*, 2010).

2.8.2 Excision sampling method

The sampling sites are neck, brisket, flank and rump (cattle) and flank, thorax lateral, brisket and breast (sheep and goats).The procedure involves obtaining four tissue samples representing a total of 20 cm^2 from each carcass 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 sterile instrument. Samples from the four sampling sites of each tested carcass may be analyzed separately or may be pooled in the same container before examination. The samples are placed aseptically into a sample container or plastic dilution bag and kept in a cool box containing dry ice for transfer to the laboratory (Nafisa *et al*, 2010).

2.8.3 Isolation of salmonella organism

The procedure involves gently mixing the swab sample mixture using vortex mixer followed by transferring 1 ml mixture to 10 ml selenite cysteine (SC) broth tube and another 1 ml mixture into a 10 ml tetrathionate (TT) broth. The SC and TT broths are incubated at 35^0C for 24 ± 2 hours. The mixture of incubated TT is streaked on prepared plates of bismuth sulphite (BS) agar and xylose lysine desoxycholate agar (XLD). BS plates are prepared a day before streaking and stored in dark at room temperature until they are streaked. The same is repeated with 3 mm loopfuls of SC broth and incubated at 35^0C for 24 ± 2 hours (FAO, 1992).

Colony appearance

Bismuth sulphite: Typical Suspicious *salmonella* spp. colony may appear brown, gray or black and sometimes have metallic sheen. The surrounding medium is usually brown at first, but may turn black in time with increasing incubation, producing so-called halo effect. Some strains may produce green colonies with little or no darkening of surrounding medium (FAO, 1992). These will be treated as suspicious colonies for *Salmonella* spp.

Xylose lysine desoxycholate agar: Pink colonies with or without black centers will be observed. Many cultures of *salmonella* may have large, glossy black centers or may appear almost completely as black colonies. Atypically, a few *salmonella* spp. produce yellow colonies with or without black centers (FAO, 1992). These will be treated as suspicious colonies for *Salmonella* species.

Confirmation of Suspicious *Salmonella* species Colonies:

Two or more suspicious colonies, if present, are selected from each XLD and BS plate having growth. These are inoculated in Triple Sugar Iron (TSI) slant by streaking slant and stabbing butt. Without flaming, Lysine Iron Agar (LIA) slant is inoculated by stabbing butt twice and then streaking slant. Plates are retained at 5-8°C. TSI Agar is incubated at 35-37°C for 22-26 hrs. Incubate LIA at 35-37°C for46-50 hrs. (FAO 1992; Mindy *et al*, 2003).

Examination of TSI and LIA Slants for Presumptive Positive Cultures:

Triple Sugar Iron Agar: Presumptive positive cultures have alkaline (red) slants and acid (yellow) butts, with or without H_2S production (blackened agar). H_2S negative slants are not excluded.

Lysine Iron Agar: Presumptive positive cultures should have an alkaline (purple) slants and alkaline butts. Only a distinct yellow coloration in the butts should be an acid (negative) reaction.

All cultures that give an alkaline butt in LIA, regardless of TSI reaction, should be retained as potential *Salmonella* isolates and submitted for biochemical and serological tests. Cultures that give an acid butt in LIA and alkaline slant and acid butt in TSI should also be considered potential *Salmonella* isolates. Cultures that give an acid butt in LIA and an acid slant and acid butt in TSI may be discarded as non-*Salmonella* (Mindy *et al*, 2003).

Serological confirmation of *Salmonella* organisms

The presence of *Salmonella* antigens is tested by slide agglutination with the appropriate sera, from pure colonies after auto-agglutinable stains have been eliminated. This method relies on the antibody/antigen reaction between a test culture and commercially prepared antiserum. The antigens to be tested for in this study will be Polyvalent Flagellar (H) and polyvalent somatic (O) (Mindy *et al*, 2003).

Polyvalent Flagellar (H) Test: Growth from each urease negative TSI slant is inoculated into 5 mL Brain Heart Infusion (BHI) broth and incubated for 4-6 hrs at 35-37°C until visible growth occurs. 2.5 mL formalinized saline solution is added to the broth culture. Two formalinized broth cultures are added and tested with *Salmonella* polyvalent flagellar (H) antisera. Further 0.5 mL of formalinized culture is added to 0.5 mL of polyvalent flagellar (H) antiserum in a small test tube (10 × 75 mm). Saline control is prepared by mixing 0.5 ml formalinized saline with 0.5 mL antiserum. The mixture is incubated in at 48-50°C water bath and observed for agglutination at 15 min. intervals. Results are read after one hr (Table 2).

Polyvalent somatic (O) Test: Using a wax pencil, test and control sections (about 1 cm square) are marked off on a glass slide; a heavy suspension is prepared by emulsifying a loopful of culture from the presumed-positive TSI slant in 1 mL saline solution. One (1) drop of the polyvalent O antiserum is placed on the test section and 1drop of the saline solution on the control section. A loopful of culture suspension is transferred to the saline drop. The loop is flamed and a second loopful of the suspension is transferred to the

antiserum section. The slide is tilted in a back-and-forth motion for 1 min. The slide is read and any degree of agglutination is considered as a positive reaction (Table 2) (Mindy *et al*, 2003).

Table 2: Agglutination reading

Result	Test	Control
Positive	Agglutination	No agglutination
Negative	No agglutination	No agglutination
Non-specific	Agglutination	Agglutination

2.9 Antibiotic residues in meat

Tetracyclines have been the most commonly abused antibiotics in Somalia by pastoralists who have been administering the drugs to their livestock since they consider it a wonder drug for treatment of all ailments. Provision of veterinary services by professionals has been missing in this country because of the ongoing conflict since 1991 when the Central government collapsed. As a consequence of this situation, there is no framework neither enough educated professional people, who can effectively ensure that administration instruction and withdrawal period are observed when animals are treated.

2.10 Sample analysis methods

2.10.1 Plate count agar (PCA)

Plate count agar is suitable for estimating total viable 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

results from the multiplication of a single bacterial cell on the surface of the agar (FAO, 1992; Roberto *et al,* 2005). The procedure involves thoroughly mixing the food sample using a vortex mixer or mechanical blender. Then 9 ml of normal saline are transferred using a sterile pipette into 10 different sterilized test tubes that are well labeled. Serial dilutions are carried out into these tubes using separate sterile pipettes. First, 1 ml of the food sample homogenate is transferred into tube 1 to make a serial dilution of 10^{-1}. From tube 1, 1 ml is transferred into tube 2 using a separate sterile pipette to make a serial dilution of 10^{-2}. These decimal preparations should be continued upto 10^{-10} depending on the estimated levels of food contamination. One (1) ml of each dilution is pipetted into separate sterilized duplicate, appropriately marked petri plates. To this, 10-15 ml of the PCA cooled to 45-46^{0}C is added to each plate within 15 minutes of original dilution. The sample dilutions and agar medium are immediately mixed thoroughly and uniformly. Agar is allowed to solidify, petri plates are inverted, and incubated promptly for 24-48 ± 2 hours at 37^{0}C. After incubation, colonies from duplicate plates having 300 or fewer colonies are counted, using a colony counter (FAO, 1992; Roberto *et al*, 2005; Siham and Taha, 2009; Martínez, 2010).

2.10.2 Total coliforms count and fecal coliforms test method

Total coliforms are determined by the most probable numbers (MPN) method. The procedure involves thoroughly mixing a swab food sample using a mechanical mixer e.g. vortex mixer. One (1) ml is then transferred into the first of the four sterilized test tubes containing 9 ml of peptone water using a sterilized pipette. This makes serial dilution 10^{-1}. From tube 1, 1 ml is transferred into tube 2 to make dilution 10^{-2}. The same is repeated upto serial dilution 10^{-4} depending on the estimated density of coliforms in food (FAO,

1992; Martínez, 2010). Then 1 ml portions are transferred to 4 sterilized and labeled tubes containing 9 ml single strength MacConkey broth for each dilution using separate sterilized pipettes. All the MacConkey broth tubes must contain Durham tubes to hold any gas that may be produced as a result of lactose fermentation by the coliforms after the incubation period. It is important to ensure that the whole process does not take more than 15 minutes from the time the sample is blended until all dilutions are in appropriate media to minimize external contamination. The tubes are incubated for 48 ± 2 hours at 37^0C. After 24 hours of incubation, the tubes are examined for gas production collected in Durham tubes and color change of the broth from purple to brown. The negative tubes are re-incubated for an additional 24 hours. Gas production and color change of the broth is an indication of coliforms presence (FAO, 1992; Martínez, 2010).

Confirmatory test on all positive tubes for coliforms

Each gassing MacConkey broth tube is agitated followed by transferring loopful of suspension to a tube of 5 ml brilliant green bile broth. The tubes are incubated for 48 ± 2 hours at 37^0C. Tubes showing gas production should be recorded. The MPN of total coliforms count can be calculated based on the combination of confirmed MacConkey broth tubes of 3 consecutive dilutions (FAO, 1992).

Confirmatory test for fecal *E. coli*

Each gassing MacConkey broth tube is gently agitated followed by transferring loopful of each suspension to tubes of 5 ml Tryptone water. These are incubated for 48 ± 2 hours at 44^0C. After 48 hours, a few drops of Kovacs reagent are added to each tube. Pink coloration is considered positive for fecal E.*Coli* while no color change for the tube is

considered negative. The MPN of fecal E. *coli* is calculated based on the proportion of confirmed pink tubes for three consecutive dilutions (FAO, 1992).

Characterization of E. *coli*

The procedure involves streaking loopfuls of suspension from each pink colored tube to prepared plates of Levine eosin methylene blue agar. The plates are incubated for 24 hours at 37^0C. Typical metallic sheen appearance colonies are observed if the sample has E. *coli*. Gram stain procedure is then performed on each metallic sheen colony. Cultures that appear as Gram-negative, short rods or cocci are characterized further using IMVIC tests (FAO, 1992).

Indole, Methyl red, Voges-proskauer and Citrate (IMVIC) test

This involves inoculating the tube of tryptone water with *E. coli* positive samples and incubating it for 24 hours at 35^0C. After the incubation period, test for Indole is carried out by adding 0.2-0.3 ml Kovacs' reagent. The appearance of distinct red color in the upper layer is positive test (FAO, 1992; Bridson, 1998).

Voges-Proskauer reactive compounds: the procedure involves inoculating the tube of MR-VP medium with *E. coli* positive samples and incubating it for 48 ± 2 hours at 35^0C. This is followed by transferring1 ml to 13 x 100 ml tube. Then 0.6 ml alpha-naphthol solution and 0.2 ml 40% KOH are added and shaken. A few crystals of Creatine are then added and shaken and allowed to stand for 2 hours. The test will be positive if eosin pink color develops (FAO, 1992; Bridson, 1998).

Methyl-red reactive compounds:-this involves incubating MR-VP tube for an additional 48 ± 2 hours at 35^0C after performing voges-proskauer test. Then 5 drops of methyl-red solution are added to each tube. Development of a yellow color is positive for *E. coli* presence, while color change to distinct red is indicative of other species (FAO, 1992; Bridson, 1998).

Utilization of citrate: The procedure involves lightly streaking the tube of Koser citrate agar and incubating it for 48 hours at 37^0C.Lack of color change from green to blue will be positive for E. *coli*. *E. coli* does not utilize citrate; therefore the color of the medium remains green (FAO, 1992; Bridson, 1998).

E. coli should be ++-- or -+-- on IMVIC test to be positive.

2.10.3 *Escherichia coli* O157 sero-group detection

The procedure involves transferring a loopful from total coliform positive tubes to prepared Sorbitol MacConkey Agar (SMA) petri dishes using a sterilized wire loop. The plates are then incubated at 37^0C for 24 hours. Development of colourless colonies is indicative of the presence of E. *coli* O157 sero-group, which is non-Sorbitol fermenter. Otherwise, majority of *E. coli* isolates ferment Sorbitol giving characteristic pink colonies. Some colourless colonies from SMA are further sub-cultured on SMA and incubated at 37^0C for 24 hours. Colonies that appear colourless are tested using E. *coli* 0157 latex agglutination test kit to see if they can cause agglutination (Agaoglu *et al*, 2000).

Latex Agglutination test

The test method involves bringing the latex reagents to room temperature making sure that the latex suspensions are mixed by vigorous shaking. Any latex from the dropper pipette is then expelled for complete mixing. One (1) drop of the test latex is dispensed onto a circle on the reaction card. It is placed close to the edge of the circle. Some loopfuls or Pasteur pipette drop of normal saline should be added to the circle, ensuring that the latex and the normal saline do not mix at this stage. Using a wire loop, a portion of the colorless colony from sorbitol MacConkey agar is picked and carefully emulsified in the normal saline drop ensuring that the resulting suspension is smooth. The test latex is mixed with the resulting mixture from normal saline and the colorless colony and spread to cover the reaction area using the flamed loop. The card is then rocked in a circular motion while observing for agglutination. The card is rocked for no more than one minute.

No magnifying glass should be used to observe for agglutination. If agglutination occurs, then a further portion of the colony is tested to ensure that the isolate is not an auto-agglutination strain (Bridson, 1998; Agaoglu *et al*, 2000).

2.11 Sampling for antibiotic residues analysis

Approximately 50 to 100 grams of labeled liver samples are obtained from the randomly selected carcasses. The sampled liver pieces are wrapped in polythene bags, put in cool boxes with dry ice or freezer packs at 4^0C, and subsequently transported to laboratory for analysis. The samples are stored at minus 20^oC until the time of analysis. The samples are then qualitatively screened for tetracycline residues using the agar inhibition test. The

inconclusive samples can further be analyzed using high-performance liquid chromatography (HPLC) (Muriuki *et al*, 2001; Duong; 2006).

2.12 Methods for tetracycline Analysis

2.12.1 Microbiological Inhibition Test

All samples are analyzed using the microbiological inhibition test with *Bacillus cereus* (ATCC 11778) as the reference strain; oxytetracycline discs (Mast Diagnostics 0.5 μg/disc as control, on agar test, pH 6. The sterile bottles of medium should be sterilized in an autoclave at 121°C for 15 min; subsequently placed in a water bath at 55°C and left for at least 30 min until they reach the temperature of the water bath. The media is added with the appropriate volumes of inoculums (*Bacillus cereus* spore suspension), gently mixed and poured into 90 mm-diameter sterile plastic plates on a leveling platform with 5 mL/plate. Liver samples are then removed from the freezer and placed at room temperature for up to 20 min. An 8 mm-diameter cylindrical core from each liver sample is cut using a stainless cork borer. The core is subsequently cut into slices of 2 mm thickness using a sterile scalpel blade. Two slices from each sample are placed opposite each other on a plate using forceps; a positive control disc being placed in the center of the plate. Plates are incubated at 30°C for approximately 18 hours. Plates are read against a black background with a light from underneath. Zones of inhibition given by the tissue slices and control discs are measured to the nearest mm using a ruler. Positive results are indicated by the complete inhibition of bacterial colony growth around both meat slices in a zone of 12-millimeter diameter or greater (the anular zone not less than 2 mm wide). Negative results are indicated by no inhibition of growth around the meat slices (Duong *et al*, 2006).

2.12.2 Analysis by high-pressure liquid chromatography (HPLC)

Sample preparation

Five grams of the organ to be analyzed are weighted using a balance, then cut into very small pieces and subsequently ground into fine powder using a conventional meat grinder. The latter is blended three times with 20 and 30 ml aliquots of Mcllvaine buffer (pH 4.0): methanol (3:7) using a high speed Elmore Parker blender and then centrifuge with Heraeus-Christ GMBH, Hannover, at 2000 ´ g for ten minutes. This is filtered using Whiteman filter paper. The filtrate is then collected in a clean beaker and the supernatant discarded. The filtrate is applied on a Baker 10 C_{18} cartridge, activated with water and methanol and the cartridge is washed twice with 20 ml of water. The tetracycline has to be eluted with 10 ml of 0.01 ml methanolic oxallic solution and collected in 10 ml volumetric flask. The extracted tetracycline should then be analyzed, identified and quantified by use of the HPLC method (Muriuki *et al*, 2001; Thiraporn *et al*, 2005).

Analysis for tetracycline residues

Tetracycline residues determination is done using a high-pressure liquid chromatography equipped with a constant flow pump and a variation wavelength UVdetector set at 350 nm. The separation is done on Lichrosorb RP-18 (10 mm, 250 ´ 4.0 mm I.D.E Merck) column with methanol-acetonitrile-0.01 M aqueous oxalic acid solution pH 2.0 (1 : 1.5 : 2.5) as the mobile phase (methanol-acetonitrile-0.01 M flow-rate of 2 ml/min at room temperature and the sensitivity range being 0.08 ppm.) For determination of tetracycline, several blanks (methanol only) and OTC and OTC standard solution (25ml) % concentrations: 10.5, 2.5, 1.25, 1.0, 0.5, 0.25 and 0.1 ppm are injected manually using 10 ml syringe in a descending order and their corresponding areas (concentrations), are recorded only if the retention time

is equal to 4.5 minutes which is the retention time for oxytetracycline. This is done in triplicates for the samples. Results for the positive samples are plotted automatically on the recorder whose attenuation is 128. To get the concentration of a given sample, a reference standard of a known concentration is injected into the HPLC and concentration of the sample is extrapolated from the curves peak height. This is done in triplicate each. A given sample can only be regarded as positive for tetracycline if its retention time and peak corresponds to that of the standard. The recorder is operated at 10 mv with a chart speed of 5 min/min. Since the concentration of standard will be known, calculations to get the concentration of the samples can be carried out as follows:

$$\text{Sample (y) Conc.} = \frac{\text{Area of sample peak (Y cm}^2\text{)} \times \text{X ppm} \acute{} \ 100\%}{\text{Area of standard peak (X cm}^2\text{)}}$$

X cm of the standard represents x ppm. Y cm. of a given sample (component) represents y ppm, where x and y are peak heights (cm) of the standard and component with the same retention time (Muriuki *et al*, 2001; Thiraporn *et al*, 2005).

Chapter 3:-Materials and Methods

3.1 Study area

The study was carried out in Somaliland (SL) and Puntland (PL) (Figure 2) states of Somalia. It took nearly five years starting from mid 2008 to the end of 2012.

Somaliland

Somaliland borders (if one follows those of the former British Protectorate) Djibouti and Gulf of Aden to the North, Ethiopia to the Southwest and Somalia to the East (Bradbury, 2008). The territory over which Somaliland government and people claim sovereignty comprises about 20% of the landmass of the Somali Republic, covering some 137,600 km^2. It is mostly a semi-arid savannah region with three distinct topographical zones. Along its northern edge on the Gulf of Aden runs a narrow coastal plain known as the *"Guban"* (meaning 'scorched') where temperatures can reach over 40^0C between the months of June and August. The land is covered with acacia bush and grass rangelands, which provide rich grazing and water for livestock (Bradbury, 2008).

3.1.1 Pastoral economy and livestock trade

Nomadic pastoralism has been the dominant economic activity in Somaliland. Sheep and goats have formed the bulk of exports, with cattle and camels exported in smaller numbers through the main port of Berbera and the tertiary port of Mait in Sanaag region (Little, 2003; Bradbury, 2008). The exports reached a peak of 2.8 million head for sheep and goats in 1997, generating US$ 120 million per year in income (UNDP, 2001; Bradbury, 2008). Imposition of livestock trade embargo to Somali livestock in 2000, by the Kingdom of Saudi Arabia and other Gulf states, following the outbreak of Rift Valley Fever, dealt an

enormous blow to its revenue-generating sector. For Somaliland, the loss of KSA market, which accounted for 95% of its livestock exports, was critical. Somaliland lost up to US$ 435 million in export revenues from the bans, with pastoralists losing up to US$ 93 million in income (Holleman, 2002; Bradbury, 2008). The loss of market for livestock exports led to investment in export abattoirs in order to export chilled carcasses of sheep and goats (Holleman, 2002; Bradbury 2008). One export slaughterhouse, known as H-Foods, was put up and started operating in 2004 at Burco, in the Togdheer region of Somaliland. The facility at the period of study in 2008 and 2009 was operational and exporting slightly more than 7500 sheep and goat carcasses per week during peak months of the year. H-foods slaughterhouse was selected for this study.

Puntland

Puntland State of the Republic of Somalia (Figure 2) lies between Somaliland and Central/South Somalia. It boasts of an autonomous status, thus enjoying separate governance from Central/Southern Somalia (represented by the Transitional Federal Government of Somalia established in 2005) that is currently embroiled in civil war. It has two export slaughterhouses of which only one was operating during the study period. The operating export slaughterhouse was Mubarak II located in Galkayo municipality of Mudug region. This was selected for data collection in this study. The other slaughterhouse was Al-Kawsar, located in Galkayo, which stopped operating early 2008 as per the information gathered during the study.

Figure 2: Map of the study area and selected slaughterhouses in Somaliland and Puntland

3.1.2 Infrastructurein the two states

The road network and mobile telephone communication were efficient in both states where data was collected. The road network is all weather in both Somaliland and Puntland in the chosen study regions.

Selection of study sites

The selection of study areas was purposive due to logistics, security reasons, and ease of communication and availability of operating export slaughterhouses. Based on these, operating slaughterhouses of H-Foods in Burco municipality (Somaliland) and Mubarak II in Galkayo municipality (Puntland) were selected for the study.

Export slaughterhouses in Somalia

The republic of Somalia boasts of having six export slaughterhouses. Of these, one is in Somaliland (H-Foods in Burco municipality) and two in Puntland (Mubarak II-operational and Al-Kawsar export slaughterhouse in Galkayo municipality which was closed during the study period). The other three are Mogadishu modern abattoir and Mubarak I,both located in Mogadishu while Mubarak III is located in Belet-weyne municipality. These last 3 export slaughterhouses, are located in Southern/Central Somalia where civil war was raging during data collection, therefore accessibility was impossible.

3.2 Data collection

Both qualitative and quantitative data collection methods were used during the study. These were mainly observation, structured interviews through administration of pre-tested questionnaire. Participatory Rural Appraisal (PRA) techniques were used to complement data collection during structured interviews. This was followed by surfacemeat swab sampling from carcasses of small ruminants slaughtered in the 2 slaughterhouses. The chronology of the data collection was as follows: 1) observation, 2) questionnaire administration through focus group discussion and key informants, 3) swab samples collection, 4) laboratory analysis, 5) data insertion into SPSS, 6) data analysis and

interpretation. Questionnaire results were tabulated in a matrix to generate frequencies while swab samples were analyzed at Analabs laboratories in Kenya to generate levels of bacterial contamination on meat. Data obtained was cleaned and fed into SPSS computer package for analysis. Obtained results were interpreted to confirm what was observed and obtained through questionnaire administration.

