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AN ASSESSMENT OF THE SOURCES OF CONTAMINATION AT ABATTOIRS AROUND HARARE.

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DEDICATION

I dedicate this project to my father and mother Mr and Mrs Muvhawa ,my husband Vasco Chaya ,my daughter Myla and the entire Muvhawa and Chaya families for their aspiration in every level of attainment that I have attained..

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My severe gratitude goes to the following important people, for without them this project was not going to be successful. Firstly I would like to thank Mr Saungweme who is the Chief Livestock and Meat Grader for being a very inspiring mentor. He gave me direction during the process and constantly encouraged me to carry on with my project. He made it very clear to me that with perseverance, all things are possible.

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Equally, I would like to express my appreciation to thank Mr Chaya who helped me with some funds during the research period not forgetting the Bindura University of Science Education's Animal Scienc edepatment lecturers namely Mr.C.Mangwiro and Mr.M.Dhliwayo for their valuable contribution.

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ABSTRACT

Poor standards of hygiene during slaughtering or carcasses handling results in high levels of microbial contamination in the meat, reduction of shelf-life and adversely affecting the sensoric properties of products fabricated from this meat. This have resulted in high returns of more than 1000kgs of beef meat due to decaying that have been experienced at various abattoirs from its customers per month. The study was designed to assess possible sources of contamination at abattoirs that are around Harare and their prevalence on these sources. Two sets of three swab samples were collected from meat handler's hands and equipments (hooks and on working knives) from the following abattoirs; Koala Park, Rainham, Lisheen, Pama and Meatfield Abattoirs .The samples were randomly collected from abattoir equipment and meat handlers' hands. The following pathogens were isolated from different abattoirs; giadia , cryptosporidium, bacillus, staphylococcus aereus, streptococcus group D, shigella, escherichia coli and yeasts. The presence of these pathogens including escherichia-coli indicated that there was poor separation of offals from the rest of the carcasses since these pathogens are mostly isolated from the gut systems of warm blooded animals. The spreading of these pathogens to meat handler's hands and equipments showed that there is high potential of transferring them to other parts of the slaughtered animal causing meat contamination. Recommendations were drawn from the research that an in-house pathogens monitoring must be constituted and abattoirs must train workers on proper hygiene practices during slaughtering so as to prevent meat contamination.

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LIST OF ABBREVIATIONS

BSE- Bovine spongiform encephalopathy

DNA- Deoxyribose nucleic acid

FAO- Food and Agriculture Organisation

pH-Potential hydrogen

TDH- Thermostable direct hymolysin

WHO- World Health Organisation

CHAPTER ONE

1.0 Introduction

In Zimbabwe, the abattoir industry is an important component of the livestock industry providing domestic meat supply to the people .However, the abattoir industries are less developed especially in developing countries and the facilities for proper carcass handling are lacking e.g. slaughtering equipments, protective clothing, knives and hooks unlike in developed countries where these facilities are adequately provided.

There is evidence that in many developing countries, conditions existing in slaughterhouses current meat handling practices contribute greatly to the high microbial load on the carcasses and the spread of zoonotic diseases (Manual, 1983). The authorities in these countries are mostly aware of the bad situation and, in some cases, have prepared plans for the mordenisation and development of their slaughterhouses as well as revision of meat handling procedures (Manual, 1983).

In Zimbabwe, the government has come up with certain regulations which focus on the public health of abattoirs , bird slaughter and meat hygiene (S.I. 50, 1995). Zimbabwe statutory instrument number 50 of 1995 regulates the operations of abattoirs in such a way that it reduces the prevalence of pathogens as well as reduction of meat contamination by stating that no person shall send or permit to be sent on his behalf to any slaughterhouse any animal or bird which is:-

(c) is diseased or had been in contact with a diseased animal or has any conditions which may render the meat, offal or product of the animal or bird unwholesome or unsound

(d) is clinically infected with salmonella or tuberculosis or which has been in contact during the last four days with any animal which has been clinically infected with salmonellosis or in which reacts positively to a tuberlin test, unless prior arrangements have been made with the meat inspector and also that offals shall be removed from a carcass in such a manner as not to cause contamination.