3.3 Data collection tools

Participatory Rural Appraisal (PRA) technique based on Okuthe *et al*,(2003 and 2006) was used. A checklist was used to guide collection of information on community resources, literacy levels, and relevance of literacy and community development programs in livestock slaughter practices for meat production. This information was collected using maps, calendars, Venn diagrams and matrices of locally available materials. A pre-tested questionnaire was used in interviews with slaughterhouse management. One-to-one discussion with slaughterhouse workers, including ranking of meat contamination risk factors was additionally applied. Transect walks and drive around the slaughterhouses was done to gather information on unclear issues such as availability of disposal pits and environmental management among others.

The primary sources of information in this study were Slaughterhouse Managers, Meat Inspectors and slaughter personnel. These were interviewed to assess the level of their knowledge on meat safety and Quality Assurance Standards. Surface meat swabs and liver samples were collected from randomly selected carcasses for analysis to determine the level of microbial contamination.

3.3.1 Surface meat sample size determination

The number of swab samples to be collected was based on the formula of Martin *et al* (1987) as follows.

$$n = \frac{Z^2\alpha\, PQ}{L^2}$$

Where Zα; this is a 2-tailed test. α=0.05, $\alpha/_2$=0.025, Zα/=1.96 and P is the proportion of the estimate of bacterial contamination on meat. Since the proportion is unknown, it is estimated at 50% (Noordhuizen *et al*, 1997), q=1-p= 0.5, L is the level of precision= 0.05

Therefore $n=1.96^2\times 0.5\times 0.5/ 0.05 \times 0.05 =384$ samples as minimum number.

This figure was adjusted downwards by a factor of 1.5 to 250 per export slaughterhouse because this was quite representative.The precision of the estimate also called the allowable error was 0.05.

3.3.2 Sampling method

The study units were two export slaughterhouses that were purposively selected.Since the slaughter figures were not known a *priori*, every fifth carcass was sampled in each slaughterhouse. Eight trips were made on randomized days for each slaughterhouse for 11 months. For every trip, 30-40 small ruminant carcasses were sampled and 18-22 liver tissues for antibiotic analyses taken. In total, 250 surface meat swabs and 80 liver samples were collected from each slaughterhouse for bacteriology and antibiotic residue analyses during the first round. During the second round of sampling, only 85 samples were collected from H-Foods export slaughterhouse when it re-opened shortly after one year of closure.

3.3.3 Samplingof carcasses from the slaughterhouses

Randomly selected carcasses from the selected slaughterhouses were swabbed in five sites; foreleg, lateral thorax, brisket, the flank and hind limb. Both wet and dry non-absorbent cotton wool swabs were applied for swabbing. A non-absorbent cotton wool swab moistened in 0.1% buffered peptone (used as transport medium) water for at least 5 seconds was initially rubbed vertically, then horizontally and finally diagonally in an area of 50 cm^2 on the selected carcass delineated by aluminium template for not less than 20 seconds. Enough pressure was applied. Repeat swabbing was done using a dry non-absorbent cotton wool swab in the same delineated portion. Both wet and dry swabs per site were placed in a sample bottle containing 5 ml of 0.1% buffered peptone water (used as transport medium). The same swabbing procedure was repeated for each of the five sites that were selected for swabbing. All the samples from the five swabbed sites were placed separately in a cool box having ice at less than 4^0C but not freezing.

During both the first and second round of sampling, swabbed samples were transported to Analabs laboratory in N airobi, Kenya for microbial analysis within 24-48 hours of the sampling. . Buffered Peptone Water was the transport medium used.

Sampling from H-Foods export slaughterhouse was done as from 12.30 to 3.00 a.m. Slaughter used to start at 4.00 pm running up to 4.00 am. Samples from Mubarak II were collected from 5.00-to 7.00 am. Slaughter at Mubarak started at 5.00 am. In total, 250 carcasses were swabbed from each slaughterhouse making a total number of 500 samples which were collected for analysis in the first round before closure of the two

slaughterhouses**.** Each sample was analyzed against TVC, *E. coli* and *Salmonella* species. A total of 1500 analyses were done during the first round of analysis.

A second round of sampling was done only on carcasses slaughtered from H-foods export slaughterhouse when it re-opened and operated from July to beginning of December, 2010. This was done after intervention which included personnel training and supply of basic livestock slaughter equipments. A total of 85 carcass swab samples were collected before final closure of the slaughterhouse upto when this thesis was drafted. Mubarak II slaughterhouse did not open till completion of the study.

Each sample was analyzed against TVC and *E.coli* only. A total of 170 analysis were carried out on the second round of analysis.

3.4 Sampling for chemical residues

Eighty (80) liver samples were collected from each slaughterhouse for tetracycline residue analysis. They were labeled and wrapped in polythene bags and put in cool boxes with dry ice or freezer packs at 4^{o}C or less and subsequently transported to Analabs laboratory, Nairobi, Kenya for analysis. The samples were stored at negative 20^{o}C until the time they were analyzed.

3.5 Analytical tests for microbiology

3.5.1 Total viable counts

Collected swab 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^{-5} for total viable counts.

One (1) ml of each dilution was transferred to each of the five sterilized marked 90mm diameter Petri dishes. Ten-fifteen (10-15) ml of PCA tempered at 45^0C was poured into each of the Petri dish plates. Each plate was swirled in figure 8 to mix. The plates were incubated at 37^0C for 24 hours.

Only plates with colonies below 300 were selected. Bacterial colonies were enumerated using a colony counter. Total number of colonies was determined by multiplying the enumerated colonies with the dilution factor of each plate (Ira, 1984). When two dilutions were in appropriate range, an average count was determined before averaging the two dilution counts 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.

3.5.2 *Escherichia coli* count

Escherichia coli count was estimated using the Most Probable Numbers (MPN) index and 95% confidence limit for three combinations of positive results when various numbers of tubes were used. Serial tenfold dilution of the sample homogenates was used in a 3- tube MPN series (Inoculation of 0.1, 0.01, and 0.001). Serial tenfold dilution in normal saline was prepared up to 10^{-3} as per the anticipated E.*coli* density. One (1) ml aliquot of each

dilution was transferred to each of the three tubes containing single strength MacConkey broth and inverted Durham tubes. The tubes were incubated at 37^0C for 24 hours. Gas production which collected in Durham tubes and change of color of broth from pink to yellow was considered positive for the test.

One (1) ml from each positive tube was sub-cultured into each tube containing 3ml Tryptone water. These were incubated at 37^0C for 24 hours. After 24 hours, a few drops of Kovacs 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 Most Probable Number (MPN) technique was used at this level to estimate the density of viable E. *coli* in the sample. The combination generated was used to interpret the number of viable E. *coli* organisms in the sample using the MPN table (FAO, 1992).

Characterization of E. *coli* isolates

Loopfuls of suspension from each positive tube were streaked to Levine eosin methylene blue agar. The plates were then incubated for 24 hours at 37^0C. They were examined for colonies with typical metallic sheen, characteristic of E. *coli*. A Gram stain was then performed on colonies displaying metallic sheen and those that did not display metallic sheen colonies characteristic of E. *coli* culture. Cultures appearing as Gram-negative, short rods or cocci were further characterized by Indole, Voges-Proskauer, Methyl Red and Citrate (IMVIC) test (FAO, 1992). This involved testing for Indole production, testing for voges-proskauer and methyl red reactive compounds as well as utilization of citrate as source of carbon.

The test for indole production involved inoculating metallic colonies into a tube of tryptone water. This was incubated for 24 hours at 35^0C. After incubation, test for Indole was done by adding 0.2-0.3 ml Kovacs' reagent. Appearance of distinct red color in the upper layer indicated a positive test.

Test for Voges-Proskauer (VP) reactive compounds involved inoculation of a tube of MR-VP medium. This was incubated for 24 hours at 37^0C. After incubation, 0.6 ml alpha-naphthol solution and 0.2 ml 40% KOH were added and mixed well. A few crystals of creatine were added, mixed and let to stand for 2 hours. Tests that developed eosin pink colour indicated a positive VP test.

Test for Methyl-red (MR) reactive compounds involved inoculation of MR-VP tubes and incubating them for 24 hours at 37^0C. After incubation, 5 drops of methyl-red solution were added to each tube. Development of a red color was indicative of a positive MR test.

Test for utilization of citrate involved inoculation of a tube of Simon's Koser Citrate Agar and incubating it for 24 hours at 37^0C. A color change from green to blue was indicative of a positive test indicating utilization of citrate as sole source of carbon. E. *coli* do not utilize citrate; therefore, the color of the medium remains green.
IMVIC results of ++-- or -+-- were confirmatory for the presence of E. *coli*.

Identification of *Escherichia coli* 0157 serogroup

A loopful from the positive tubes was transferred to prepared Sorbitol MacConkey Agar petri dishes using a sterilized wire loop. The plates were incubated at 37^0C for 24 hours.

Colourless colonies were regarded as being positive for E.*coli* O157 sero group, which is non-Sorbitol fermenter. Majority of E. *coli* isolates fermented Sorbitol and gave characteristic pink colonies.

Some colonies from Sorbitol MacConkey that were non-Sorbitol fermenters were sub-cultured on Sorbitol MacConkey Agar (SMA) prepared plates and incubated at 37^0C for 24 hours. The same colony from SMA was characterized by carrying out IMVIC test and sub-cultured on Eosin Methylene blue Agar (EMBA).

The non-Sorbitol fermenting E. *coli* isolates were tested for the presence of 0157 sero group using agglutination test kit .

Procedure for the agglutination test

The latex reagents were raised to room temperature from storage temperature of 2-8^0C. They were mixed by vigorous shaking. One (1) drop of the test latex was dispensed onto the circle of the reaction card but close to the edge of the circle. A Pasteur pipette drop of normal saline was added onto the same card but in a different portion on the opposite side of the same circle so that it did not mix with the latex reagent at this stage. A colorless colony from SMA was transferred using a sterilized wire loop to the saline portion. This was mixed thoroughly to emulsify until the suspension was smooth. The test latex and the suspension were then mixed using a sterilized wire loop. The card was rocked for not more than one minute in a circular motion while observing for agglutination.

3.5.3 Identification of *Salmonella* organisms

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 ± 1^0C for 24 hrs with the tube being securely capped for pre-enrichment.

Selective enrichment

One (1) ml of the pre-enrichment buffered peptone water was transferred to 10 ml of Selenite Cystine (SC). SC broth 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 ± 1^0C for 24 hrs.

BGA: Brown, gray or black and sometimes metallic sheen colonies that developed were suspicious of *Salmonella* species.

XLD: pink colonies with or without black centers observed were suspicious of *Salmonella* spp.

Confirmation of Suspicious *Salmonella* species Colonies:

Two or more suspicious colonies from each XLD and BGA plate were inoculated in Triple Sugar Iron (TSI) slant by streaking slant and stabbing butt. Moreover, without flaming, inoculation was further done in Lysine Iron Agar (LIA) slant by stabbing butt twice and then streaking slant. The TSI Agar were incubated at 35-37°C for 22-26 hrs while LIA were incubated at 35-37°C for 46-50 hrs.

Examination of TSI and LIA slants for presumptive positive cultures:

TSI Agar: Presumptive positive cultures appeared alkaline (red) slants and acid (yellow) butts, with or without H_2S production (blackened agar).

LIA: Presumptive positive cultures appeared alkaline (purple) slants. Distinct yellow coloration in the butt as an acid (negative) reaction were also tested further for *Salmonella* spp.

All cultures that gave an alkaline butt in LIA, regardless of TSI reaction, were retained as potential *Salmonella* isolates. These were submitted for biochemical and serological tests. Cultures that gave an acid butt in LIA and alkaline slant and acid butt in TSI were considered potential *Salmonella* isolates. These were taken for serological testing.

Serological confirmation of *Salmonella* organisms

Polyvalent Flagellar (H) Test:

Presumptive *Salmonella* positive colonies from each urease negative TSI slant were inoculated into 5 ml Brain Heart Infusion (BHI) broth and incubated for 4-6 hrs at 35-37°C until visible growth occurred. About 2.5 ml formalinized saline solution was added to the broth culture. Two formalinized broth cultures were selected and tested with *Salmonella* polyvalent flagellar (H) antisera. About 0.5 ml of formalinized culture was added to 0.5 ml of polyvalent flagellar (H) antiserum in a small test tube (10 × 75 mm). Saline control was prepared by mixing 0.5 ml formalinized saline with 0.5 ml antiserum. The mixtures were incubated in a 48-50°C water bath and agglutination was observed at 15 min. intervals. The final results were read after one hour as indicated in table 3 below.

Polyvalent somatic (O) Test:

A wax pencil was used to mark off test and control sections (about 1 cm square) on a glass slide. A heavy suspension was prepared by emulsifying a loopful of culture from the

presumed-positive TSI slant in 1 ml saline solution. One (1) drop of the polyvalent O antiserum was placed on the test section and 1drop of the saline solution on the control section. A loopful of culture suspension was transferred to the saline drop. The loop was flamed and used to transfer a second loopful of the suspension to the antiserum section. The slide was tilted in a back-and-forth motion for 1 min. The slide was read and any degree of agglutination was considered as a positive reaction as per Table 3 below.

Table 3 : Agglutination reading

Result	Test	Control
Positive	Agglutination	No agglutination
Negative	No agglutination	No agglutination
Non-specific	Agglutination	Agglutination

3.6 Antibiotic residues analysis

3.6.1 Test for Tetracycline Residues (Microbiological inhibition test)

All 160 liver samples were analyzed for the presence of tetracycline residues, using the microbiological inhibition test with *Bacillus cereus* ATCC 11778 as reference strain, Oxytetracycline discs (Mast Diagnostics 0.5 µg/disc) were used as control, on agar test pH 6. Sterile bottles of the medium were sterilized in an autoclave at 121°C for 15 min. They were subsequently placed in a water bath at 55°C and left for at least 30 min until they reached the temperature of the water bath. The medium was added with the appropriate volumes of inoculums (*Bacillus cereus* spore suspension), gently mixed and poured into 90 mm-diameter sterile plastic plates on a leveling platform with 5 mL/plate. Frozen liver

samples' temperature was raised to room temperature. An 8 mm-diameter cylindrical core size from each liver sample was cut using a stainless cork borer. The core was subsequently cut into liver slices of 2 mm thickness using a sterile scalpel blade. Two liver slices from each sample were placed opposite each other on a plate using forceps with a tetracycline positive control disc being placed in the center of the plate. The plates were incubated at 30°C for approximately 18 hours. Plates were read against a black background with a light from underneath to examine if there was complete or partial colony inhibition around the slices.

3.7 Data management and analysis

3.7.1 Statistical description of level of non-compliance with hygiene practices from the two slaughterhouses

A two tailed normal distribution curve was developed to compare the levels of non-compliance with export slaughterhouse meat production guidelines. The comparisons were made between non-compliance risk factors from H-foods and Mubarak II export slaughterhouses to generate Z value at p-value < 0.05.

3.7.2 Descriptive statistics analysis of samples

Carcass sample results were grouped as having either high or low level of contamination. The level of contamination was coded as: low = 0 and high = 1. Carcass samples which were grouped as having low level of contamination were those which were categorized through the GCC microbiological testing procedure as excellent, good and fair while those that were categorized as poor and very poor were considered to have high level of contamination.

The descriptive statistical analysis involved cross tabulation to determine the frequency and proportion of samples which either had high or low level of contamination. Inferential analysis was done using generalized logistic regression with level of contamination being the dependent variable while the abattoirs (Mubarak II and H-foods) and carcass swab sites (brisket, forequarter, hindquarter, flank, lateral thorax) were considered as independent variables. The analysis was done using SPSS® software. In all cases, the level of significance was set at 5%.

3.8 Economic analysis of incorporating HACCP system in export slaughterhouses in Somalia.

Despite the many challenges, an investment matrix was developed which included listing of the cost elements and expected benefits as presented in Table 4 below.

Table 4: Cost elements and expected benefits

Type of intervention	Cost (USD)	Benefits
Institute food safety and quality assurance systems (SSOPs and HACCP)	USD	High quality meat, less contamination and wastage through spoilage- more demand, more market outlets and profit

3.8.1 Costs and Benefits of operating without HACCP System at the two slaughterhouses

Table 5 below was developed to detail the operational costs of processing carcasses and benefits after selling the carcasses. The costs included purchase price of sheep and goats,

workers wages, transportation costs (land and air) and simple maintenace costs of the slaughterhouse (water supply, electricity supply, cleaning and sanitation, maintenance of equipment).

Table 5: Benefits and costs of operation without HACCP system

Year	Carcasses exported	Unit production cost (USD)	Total Production costs (USD) (Millions)	Unit benefit (USD)	Total Benefits (Millions)	Net benefit (USD) (Millions)

3.8.2 Benefit Cost Analysis of incorporating a HACCP system in the slaughterhouses

A Benefit-Cost analysis matrix (Table 6) was developed whereby the present value of benefits (PVB) were compared with the present value of costs (PVC). For any project to be considered profitable at a given discount rate, the present value of benefits should exceed that of costs (i.e. PVB>PVC). Two decision making criteria were used in this analysis, namely the Net Present Value (NPV) and the Benefit/Cost ratio (B/C ratio). These were derived as follows:

Net Present Value (NPV)

NPV= PVB-PVC or mathematically

$$NPV=\sum_{t1}^{n} \frac{B_t-C_t}{(1+i)^t}$$

Where NPV= Net Present Value

PVB =Present Value of Benefit

PVC = Present Value of Cost

B_t- C_t = is the changes in benefits and costs which can be negative or positive

Benefit- Cost Ratio (BCR)

A Benefit cost ratio was calculated as shown below:

BCR=PVB/PVC

A discount rate of 10% was applied.

For a project to be viable, the benefit-cost ratio should be greater than 1.

Table 6: Projected BCR and NPV with HACCP system

Year	Projected carcasses to be exported	Unit production cost (USD)	Total Production costs (USD)	Discount Factor @10%	PVC	Unit benefit (USD)	Total Benefits (USD)	Discount Factor @ 10%	PVB

Chapter 4: Results

4.1 Compliance with hygiene practices

The findings of the level of compliance with meat contamination risk factors were tabulated in Table 7 below as either compliant (C) or non-compliant (NC).

Table 7: Compliance with hygiene practices meant to reduce contamination of meat during slaughter

	Hygiene practices/risk factors	Slaughterhouse level of compliance	
S.No		**H- Foods**	**Mubarak II**
1	Improper location of slaughterhouse	C	C
2	Availability of holding pens	C	C
3	Improper cleaning of holding pens	NC	NC
4	Provision of isolation pens	C	NC
5	Stainless steel slaughter tables provided	C	C
6	Bleeding chain availability	NC	NC
7	Carcass hoisting facilities availability	C	C
8	Demarcation between clean & dirty areas	C	C
9	Room for heads, skins, offal etc.	C	NC
10	Immediate removal of heads, offal, skins and legs	C	NC
11	Adequate light provision	C	C
12	Condemnation disposal pit availability	C	NC
13	Impervious floors & walls	C	C
14	Floors & walls are cracked	C	NC
15	Well maintained drainage system	C	C
16	Stainless steel slaughter equipment	C	NC

17	Equipment washed immediately	C	NC
18	Wash equipment contaminated by before next use	C	C
19	Dirty livestock washed	C	NC
20	Available dress changing room	C	NC
21	Personnel put on protective gear	C	NC
22	Gear washed immediately after use	C	NC
23	Wash or scrub ingesta on carcass	C	C
24	Change equipment that contact abscesses	C	C
25	Sick employees work as usual	C	NC
26	Employees eat, smoke etc. on duty	C	C
27	Available hand washing facilities	C	NC
28	Employees go for regular medical check up	NC	NC
29	Waste accumulation permitted	C	NC
30	Provision of adequate cold potable water	C	C
31	Provision of adequate hot potable water	C	NC
32	Employees put onjewelry, watches etc. during work	C	NC
33	Rubbish heaps accumulate in compound	C	C
34	Trim or wash meat that contacts ingesta?	C	C
35	Meat loaders are in protective gear	C	NC
36	Meat carriers washed and sanitized immediately after delivery of meat	C	C
37	Meat carriers refrigerated	C	C
	Total	**C-34 NC-3**	**C-17 NC-20**

Out of 37 hygiene practices investigated; H-Foods export slaughterhouse correctly practiced 34 (92%) meat hygiene handling and slaughter practices while 3 (8%) were incorrectly practiced. On the other hand, Mubarak II export slaughterhouse correctly practiced 17 (46%) meat hygiene handling and slaughter practices while 20 (54%) were incorrectly practiced. Table 8 below summarises levels of compliance and non-compliance with hygiene practices at the two slaughterhouses under study.

Table 8: Levels of compliance and non-compliance with meat contamination risk factors

Risk factor	H-foods	Mubarak II	Total
Compliant (C)	34	17	51
Non-compliant (NC)	3	20	23
Total	37	37	74

4.1.1 Bimodal Statistical description of level of non-compliance with hygiene practices

There was a statistical difference in the level of non compliance with the guidelines set for export slaughterhouses in Somalia. Based on the non-compliance results, a $Z = 4.92$ which is higher than 1.96 for a normal distribution curve at, p-value < 0.05 was generated. This indicated a statistical significance with export guidelines.

4.2 First round of 500 sample analysis results

4.2.1 Total viable counts

H-Foods export slaughterhouse, which complied with most of the hygiene practices, had low level of bacterial contamination of carcasses sampled from it. Out of 250 carcasses

sampled and analyzed, 122 (48.8%) were of excellent grade, 120 (48%) were of good grade, 7 (2.8%) were of fair grade and only 1 (0.4%) was of poor grade. No sample was of very poor grade as shown in Table 9 below. This was in contrast to carcasses sampled from Mubarak II export slaughterhouse which had higher level of non-compliance with hygiene practices during slaughter. Out of the 250 samples collected from carcasses in Mubarak II slaughterhouse and analyzed, no sample was of excellent grade, 29 (11.6%) were of good grade, 77 (30.8%) were of fair grade, 68 (27.2%) were of poor grade and 76 (30.4%) were of very poor grade. Table 9 shows the levels of meat contamination from the two slaughterhouses.

Table 9: Grading of carcases based on the level of contamination with (TVC) from samples collected from selected slaughterhouses in Somalia

Slaughterhouse	**Mubarak II Export Slaughterhouse**		**H-Foods Export Slaughterhouse**	
Grading	No. of samples	Percentage	No. of samples	Percentage
Excellent	0	0.0%	122	48.8%
Good	29	11.6%	120	48%
Fair	77	30.8%	7	2.8%
Poor	68	27.2%	1	0.4%
Very Poor	76	30.4%	0	0.0%
Total	250	100%	250	100%

Key: Excellent-<200 cfu/cm^2 , Good -201-2000 cfu/cm^2 , Fair-2001-20,000 cfu/cm^2, Poor-20,001-200,000 cfu/cm^2& Very poor->200,000 cfu/cm^2

4.2.2 Meat contamination with E. *coli* organisms

The samples collected from carcasses in H-Foods export slaughterhouse had very low E. *coli* contamination levels. Out of the 250 samples analyzed, 242 (96.8%) were of excellent grade, 7 (2.8%) were of good grade while only 1 (0.4%) was of fair grade. None was of poor or very poor grades (Table 10). On the contrary, samples collected from carcasses in

Mubarak II, had high levels of *E. coli* contamination. Of the 250 samples collected and analyzed, 49 (19.6%) were of excellent grade, 53 (21.2%) were of good grade, 63 (25.2%) were of fair grade, 32 (12.8%) were of poor grade and 53 (21.2%) were of very poor grade (Table10). Out of all carcasses sampled and analyzed for *E. coli* contamination, 209 (41.8%) samples tested positive. However, none was positive for *E. coli* 0157 sero-group.

Table 10: Grading of carcases based on the level of *E.coli* contamination from selected slaughterhouses in Somalia

	Mubarak II Export Slaughterhouse		**H-Foods Export Slaughterhouse**	
Grading	No. of samples	Percentage	No. of samples	Percentage
Excellent	49	19.6%	242	96.8%
Good	53	21.2%	7	2.8%
Fair	63	25.2%	1	0.4%
Poor	32	12.8%	0	0.0%
Very Poor	53	21.2%	0	0.0%
Total	250	100%	250	100%

Key -Excellent-<3 cfu/cm^2-Good -3-10 cfu/cm^2-Fair-11-100 cfu/cm^2-Poor-101-1100 cfu/cm^2-Very poor->1,100 cfu/cm^2

4.2.3 Contamination of meat with *Salmonella* organisms

All the 250 samples collected from H-foods tested negative for the presence of *Salmonella* species. However, 33 samples out of 250 collected from Mubarak II tested positive for *Salmonella* species (Table11). Thus, Mubarak II export slaughterhouse, which was non-compliant in more than 50% of the hygiene practices, produced carcasses that were heavily contaminated with *Salmonella* species.

Table 11: Grading for *Salmonella* contamination

Slaughterhouse	Mubarak II Export Slaughterhouse		H-Foods Export Slaughterhouse	
Grading	No. of samples	Percentage isolation	No. of samples	Percentage isolation
Absent	217	86.8%	250	100.0%
Present	33	13.2%	0	0.0%
Total	250	100%	250	100%

4.3 Determinantion of level of carcass contamination in the selected export slaughterhouses in Somalia

Factors which influenced the extent of carcass contamination with bacteria (TVC, E. *coli* and *Salmonella* spp) are shown in Table 12 below. The results reveal that samples which were collected from Mubarak II slaughterhouse were more likely to be contaminated (Odds ratio = 264.4; P- value <0.001) as compared to the second round samples which were collected from H-foods slaughterhouse.

The Total Viable Count (TVC) was the most likely cause of carcass contamination in the two slaughterhouses (Odds ratio = 1.69 ;P- value <0.001) when compared with contamination with *E. Coli* organsims. However, the level of contamination of samples from lateral thorax and flanks were marginally significantly different with odds ratios of 1.02 and 1.15 at P-value <0.001 respectively when compared to the briske (table 12).

Table 12: Factors determining whether a sampled carcass had high or low level of contamination

Parameter	Estimate	S.E	t(1670)	P-value	Odds ratio	95% Lower limit	95% Upper limit
Intercept	-14.08	0.54	-25.85	<0.001	0.00	0.00	0.00
Flank	0.14	0.10	1.39	0.165	1.15	0.94	1.40
Fore Quarter	-0.08	0.11	-0.73	0.464	0.93	0.75	1.14
Hind Quarter	-0.17	0.11	-1.51	0.132	0.85	0.68	1.05
Lateral thorax	0.02	0.10	0.18	0.858	1.02	0.83	1.25
Salmonella	-0.95	0.11	-8.55	<0.001	0.39	0.31	0.48
TVC	0.53	0.07	7.14	<0.001	1.69	1.47	1.96
H-foods1	-3.32	3.22	-1.03	0.304	0.04	0.00	20.20
Mubarak	5.58	0.54	10.34	<0.001	264.40	91.82	761.60

Parameters for factors are differences compared with the reference level:
Factor Reference level (Intercept)
Description Brisket
Organism *E.coli*
Abattoir H-Foods2

4.3.1 High and low contamination levels

From the results generated in Figure 3,sampled carcass sites did not reveal any statistically significant difference on the level of contamination by the pathogens.

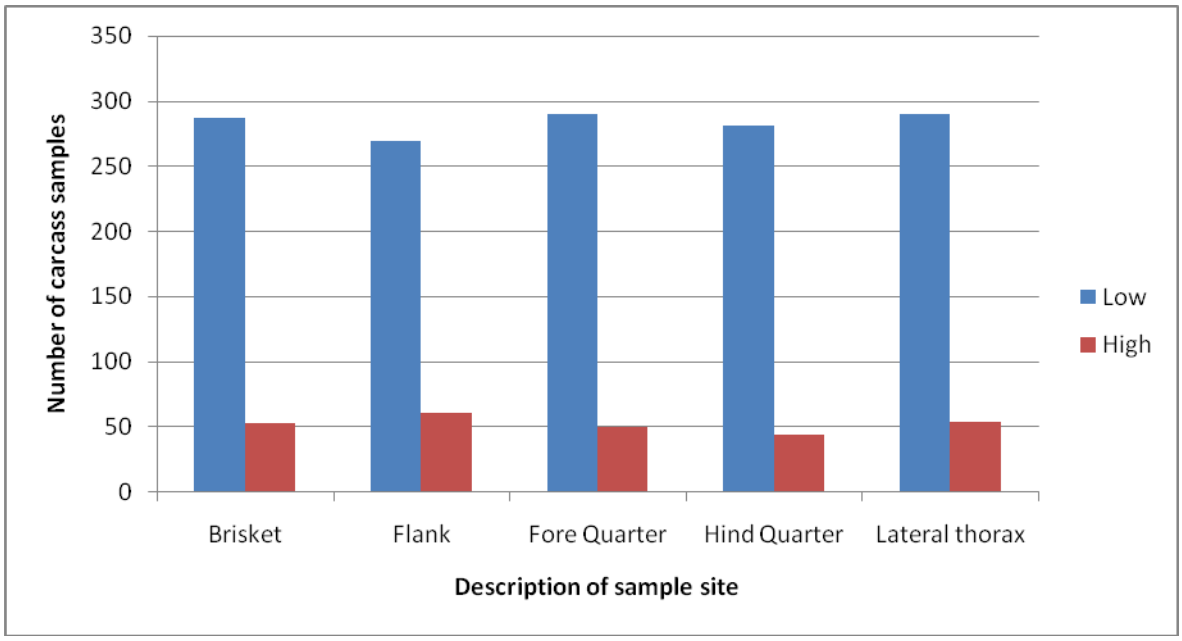

Figure 3: Carcass samples categorised as having high or low level of contamination by sites in Mubarak II and H-foods slaughterhouses

4.4 Qualitative description of the risk of carcass contamination in selected slaughterhouses in Somalia

4.4.1 H-Foods export slaughterhouse (general description)

This slaughterhouse started operating from 2004. It is located in Burco District, Togdhere region in Somaliland, which declared itself to be an independent Republic from the greater Republic of Somalia. It is owned and run by Daallo Company which had regularly hired 153 workers either as permanent or long-term casuals during the study period. The personnel rendered services like day-to-day slaughterhouse management, livestock slaughter, slaughterhouse maintenance, equipment and general environmental hygiene activities. Out of the 153 workers, 61 who included the manager and private veterinarian almost operated as permanent employees of the Company.

The slaughterhouse slaughtered and exported chilled carcasses of small ruminants (sheep and goats) to the Gulf countries especially the United Arab Emirates and the Kingdom of Saudi Arabia. During peak months, upto 7,200 small ruminants were slaughtered per week, while during non-peak months, upto 3,000 were slaughtered weekly. The slaughter process used to start at 4.00 pm running upto 4.00 am. According to the slaughterhouse manager, this was meant to reduce carcass contamination with dust and as a way of controlling flies.

The slaughterhouse compound was enclosed in a concrete block wall. This kept off predators like dogs, hyenas, wild and domestic cats from accessing the slaughterhouse and pose a threat of meat contamination. The enclosing block wall had two gates; one for entrance of people and vehicles while the other was for entrance of livestock; either on hoof or by lorry.

The lairage and pens were sloppy and made of impervious concrete floor for easy removal and cleaning of manure and any other dirt. From the lairages to the slaughterhouse was a small footbath for livestock that was not well maintained. This allowed dirt from the lairage and pens to reach the livestock killing floor.

There was no provision for washing dirty livestock presented for slaughter before reaching the killing floor. Instead, carcasses were washed when bleeding on the floor after sticking. Livestock were slaughtered on stainless steel tables in a halal manner and let to bleed from the floor (Figure 4) as the carcasses were being washed to reduce dirt on their skins. This represents a source of meat contamination.

Figure 4: Bleeding slaughtered carcasses on floor- H-Foods

The slaughterhouse floor and wall had been finished using ceramic mosaic tiles making it easier for cleaning and sanitization after slaughter. Furthermore, the floor did not have any cracks. It sloped into a well-constructed and maintained drainage system that was usually thoroughly cleaned immediately after the slaughter process. The slaughterhouse (floor and walls) was normally washed immediately after slaughter with lots of warm water and soap, making it ready for next use.

The slaughterhouse further had separate rooms for condemned carcasses, plucks (liver, heart and lungs) and tripes (stomachs and intestines). Provided also were well-maintained lavatories that were supplied with adequate warm water and liquid soap for washing hands by personnel after using them.

The slaughterhouse had adequate livestock slaughter equipment like stainless steel knives, knives' sterilizers, hooks, slaughter tables, red and white offal down chutes and tables, trolleys for moving carcasses to pre-chillers and chillers, well maintained carcass hoisting automatic overhead chain, automatic skin puller, stainless steel receptacles, weighing machine and well maintained chillers. All these equipment were usually washed with warm water (45-55^{0}C) and powder soap and sanitized with chlorinated water immediately after the slaughter process.

Sterilizers were strategically placed and supplied with hot (82^{0}C) and cold water and liquid soap; they were readily accessed by stickers, flayers and eviscerators, to sterilize their knives when ever demand arose (Figure5).

Chillers and refrigerated meat trucks were washed with cleaning- in- place (CIP) system that is computer controlled.

Figure 5: Sterilizing the knife after evisceration-H-Foods

Slaughterhouse personnel were supplied with protective gear that included white overall/coat, hat/helmet, gumboots and aprons (Figure 6). The abattoir workers in the production section put on the protective gear before start of work. Additionally, the gear was strictly used only during the slaughter process. However, not all workers were supplied with protective gear because it was not adequate.Workers without the protective gear worked in cleaning sections that were not actively involved during the slaughter process. In addition to personnel being provided with protective gear, they were also trained in minimum meat hygiene handling practices during slaughter by FAO Somalia personnel and by technical implementing partners- Cooperazione Internazionale (COOPI) and Veterinaries sans Frontieres- Germany (VSF-G).

Figure 6: Abattoir workers in protective gear- H-Foods

Additionally, the slaughterhouse had adequate natural/artificial light provided by generators during the entire operation. The electricity was also used by the CIP system for cleaning the chillers and refrigerated meat trucks, pumping potable water from a nearby borehole of about 170 m deep, running the chillers and fans for ventilation system.

There was adequate provision of potable water that was pumped from a well maintained nearby private borehole owned by the company running the slaughterhouse. The water was supplied to different sections of the slaughterhouse as piped hot or cold water and distributed throughout the slaughterhouse by means of well color-coded hose-pipes for different sections. The water was used for thorough cleaning of the slaughterhouse, equipment and final washing of carcasses before being taken to the chillers.

The liquid effluent from the slaughterhouse was led out through a well-constructed and maintained drainage system into septic tanks, then to soak away pit. The effluent was

eventually pumped out of the soak away pit and used for sub-surface irrigation of the nearby farm where fodder crops were being grown for livestock.

4.4.2 Levels of carcass contamination from H-Foods slaughterhouse

Total viable count (TVC) levels

Out of 250 swab samples collected from carcasses in H-Foods export slaughterhouse for microbiological analysis, 122 (49%) had cfu/cm^2 of excellent grade, 120 (48%) were of good grade, 7 (3%) were of fair grade. No sample was of poor or very poor grades. From this analysis, no carcass could have been rejected in this study based on TVC levels as per the GCC microbiological standards.

E. *coli* meat contamination levels

Nearly all samples i.e. 242 (97%) of the 250 samples collected and analyzed for E. *coli* had cfu/cm^2 of excellent grade. Seven(7) (3%) were of good grade and only 1 (0%) was of fair grade. No sample was of poor or very poor grades. Thus, all carcasses could have been accepted in this study based on E. *coli* levels as per the GCC microbiological standards.

4.4.3 Contamination with *Salmonella* organisms

All the 250 samples collected did not yield *salmonella* organisms.

4.4.4 Identified critical control points (CCPs)

From the study and investigation, H-Foods export slaughterhouse had some points along the meat processing chain that could likely be established as critical control points for carcass contamination (Figure 7). Livestock holding pen could be a potential CCP for biological hazards as the pen was hardly cleaned of manure. Additionally, the

slaughterhouse had no livestock washing spray race to ensure their cleanliness before slaughter. The provided footbath was only serving aesthetic purpose. However, these points were not regarded as CCPs because of proper meat safety hazard control measures that lay ahead of the meat production chain.

The CCPs in this export slaughterhouse were during clothing or shrouding of carcasses incase of use of cloths or fabrics whose packs could have been broken from the sterile package and exposed to contamination. This happened when fabrics used during the previous consignment were left over. This could pose a risk of contaminating carcasses with biological hazards. This was observed as a critical control point (CCP) as there was no other hazard control measure during pre-chilling and chilling. Chillers were identified as other crucial CCPs incase of poor temperature monitoring and control. Contaminating psychrophilic bacteria could multiply and increase in numbers during this period of storage if monitoring to ensure that the established critical temperature limits is not kept constant. Moreover, incase of deviation from proper cleaning, sanitation and sterilization of the chillers after carcass dispatch could present contamination risk factors to carcasses stored there for chilling before export. Additional identified CCP was during carcass transportation to Berbera airport for air freighting to importing countries of the Middle East (Figure 7). Carcasses were stack together during packing in the refrigerarted transport trucks increasing chances of cross-contamination between carcasses. Bacterial contamination, especially from psychrophilic agents, were likely to increase in numbers before reaching the destination export markets and before meat is prepared and consumed by end users

Identified HACCP tree during the slaughter process in H-Foods

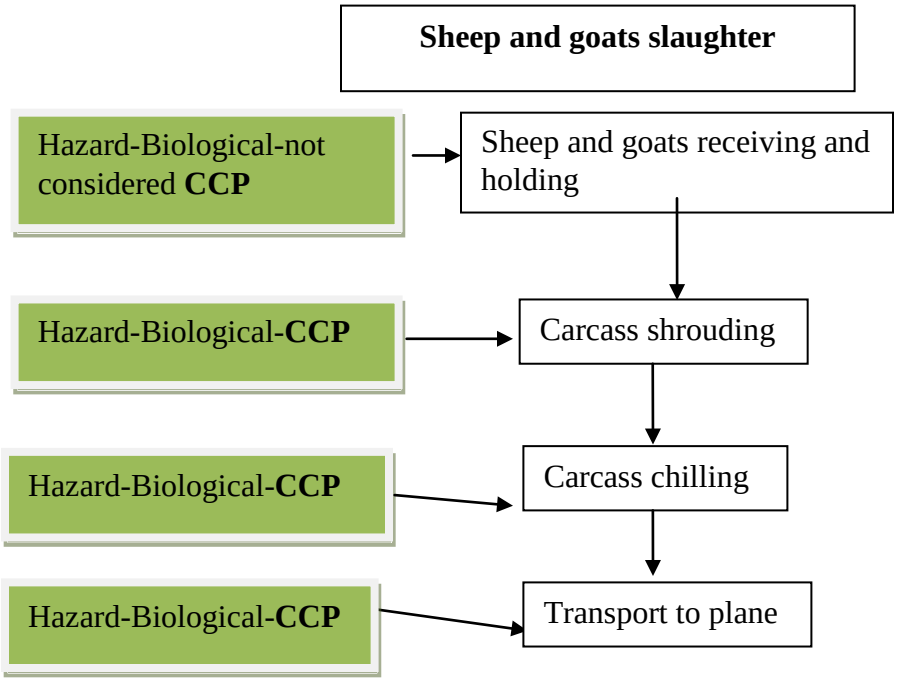

Figure 7: Identified CCPs in sheep and goats slaughter process- H-Foods slaughterhouse

4.5 Antibiotic residue analysis

None of the 80 liver samples analyzed for tetracycline residues was positive for the test. Tetracycline was tested because it is the commonly used and most probably abused antibiotic under Somalia context.

4.6 Mubarak II export slaughterhouse (general description)

Mubarak II export slaughterhouse is located in Galkayo municipality, Mudhug region in the autonomous Puntland State of the Republic of Somalia. Galkacyo municipality is on the boundary of South/Central Somalia, which is still under the raging civil war. The export slaughterhouse was established and started operating in1999-2000. It was owned by 7

private developers but managed by one individual among the seven of them (Mr Bashir Mohamed) on day-to-day basis as the manager.

The slaughterhouse at the time of the study was regularly hiring 126 workers mostly on casual basis. These were involved in active daily livestock slaughter activities and general cleanliness of the slaughterhouse, equipment and the surrounding environment after every slaughter.

The weekly throughput at the time of the study was 6,200-7,500 carcasses per week during peak months and about 3,000 or less per week during non-peak months. Slaughter usually began at 5.00 am running upto about 2.00-3.00pm. There was adequate natural and artificial light supplied by a generator during the entire slaughter operation process.

The slaughterhouse was securely enclosed in a well-constructed solid block wall fence with only two entry points that had well manned gates. Lairages and pens were well constructed with impervious concrete floors but were hardly cleaned to remove manure. Manure heaps could be seen throughout the entire lairage line and pens. There was no provision of footbaths for both people and livestock meant for slaughter. Hence, some dirt from these sections could reach the killing floor becoming a source of meat contamination. Compounding the situation, there was no provision for washing dirty livestock meant for slaughter according to HACCP principles.

The slaughterhouse floor and half the walls were impervious and finished using ceramic mosaic tiles. The floor slopes into well constructed and maintained drainage system. Hence

it was easier to wash and sanitize the floors and walls after every slaughter process. The walls were properly fitted with adequate ventilation systems.

Livestock were being slaughtered the Halal way of Muslims on stainless steel tables. They were left to bleed from the floor before being transferred to fixed metallic pipes for hoisting before beginning of skinning. This provided a source of meat contamination.

Only batch slaughter was practiced in this slaughterhouse, which made demarcation between clean and dirty areas impossible during the slaughter procedure. Carcasses were hoisted onto fixed metal pipes before start of skinning, evisceration and final carcass washing in the same point. There were no sterilizers to sterilize knives when demand arose. Personnel used unhygienic plastic containers for emptying in offal while skins, heads and legs were being collected in a nearby corner in the same slaughter hall. The same containers held non-potable water that was being used to lubricate the fists for pushing off the skin from the carcasses. This served as a source of meat contamination. After the final carcass washing was done, carcasses were transferred to the clean area where they were hoisted onto fixed metallic pipes waiting for meat inspection by the private meat inspector. There was a physical barrier between dirty and clean area. This, limited movement of personnel from dirty to clean areas thus minimizing chances of meat contamination.

Nearly all slaughter personnel had no protective gear (gumboots, white/yellow coats, hats and plastic aprons) (Figure 8) greatly compromising meat handling hygiene practices.In addition, personnel were not aware of the importance of medical check up for operators in

food establishment like the slaughterhouse. This complicated the whole situation because even sick personnel could be allowed to work normally.

Figure 8: Initial flaying stages-Mubarak II- personnel without protective gear

The slaughterhouse did not have adequate stainless steel knives, receptacles, hooks, no chillers but instead depended on meat transport trucks' freezers for freezing instead of chilling the carcasses. The meat carriers' temperature was not strictly regulated or well controlled. Carcasses were suspended in meat carriers using ropes (Figure 9) that were hardly washed. This provided another source of meat contamination.

Figure 9: Carcasses being suspended in meat carrier using ropes-Mubarak II

There was adequate supply of potable borehole water that was supplied by the Galkacyo municipality. The water was piped into the slaughterhouse, and distributed using color-coded hose pipes during slaughter operations. The adequate water supply enabled thorough washing of the slaughterhouse and equipment immediately after slaughter process. Furthermore, carcasses were thoroughly washed immediately after skinning and evisceration to reduce physical dirt in addition to some bacterial load.

There were two lines of well-constructed drainage system that were normally thoroughly cleaned immediately after every slaughter. This system led to a septic tank and the soak-away pit.

Manure, bones, stomachs, legs and heads were being disposed in a far-away designated county coucil landfill outside the town where there were no inhabitants. This greatly reduced slaughterhouse solid waste accumulation in its environs.

4.6.1 Levels of carcass contamination from Mubarak II export slaughterhouse

TVC meat contamination levels

Out of the 250 samples collected and analyzed for TVC, no carcass was of excellent grade, 29 (12%) were of good grade, 77 (31%) were of fair grade, 68 (27%) were of poor grade and 76 (30%) were of very poor grade. From this study, 57% of the carcasses could have been rejected based on TVC meat contamination levels as per the GCC microbiological performance criteria.

E. coli meat contamination levels

From the swab sample analysis of 250 samples for E. *coli*, 49 (20%) carcasses were of excellent grade, 53 (21%) were of good grade, 63 (25%) were of fair grade, 32 (13%) were of poor grade and 53 (21%) were of very poor grade. Thus 34% of the carcasses could have been rejected in this study based of E. *coli* counts as per the GCC microbiological performance criteria.

4.6.2 Contamination with *Salmonella* organisms

About 33 (13%) of 250 carcasses sampled from Mubarak II export slaughterhouse yielded S*almonella* organisms.

4.6.3 Identified CCPs in Mubarak II export slaughterhouse

This slaughterhouse operated more like a local slaughterhouse during the investigation period. All livestock slaughter chain process from receiving and holding in pens, slaughter, flaying, evisceration, and storage in refregirated transport trucks where carcasses were hanged on dirty recycled ropes were identified as CCPs (Figure 10).

The livestock holding pens and lairages were hardly cleaned; therefore were identified as CCPs for biological hazards as there were no other better food safety hazard control measures ahead in the production chain.

The slaughterhouse had no knife sterilizers making it difficult to ensure use of sterilized knives during flaying, evisceration and carcass trimming. These points similarly were identified as CCPs throughout the meat production chain.