Factors such as dirty hands and knives used by meat handlers lead to contamination of meat, bacteria multiplication and possible toxin production. Lack of clean water and refrigeration facilities, the heat and moisture prevalent in tropical countries, methods of selling carcasses, meat mixed with offals, presence of flies, mosquitoes and cockroaches and numerous other unhygienic factors, contribute to the danger of pathogenic infections (manual, 1983).

Poor standards of hygiene during slaughtering or carcasses handling result in high levels of microbial contamination in the meat, thus reducing the shelf-life and adversely affecting the sensoric properties of products fabricated from this raw material (Manual, 1991).

During slaughter operations performed in slaughter houses with in adequate sanitation and skilled staff ,contamination frequently occurs from dirty ,unclean water ,intestinal content or from dirty knives hands or clothing of meat handlers .These factors all lead to contamination of carcasses at abattoirs ,bacterial multiplication and possible toxins.

It is essential then that the producers, the sellers and the consumers all have at least a rudimentary knowledge of bacteriology and, where possible, are backed by a competent laboratory service where close cooperation is ensured between the medical and veterinary professionals from the highest level to that of auxiliary personnel (Manual, 1983).

Meat contaminated foods created an enormous social and economic burden in communities and their health systems. In the USA, diseases caused by the major pathogens found in contaminated meat alone are estimated to cause up to US$37.1 billion annually in medical costs and lost productivity (Factsheet, 2000).

Contamination may also be from the source or the farm, a situation which may be further compounded if the carcass is not properly handled during slaughtering and processing giving way for pathogens to multiply. The conditions under which these carcases are handled raise questions regarding their microbiological quality. Studies conducted in different countries to investigate the microbiological quality of food of animal origin reported the presence of potential human pathogens (Nicoline F. Tanih et al. 2015)

1.1 Background of the study

In recent years, concern has increased about the health hazards arising from the consumption of contaminated food especially of animal origin. Of the human foods, those of animal origin tend to be most hazardous (Manual, 1983). Many food borne disease due to meat and meat products are the consequences of zoonoses in domestic animals (Factsheet, 2000). Meat borne diseases may be caused by various agents such as bacteria, moulds, viruses, protozoa, helminths and poisonous chemicals (Manual, 1983).

1.2 Problem Statement

The high bacterial load on bovine carcasses has caused reduced shelf life of the carcasses and the animal by- products fabricated from it. This have resulted in high returns of more than1000kgs of beef meat due to decaying that have been experienced at various abattoirs especially Koala Park Abattoir per month from the retailers . Researches that have been carried out so far pointed out that there is a correlation between operations performed in slaughterhouses with inadequate sanitation and skilled staff which may lead to contamination of meat, bacterial multiplication and possible toxins thereby reduction of the shelf life (Manual 1993).

1.3 Justification

The research seeks to identify the possible sources of meat pathogens in slaughter houses during slaughter processing .It is of most interest for the abattoirs to get as much profit after they have sold the slaughtered carcasses. However in the case of this research questions may be; is the meat contamination as a result of poor slaughter processes or other factors? The research was done in Group B abattoirs and it is hoped that the results obtained are more realistic in line with the conditions experienced in these abattoirs. Therefore this projects trust is to find possible sources of contamination that leads to high microbial load on the carcases which results in low shelf life.

1.4 Aim

To assess the sources that are associated with meat spoilage

1.5 Objectives

1.5.1 Main Objective

To investigate the prevalence of pathogens on equipment and meat handlers' hands in Harare metropolitan abattoirs as possible sources of meat contamination.

1.5.2 Specific Objectives

- To identify pathogens found in Harare abattoirs.
- To investigate on the prevalence of microbes associated with meat spoilage in Abattoirs
- To identify possible sources of meat contamination in Abattoirs.
- To compare abattoirs in Harare for microbes

Research Hypothesis

H_0 - Pathogens found meat handlers hands and equipments have no significant effect on meat contamination.