Personnel working in the slaughterhouse production area had no protective gear. These served as sources of meat contamination at every level of the production chain. The few protective gear supplied by FAO and partnership organizations were like a drop in the ocean.

After carcass washing, carcasses were being suspended using unhygienic re-used nylon ropes in the refrigerated meat transport trucks whose temperature monitoring and regulation was not dependable. The ropes served as sources of meat contamination thereby providing a CCP (Figure10).

The slaughterhouse faced quite some internal obstacles that made it difficult to implement even the generic HACCP system. These included among others inadequate basic meat production hygiene standards of good hygiene practices, lack of expertise and information about HACCP system, human resources constraint including high rate of turnover of staff due to engagement of internally displaced persons from South-Central Somalia where there is civil war, lack of protective gear, inefficient working tools, equipment, facilities, and inadequate infrastructure.

CCPs tree in Mubarak II export slaughterhouse

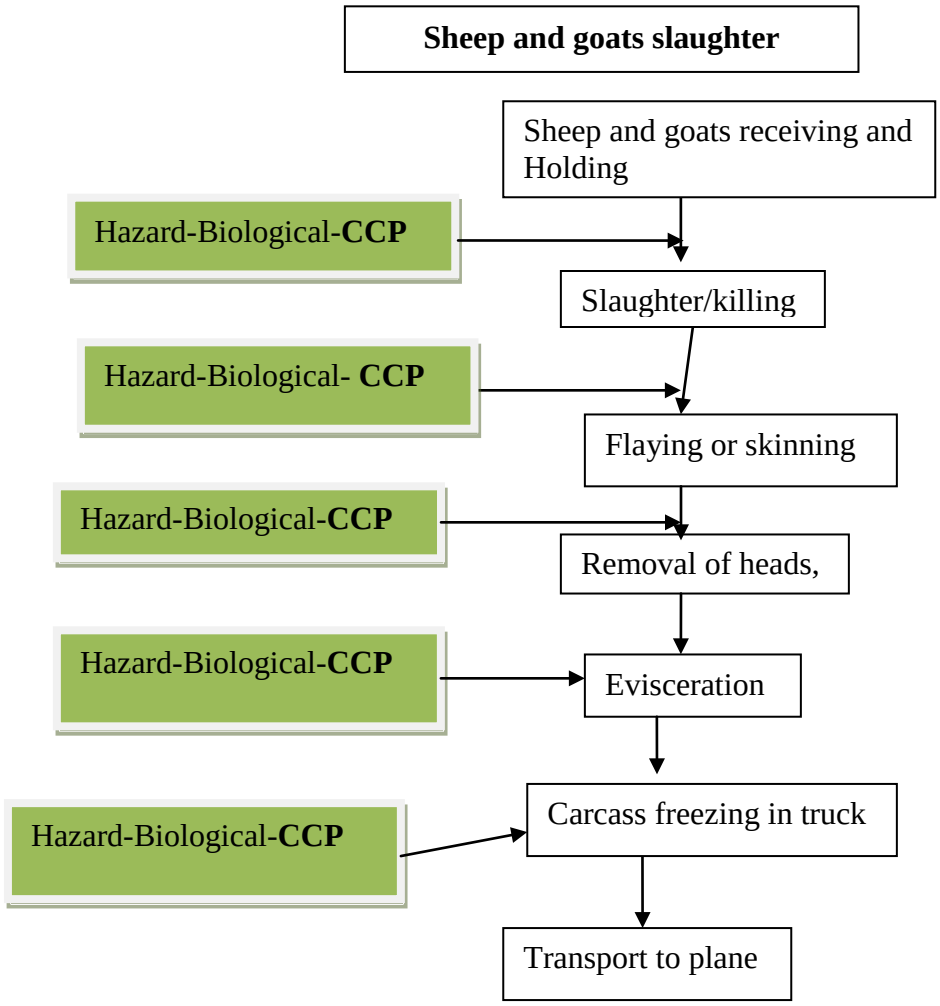

Figure 10: Identified CCPs of sheep and goat slaughter process from Mubarak II slaughterhouse

4.7 Antibiotic residue analysis

No liver sample out of the 80 samples collected and analyzed tested positive for tetracycline residues.

4.8 Benefit Cost-Analysis of instituting food safety quality assurance (HACCP) system

4.8.1 H-Foods export slaughterhouse

After an evaluation, a number of facilities were found to be necessary to enable full adoption and compliance with food safety quality assurance systems that include Sanitary Standard Operating Procedures (SSOP) concept and Hazard Analysis and Critical Control Point (HACCP) system. The estimated cost of repairs was USD 20,000 according to the manager and the slaughterhouse owner after consulting a quantity surveyor in January 2012. Table 13 below details the requirements and estimated costs in USD for instituting a HACCP system at H-Foods export slaughterhouse.

Table 13: Estimated cost for including HACCP system in H-Foods slaughterhouse

	Proposed intervention	**Estimated cost (USD)**	**Benefit**
1	General repairs and rehabilitation- animal pens, spray race, footbath, repair of minor cracks (floor, walls), drainage system, lockable blood pit, lockable condemnation pit, pest and fly control systems	10,800	Improve condition of infrastructure to minimize meat contamination
2	Environemental Impact Audit	3,500	Inform of required facelift
3	Abattoir workers trainings in GHP, SSOP, SOPs as pre-requiscites for a HACCP system	5,700	Improve personnel skills for quality meat production
	Total	**20,000**	

4.8.2 Chilled carcass exports

Table 14 below indicates the number of small ruminant carcasses exported for six years before closure of the slaughterhouse. The export figures from 2005- 2010 were not steady, indicating the unreliable export market due to several factors including poor food safety quality assurance and control system. Over 183,350 carasses were exported in 2006 while a paltry 64,900 carcasses were exported in 2007. Through the intervention made by FAO and support from the management, export figures picked up to 136,269 carcasses in 2008 before the slaughterhouse closed in 2009 after a few months of operation. It re-opened in 2010 but closed shortly after.

Table 14: Exports of sheep and goats carcasses for the past five years – H-Foods slaughterhouse

Year	Carcasses Exported
2010	20 077
2009	58 440
2008	136 269
2007	64 900
2006	183 350
2005	75 875

Wamalwa *et al*, 2012

4.8.3 Costs and Benefits of operating without HACCP System at H-Foods slaughterhouse

Table 15 below details the operational costs of processing carcasses and benefits after selling the carcasses. The costs include purchase price of sheep and goats, workers wages, transportation costs (land and air) and simple maintenace costs of the slaughterhouse (water supply, electricity production, cleaning and sanitation, maintenance of equipment).

Table 15: Benefits and costs of operation without HACCP system at H-Foods

Year	Carcasses exported	Unit production cost (USD)	Total Production costs (USD) (Millions)	Unit benefit (USD)	Total Benefits (Millions)	Net benefit (USD) (Millions)
2005	75,875	55	4.2	57	4.3	0.1
2006	183,350	56.5	10.4	58	10.6	0.2
2007	64,900	62.5	4.1	65	4.2	0.1
2008	136,269	62.5	8.5	65	8.9	0.4
2009	58,440	63	3.7	65.5	3.8	0.1
2010	20,077	63	1.29	65.5	1.3	0.01
Total			**32.2**		**33.1**	**0.9**

4.8.4 Benefit appraisal

During the period of operations, the value of net benefit was the highest in the year 2008 with a net benefit of US$ 0.4 million, while it was the lowest in the year 2010, with a value of net benefit estimated at US$ 0.01 million (Figure 11). The low net profit was as a result of closure of the slaughterhouse mid way the year.

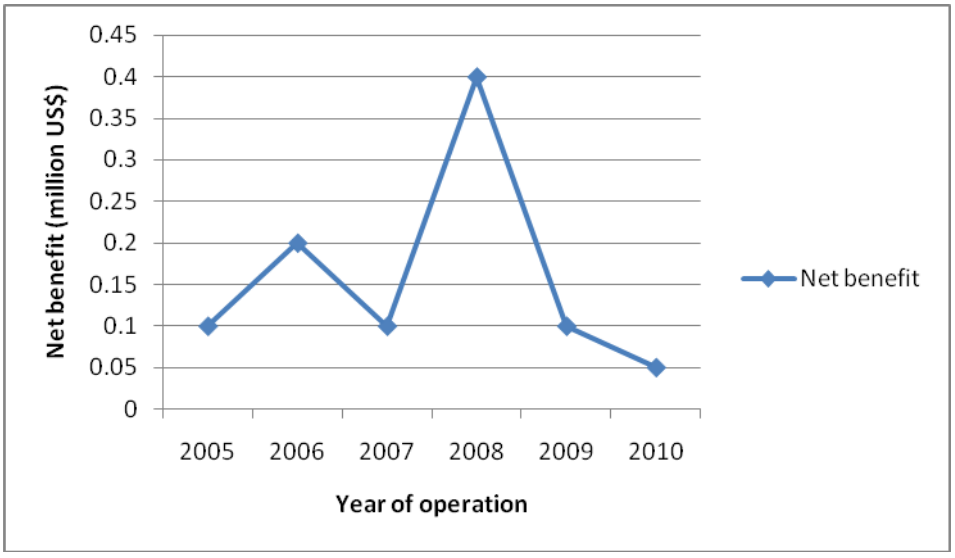

Figure 11: Level of net benefit (US$) for operating H-Foods before intervention

4.8.5 Projected BCR and NPV after incooperation of HACCP system

Table 16 below provides a projection of carcass production and exports for a period of 8 years made on the assumption that during slaughterhouse operation, there will be no bans to carcass exports, no severe drought to affect livestock body conditions, no interruptions to meat transportation means and exports to the Kingdom of Saudi Arabia market will have opened up.

Table 16: BCR and NPV with HACCP system at H-foods

Year	Projected carcasses to be exported	Unit production cost (USD)	Total Production costs (USD)	Discount Factor @10%	PVC	Unit benefit (USD)	Total Benefits (USD)	Discount Factor @ 10%	PVB
1	183,350	62.50	11,459,375	0.909	10,416,571.88	66.00	12,101,100.00	0.909	10,999,899.90
2	195,200	62.50	12,200,000	0.826	10,077,200.00	66.00	12,883,200.00	0.826	10,641,523.20
3	198,720	63.00	12,519,360	0.751	9,402,039.36	67.00	13,314,240.00	0.751	9,998,994.24
4	201,230	63.00	12,677,490	0.683	8,658,725.67	67.00	13,482,410.00	0.683	9,208,486.03
5	208,120	63.50	13,215,620	0.621	8,206,900.02	67.50	14,048,100.00	0.621	8,723,870.10
6	210,345	64.00	13,462,080	0.564	7,592,613.12	68.00	14,303,460.00	0.564	8,067,151.44
7	210,140	64.00	13,448,960	0.513	6,899,316.48	68.00	14,289,520.00	0.513	7,330,523.76
8	211,560	64.50	13,645,620	0.467	6,372,504.54	68.00	14,386,080.00	0.467	6,718,299.36
					67,625,871.07				71,688,748.03

BCR= 71,688,748.03 /67,625,871.07

BCR = 1.060078738

A BCR of 1.060078738 which is greater than 1 indicates that inclusion of a HACCP system into slaughterhouse operations will earn the management substantial profit.

NPV= PVB-PVC

NPV= 71,688,748.03 - 67,625,871.07

NPV= 4,062,876.97.9

4.9 Mubarak II Export slaughterhouse

4.9.1 Estimated cost of incooperating HACCP System

The export slaughterhouse management estimated the cost of incorporating SSOP and HACCP compliant facilities into the slaughterhouse to be USD 85,000 after consultation with the quantity surveyor in January 2012 (Table 17).

Table 17: Estimated costs for including HACCP system in Mubarak II slaughterhouse

	Proposed intervention	Estimated cost (USD)	Benefits
1	Construction of chillers and provision of cleaning in place (CIP)	21,000	Minimize bacterial multiplication amd imporove cleaning
2	Construction of spray race, foot baths (human and animals), general repairs of cracks, drainage system, lockable blood pit, lockable condemnation pit, pest and fly control systems	16,800	Present clean livestock for slaughter
3	Procurement and installation of automated carcass hoisting system	19,000	Minimize bacterial contamination
4	Procurement and provision of livestock slaughter equipments and protective gear	19,000	Minimize bacterial contamination
5	Environemental Impact Audit	3,500	Inform type of intervention
6	Abattoir workers trainings in GHP, SSOP, SOPs as pre-requisites for a HACCP system	5,700	Improve personnel skills for quality meat production
	Total	**85,000**	

Table 18 below indicates the number of carcasses exported for five years (2005-2009) before closure of the slaughterhouse. The carcass export figures were not steady, indicating the unreliable export market due to several facors including lack of food safety quality assurance and control system.

Table 18: Exports of sheep and goats carcasses for the past five years- Mubarak II slaughterhouse

Year	Carcasses exported
2010	Not operational
2009	44 105
2008	78 025
2007	118 579 (estimate)
2006	128 537
2005	23 619

Wamalwa *et al*, 2012

4.9.2 Benefits and Costs of operation without HACCP System at Mubarak II slaughterhouse

Table 19 below details the operational costs of processing carcasses and benefits after selling the carcasses at UAE. The costs include purchase price of sheep and goats, workers wages, transportation costs and simple running costs of the slaughterhouse.

Table 19: Costs and Benefits without HACCP system at Mubarak II slaughterhouse

Year	Carcasses exported	Unit production cost (USD)	Total Production costs (USD) (Millions)	Unit benefit (USD)	Total Benefits (USD) (Millions)	Net Benefits (USD) (Millions)
2005	23,619	46	1.1	47.5	1.1	0.04
2006	128,537	46	5.9	47.5	6.1	0.2
2007	118,579	47	5.6	49	5.8	0.2
2008	78,025	48	3.7	49	3.8	0.1
2009	44,105	48	2.1	49.5	2.2	0.1
Total			**18,434,629**		**19,044,203.50**	**0.64**

4.9.3 Net benefit from Mubarak II

Figure 12 below shows the net profit per year for the five years the slaughterhouse operated. It was an average of 0.12 millinon US Dollars per year. The net profit was highest between 2006- 2007 and lowest in 2005.

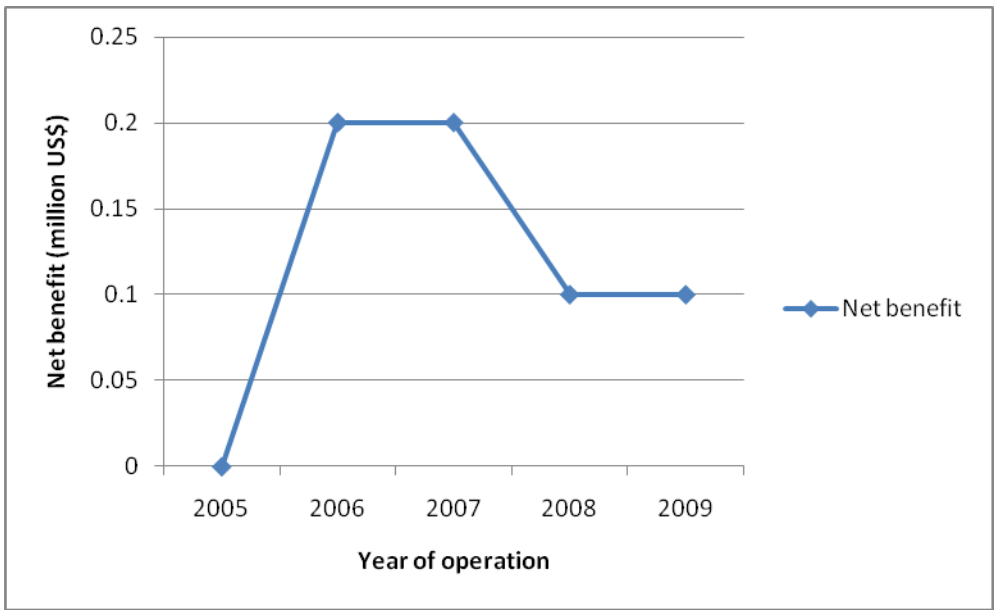

Figure 12: Net benefit (US$) for operating Mubarak II slaughterhouse

4.9.4 Projected BCR and NPV after incooperation of HACCP system

Table 20 below provides eight year of carcass exports, costs and projected profits. The projection is based on the assumption that the slaughterhouse will operate without interruptions of exports due to bans, no severe drought to affect livestock body conditions, lack of transportation and venturing into the Kingdom of Saudi Arabia market.

Table 20: Projected BCR and NPV with HACCP system at Mubarak II

Year	Projected carcasses to be exported	Unit production cost (USD)	Total Production costs (USD)	Discount Factor @10%	PVC	Unit benefit (USD)	Total Benefits (USD)	Discount Factor @ 10%	PVB
1	78,025	48.00	3,745,200	0.909	3,404,386.80	51.00	3,979,275.00	0.909	3,617,160.98
2	108,340	54.00	5,850,360	0.826	4,832,397.36	57.00	6,175,380.00	0.826	5,100,863.88
3	112,600	54.00	6,080,400	0.751	4,566,380.40	57.00	6,418,200.00	0.751	4,820,068.20
4	123,780	55.00	6,807,900	0.683	4,649,795.70	57.50	7,117,50.00	0.683	4,861,150.05
5	120,500	56.00	6,748,000	0.621	4,190,508.00	59.00	7,109,500.00	0.621	4,414,999.50
6	118,760	55.50	6,591,180	0.564	3,717,425.52	59.00	7,006,840.00	0.564	3,951,857.76
7	126,430	56.00	7,080,080	0.513	3,632,081.04	59.00	7,459,370.00	0.513	3,826,656.81
8	123,610	56.50	6,983,965	0.467	3,261,511.66	60.00	7,416,600.00	0.467	3,463,552.20
					32,254,486.48				34,056,309.38
		BCR	1.055862706						

BCR= 34,056,309.38/32,254,486.48

BCR= 1.055862706

A BCR of 1.055862706 is greater than 1, indicating that incorporation of a HACCP system would be profitable.

NPV = 34,056,309.38 - 32,254,486.48

NPV = 1,801,822.90

4.10 Identified gaps in meat production process

A needs assessment for the training programme for the export meat industry in Somaliland and Puntland was the first step that was taken in this investigation. After the laboratory analysis and observations of the meat production systems in the two study slaughterhouses, gaps in the hygiene practices were identified. These included among others, inadequate transfer of knowledge, skills and technology as pertains to the ever evolving and rising food safety standards.

Other internal obstacles identified were: inadequate basic food hygiene standards, lack of expertise and information, human resource constraint, high turnover rate of staff for Mubarak II export slaughterhouse, inadequate infrastructure and facilities. In addition, other perceived and real financial constraints included: significant costs associated with the development and implementation of programmes including capital costs; training costs and consultant's fee; costs associated with training of the management and staff; costs associated with initial and on-going accreditation/verification; additional costs to develop and support HACCP system plans and costs to train meat inspectors and undertake a HACCP verification process. All these costs could be included in the B/C analysis.

Meat producers should be trained in good hygiene meat handling and production practices, standard operating practices, slaughterhouse waste management and environmental hygiene, sanitary standard operating procedures, HACCP principles while the management and meat inspectors should be taken through a human resource management course. In addition, meat inspectors should be trained on meat inspection procedures, disease

surveillance, detection and management at slaughterhouses among other relevant identified trainings.

4.11 Interventions carried out to bridge the gaps

After establishing the training needs in the two slaughterhouses, non-technical and technical workers were trained in Good Hygiene Practices (GHP) and Sanitary Standard Operating Procedures (SSOP), Standard Operating Procedures (SOP), which are pre-requisite requirements for establishment of a HACCP system.

A HACCP team was afterwards established for the two slaughterhouses to ensure quality production of meat. Ninety-two (92%) and 85% of abattoir workers of H-Foods (total workers 153) and Mubarak II (total workers 126) export slaughterhouses respectively were trained in good hygiene practices and SSOP to ensure compliance with hygiene practices during meat production and sanitary procedures:- pre-operationaland operational procedures before, during and after slaughter process.

Moreover, the two slaughterhouses were supplied with basic livestock slaughter tools including stainless steel knives, hooks, receptacles and protective gear for workers involved in meat production to facilitate compliance with quality assurance practices of meat production like GHP and SSOP to ensure safe and suitable meat production from the two slaughterhouses.

4.12 Second round of bacteriological sample collection and analysis after intervention

This activity was carried out in 2010 when H-Foods export slaughterhouse re-opened and operated from July to December. It exported only 20,253 chilled small ruminant carcasses before it closed for a second time until the time of writing this thesis.

In total, 85 samples were collected and analyzed for total viable counts and E. *coli* counts. This exercise came to an abrupt end when the slaughterhouse stopped operating in October 2010. The second sample collection and analysis was not possible for Mubarak II export slaughterhouse since it remained non-operational since 2009 when it stopped operations.

4.12.1 Results of sampling and analysis from H-Foods export slaughterhouse

Total Viable Counts

Ninety six (96%) and four (4%) percentage of sample results were of excellent and good grades; respectively. However, there was no statistical significant difference from the first round of sample analysis before intervention though hygiene standard had improved.

The number of samples in excellent grade was 96% as compared to 49% before intervention. Moreover, no sample was of fair or poor grade, an indication that hygiene operational standards had greatly improved.

***E. Coli* counts**

Nearly all samples were in excellent grade according to GCC microbiological performance criteria. There was no statistical difference with the results from the initial analysis before intervention.

4.13 Opportunities identified

- The demand of carcasses in United Arab Emirates, the main market was very high since consumers preferred small ruminants from Somalia due to their small size, organic production management and financial affordability.
- Given the huge numbers of chilled small ruminant carcass exports from these study slaughterhouses, ready availability of livestock for slaughter in addition to having hired staff on a regular contractual basis either as permanent or casual, there was every opportunity of establishing a vibrant HACCP system in the two facilities in order to guarantee the quality and safety of meat from the slaughterhouse for end consumers (Castiello *et al*, 2013).
- Availability of livestock for slaughter from Region Five of Ethiopia could ensure steady supply of small ruminants for slaughter despite the cyclic drought in Somalia that affects livestock body condition.