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CHAPTER TWO

Literature Review

Meat can transfer pathogenic organisms to the people (or animals) that eat or handle it. These organisms can originate from the slaughtered bird or animal that is sick or one that is a carrier of the organism or from other sources. These sources include food handlers that is the people who work with food, at the abattoir, wholesalers or retailers, even the house wife in her kitchen (abattoir hygiene manual, 2007)

2.1 Pathogens

A pathogen is a microbe or microorganism such as a virus, bacterium, prion or fungus that causes diseases in its animal or plant host (FAO/WHO manual, 2003). Today, while many medical advances have been made to safeguard against infection by pathogens through the use of vaccinations, antibiotics and fungicides, pathogens continue to threaten human life (Frantamico et al 2005). Social advances such as food safety, hygiene and water treatment have reduced the threat from some pathogens. Not all pathogens are negative, some are essential for the production of foods such as cheese, yogurt, other fermented foods, bread, beer, and wine (FAO/WHO manual, 2003).

2.1.0 Types of Pathogens

2.1.1 Viral

Pathogenic viruses are mainly those of the families of Adenoviridae, Picornaviridae, Retronoviridae, Polyomavirus, Rhabdoviridae and Togaviridae. Some notable pathogenic viruses cause small pox, influenza, mumps, measles, chickenpox, ebola and rubella. A virus typically ranges between 20-300 manometers in length (Frantamico et al 2005).

.2.1.2 Bacterial

Although the majority of bacteria are harmless or beneficial, a few pathogenic bacteria can cause infectious diseases. The most common bacterial diseases is tuberculosis caused by the bacterium mycobacterium tuberculosis. Pathogenic bacteria contribute to other globally important diseases such as pneumonia, which can be caused by bacteria such as streptococcus and pseudomonas and food borne illness, which can be caused by bacteria such as shigella, campylobacter, and salmonella. Pathogenic bacteria also cause infections such as tetanus, typhoid fever, diphtheria, syphilis and hansen's disease. Bacteria can often be killed by antibiotics because their cell wall in the outside is destroyed and then the DNA. They typically range between 1 to 5micrometers in length (FAO, 2010).

2.1.3 Fungal

Fungi comprise a eukaryotic kingdom of microbes that are usually saprophytes but can cause diseases in humans, animals and plants. Fungi are the most common cause of diseases in crops and other plants. Life threatening fungal infections in humans most often occurs in immune compromised patients or vulnerable people with a weakened immune system, although fungi are common problems in the immunocompetent population as the causative agents for skin, nail or yeast infections(Frantamico et al 2005).. Most antibiotics that function on bacterial pathogens cannot be used to treat fungal infections because fungi and their hosts both have eukaryotic cells. Most clinical fungicides belong to the azole group. The typical fungal spore size is 1 – 40 micrometers in length (FAO, 2010).

2.1.4 Prionic

Prions are infectious pathogens that do not contain nucleic acids. They are abnormal proteins whose presence cause some diseases such as scrapie, bovine spongiform encephalopathy (BSE), (mad cow disease) and Creutzfeldt – Jacob's Disease (CJD) (Ljungh A et al, 2009)

2.1.5 **Other Parasites**

Some eukaryotic organisms such as protists and helminths, cause diseases. One of the best known disease caused by protists in the genus plasmodium is malaria. These can range from 3 – 300 micrometers in length (FAO, 2010).

2.2 Food Borne Pathogens

These are the leading causes of illness and death in less developed countries killing approximately 1.8 million people annually (Frantamico et al, 2005). Bacterial diseases such as salmonella, campylobacter, yersinia enterocolitica, staphylococcus aureus, listeria monocytogenes, clostridium perfringens and clostridium botulinum are some of the common causes of illness to persons consuming contaminated food. Clostridium botulinum is particularly dangerous because it produces one of the most powerful known toxins (Machida, 2010).

2.2.1 Enteric Viruses

Food and waterborne viruses contribute to a substantial number of illness throughout the world. Among these, the most commonly known ones are hepatitis A viruses, rotavirus, enteric adenovirus, hepatitis E virus, and the human calicivirus consisting of the noroviruses and sapporo viruses. The diverse group is transmitted by fecal-oral route, often by ingestion of contaminated water and food (Richards, 2005).