4.14 Challenges encountered

Following concessions by the UAE, the meat export market grew substantially from 2006 to 2008, albeit with challenges. Causes of interruptions that culminated to closure of the slaughterhouses included among others:

- Poor quality livestock due to drought and climatic shocks (inadequate pasture and water);
- Increased competition in Middle East (ME) markets by stronger exporters (e.g. Australia, Ethiopia);

- Low demand of carcasses in the UAE especially during summer time when foreign workers are on holidays;
- Under exploitation of the potential of Somali meat export market;
- Stiff internal competition following the resumption of export of live livestock after the lifting of the trade ban in October, 2009 by the Kingdom of Saudi Arabia (KSA) against the importation of livestock from Somalia.
- As consequence, the ports of Berbera and Bosasso increased export operations following the construction and operationalization of quarantine holding grounds in the two ports by Gulf International Company (GIC) from the ME; traders operating through these structures, due to high demand of livestock during the holy season (haji), increased the price paid for live animals at the source reducing possibilities for the slaughterhouses to access animals at competitive prices, therefore undermining supply consistency (Castiello *et al*, 2013);
- Change of management of operations by DAALLO Airlines which was the sole means of transport of chilled carcasses from all the export slaughterhouses in Somalia to the ME countries(Castiello *et al*, 2013);
- Temporary ban of cargo from Somalia to KSA after two explosives were found on 2 planes destined for America from Yemen complicated the situation. Carcasses were air freighted to Oman then transported by refrigerated trucks to the United Arab Emirates (UAE). The quality of most carcasses deteriorated by the time of reaching the destination market (Castiello *et al*, 2013).

Because of the number of challenges narrated above, the two slaughterhouses under study stopped operating within the last three months of 2009. H-Foods export slaughterhouse re-opened and operated in 2010 from July upto December and closed doors for a second time.

No operation was reported in the two slaughterhouses the whole of 2011 upto the time of drafting this thesis. However, there are plans to re-open H-Foods export slaughterhouse, all still under consideration and planning stage.

Chapter 5: Discussion

Primary production of livestock is a significant source of hazards associated with meat. A number of hazards are present in animal populations intended for slaughter, and their control during primary production often presents considerable challenges, e.g., contamination with E. *coli* O157:H7, *Salmonella* organisms, *Campylobacter* species, *Yersinia* species and various chemical and physical hazards. A risk-based approach to meat hygiene should include consideration of risk management options that may have a significant impact on risk reduction when applied at the level of primary production. However, E. *coli* as an indicator organism for fecal contamination may not completely be removed from abattoir lairages by standard cleaning practices (CAC, 2004; Food standards agency, 2005; Small *et al*, 2006).

Thus, lairages may allow a risk of transfer of contamination from one meat production day to the next. Potentially, bacteria such as *Salmonella* organisms may be transferred to the outer surfaces of animals held in the lairage facilities, and the skin or hide is a significant source of microbial contamination on the red meat carcasses subsequently produced (CAC, 2004; Food standards agency, 2005; Small *et al*, 2006). Therefore, primary production should be managed in a way that reduces the likelihood of introduction of hazards and appropriately contribute to meat being safe and suitable for human consumption. Whenever possible and practicable, food safety and quality assurance systems should be established by the primary production sector. These include butnot limited to livestock keepers, slaughterhouses and the competent authority (veterinary department). These should collect, collate and make available, information on public health hazards and conditions that may

be present in animal populations which will affect the safety and suitability of meat trade. It should include official or officially recognized programmes for the control and monitoring of zoonotic agents in animal populations and the environment as appropriate to the circumstances, and notifiable zoonotic diseases should be reported as required (CAC, 2004; Food standards agency, 2005; Small *et al*, 2006).

Even though Somaliland and Puntland have fragile institutions to pragmatically mitigate wholesale food safety requirements, the livestock traders and slaughterhouse management desist from presenting or purchasing sick or treated livestock for slaughter. The livestock trade in Somalia is mainly implemented through the operation of middlemen who gather livestock from remote areas and sell to main traders in town (or in other collection points). The system runs based on family/clan- network and builds on mutual trust between actors in the chain (from oral interview). One of the main pre-requisite for mobilizing livestock is the health status for which the middleman (*dillal*) is accountable to the trader. Livestock mainly slaughtered in both slaughterhouses at the period of investigation were aged between 6 months and 1½ years whose tender meat and carcasses' size were most preferred in ME countries. These young sheep and goats most likely had not been subjected to much treatment explaining the reasons why none of the 160 liver samples tested against tetracycline did not yield any positive results.

On the other hand, as far as applicable and possible, good hygienic practice (GHP) at the level of livestock primary production should involve for example: the health and hygiene of animals, records of treatments if any, feed stuffs and relevant environmental factors. It

should also include application of hazard analysis and critical control point (HACCP) principles during slaughter process to the greatest extent practicable (Food Safety and Inspection Services, 1999;CAC,2004;U.S Department of Health and Human Services Food and Drug Administration, 2006). For example, for animals with high degree of contamination on the external surfaces that is likely to compromise hygienic slaughter and dressing, yet suitable interventions such as washing with potable water is not available should not be presented for slaughter. Alternatively, all animals meant for slaughter should be washed with clean potable water just before slaughter. This reduces physical dirt and micro-organisms on the animal, thereby ensuring that animals presented for slaughter are sufficiently clean to avoid compromising hygienic slaughter and dressing (CAC, 2004).This was not the case for livestock slaughtered in H-Foods and Mubarak II export slaughterhouses. Instead, carcasses were washed immediately after slaughter in H-Foods export slaughterhouse when they were bleeding on the floor. However, no such washing took place in Mubarak II. This presented a risk of contaminating the final product. This therefore served as a potential CCP in both slaughterhouses if there were no other hazard control methods ahead in the processing chain like in the case of Mubarak II.

Primary production of meat should not be undertaken in areas where the presence of food safety hazards in the environment could lead to an unacceptable level of such hazards in meat. Therefore, competent authorities and slaughterhouse management should design and administer monitoring and surveillance systems to eliminate hazards (manure, bones, condemned carcasses, meat trims, horns etc.) arising from animals, plants (e.g. bushes), rubbish heaps and human encroachment that may compromise the production of meat that

is safe and suitable for human consumption (CAC, 2004; International Finance Corporation and World Bank, 2007).

Both H-Foods and Mubarak II export slaughterhouses had well maintained slaughterhouse compounds with no rubbish heaps, manure heaps, bushes or any bones to an extent of compromising the hygiene standards of meat produced.

Furthermore, there was no human encroachment to any of the two facilities. However, the pens and lairages of both slaughterhouses were hardly cleaned of manure, posing a risk of contaminating meat, which was identified as one of the CCP for Mubarak II slaughterhouse as it had no other control measure in the meat production chain. This feature contrasts with the requirement that these facilities should be operated in a way that soiling and cross-contamination of animals with food-borne pathogens are minimized to the greatest extent practicable as per the HACCP principles (CAC, 2008).

Apart from aesthetic considerations, the objective of hygienic practices is to reduce meat contamination with microorganisms and physical dirt. As such, the physical separation of unclean from clean areas is intended to diminish contamination of the meat from the soil, hides, and gut contents *inter alia* (Robert and Pharm,1980; Kang'ethe, 1993). In addition, a separate, suitable and sufficient room for the preparation and cleaning of red offal, which includes a separate area for handling heads at sufficient distance from other offal, must be in place (Livestock and meat industries regulations-Botswana, 2007). The latter condition was conspicuously absent in the design and layout of Mubarak II export slaughterhouse,

thereby promoting chances of meat contamination as confirmed from the analyzed surface meat swab samples.

Employers should provide all slaughter personnel working in the abattoir, free of charge, with suitable protective gear (gumboots, caps, aprons and white coat or overall) of washable material, in light color, and ensure that they are kept clean in a good condition. He or she shall ensure that they are worn by persons only during working hours (Laws of Kenya, 1977; Livestock and meat industries regulations-Botswana, 2007). More than three quarters of Mubarak II export slaughterhouse personnel had no protective gear during slaughtering and meat production for the period this study was being undertaken. For those who had it, it was incomplete (only yellow dust coat). This contributed to poor hygiene standards of meat handling resulting to high levels of contamination of carcasses with TVC, E. *coli* and *Salmonella* organisms as reflected in the analyzed samples from carcasses slaughtered in the slaughterhouse.

There should be provision of adequate stainless steel slaughter equipment like stainless steelknives, hooks, receptacles, slaughter tables, readily accessible sterilizers among others that are easy to wash and sanitize immediately after slaughter process. Receptacles should be suitable and sufficient with closely fitting covers for the collection and removal of all waste and fresh meat not intended for human consumption (Livestock and meat industries regulations-Botswana, 2007). These were lacking or insufficient in Mubarak II export slaughterhouse, thus promoting risks of meat contamination.

Slaughterhouses should have adequate supply of clean and potable hot (82^0C) and cold water or premixed to a suitable temperature (45^0C to 50^0C), available at an adequate pressure for cleaning and washing of the slaughterhouse and equipment. According to SSOP and HACCP principles, water is a very important source of contamination to carcasses if not potable when carcasses are finally washed or when equipment is washed to be ready for next use. Furthermore, there should be hand-wash basins and solid/liquid or powder soap available in adequate supply for hand washing before start of slaughter process or after visiting the toilets by personnel (Laws of Kenya,1977; USDA, Food Safety and Inspection Services, 1999 ;Almond Board of California, 2005; Livestock and meat industries regulations-Botswana, 2007). The slaughterhouse and equipment should be washed immediately after slaughter process ready for next slaughter. Both slaughterhouses had adequate supply of potable water. However, Mubarak II slaughterhouse had no hot or premixed water and hand-wash basins, which compromised meat hygiene handling standards. This partly explains the high TVC, comprising E. *coli* and *salmonella* organisms as compared with those from H-Foods. Many carcasses in this study from Mubarak II slaughterhouse were in the rejection level according to GCC microbiological performance criteria.

Training needs assessment has been found to be a critical activity for the design of training and development function of any food production industry and enterprise. Slaughterhouse technical and non-technical personnel should be adept at performing a training needs assessment (Janice and Diana, 2002).

Training in minimum meat hygiene handling practices is a very important aspect in order to produce high quality meat with low levels of bacterial contamination. According to FAO (2004) and Wamalwa *et al*, (2011[2]), capacity building and training of slaughter personnel is a fundamental requirement in achieving or attaining high quality meat with low levels of bacterial contamination. H-Foods export slaughterhouse personnel had had some training as compared to those from Mubarak II where there was a high turnover rate of personnel due to the civil war in South/central Somalia. This may explain partially why levels of meat contamination were much higher for carcasses sampled from Mubarak II as compared to those from H-Foods.

The turnover of abattoir workers in Mubarak II slaughterhouse was high because of dependence on internally displaced persons (IDPs) from Central and Southern Somalia that was still under civil warat the time of data collection. The IDPs returned to their places of origin once relative calm returned or were relocated to other better places even though they could have been trained in meat hygiene handling practices. The management was being forced to hire new personnel who had no concept of hygienic meat production practices. During the investigation, high abattoir workers' turnover was observed as one of the constraints in this slaughterhouse.

A second sample collection and analysis carried out at the H-Foods slaughterhouse after intervention through training and supply of some basic livestock slaughter equipment and tools, led to slightly improved hygiene reflected in the reduced levels of meat contamination with TVC and E. *coli* though this was not statistically significant.

To develop a comprehensive implementation and compliance with SSOP concept and HACCP system in the two slaughterhouses, the need to review and improve the designs and layout of the slaughterhouses' structures and facilities was identified. A projected BCR of more than 1 for both slaughterhouses was a good indication that inclusion of the HACCP system into each slaughterhouse could have been profitable. Inclusion of the HACCP system was not possible due to *force majeure* conditions.

The quality assurance system (SSOP concept and HACCP system) incorporation could have contributed to increased income from presumed increased sales as a result of reduced rejection of carcasses by the importing countries, reduced losses through meat spoilage due to increased shelf-life and the possible ease to access the market that is characterized by more restrictive sanitary requirements such as the Kingdom of Saudi Arabia. This should be one of the considerations once the slaughterhouses re-open and start operations again.

Moreover, there will be need to do capacity building for the sub-sector through upgrading of the slaughter facilities, equipment and regular conducting of refresher trainings for both technical and non-technical personnel working in the two export slaughterhouses. Training should focus on the stringent food safety standards taking into account quality assurance systems including the HACCP system (appendix II) for assured food safety hazard control. The capacity building should take into consideration the natural attrition of the involved personnel and keep abreast with the ever-rising food safety standards in addition to regular replacement of worn out equipment.

Unfortunately, Mubarak II slaughterhouse closed towards the end of 2009 and has not operated since while H-Foods slaughterhouse operated for only 4 months in 2010 and closed a second time. Both slaughterhouses were still closed at the time of drafting this thesis even though there were possibilities of re-opening H-Foods slaughterhouse since the owner contracted an Environmental Impact Audit expert with the help of FAO Somalia in January, 2012. He requested inspection of the facilities by the World Organization for Animal Health (OIE) with the help of FAO. He intends to export his chilled carcasses to the Kingdom of Saudi Arabia.

Chapter 6: Conclusions and Recommendations

6.1 Conclusions

Despite the multiple constraints and challenges such as poor hygiene meat handling practices, poor infrastructure facilities for establishing SSOP and HACCP system in the two export slaughterhouses under investigation, there is still some potential of developing the system in the near future since Somalia is on a slow path of recovery to peace and security. In conclusion, the following were findings and observations:

- Mubarak II export slaughterhouse was 46% compliant with meat hygiene handling practices while H-Foods was 92% compliant.
- Meat produced from Mubarak II slaughterhouse was of low quality with no carcass categorized as of excellent grade, with respect to TVC and 13% of carcasses tested positive for *Salmonella* organism; a sign of very poor hygiene meat handling practices. Carcasses from this slaughterhouse were 264.4 times (P- value <0.001) more likely to be contaminated with micro-organisms as compared to those slaughtered from H-Foods export slaughterhouse. Many carcasses from this slaughterhouse investigated in this study could have been rejected by the importing Middle East countries according to GCC microbiological performance criteria
- Meat produced from H-Foods slaughterhouse was of high quality with only 0.4% of carcasses sampled being categorized as of poor grade, with respect to TVC. The carcasses also posted low levels of E. *coli* and no presence of *Salmonella* organism.
- Intervention through training of abattoir workers in both slaughterhouses in GHP, SSOP, SOP, HACCP principles, environmental hygiene and waste management and

human resource will be essential for production of high quality meat from both slaughterhouses but especially Mubarak II if they start operating again.

- Cirtical Control Points (CCPs) identified from H-Foods included carcass shrouding, chilling and transportation to airport while in Mubarak II slaughterhouse, CCPs were identified to be all along the slaughter process from livestock receiving, slaughter, flaying, freezing and transportation to airport.
- Implementation of quality assurance system of SSOP and HACCP system in the two slaughterhouses was hampered by closure of the slaughterhouses when the study was still going on. Recommendations could not be acted upon.

6.2 Recommendations

After establishing possible sources of carcasses' contamination in the two slaughterhouses and especially Mubarak II export slaughterhouse, mitigation measures to focus on sufficiently high standards though simple and inexpensive to maintain corrective measures, were recommended in accordance with quality control programs of Good Hygiene Practices (GHP), Hazard Analysis and Critical Control Point (HACCP) principles and Sanitation Standard Operating Procedures (SSOPs). These included but not limited to:

- Training of abattoir workers, government staff in charge of meat inspection services and facilitation of enforcement of Meat Inspection and Control Act;
- Provision of some basic livestock slaughter equipment and protective gear for all workers to put on during slaughter. This can be provided by slaughterhouse management and development partners.

- Mubarak II export slaughterhouse requires to be supplied with basic livestock slaughter equipment like stainless steel knives, hooks, receptacles, wheelbarrows, and trolleys *inter alia*.
- Mubarak II slaughter system should be changed from batch slaughter to line slaughter. Provision of automated overhead slaughter chain is recommended . This will provide different stages where food safety hazards will be controlled or reduced to acceptable levels along the production chain in accordance with HACCP principles.
- Appropriate chillers should be installed in Mubarak II slaughterhouse to avoid use of meat carriers to freeze meat.
- The management of Mubarak II export slaughterhouse should endeavor to recruit local staff instead of depending on IDPs. This will mitigate high turnover rate of personnel trained in meat hygiene production practices.
- There is need to construct a spray race for washing all dirty livestock just before slaughter at the two slaughterhouses. This will enable the operators to comply with HACCP system requirements.
- Footbaths should be constructed at all entrances both for livestock meant for slaughter and abattoir workers. The footbaths should be maintained according to established sanitary standards.
- Both slaughterhouses should make provision for separation of blood from the slaughterhouse liquid effluent. This can be done by providing lockable blood pits.
- Lockable condemnation pits for condemned carcasses and organs should be put in place in the two slaughterhouses.

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Appendix I: 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)

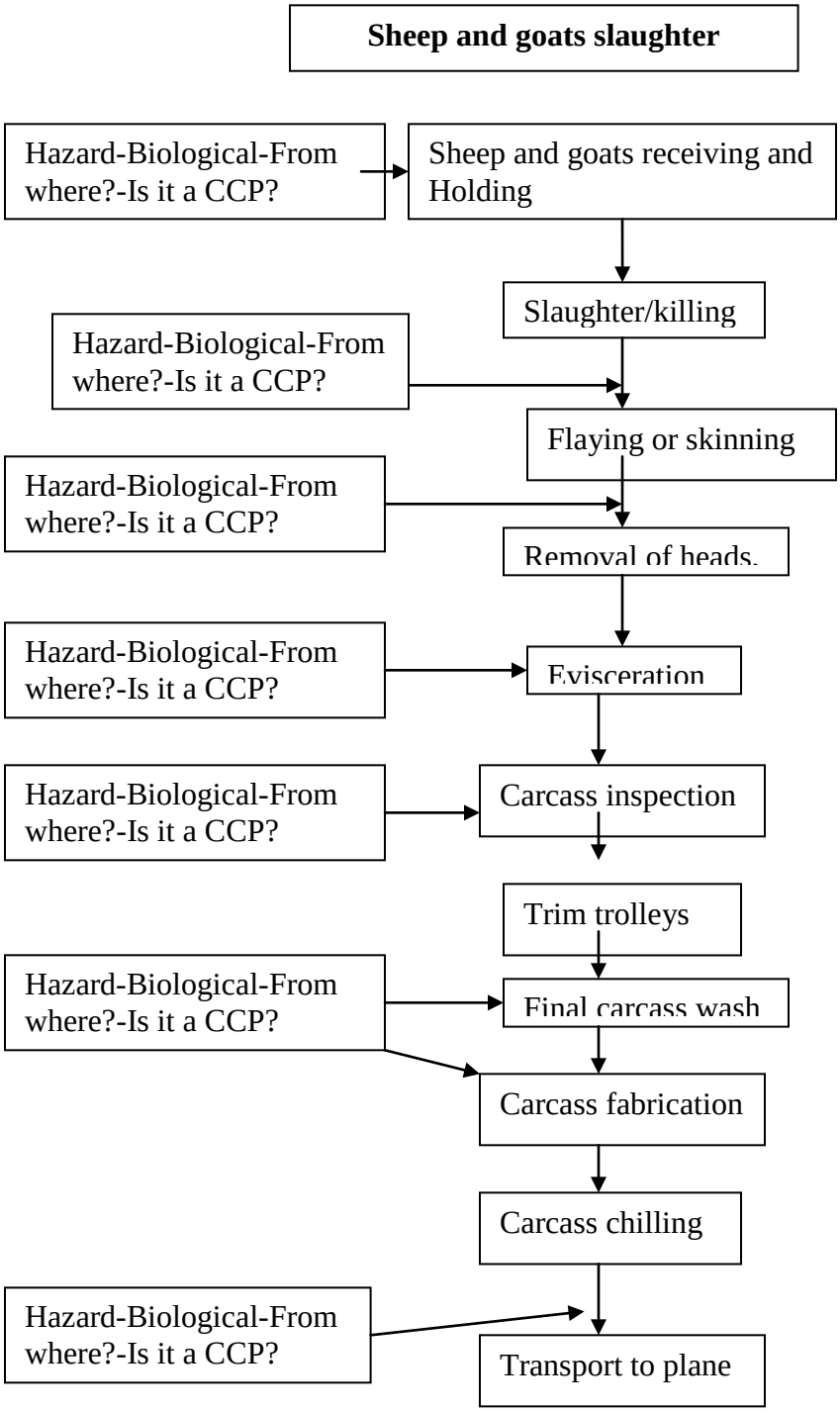
3 Tubes per dilution

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

Appendices II:-Hazard Analysis Critical Control Points (HACCP) tree



Appendix III:-Questionnaire on food (meat) safety production

Date: Dd/Month/Year……..

Name of Respondent……Sex.....

Organization working for if any.....

Name of city…….....

Address/ phone No ……

Type of facility.....

Ownership…….....

Date Established…….....

Registration No…….....

Date Registered…….....

Average No. of Slaughter per Day…….....

Goats…….....

Sheep…….....

No. of Inspectors…….....

Government/private…….....

No. of Employees……

Working Days per Week……

No. of Shifts per Day……..

Working Hours per Shift…….

Sanitary standard operating procedures (SSOPs)

1. Is the location of the slaughterhouse subject to water stagnation, floods, objectionable odours, smoke, dust or other contaminants?
   Yes, No...

2. Are there overnight holding pens before slaughter?
   Yes, No...

3. Are the pens thoroughly washed after every slaughter?
   Yes, No

4. Are there isolation pens for suspect cases?
   Yes, No...

5. Are there slaughter tables that are easy to wash and sanitize?
   Yes, No

6. Is there a bleeding chain? Y/N

7. Are there hoisting facilities before skinning and evisceration? Yes, No

8. Is there a clear demarcation between the dirty area and a clean area during slaughtering and handling? Yes, No

9. Is there a room for keeping heads, hides, skins and legs? Yes, No,

10. Are they removed immediately from meat processing line?
    Yes, No
11. Is there a separate room for handling offals?
    Yes, No
12. Is there adequate natural and/ artificial light to enable proper operations?
    Yes, No
13. Do you have a disposal pit for condemns that is lockable?Yes, No

14. Are floors and walls made of light impervious hard material for easy washing and disinfection? Yes, No
15. Are walls or floors cracked? Y/N

16. Is there a good drainage system? Yes, No,

17. Are slaughter equipments e.g. knives, hooks, saws e.t.c. made of easy to clean material like stainless steel? Yes, No

18. Are they washed and sanitized immediately after slaughter process? Y/N

19. Is there adequate cold and hot potable water (82^0c) for washing used utensils, floor and walls after slaughter? Yes, No

20. Is there a provision of washing dirty animals presented for slaughter before slaughter? Yes, No

21. Is there a dress changing room for workers? Yes, No,

22. Do workers put on clean protective clothes before start of work? Yes, No,

23. Are the protective gear washed and sanitized immediately after work ready for next use? Y/N

24. Are tools, hands aprons and boots cleaned and sanitized (if appropriate) to prevent contamination during evisceration or processing of skinned carcasses? Y/N,

25. Are tools that may contact abscessed carcass portions changed, cleaned and sterilized before next use? Y/N

26. Is an employee with illness or open infected wound prohibited from handling meat? Y/N

27. Are employees discouraged from putting on jewellery, watches, e.t.c. while handling meat? Y/N

28. Are employees permitted to eat, smoke, chew, drink e.t.c. in slaughter hall and when handling meat? Y/N

29. Do employees wash hands thoroughly with warm potable water before start of work and after visiting a toilet, blowing nose or before start of work? Y/ N.

30. Are hand washing facilities and toilets in good supply and functioning? Y/N

31. Is accumulation of waste during or after the operation permitted? Y/N

32. When carcass meat comes in contact with faeces or intestinal contents during slaughtering and processing do you carry out corrective measures like Washing with lots of potable water, Scrub? Y/N

AppendixIV: - Laboratory Report

Mubarak II export slaughterhouse

Analabs Ref No.	Description	Results	Interpretation PHD Dubai municipality
M0394	Swab – Goat 1 Site Lateral thorax	TVC >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = positive	V. poor V. poor
M0395	Swab – Goat 1 Site Brisket	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = positive	V. poor V. poor
M0396	Swab – Goat 1 Site Flank	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 21 MPN index/ml=2.1 cfucm^2 *Salmonella* sp = positive	V. poor Fair
M0397	Swab – Goat 1 Site Fore Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = positive	V. poor V. poor
M0398	Swab – Goat 1 Site Hind Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = positive	V. poor V. poor
M0399	Swab – Goat 2 Site Lateral thorax	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0400	Swab – Goat 2 Site Brisket	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 460 MPN index/ml=46 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0401	Swab – Goat 2 Site Flank	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 28 MPN index/ml=2.8 cfucm^2 *Salmonella* sp = absent	V. poor Fair
M0402	Swab – Goat 2 Site Fore Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = absent	V. poor Excellent
M0403	Swab – Goat 2 Site Hind Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = absent	V. poor Excellent
M0404	Swab – Goat 3 Site Lateral thorax	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 240 MPN index/ml=24 cfucm^2 *Salmonella* sp = absent	V. poor Poor
M0405	Swab – Goat 3 Site Brisket	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml *Salmonella* sp = absent	V. poor V. poor
M0406	Swab – Goat 3 Site Flank	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0407	Swab – Goat 3 Site Fore Quarter	TVC = >200,000 cfu/cm^2 *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = absent	V. poor V. poor

M0408	Swab – Goat 3 Site Hind Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0409	Swab – Goat 4 Site Lateral thorax	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0410	Swab – Goat 4 Site Brisket	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0411	Swab – Goat 4 Site Flank	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0412	Swab – Goat 4 Site Fore Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0413	Swab – Goat 4 Site Hind Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 43 MPN index/ml=4.3 cfu/cm^2 *Salmonella* sp = absent	V. poor Fair
M0414	Swab – Goat 5 Site Lateral thorax	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 28 MPN index/ml=2.8 cfu/cm^2 *Salmonella* sp = absent	V. poor Fair
M0415	Swab – Goat 5 Site Brisket	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 210 MPN index/ml=21 cfu/cm^2 *Salmonella* sp = absent	V. poor Poor
M0416	Swab – Goat 5 Site Flank	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0417	Swab – Goat 5 Site Fore Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0418	Swab – Goat 5 Site Hind Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0419	Swab – Goat 6 Site Lateral thorax	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 M index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0420	Swab – Goat 6 Site Brisket	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0421	Swab – Goat 6 Site Flank	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 460 MPN index/ml=46 cfu/cm^2 *Salmonella* sp = absent	V. poor Poor
M0422	Swab – Goat 6 Site Fore Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0423	Swab – Goat 6 Site Hind Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfuc/m^2 *Salmonella* sp = absent	V. poor V. poor
M0424	Swab – Goat 7 Site Lateral thorax	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor

M0425	Swab – Goat 7 Site Brisket	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = absent	V. poor V. poor
M0426	Swab – Goat 7 Site Flank	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0427	Swab – Goat 7 Site Fore Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 120 MPN index/ml=12 cfucm^2 *Salmonella* sp = absent	V. poor Poor
M0428	Swab – Goat 7 Site Hind Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0429	Swab – Goat 8 Site Lateral thorax	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0430	Swab – Goat 8 Site Brisket	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0431	Swab – Goat 8 Site Flank	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0432	Swab – Goat 8 Fore Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0433	Swab – Goat 8 Site Hind Quarter	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0434	Swab – Goat 9 Site Lateral thorax	TVC = >200,000 cfu/cm^2 estimated *E. coli* =>1,100 MPN index/ml=110 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0435	Swab – Goat 9 Site Brisket	TVC = >200,000 cfu/cm^2 estimated *E. coli* = 11 MPN index/ml=1.1 cfucm^2 *Salmonella* sp = absent	V. poor V. poor
M0700	Swab – Goat 10 Site Lateral thorax	TVC = 17,180 cfu/cm^2 *E. coli* = 460 MPN index/ml=46 cfu/cm^2 *Salmonella* sp = Not detected in swab	Fair Poor
M0701	Swab – Goat 10 Site Brisket	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	V. poor V. poor
M0702	Swab – Goat 10 Site Flank	TVC = 115,000 cfu/cm^2 *E. coli* = 1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor V. poor
M0703	Swab – Goat 10 Site Fore Limb	TVC = 155,000 cfu/cm^2 *E. coli* =>1,100 MPN index/ml= 110cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor V. poor
M0704	Swab – Goat 10 Site Hind Limb	TVC = 18,900 cfu/cm^2 *E. coli* = 460 MPN index/ml=46 cfu/cm^2 *Salmonella* sp = Not detected in swab	Fair Poor
M0705	Swab – Goat11 Site Lateral thorax	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* = 240 MPN index/ml=24 cfu/cm^2 *Salmonella* sp = Not detected in swab	V. poor Poor

M0706	Swab – Goat 11 Site Brisket	TVC = 21,545 cfu/cm^2 *E. coli* = 93 MPN index/ml=9.3 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor Fair
M0707	Swab- Goat 11 Flank	TVC = 54,000 cfu/cm^2 *E. coli* = 23 MPN index/ml=2.3 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor Fair
M0708	Swab- Goat 11 Fore Limb	TVC = 28,360 cfu/cm^2 *E. coli* = 4 MPN index/ml=0.4 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor Good
M0709	Swab- Goat 11 Hind Limb	TVC = 299,000 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 cfu/cm^2 *Salmonella* sp = Not detected in swab	V. poor Excellent
M0710	Swab- Goat 12 Lateral thorax	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* = 240 MPN index/ml=24 cfu/cm^2 *Salmonella* sp = Not detected in swab	V. poor Poor
M0711	Swab- Goat 12 Brisket	TVC = 16,180 cfu/cm^2 *E. coli* = 28 MPN index/ml=2.8 cfu/cm^2 *Salmonella* sp = Not detected in swab	Fair Fair
M0712	Swab- Goat12 Flank	TVC = 57,000 cfu/cm^2 *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor V. poor
M0713	Swab- Goat 12 Fore Limb	TVC = 71,000 cfu/cm^2 *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor V. poor
M0714	Swab- Goat 12 Hind Limb	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	V. poor V. poor
M0715	Swab –Goat 13 Lateral thorax	TVC = 56,000 cfu/cm^2 *E. coli* = 1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor V. poor
M0716	Swab- Goat 13 Brisket	TVC = 20,545 cfu/cm^2 *E. coli* = 460 MPN index/ml=46 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor Poor
M0717	Swab- Goat 13 Flank	TVC = 187,000 cfu/cm^2 *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor V. poor
M0718	Swab- Goat 13 Fore Limb	TVC = 77,000 cfu/cm^2 *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor V. poor
M0719	Swab- Goat 13 Hind Limb	TVC = 14,727 cfu/cm^2 *E. coli* = 210 MPN index/ml=21 cfu/cm^2 *Salmonella* sp = Not detected in swab	Fair Poor
M0720	Swab- Goat 14 Lateral thorax	TVC = 101,000 cfu/cm^2 *E. col* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor V. poor
M0721	Swab- Goat 14 Brisket	TVC = 4,900 cfu/cm^2 *E. coli* = 210 MPN index/ml=21 cfu/cm^2 *Salmonella* sp = Not detected in swab	Fair Poor
M0722	Swab- Goat 14 Flank	TVC = 145,000 cfu/cm^2 *E. coli* = 460 MPN index/ml=46 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor Poor

M0723	Swab- Goat 14 Fore Limb	TVC = 48,000 cfu/cm^2 *E. coli* = 460 MPN index/ml=46 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor Poor
M0724	Swab- Goat 14 Hind Limb	TVC = 2,800 cfu/cm^2 *E. coli* = 43 MPN index/ml-4.3 cfu/cm^2 *Salmonella* sp = Not detected in swab	Fair Fair
M0725	Swab- Goat 15 Lateral thorax	TVC = 173,000 cfu/cm^2 *E. coli* = 3 MPN index/ml=0.3 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor Excellent
M0726	Swab –Goat15 Brisket	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* = 460 MPN index/ml=46 cfu/cm^2 *Salmonella* sp = Not detected in swab	V. poor Poor
M0727	Swab- Goat 15 Flank	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* = 1,100 MPN index/m=110 cfu/cm^{2}l *Salmonella* sp = Not detected in swab	V. poor V. poor
M0728	Swab- Goat 15 Fore Limb	TVC = 30,090 cfu/cm^2 *E. coli* = 210 MPN index/ml=21 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor Poor
M0729	Swab- Goat 15 Hind Limb	TVC = 14,363 cfu/cm^2 *E. coli* = 28 MPN index/ml=2.8 cfu/cm^2 *Salmonella* sp = Not detected in swab	Fair Fair
M0730	Swab- Goat 16 Lateral thorax	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* >1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	V. poor V. poor
M0731	Swab- Goat 16 Brisket	TVC = 189,000 cfu/cm^2 *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor V. poor
M0732	Swab- Goat 16 Flank	TVC = 49,000 cfu/cm^2 *E. coli* = 1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor V. poor
M0733	Swab- Goat 16 Fore Limb	TVC = 176,000 cfu/cm^2 *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor V. poor
M0734	Swab –Goat 16 Hind Limb	TVC = 36,000 cfu/cm^2 *E. coli* = 7 MPN index/ml=0.7 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor Good
M0735	Swab- Goat 17 Lateral thorax	TVC = 111,000 cfu/cm^2 *E. coli* = 3 MPN index/ml=0.3 cfu/cm^2 *Salmonella* sp = Not detected in swab	Poor Excellent
M0736	Swab- Goat 17 Fore Limb	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Not detected in swab	V. poor V. poor

M0737	Swab- Goat 17 Flank	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* = 240 MPN index/ml=24 cfu/cm^2 *Salmonella* sp = Detected in swab	V. poor Poor
M0738	Swab- Goat 18 Lateral thorax	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Detected in swab	V. poor V. poor
M0739	Swab- Goat 18 Brisket	TVC = 10,200 cfu/cm^2 *E. coli* = 460 MPN index/ml=46 cfu/cm^2 *Salmonella* sp = Detected in swab	Fair Poor
M0740	Swab- Goat 918 Flank	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Detected in swab	V. poor V. poor
M0741	Swab- Goat 18 Fore Limb	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* =>1,100 MPN index/ml=110 cfu/cm^2 *Salmonella* sp = Detected in swab	V. poor V. poor
M0623	Swab – Goat 19 Site Flank	TVC = 1,300 cfu/cm^2 *E. coli* = 23 MPN index/ml=2.3 cfucm^2 *Salmonella* sp = Detected in swab	Good Fair
M0624	Swab – Goat 19 Site Fore Limb	TVC = 5,270 cfu/cm^2 *E. coli* = 23 MPN index/ml=2.3 cfucm^2 *Salmonella* sp = Not detected in swab	Fair Fair
M0625	Swab – Goat 19 Site Hind Limb	TVC = 2,200 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected in swab	Fair Excellent
M0626	Swab – Goat 19 Site Lateral thorax	TVC = 1,300 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Detected in swab	Good Excellent
M0627	Swab – Goat 19 Site Brisket	TVC = 3,400 cfu/cm^2 *E. coli* = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Detected in swab	Fair Good
M0628	Swab- Goat 20 Flank	TVC = 2,800 cfu/cm^2 *E. coli* = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected in the swab	Fair Good
M0629	Swab- Goat 20 Fore Limb	TVC = 4,300 cfu/cm^2 *E. coli* = 4 MPN index/ml=0.4 cfucm^2 *Salmonella* sp = Not detected in the swab	Fair Good
M0630	Swab- Goat 20 Hind Limb	TVC = 1,600 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 cfucm^2 *Salmonella* sp = Not detected in the swab	Good Excellent
M0631	Swab- Goat 21 Lateral thorax	TVC = 2,000 cfu/cm^2 *E. coli* = 9 MPN index/ml=0.9 cfucm^2 *Salmonella* sp = Not detected in the swab	Good Good

M0632	Swab- Goat 21 Brisket	TVC = 3,500 cfu/cm^2 *E. coli* = 23 MPN index/ml=2.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Fair
M0633	Swab- Goat 21 Flank	TVC = 3,300 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Excellent
M0634	Swab- Goat 21 Fore Limb	TVC = 2,600 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Excellent
M0635	Swab- Goat 21 Hind Limb	TVC = 10,700 cfu/cm^2 *E. coli* = 43 MPN index/ml=4.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Fair
M0636	Swab –Goat 22 Lateral thorax	TVC = 6,600 cfu/cm^2 *E. coli* = 1,100 MPN index/ml=110 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair V. poor
M0637	Swab- Goat 22 Brisket	TVC = 1,100 cfu/cm^2 *E. coli* = 4 MPN index/ml=0.4 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Good Good
M0638	Swab- Goat 22 Flank	TVC = 7,600 cfu/cm^2 *E. coli* = 93 MPN index/ml=9.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Fair
M0639	Swab- Goat 22 Fore Limb	TVC = 1,500 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Good Excellent
M0640	Swab- Goat 22 Hind Limb	TVC = 1,000 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Good Excellent
M0641	Swab- Goat 23 Lateral thorax	TVC = 5,500 cfu/cm^2 *E. coli* = 4 MPN index/ml=0.4 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Good
M0642	Swab- Goat 23 Brisket	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* = 23 MPN index/ml=2.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	V. poor Fair
M0643	Swab- Goat 23 Flank	TVC = 7,700 cfu/cm^2 *E. coli* = 9 MPN index/ml=0.9 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Good
M0644	Swab- Goat 23 Fore Limb	TVC = 8,700 cfu/cm^2 *E. coli* = 23 MPN index/ml=2.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Good Fair
M0645	Swab- Goat 23 Hind Limb	TVC = 1,500 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Good Excellent

M0646	Swab- Goat 24 Lateral thorax	TVC = 2,900 cfu/cm^2 *E. coli* = 9 MPN index/ml=0.9 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Good
M0647	Swab –Goat 24 Brisket	TVC = 4,100 cfu/cm^2 *E. coli* = 4 MPN index/ml=0.4 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Good
M0648	Swab- Goat 24 Flank	TVC = 22,900 cfu/cm^2 *E. coli* = 93 MPN index/ml=9.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Poor Fair
M0649	Swab- Goat 24 Fore Limb	TVC = 4,000 cfu/cm^2 *E. coli* = 23 MPN index/ml=2.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Fair
M0650	Swab- Goat 24 Hind Limb	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* = 4 MPN index/ml=0.4 $cfucm^2$ *Salmonella* sp = Not detected in the swab	V. poor Good
M0651	Swab- Goat 25 Lateral thorax	TVC = 2,500 cfu/cm^2 *E. coli* = 15 MPN index/ml=1.5 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Fair
M0652	Swab- Goat 25 Brisket	TVC = 79,000 cfu/cm^2 *E. coli* = 4 MPN index/ml=0.4 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Poor Good
M0653	Swab- Goat 25 Flank	TVC = 13,550 cfu/cm^2 *E. coli* = 240 MPN index/ml=24 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Poor
M0654	Swab- Goat 25 Fore Limb	TVC = 2,100 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Excellent
M0655	Swab –Goat25 Hind Limb	TVC = 1,400 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Good Excellent
M0656	Swab- Goat 26 Lateral thorax	TVC = 2,100,000 cfu/cm^2 *E. coli* = 9 MPN index/ml=0.9 $cfucm^2$ *Salmonella* sp = Not detected in the swab	V. poor Good
M0657	Swab- Goat 26 Brisket	TVC = 1,400 cfu/cm^2 *E. coli* = 9 MPN index/ml=0.9 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Good Good
M0658	Swab- Goat 26 Flank	TVC = >200,000 cfu/cm^2 (estimated) *E. coli* = 150 MPN index/ml=15 $cfucm^2$ *Salmonella* sp = Not detected in the swab	V. poor Poor
M0659	Swab- Goat 26 Fore Limb	TVC = 1,900 cfu/cm^2 *E. coli* = 9 MPN index/ml=0.9 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Good Good

M0660	Swab –Goat 26 Hind Limb	TVC = >200,000 cfu/cm^2 *E. coli* = 23 MPN index/ml=2.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	V. poor Fair
M0661	Swab- Goat27 Lateral thorax	TVC = 2,000 cfu/cm^2 *E. coli* = 9 MPN index/ml=0.9 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Good Good
M0662	Swab- Goat 27 Brisket	TVC = 240,000 cfu/cm^2 *E. coli* =<3 MPN index/ml=0.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	V. poor Excellent
M0663	Swab- Goat 27 Flank	TVC = 1,400 cfu/cm^2 *E. coli* = 120 MPN index/ml=12 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Good Poor
M0664	Swab- Goat27 Fore Limb	TVC = 8,500 cfu/cm^2 *E. coli* = 93 MPN index/ml=9.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Fair
M0665	Swab- Goat 27 Hind Limb	TVC = 3,400 cfu/cm^2 *E. coli* = 43 MPN index/ml=4.3 $cfucm^2$ *Salmonella* sp = Not detected in the swab	Fair Fair
M0861	Swab – Goat 28 Site Lateral thorax	TVC = >200,000 cfu/cm2(estimated) E. coli = <3 MPN index/ml Salmonella sp = Detected in swab	V. Poor Excellent
M0862	Swab – Goat 28 Site Brisket	TVC = >200,000 cfu/cm2 (estimated) E. coli = 4 MPN index/ml Salmonella sp = Detected in swab	V. Poor Good
M0863	Swab – Goat 28 Site Flank	TVC = >200,000 cfu/cm2 (estimated) E. coli = 15 MPN index/ml Salmonella sp = Detected in swab	V. Poor Fair
M0864	Swab – Goat 28 Site Fore Limb	TVC = 16,000 cfu/cm2 E. coli = 9 MPN index/ml Salmonella sp = Detected in swab	Fair Good
M0865	Swab – Goat 28 Site Hind Limb	TVC = >200,000 cfu/cm2 (estimated) E. coli = <3 MPN index/ml Salmonella sp = Detected in swab	V. Poor Excellent
M0866	Swab – Goat 29 Site Lateral thorax	TVC = 171,000 cfu/cm2 E. coli = <3 MPN index/ml Salmonella sp = Detected in swab	Poor Excellent
M0867	Swab – Goat 29 Site Brisket	TVC = 31,000 cfu/cm2 E. coli = 4 MPN index/ml Salmonella sp = Detected in swab	Poor Good
M0868	Swab- Goat 29 Flank	TVC = >200,000 cfu/cm^2 (estimated) E. coli = <3 MPN index/ml Salmonella sp = Detected in swab	V. Poor Excellent

M0869	Swab- Goat 29 Fore Limb	TVC = 24,000 cfu/cm2 E. coli = <3 MPN index/ml Salmonella sp = Detected in swab	Poor Excellent
M0870	Swab- Goat 29 Hind Limb	TVC = >200,000 cfu/cm2 (estimated) E. coli = 9 MPN index/ml Salmonella sp = Detected in swab	V. Poor Good
M0871	Swab- Goat 30 Lateral thorax	TVC = >200,000 cfu/cm2 (estimated) E. coli = 15 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Fair
M0872	Swab- Goat 30 Brisket	TVC = >200,000 cfu/cm2 (estimated) E. coli = 93 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Fair
M0873	Swab- Goat 30 Flank	TVC = >200,000 cfu/cm2 (estimated) E. coli = 240 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Poor
M0874	Swab- Goat 30 Fore Limb	TVC = >200,000 cfu/cm2 (estimated) E. coli = <3 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Excellent
M0875	Swab- Goat 30 Hind Limb	TVC = >200,000 cfu/cm2 (estimated) E. coli = 460 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Poor
M0876	Swab –Goat 31 Lateral thorax	TVC = >200,000 cfu/cm2 (estimated) E. coli = 4 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Good
M0877	Swab- Goat 31 Brisket	TVC = >200,000 cfu/cm2 (estimated) E. coli = 15 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Fair
M0878	Swab- Goat 31 Flank	TVC = 196,000 cfu/cm2 E. coli = 93 MPN index/ml Salmonella sp = Not detected in swab	Poor Fair
M0879	Swab- Goat 31 Fore Limb	TVC = >200,000 cfu/cm2 (estimated) E. coli = <3 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Excellent
M0880	Swab- Goat 31 Hind Limb	TVC = 55,000 cfu/cm2 E. coli = 150 MPN index/ml Salmonella sp = Not detected in swab	Poor Poor
M0881	Swab- Goat 32 Lateral thorax	TVC = >200,000 cfu/cm2 (estimated) E. coli = 43 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Fair
M0882	Swab- Goat 32 Brisket	TVC = >200,000 cfu/cm2 (estimated) E. coli = 15 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Fair

M0883	Swab- Goat 32 Flank	TVC = 120,000 cfu/cm2 E. coli = 240 MPN index/ml Salmonella sp = Not detected in swab	Poor Poor
M0884	Swab- Goat 32 Fore Limb	TVC = >200,000 cfu/cm2 (estimated) E. coli = 9 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Good
M0885	Swab- Goat 32 Hind Limb	TVC = >300,00 cfu/cm2 (estimated) E. coli = 23 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Fair
M0886	Swab- Goat 33 Lateral thorax	TVC = >200,000 cfu/cm2 (estimated) E. coli = 9 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Good
M0887	Swab –Goat 33 Brisket	TVC = >200,000 cfu/cm2 (estimated) E. coli = 93 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Fair
M0888	Swab- Goat 33 Flank	TVC = >200,000 cfu/cm2 (estimated) E. coli = 43 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Fair
M0889	Swab- Goat 33 Fore Limb	TVC = 46,000 cfu/cm2 E. coli = 23 MPN index/ml Salmonella sp = Not detected in swab	Poor Fair
M0890	Swab- Goat 33 Hind Limb	TVC = >200,000 cfu/cm2 (estimated) E. coli = 150 MPN index/ml Salmonella sp = Not detected in swab	V. Poor Poor
M0891	Swab- Goat35 Lateral thorax	TVC = >200,000 cfu/cm2 (estimated) E. coli = 43 MPN index/ml Salmonella sp = Detected in swab	V. Poor Fair
M0892	Swab- Goat 34 Brisket	TVC = 155,000 cfu/cm2 E. coli = 15 MPN index/ml Salmonella sp = Detected in swab	Poor Fair
M0893	Swab- Goat 34 Flank	TVC = >200,000 cfu/cm2 (estimated) E. coli = 240 MPN index/ml Salmonella sp = Detected in swab	V. Poor Poor
M0894	Swab- Goat 34 Fore Limb	TVC = 262,000 cfu/cm2 E. coli = 93 MPN index/ml Salmonella sp = Detected in swab	V. Poor Fair
M0895	Swab –Goat 34 Hind Limb	TVC = >200,000 cfu/cm2 (estimated) E. coli = 23 MPN index/ml Salmonella sp = Detected in swab	V. Poor Fair
M0896	Swab- Goat35 Lateral thorax	TVC = >200,000 cfu/cm2 (estimated) E. coli = 9 MPN index/ml Salmonella sp = Detected in swab	V. Poor Good

M0897	Swab- Goat 35 Brisket	TVC = 84,000 cfu/cm2 E. coli = 43 MPN index/ml Salmonella sp = Detected in swab	Poor Fair
M0898	Swab- Goat 35 Flank	TVC = >200,000 cfu/cm2 (estimated) E. coli = >1,100 MPN index/ml Salmonella sp = Detected in swab	V. Poor V. Poor
M0899	Swab- Goat 35 Fore Limb	TVC = 66,000 cfu/cm2 E. coli = 4 MPN index/ml Salmonella sp = Detected in swab	Poor Good
M0900	Swab –Goat 35 Hind Limb	TVC = >200,000 cfu/cm2 (estimated) E. coli = 9 MPN index/ml Salmonella sp = Detected in swab	V. Poor Good
M1001	Swab – Goat 36 Site Lateral thorax	TVC = 6,820 cfu/cm2 E. coli = <3 MPN index/ml Salmonella sp = Not detected in swab	Fair Excellent
M1002	Swab – Goat 36 Site Brisket	TVC = 1,400 cfu/cm2 E. coli = 7 MPN index/ml Salmonella sp = Not detected in swab	Good Good
M1003	Swab- Goat 36 Flank	TVC = 17,000 cfu/cm2 E. coli = 7 MPN index/ml Salmonella sp = Not detected in swab	Fair Good
M1004	Swab- Goat 36 Fore Limb	TVC = 2,800 cfu/cm2 E. coli = 7 MPN index/ml Salmonella sp = Not detected in swab	Fair Good
M1005	Swab- Goat 36 Hind Limb	TVC = 5,800 cfu/cm2 E. coli = 4 MPN index/ml Salmonella sp = Not detected in swab	Fair Good
M1006	Swab- Goat 37 Lateral thorax	TVC = 16,200 cfu/cm2 E. coli = 7 MPN index/ml Salmonella sp = Not detected in swab	Fair Good
M1007	Swab- Goat 37 Brisket	TVC = 14,270 cfu/cm2 E. coli = 4 MPN index/ml Salmonella sp = Not detected in swab	Fair Good
M1008	Swab- Goat 37 Flank	TVC = 1,500 cfu/cm2 E. coli = 93 MPN index/ml Salmonella sp = Not detected in swab	Good Fair
M1009	Swab- Goat 37 Fore Limb	TVC = 3,300 cfu/cm2 E. coli = 4 MPN index/ml Salmonella sp = Not detected in swab	Fair Good
M1010	Swab- Goat 37 Hind Limb	TVC = 1,400 cfu/cm2 E. coli = 7 MPN index/ml Salmonella sp = Not detected in swab	Good Good

M1011	Swab –Goat 38 Lateral thorax	TVC = 10,200 cfu/cm2 E. coli = 23 MPN index/ml Salmonella sp = Not detected in swab	Fair Fair
M1012	Swab- Goat38 Brisket	TVC = 2,800 cfu/cm2 E. coli = 93 MPN index/ml Salmonella sp = Not detected in swab	Fair Fair
M1013	Swab- Goat 38 Flank	TVC = 13,090 cfu/cm2 E. coli = 9 MPN index/ml Salmonella sp = Not detected in swab	Fair Good
M1014	Swab- Goat 38 Fore Limb	TVC = 8,500 cfu/cm2 E. coli = <3 MPN index/ml Salmonella sp = Not detected in swab	Fair Excellent
M1015	Swab- Goat 38 Hind Limb	TVC = 5,546 cfu/cm2 E. coli = 93 MPN index/ml Salmonella sp = Not detected in swab	Fair Fair
M1016	Swab- Goat 39 Lateral thorax	TVC = 2,900 cfu/cm2 E. coli = 43 MPN index/ml Salmonella sp = Not detected in swab	Fair Fair
M1017	Swab- Goat 39 Brisket	TVC = 1,300 cfu/cm2 E. coli = 120 MPN index/ml Salmonella sp = Not detected in swab	Good Poor
M1018	Swab- Goat 39 Flank	TVC = 7,000 cfu/cm2 E. coli = 43 MPN index/ml Salmonella sp = Not detected in swab	Fair Fair
M1019	Swab- Goat 39 Fore Limb	TVC = 5,700 cfu/cm2 E. coli = 9 MPN index/ml Salmonella sp = Not detected in swab	Fair Good
M1020	Swab- Goat 39 Hind Limb	TVC = 7,200 cfu/cm2 E. coli = 23 MPN index/ml Salmonella sp = Not detected in swab	Fair Fair
M1021	Swab- Goat 40 Lateral thorax	TVC = 2,300 cfu/cm2 E. coli = 23 MPN index/ml Salmonella sp = Not detected in swab	Fair Fair
M1022	Swab –Goat 40 Brisket	TVC = 2,200 cfu/cm2 E. coli = 43 MPN index/ml Salmonella sp = Not detected in swab	Fair Fair
M1023	Swab- Goat 40 Flank	TVC = 5,500 cfu/cm2 E. coli = 93 MPN index/ml Salmonella sp = Not detected in swab	Fair Fair
M1024	Swab- Goat 40 Fore Limb	TVC = 5,100 cfu/cm2 E. coli = 15 MPN index/ml Salmonella sp = Not detected in swab	Fair Fair

M1025	Swab- Goat 40 Hind Limb	TVC = 4,400 cfu/cm2 E. coli = 9 MPN index/ml Salmonella sp = Not detected in swab	Fair Good
M1026	Swab- Goat 41 Lateral thorax	TVC = 42,000 cfu/cm2 E. coli = 43 MPN index/ml Salmonella sp = Not detected in swab	Poor Fair
M1027	Swab- Goat 41 Brisket	TVC = 2,600 cfu/cm2 E. coli = 9 MPN index/ml Salmonella sp = Not detected in swab	Fair Good
M1028	Swab- Goat 41 Flank	TVC = 279,000 cfu/cm2 E. coli = 240 MPN index/ml Salmonella sp = Not detected in swab	V. poor Poor
M1029	Swab- Goat 41 Fore Limb	TVC = 20,545 cfu/cm2 E. coli = 43 MPN index/ml Salmonella sp = Not detected in swab	Poor Fair
M1030	Swab –Goat 41 Hind Limb	TVC = 14,818 cfu/cm2 E. coli = 4 MPN index/ml Salmonella sp = Not detected in swab	Fair Good
M1031	Swab- Goat 42 Lateral thorax	TVC = 28,000 cfu/cm2 E. coli = 240 MPN index/ml Salmonella sp = Not detected in swab	Poor Poor
M1032	Swab- Goat42 Brisket	TVC = 22,000 cfu/cm2 E. coli = 3 MPN index/ml Salmonella sp = Not detected in swab	Poor Excellent
M1033	Swab- Goat 42 Flank	TVC = 79,000 cfu/cm2 E. coli = 1,100 MPN index/ml Salmonella sp = Not detected in swab	Poor V. poor
M1034	Swab- Goat 42 Fore Limb	TVC = 2,800 cfu/cm2 E. coli = 93 MPN index/ml Salmonella sp = Not detected in swab	Fair Fair
M1035	Swab –Goat 42 Hind Limb	TVC = 26,090cfu/cm2 E. coli = 43 MPN index/ml Salmonella sp = Not detected in swab	Poor Fair
M1036	Swab- Goat 43 Lateral thorax	TVC = 73,000 cfu/cm2 E. coli = 43 MPN index/ml Salmonella sp = Not detected in swab	Poor Fair
M1037	Swab- Goat 43 Brisket	TVC = 25,455 cfu/cm2 E. coli = 93 MPN index/ml Salmonella sp = Not detected in swab	Poor Fair
M1038	Swab- Goat 43 Flank	TVC = 13,909 cfu/cm2 E. coli = 240 MPN index/ml Salmonella sp = Not detected in swab	Fair Poor

M1039	Swab- Goat 43 Fore Limb	TVC = 75,000 cfu/cm2 E. coli = 9 MPN index/ml Salmonella sp = Not detected in swab	Poor Good
M1040	Swab- Goat 43 Hind Limb	TVC = 59,000 cfu/cm2 E. coli = 460 MPN index/ml Salmonella sp = Not detected in swab	Poor Poor
M0342	Swab – Goat 44 Site Brisket	TVC = >30,000 cfu/ cm2 estimated E. coli = <3 MPN index/ml=0.3 cfucm2 Salmonella sp = absent	Poor Excellent
M0343	Swab – Goat 44 Site Lateral thorax	TVC = >30,000 cfu/ cm2 estimated E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Poor Excellent
M0344	Swab – Goat 44 Site Hind Quarter	TVC = <30,000 cfu/ cm2 estimated E. coli = 4 MPN index/ml=0.4 cfu/m2 Salmonella sp = absent	Poor Good
M0345	Swab – Goat 44 Site Fore Quarter	TVC = 12,700 cfu/ cm2 E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Fair Excellent
M0346	Swab – Goat 45 Site Hind Quarter	TVC = 22,300 cfu/ cm2 E. coli = 9 MPN index/ml=0.9 cfu/m2 Salmonella sp = absent	Poor Good
M0347	Swab – Goat 45 Site Brisket	TVC = 8,200 cfu/ cm2 E .coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Fair Excellent
M0348	Swab – Goat 45 Site Flank	TVC = 12,400 cfu/cm2 E. coli = 20 MPN index/ml=2.0 cfu/m2 Salmonella sp = absent	Fair Fair
M0349	Swab – Goat 45 Site Lateral thorax	TVC = 1,350 cfu/ cm2 E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Good Excellent
M0350	Swab – Goat 45 Site Fore Quarter	TVC = >30,000 cfu/cm2 E. coli = 4 MPN index/ml=0.4 cfu/m2 Salmonella sp = absent	Poor Good
M0351	Swab – Goat 46 Site Lateral thorax	TVC = 1,927 cfu/cm2 E. coli = 7 MPN index/ml=0.7 cfu/m2 Salmonella sp = absent	Good Good
M0352	Swab – Goat 46 Site Flank	TVC = 3,100 cfu/cm2 E. coli = 9 MPN index/ml=0.9 cfu/m2 Salmonella sp = absent	Fair Good
M0353	Swab – Goat 46 Site Hind Quarter	TVC = 2,327 cfu/cm2 E. coli = 21 MPN index/ml=2.1 cfu/m2 Salmonella sp = absent	Fair Fair

M0354	Swab – Goat 46 Site Fore Quarter	TVC = >30,000 cfu/cm2 estimated E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Poor Excellent
M0355	Swab – Goat 46 Site Brisket	TVC = 1,409 cfu/cm2 E. coli = 23 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Good Fair
M0356	Swab – Goat 47 Site Hind Quarter	TVC = 3,100 cfu/cm2 E. coli = 4 MPN index/ml=0.4 cfu/m2 Salmonella sp = absent	Fair Good
M0357	Swab – Goat 47 Site Flank	TVC = 18,000 cfu/cm2 E. coli = 23 MPN index/ml=2.3 cfu/m2 Salmonella sp = absent	Fair Fair
M0358	Swab – Goat 47 Site Fore Quarter	TVC = 18,300 cfu/cm2 E .coli = 3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Fair Excellent
M0359	Swab – Goat 47 Site Brisket	TVC = 11,200 cfu/cm2 E. coli = 4 MPN index/ml=0.4 cfu/m2 Salmonella sp = absent	Fair Good
M0360	Swab – Goat 47 Site Lateral thorax	TVC = 5,200 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Fair Excellent
M0361	Swab – Goat 48 Site Flank	TVC = 1,945 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Good Excellent
M0362	Swab – Goat 48 Site Fore Quarter	TVC = 4,100 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Fair Excellent
M363	Swab – Goat 48 Site Lateral thorax	TVC = 1,440 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Good Excellent
M0364	Swab – Goat 48 Site Hind Quarter	TVC = 1,745 cfu/cm2 E. coli = 9 MPN index/ml=0.9 cfu/m2 Salmonella sp = absent	Good Good
M0365	Swab – Goat 48 Site Brisket	TVC = >30,000 cfu/cm2 estimated E. coli = 15MPN index/ml=1.5 cfu/m2 Salmonella sp = absent	Poor Fair
M0366	Swab – Goat 48 Site Flank	TVC = 8,000 cfu/cm2 E .coli = 4 MPN index/ml=0.4 cfu/m2 Salmonella sp = absent	Fair Good
M0367	Swab – Goat 48 Site Fore Quarter	TVC = 1,836 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Good Excellent

M0368	Swab – Goat 49 Site Fore Quarter	TVC = 550 cfu/cm2 E. coli = 9 MPN index/ml=0.9 cfu/m2 Salmonella sp = absent	Good Good
M0369	Swab – Goat 49 Site Brisket	TVC = 5,600 cfu/cm2 E. coli = 23 MPN index/ml=2.3 cfu/m2 Salmonella sp = absent	Fair Fair
M0370	Swab – Goat 49 Site Lateral thorax	TVC = 12,100 cfu/cm2 E. coli = 3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Fair Excellent
M0371	Swab – Goat 49 Site Hind Quarter	TVC = 909 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Good Excellent
M0372	Swab – Goat 49 Site Flank	TVC = 2,073 cfu/cm2 E. coli = <3MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Fair Excellent
M0373	Swab – Goat 50 Site Fore Quarter	TVC = 900 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Good Excellent
M0374	Swab – Goat 50 Site Brisket	TVC = 7,800 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Fair Excellent
M0375	Swab – Goat 50 Site Flank	TVC = 8,200 cfu/cm2 E. coli = 23 MPN index/ml=2.3 cfu/m2 Salmonella sp = absent	Fair Fair
M0376	Swab – Goat 51 Site Lateral thorax	TVC = >30,000 cfu/cm2 estimated E. coli = 4 MPN index/ml=0.4 cfu/m2 Salmonella sp = absent	Poor Good
M0377	Swab – Goat 51 Site Hind Quarter	TVC = 1,482 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Good Excellent
M0378	Swab – Goat 51 Site Hind Quarter	TVC = >30,000 cfu/cm2 estimated E. coli =<3 MPN index/ml=0.3 cfu/m2 Salmonella sp = absent	Poor Excellent
M0379	Swab – Goat 51 Site Lateral thorax	TVC = 2,754 cfu/cm2 E. coli = <3 MPN index/ml Salmonella sp = absent	Fair Excellent
M0380	Swab – Goat 51 Site Brisket	TVC = 2,536 cfu/cm2 E. coli = <3 MPN index/ml Salmonella sp = absent	Fair Excellent
M0381	Swab – Goat 551 Site Hind Quarter	TVC = 3,900 cfu/cm2 E. coli = 4 MPN index/ml Salmonella sp = absent	Fair Good

M0382	Swab – Goat 51 Site Flank	TVC = 3,100 cfu/cm2 E. coli = 15 MPN index/ml Salmonella sp = absent	Fair Fair
M0383	Swab – Goat 52 Site Fore Quarter	TVC = 1,410 cfu/cm2 E. coli = <3 MPN index/ml Salmonella sp = absent	Good Excellent
M0384	Swab – Goat 52 Site Brisket	TVC = 227 cfu/cm2 E. coli = 3 MPN index/ml Salmonella sp = absent	Good Excellent

H-Foods export slaughterhouse (Burao-Somaliland)

	Analabs Ref No.	Sample Description	Results	Interpretation PHD Dubai municipality
1	M0544	Swab- Goat 1 Hind Limb	TVC = 650 cfu/cm2 E. coli = 43 MPN index/ml cfucm2 *Salmonella* sp = Not detected in the swab	Excellent Excellent
2	M0545	Swab – Goat 1 Site Flank	TVC = 130 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
3	M0546	Swab – Goat 1 Site Brisket	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
4	M0547	Swab – Goat 1 Site Lateral thorax	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
5	M0548	Swab – Goat 1 Site Fore Limb	TVC = 230 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
6	M0549	Swab – Goat 2 Site Hind Limb	TVC = 20 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent

7	M0550	Swab – Goat 2 Site Flank	TVC = 80 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
8	M0551	Swab – Goat 2 Site Brisket	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
9	M0552	Swab- Goat 2 Site Lateral thorax	TVC = 100 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
10	M0553	Swab- Goat 2 Site Fore Limb	TVC = 360 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
11	M0554	Swab- Goat 3 Site Hind Limb	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
12	M0555	Swab- Goat 3 Site Flank	TVC = 990 cfu/cm2 E. coli = 4 MPN index/ml *Salmonella* sp = Not detected in swab	Good Good
13	M0556	Swab- Goat 3 Site Brisket	TVC = 590 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
14	M0557	Swab- Goat 3 Site Lateral thorax	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
15	M0558	Swab- Goat 3 Site Fore Limb	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
16	M0559	Swab- Goat 3 Site Hind Limb	TVC = 150 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
17	M0560	Swab –Goat 4 Site Flank	TVC = 240 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent

18	M0561	Swab- Goat 4 Site Brisket	TVC = 50 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
19	M0561	Swab- Goat 4 Site Lateral thorax	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
20	M0562	Swab- Goat 4 Site Fore Limb	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
21	M0563	Swab- Goat 5 Site Hind Limb	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
22	M0564	Swab- Goat 5 Site Flank	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
23	M0565	Swab- Goat 5 Site Brisket	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
24	M0566	Swab- Goat 5 Site Lateral thorax	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
25	M0567	Swab- Goat 5 Site Fore Limb	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
26	M0568	Swab- Goat 5 Site Hind Limb	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
27	M0569	Swab- Goat 6 Site Flank	TVC = 460 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
28	M0570	Swab –Goat 6 Site Brisket	TVC = 290 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent

29	M0571	Swab- Goat 6 Site Lateral thorax	TVC = 230 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
30	M0572	Swab- Goat 6 Site Fore Limb	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
31	M0573	Swab- Goat 7 Site Hind Limb	TVC = 50 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
32	M0574	Swab- Goat 7 Site Flank	TVC = 860 cfu/cm2 E. coli = <3MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
33	M0575	Swab- Goat 7 Site Brisket	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
34	M0576	Swab- Goat 7 Site Lateral thorax	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
35	M0577	Swab- Goat 7 Site Fore Limb	TVC = 610 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
36	M0578	Swab –Goat 8 Site Hind Limb	TVC = 780 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
37	M0579	Swab- Goat 8 Site Flank	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
38	M0580	Swab- Goat 8 Site Brisket	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
39	M0581	Swab- Goat 8 Site Lateral thorax	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent

40	M0582	Swab- Goat 8 Site Fore Limb	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
41	M0583	Swab – Sheep 9 Site Flank	TVC = 20 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
42	M0584	Swab – Sheep 9 Site Brisket	TVC = 80 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
43	M0585	Swab – Sheep 9 Site Lateral thorax	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
44	M0586	Swab – Sheep 9 Site Fore Limb	TVC = 110 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
45	M0587	Swab – Sheep 9 Site Hind Limb	TVC = 140 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
46	M0588	Swab – Sheep 10 Site Flank	TVC = 50 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
47	M0589	Swab – Sheep 10 Site Brisket	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
48	M0590	Swab- Sheep 10 Lateral thorax	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
49	M0591	Swab- Sheep 10 Fore Limb	TVC = 30 cfu/cm2 E. coli = <3MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent

50	M0592	Swab- Sheep 10 Hind Limb	TVC = 60 cfu/cm2 E. coli = 4 MPN index/ml=0.4 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
51	M0593	Swab- Goat 11 Brisket	TVC = 1,136 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
52	M0594	Swab- Goat 11 Lateral thorax	TVC = 2,510 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Fair Excellent
53	M0595	Swab- Goat 11 Fore Limb	TVC = 20 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
54	M0596	Swab- Goat 11 Hind limb	TVC = 410 cfu/cm2 E. coli = 93 MPN index/ml=9.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Fair
55	M0597	Swab –Goat 12 Brisket	TVC = 945 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
56	M0598	Swab- Goat 12 Lateral thorax	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
57	M0599	Swab- Goat 13 Site Lateral thorax	TVC = 1,040 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
58	M0600	Swab- Goat 13 Site Fore Limb	TVC = 6,900 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Fair Excellent
59	M0601	Swab- Goat 14 Site Flank	TVC = 170 cfu/cm2 E. coli = <3MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
60	M0602	Swab- Goat 14 Site Brisket	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
61	M0603	Swab- Goat14 Site Lateral thorax	TVC = 150 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent

62	M0604	Swab- Goat 14 Site Fore Limb	TVC = 360 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
63	M0605	Swab –Goat 14 Site Hind Limb	TVC = 320 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
64	M0606	Swab- Goat 15 Site Flank	TVC = 800 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
65	M0607	Swab- Goat 15 Site Brisket	TVC = 280 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
66	M0608	Swab- Goat 15 Site Lateral thorax	TVC = 320 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
67	M0778	Swab – Goat 16 Site Flank	TVC = 7,100 cfu/cm2 E. coli = <3 MPNindex/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Fair Excellent
68	M0779	Swab – Goat 16 Site Brisket	TVC = 510 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
69	M0780	Swab – Goat 16 Site Lateral thorax	TVC = 260 cfu/cm2 E. coli = 4 MPN index/ml=0.43cfu/cm2 *Salmonella* sp = Not detected in swab	Good Good
70	M0781	Swab – Goat 16 Site Fore Limb	TVC = 460 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
71	M0782	Swab – Goat 16 Site Hind Limb	TVC = 940 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent

72	M0783	Swab – Goat 17 Site Flank	TVC = 250 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
73	M0784	Swab – Goat 17 Site Brisket	TVC = 210 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
74	M0785	Swab- Goat 17 Site Lateral thorax	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
75	M0786	Swab- Goat 17 Site Fore Limb	TVC = 520 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
76	M0787	Swab- Goat 17 Site Hind Limb	TVC = 190 cfu/cm2 E. coli = 9 MPN index/ml=0.9cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Good
77	M0788	Swab- Goat 18 Site Flank	TVC = 780 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
78	M0789	Swab- Goat 18 Site Brisket	TVC = 180 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
79	M0790	Swab- Goat18 Site Lateral thorax	TVC = 330 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
80	M0791	Swab- Goat 18 Site Fore Limb	TVC = 3,800 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Fair Excellent
81	M0792	Swab- Goat 18 Site Hind Limb	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
82	M0793	Swab –Goat 19 Site Flank	TVC = 1,145 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent

83	M0794	Swab- Goat 19 Site Brisket	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
84	M0795	Swab- Goat 19 Site Lateral thorax	TVC = 140 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
85	M0796	Swab- Goat 19 Site Fore Limb	TVC = 310 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
86	M0797	Swab- Goat 19 Site Hind Limb	TVC = 340 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
87	M0798	Swab- Goat 20 Site Flank	TVC = 2,400 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Fair Excellent
88	M0799	Swab- Goat 20 Site Brisket	TVC = 230 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
89	M0800	Swab- Goat 20 Site Lateral thorax	TVC = 220 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
90	M0801	Swab- Goat 20 Site Fore Limb	TVC = >30,000cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Poor Excellent
91	M0802	Swab- Goat 20 Site Hind Limb	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
92	M0803	Swab- Goat 21 Site Flank	TVC = 410 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
93	M0804	Swab –Goat 21 Site Brisket	TVC = 260 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
94	M0805	Swab- Goat 21 Site Lateral thorax	TVC = 1,040 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent

95	M0806	Swab- Goat 21 Site Fore Limb	TVC = 6,900 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Fair Excellent
96	M0808	Swab- Goat 22 Site Flank	TVC = 170 cfu/cm2 E. coli = <3MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
97	M0809	Swab- Goat 22 Site Brisket	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
98	M0810	Swab- Goat 22 Site Lateral thorax	TVC = 150 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
99	M0811	Swab- Goat 22 Site Fore Limb	TVC = 360 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
10	M0812	Swab –Goat 22 Site Hind Limb	TVC = 320 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
101	M0813	Swab- Goat 23 Site Flank	TVC = 4,800 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Fair Excellent
102	M0814	Swab- Goat 23 Site Brisket	TVC = 280 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
103	M0815	Swab- Goat 23 Site Lateral thorax	TVC = 320 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
104	M0816	Swab- Goat 23 Site Fore Limb	TVC = 580 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
105	M0817	Swab –Goat 23 Site Hind Limb	TVC = 190 cfu/cm2 E. coli = 4 MPN index/ml=0.4cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Good
106	M0818	Swab- Goat24 Site Flank	TVC = 160 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent

107	M0819	Swab- Goat 24 Site Brisket	TVC = 80 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
108	M0820	Swab- Goat 24 Site Lateral thorax	TVC = 130 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
109	M0821	Swab- Goat 24 Site Fore Limb	TVC = 290 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Good Excellent
110	M0822	Swab- Goat 24 Site Hind Limb	TVC = 130 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
111	M0500	Swab – Goat 25 Site Brisket	TVC = 20 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
112	M0501	Swab – Goat 25 Site Lateral thorax	TVC = 350 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
113	M0502	Swab – Goat 25 Site Fore Limb	TVC = 440 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
114	M0503	Swab – Goat 25 Site Hind Limb	TVC = 10 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
115	M0504	Swab – Goat 26 Site Flank	TVC = 50 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
116	M0505	Swab – Goat 26 Site Brisket	TVC = 860 cfu/cm2 E. coli = 7 MPN index/ml=0.7 cfucm2 *Salmonella* sp = Not detected in swab	Good Good
117	M0506	Swab – Goat 26 Site Lateral thorax	TVC = 820 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent

118	M0507	Swab – Goat 26 Site Fore Limb	TVC = 280 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
119	M0508	Swab – Goat 26 Site Hind Limb	TVC = 750 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
120	M0509	Swab – Goat 27 Site Flank	TVC = 420 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
121	M0510	Swab – Goat 27 Site Brisket	TVC = 754 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
122	M0511	Swab – Goat 27 Site Lateral thorax	TVC = 430 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
123	M0512	Swab – Goat 27 Site Fore Limb	TVC = 160 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
124	M0513	Swab – Goat 27 Site Hind Limb	TVC = 450 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
125	M0514	Swab – Goat 28 Site Flank	TVC = 20 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
126	M0515	Swab – Goat 28 Brisket	TVC = 350 cfu/cm2 E. coli = 4 MPN index/ml=0.4 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
127	M0516	Swab – Goat 28 Site Lateral thorax	TVC = 727 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
128	M0517	Swab- Goat 28 Fore Limb	TVC = 740 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent

129	M0518	Swab – Goat 28 Hind Limb	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
130	M0519	Swab- Goat 29 Flank	TVC = 636 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
131	M0520	Swab- Goat 29 Brisket	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
132	M0521	Swab- Goat 29 Lateral thorax	TVC = 1,036 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
133	M0522	Swab- Goat 29 Fore Limb	TVC = 1,218 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
134	M0523	Swab- Goat 29 Hind Limb	TVC = 1,973 cfu/cm2 E. coli = 4 MPN index/ml=0.4 cfucm2 *Salmonella* sp = Not detected in swab	Good Good
135	M0524	Swab- Goat 30 Flank	TVC = 550 cfu/cm2 E. coli = 4 MPN index/ml=0.4 cfucm2 *Salmonella* sp = Not detected in swab	Good Good
136	M0525	Swab- Goat 30 Brisket	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
137	M0526	Swab- Goat 30 Lateral thorax	TVC = 290 cfu/cm2 E. coli = 9 MPN index/ml=0.9 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
138	M0527	Swab- Goat 30 Forelimb	TVC = 760 cfu/cm2 E. coli = 4 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
139	M0528	Swab- Goat 30 Hind Limb	TVC = 480 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
140	M0529	Swab- Goat 31 Flank	TVC = 330 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent

141	M0530	Swab- Goat 31 Brisket	TVC = 518 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
142	M0531	Swab- Goat 31 Lateral thorax	TVC = 660 cfu/cm2 E. coli = 4 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
143	M0532	Swab- Goat 31 Fore Limb	TVC = 470 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
144	M0533	Swab- Goat 31 Hind Limb	TVC = 750 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
145	M0534	Swab- Goat 32 Flank	TVC = 755 cfu/cm2 E. coli = 23 MPN index/ml=2.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
146	M0535	Swab- Goat 32 Brisket	TVC = 260 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
147	M0536	Swab- Goat 32 Lateral thorax	TVC = 145 cfu/cm2 E. coli<3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Excellent Excellent
148	M0537	Swab- Goat 32 Fore Limb	TVC = 810 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
149	M0538	Swab- Goat 32 Hind Limb	TVC = 2,164 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
150	M0539	Swab- Goat 32 Flank	TVC = 260 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
151	M0540	Swab- Goat 32 Brisket	TVC = 964 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
152	M0541	Swab- Goat 32 Lateral thorax	TVC = 110 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Excellent Excellent

153	M0542	Swab- Goat 32 Fore Limb	TVC = 460 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
154	M0543	Swab- Goat 32 Hind Limb	TVC = 650 cfu/cm2 E. coli<3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good excellent
155	M1047	Swab – Goat 33 Site Flank	TVC = 130 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
156	M1048	Swab – Goat 33 Site Brisket	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
157	M1049	Swab – Goat 33 Site Lateral thorax	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
158	M1050	Swab – Goat 33 Site Fore Limb	TVC = 230 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
159	M1051	Swab – Goat 33 Site Hind Limb	TVC = 20 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
160	M1052	Swab – Goat 34 Site Flank	TVC = 80 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
161	M1053	Swab – Goat 34 Site Brisket	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
162	M1054	Swab- Goat 34 Site Lateral thorax	TVC = 100 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
163	M1055	Swab- Goat34 Site Fore Limb	TVC = 360 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent

164	M1056	Swab- Goat 34 Site Hind Limb	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
165	M1057	Swab- Goat 35 Site Flank	TVC = 990 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
166	M1058	Swab- Goat 35 Site Brisket	TVC = 590 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
167	M1059	Swab- Goat 35 Site Lateral thorax	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
168	M1060	Swab- Goat 35 Site Fore Limb	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
169	M1061	Swab- Goat 35 Site Hind Limb	TVC = 150 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
170	M1062	Swab –Goat 36 Site Flank	TVC = 240 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
171	M1063	Swab- Goat 36 Site Brisket	TVC = 50 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
172	M1064	Swab- Goat 36 Site Lateral thorax	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
173	M1065	Swab- Goat 36 Site Fore Limb	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
174	M1066	Swab- Goat 36 Site Hind Limb	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
175	M1067	Swab- Goat 36 Site Flank	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent

176	M1068	Swab- Goat 36 Site Brisket	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
177	M1069	Swab- Goat 36 Site Lateral thorax	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
178	M1070	Swab- Goat 36 Site Fore Limb	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
179	M1071	Swab- Goat 36 Site Hind Limb	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
180	M1072	Swab- Goat 37 Site Flank	TVC = 460 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
181	M1073	Swab –Goat 37 Site Brisket	TVC = 290 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
182	M1074	Swab- Goat 37 Site Lateral thorax	TVC = 230 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
183	M1075	Swab- Goat 37 Site Fore Limb	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
184	M1076	Swab- Goat 37 Site Hind Limb	TVC = 50 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
185	M1077	Swab- Goat 38 Site Flank	TVC = 860 cfu/cm2 E. coli = <3MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
186	M1078	Swab- Goat38 Site Brisket	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
187	M1079	Swab- Goat 38 Site Lateral thorax	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent

188	M1080	Swab- Goat 38 Site Fore Limb	TVC = 610 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
189	M1081	Swab –Goat 37 Site Hind Limb	TVC = 780 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
190	M1082	Swab- Goat 39 Site Flank	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
191	M1083	Swab- Goat 39 Site Brisket	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
192	M1084	Swab- Goat 39 Site Lateral thorax	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
193	M1085	Swab- Goat 39 Site Fore Limb	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
194	M1086	Swab –Goat 39 Site Hind Limb	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellentr
195	M1087	Swab- Goat 40 Site Flank	TVC = 1,360 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
196	M1088	Swab- Goat 40 Site Brisket	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
197	M1089	Swab- Goat 40 Site Lateral thorax	TVC = 210 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
198	M1090	Swab- Goat 40 Site Fore Limb	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent

199	M1091	Swab- Goat 40 Site Hind Limb	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
200	M1092	Swab- Goat 41 Flank	TVC = 755 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in the swab	Good Excellent
201	M1093	Swab- Goat 41 Brisket	TVC = 260 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
202	M1094	Swab- Goat 41 Lateral thorax	TVC = 2,145 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in the swab	Good Excellent
203	M1095	Swab- Goat 41 Fore Limb	TVC = 810 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
203	M1096	Swab- Goat41 Hind Limb	TVC = 2,164 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
205	M1097	Swab- Goat 42 Flank	TVC = 260 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
206	M1098	Swab- Goat 42 Brisket	TVC = 964 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
207	M1099	Swab- Goat 42 Lateral thorax	TVC = 110 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Excellent Excellent
208	M1100	Swab- Goat 42 Fore Limb	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Excellent Excellent
209	M1200	Swab – Goat 43 Site Flank	TVC = 420 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
210	M1201	Swab – Goat 43 Site Brisket	TVC = 754 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent

211	M1202	Swab – Goat 43 Site Lateral thorax	TVC = 430 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
212	M1203	Swab – Goat 43 Site Fore Limb	TVC = 160 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
213	M1204	Swab – Goat 43 Site Hind Limb	TVC = 450 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
214	M1205	Swab – Goat 44 Site Flank	TVC = 20 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
215	M1206	Swab – Goat 44 Brisket	TVC = 150 cfu/cm2 E. coli = 4 MPN index/ml=0.4 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
216	M1207	Swab – Goat 44 Site Lateral thorax	TVC = 127 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
217	M1208	Swab- Goat 44 Fore Limb	TVC = 740 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
218	M1209	Swab – Goat 44 Hind Limb	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
219	M1210	Swab- Goat 45 Flank	TVC = 636 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
220	M1211	Swab- Goat 45 Brisket	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
221	M1212	Swab- Goat 45 Lateral thorax	TVC = 1,036 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent

222	M1213	Swab- Goat 45 Fore Limb	TVC = 1,218 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
223	M1214	Swab- Goat 45 Hind Limb	TVC = 1,973 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
224	M1215	Swab- Goat 46 Flank	TVC = 550 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
225	M01216	Swab- Goat 46 Brisket	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Excellent Excellent
226	M1217	Swab- Goat 46 Lateral thorax	TVC = 90 cfu/cm2 E. coli<3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
227	M1218	Swab- Goat 46 Forelimb	TVC = 760 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
228	M1219	Swab- Goat 46 Hind Limb	TVC = 480 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
229	M1220	Swab- Goat 47 Flank	TVC = 330 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
230	M1221	Swab- Goat 47 Brisket	TVC = 518 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in swab	Good Excellent
231	M1222	Swab- Goat 47 Lateral thorax	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
232	M1223	Swab- Goat 47 Fore Limb	TVC = 470 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
233	M1224	Swab- Goat 47 Hind Limb	TVC = 750 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent

234	M1225	Swab- Goat 48 Flank	TVC = 755 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
235	M1226	Swab- Goat 48 Brisket	TVC = 260 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
236	M1227	Swab- Goat 48 Lateral thorax	TVC = 165 cfu/cm2 E. coli = 4 MPN index/ml=0.4 cfucm2 *Salmonella* sp = Not detected in the swab	Excellent Good
237	M1228	Swab- Goat 48 Fore Limb	TVC = 810 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
238	M1229	Swab- Goat 48 Hind Limb	TVC = 164 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Excellent Excellent
239	M1230	Swab- Goat 49 Flank	TVC = 260 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
240	M1231	Swab- Goat 49 Brisket	TVC = 64 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Excellent Excellent
241	M1232	Swab- Goat 49 Lateral thorax	TVC = 110 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Excellent Excellent
242	M1233	Swab- Goat 49 Fore Limb	TVC = 460 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
243	M1234	Swab- Goat 49 Hind Limb	TVC = 650 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2 *Salmonella* sp = Not detected in the swab	Good Excellent
244	M1235	Swab – Goat 50 Site Flank	TVC = 130 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
245	M1236	Swab – Goat 50 Site Brisket	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent

246	M1237	Swab – Goat 50 Site Lateral thorax	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
247	M1238	Swab – Goat 50 Site Fore Limb	TVC = 230 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Good Excellent
248	M1239	Swab – Goat 50 Site Hind Limb	TVC = 20 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
249	M1240	Swab – Goat 51 Site Flank	TVC = 80 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent
250	M1241	Swab – Goat 51 Site Brisket	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml *Salmonella* sp = Not detected in swab	Excellent Excellent

Appendix V: Second sample analysis of 85 samples from H-foods export slaughterhous

	Analabs Ref No.	Sample Description	Results	Interpretation PHD Dubai municipality
1	M2001	Swab- Goat 1 Hind Limb	TVC = 150 cfu/cm2 E. coli = <3 MPN index/ml cfucm2	Excellent Excellent
2	M2002	Swab – Goat 1 Site Flank	TVC = 130 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
3	M2003	Swab – Goat 1 Site Brisket	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
4	M2004	Swab – Goat 1 Site Lateral thorax	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
5	M2005	Swab – Goat 1 Site Fore Limb	TVC = 230 cfu/cm2 E. coli = <3 MPN index/ml	Good Excellent
6	M2006	Swab – Goat 2 Site Hind Limb	TVC = 20 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
7	M2007	Swab – Goat 2 Site Flank	TVC = 80 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
8	M2008	Swab – Goat 2 Site Brisket	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
9	M2009	Swab- Goat 2 Site Lateral thorax	TVC = 100 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
10	M2010	Swab- Goat 2 Site Fore Limb	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
11	M2011	Swab- Goat 3 Site Hind Limb	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
12	M2012	Swab- Goat 3 Site Flank	TVC = 465 cfu/cm2 E. coli = 4 MPN index/ml	Good Good
13	M2013	Swab- Goat 3 Site Brisket	TVC = 135 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
14	M2014	Swab- Goat 3 Site Lateral thorax	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
15	M2015	Swab- Goat 3 Site Fore Limb	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
16	M2016	Swab- Goat 4 Site Hind Limb	TVC = 150 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
17	M2017	Swab –Goat 4 Site Flank	TVC = 640 cfu/cm2 E. coli = <3 MPN index/ml	Good Excellent
18	M2018	Swab- Goat 4 Site Brisket	TVC = 50 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
19	M2019	Swab- Goat 4 Site Lateral thorax	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
20	M20120	Swab- Goat 4 Site Fore Limb	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
21	M2021	Swab- Goat 5 Site Hind Limb	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
22	M2022	Swab- Goat 5 Site Flank	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
23	M2023	Swab- Goat 5 Site Brisket	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent

24	M2024	Swab- Goat 5 Site Lateral thorax	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
25	M2025	Swab- Goat 5 Site Fore Limb	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
26	M2026	Swab- Goat 6 Site Hind Limb	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
27	M2027	Swab- Goat 6 Site Flank	TVC = 160 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
28	M2028	Swab –Goat 6 Site Brisket	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
29	M2029	Swab- Goat 6 Site Lateral thorax	TVC = 130 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
30	M2030	Swab- Goat 6 Site Fore Limb	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
31	M2031	Swab- Goat 7 Site Hind Limb	TVC = 50 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
32	M2032	Swab- Goat 7 Site Flank	TVC = 160 cfu/cm2 E. coli = <3MPN index/ml	Excellent Excellent
33	M2033	Swab- Goat 7 Site Brisket	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
34	M2034	Swab- Goat 7 Site Lateral thorax	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
35	M2035	Swab- Goat 7 Site Fore Limb	TVC = 610 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
36	M2036	Swab –Goat 8 Site Hind Limb	TVC = 180 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
37	M2037	Swab- Goat 8 Site Flank	TVC = 90 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
38	M2038	Swab- Goat 8 Site Brisket	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
39	M2039	Swab- Goat 8 Site Lateral thorax	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
40	M2040	Swab- Goat 8 Site Fore Limb	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml	Excellent Excellent
41	M2501	Swab – Sheep 9 Site Hind Limb	TVC = 20 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent
42	M2502	Swab – Sheep 9 Site Flank	TVC = 80 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent
43	M2503	Swab – Sheep 9 Site Brisket	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent
44	M2504	Swab – Sheep 9 Site Lateral thorax	TVC = 110 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent
45	M2505	Swab – Sheep 9 Site Fore Limb	TVC = 140 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent
46	M2506	Swab – Sheep 10 Site Hind Limb	TVC = 50 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent
47	M2507	Swab – Sheep 10 Site Flank	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent
48	M2508	Swab- Sheep 10 Brisket	TVC = 70 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent

49	M2509	Swab- Sheep 10 Lateral thorax	TVC = 30 cfu/cm2 E. coli = <3MPN index/ml=0.3 cfucm2	Excellent Excellent
50	M2010	Swab- Sheep 10 Fore Limb	TVC = 60 cfu/cm2 E. coli = <3 MPN index/ml=0.4 cfucm2	Excellent Excellent
51	M2511	Swab- Goat 11 Brisket	TVC = 1,136 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent
52	M2512	Swab- Goat 11 Lateral thorax	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent
53	M2513	Swab- Goat 11 Fore Limb	TVC = 20 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent
54	M2514	Swab- Goat 11 Hind limb	TVC = 110 cfu/cm2 E. coli = <3 MPN index/ml=9.3 cfucm2	Excellent Excellent
55	M2515	Swab –Goat 11 Brisket	TVC = 450 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Good Excellent
56	M2516	Swab- Goat 12 Lateral thorax	TVC = 170 cfu/cm2 E. coli = <3 MPN index/ml=0.3 cfucm2	Excellent Excellent
57	M2517	Swab- Goat 12 Site Lateral thorax	TVC = 130 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
58	M2518	Swab- Goat 12 Site Fore Limb	TVC = 120 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
59	M2519	Swab- Goat 12 Site Flank	TVC = 170 cfu/cm2 E. coli = <3MPN index/ml	Excellent Excellent
60	M2520	Swab- Goat 12 Site Brisket	TVC = 30 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
61	M2521	Swab- Goat13 Site Lateral thorax	TVC = 150 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
62	M2522	Swab- Goat 13 Site Fore Limb	TVC = 1850 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
63	M2523	Swab –Goat 13 Site Hind Limb	TVC = 160 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
64	M2524	Swab- Goat 13 Site Flank	TVC = 100 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
65	M2525	Swab- Goat 13 Site Brisket	TVC = 180 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
66	M2526	Swab- Goat 14 Site Lateral thorax	TVC = 120 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
67	M2527	Swab – Goat 14 Site Flank	TVC = 100 cfu/cm2 E. coli = <3 MPNindex/ml=0.3cfu/cm2	Excellent Excellent
68	M2528	Swab – Goat 14 Site Brisket	TVC = 140 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
69	M2520	Swab – Goat 14 Site Lateral thorax	TVC = 160 cfu/cm2 E. coli = <3 MPN index/ml=0.43cfu/cm2	Excellent Excellent
70	M2530	Swab – Goat 14 Site Fore Limb	TVC = 180 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
71	M2531	Swab – Goat 15 Site Hind Limb	TVC = 150 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
72	M2532	Swab – Goat 15 Site Flank	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent

73	M2533	Swab – Goat 15 Site Brisket	TVC = 110 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
74	M2534	Swab- Goat 15 Site Lateral thorax	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
75	M2535	Swab- Goat 15 Site Fore Limb	TVC = 120 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
76	M2536	Swab- Goat 15 Site Hind Limb	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml=0.9cfu/cm2	Excellent Excellent
77	M2537	Swab- Goat 15 Site Hind Limb	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml=0.9cfu/cm2	Excellent Excellent
78	M2538	Swab – Goat 14 Site Lateral thorax	TVC = 160 cfu/cm2 E. coli = <3 MPN index/ml=0.43cfu/cm2	Excellent Excellent
79	M2539	Swab – Goat 14 Site Fore Limb	TVC = 160 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
80	M2540	Swab – Goat 15 Site Hind Limb	TVC = 120 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
81	M2541	Swab – Goat 15 Site Flank	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
82	M2542	Swab – Goat 15 Site Brisket	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
83	M2543	Swab- Goat 15 Site Lateral thorax	TVC = 200 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
84	M2544	Swab- Goat 15 Site Fore Limb	TVC = 120 cfu/cm2 E. coli = <3 MPN index/ml=0.3cfu/cm2	Excellent Excellent
85	M2545	Swab- Goat 15 Site Hind Limb	TVC = 190 cfu/cm2 E. coli = <3 MPN index/ml=0.9cfu/cm2	Excellent Excellent