2.2.2 Mycotoxins

Moulds produce mycotoxins which are secondary metabolites that can cause acute or chronic diseases in humans when ingested from contaminated foods. Potential diseases include cancers and tumors in different organs such as heart, liver, kidneys and nerves, gastrointestinal disturbances, alteration of the immune system and reproductive problems (Causin, 2005).

2.2.3 Vibrio

Vibrio species are prevalent in estuarine and marine environments and seven species can cause foodborne infections associated with seafood. Vibrio cholera 01 and 0139 serotypes produce cholera toxin and are agents of cholera. Vibrio cholera non01/0139 strains may cause gastroenteritis through production of known toxins or unknown mechanism (Nishibuchi, 2005).

Vibrio strains are capable of producing thermostable direct hemolysin (TDH) and / or TDH-related hemolysin are most important causes of gastroenteritis associated with seafood consumption. Vibrio vulnificus is responsible for seafood borne primary septicemia, and its infectivity depends primarily on the risk factors of the host. Vibrio vulnificus infections has the highest case fatality rate of any food borne pathogens (Nishibuchi, 2005).

2.2.4 Bacillus

The bacillus group comprises six members; bacillus anthracis, bacillus cereus, bacillus mycoides, bacillus pseudomycoides and bacillus thuringiensis. These species are closely related and should be placed within one species, except for Bacillus anthracis that possesses specific large virulence plasmids.

Bacillus cereus is a normal soil inhabitant and is frequently isolated from a variety of foods, including vegetables, dairy products and meat. Deserts, meat dishes and dairy products are the foods most frequently associated with diarrheal illness, whereas rice and pasta are the most common vehicles of emetic illness (Causin, 2005).

2.2.5 Shigella

Shigella species are members of the family enterobacteriaceae and are gram negative, non-motile rods. The transmission of the pathogens is by the faecal-oral route, commonly through food and water. The infectious dose ranges from 10-100 organisms. Shigella species have a sophisticated pathogenic mechanism to invade colonic epithelial cells of the host, and the ability to multiply intracellularly and spread from cell to adjacent cell via actin polymerisation (Abattoir Hygiene, 2007).

2.3 **Meat borne Pathogens**

From the moment of slaughter, each onwards processing step subjects the carcass to contamination with organisms from the exterior surfaces, utensils, equipment and most importantly, from the gastrointestinal tract (Abattoir Hygiene, 2007). Cutting of carcasses also involves the use of utensils and equipment and transfers microorganisms to the cut surfaces. Theoretically, removal of the skin should expose the sterile surfaces of the muscle but in practice the extra handling seems to contribute significantly to the bacterial load on the surfaces(Machida, 2010).

2.3.1 **Staphylococcus Aureus**

According to Machida (2010), sources of staphylococcus areus includes the nasal passage , skin of food handlers and animals, wounds and cuts and cross contamination during carcasses processing. Temperature abuse allows a large number of organisms to develop with the production of a heat-stable toxin that cannot be inactivated by boiling. Growth and toxin production can occur over a wide range of temperature usually 10 – 40^{o}C with 37^{o}C at best. No sensory changes may be present (Abattoir Hygiene, 2007)

2.3.2 Other Meat borne Pathogens

The following are other pathogens that can be isolated from the meat but they are not limited to; shigella, salmonella, bacillus cereus, yeasts, moulds, vibrio, parasites, clostridium perfringens and botulism, staphylococcus aureus, listeria, yersinia enterocolitica, campylobacter and many others (FAO/WHO, 2007).

2.4 **Requirements for Bacterial Growth**

It is important to remember that, like all animals, bacteria require moisture and certain nutrients in order to grow. Meat is rich in nutrients and water and can support good growth of a variety of bacteria. In addition, there are many other environmental factors that influence the ability of bacteria to survive and grow, such as temperature, the gasses in the atmosphere around them (gaseous atmosphere), acidity (pH). It is the manipulation of these growth requirements that helps us to control micro-organisms in the abattoir (Abattoir Hygiene, 2007).

2.4 .1 **Method of Bacterial Growth (Multiplication)**

Bacteria multiply by the process of binary fission, which is 1 parent cell divides to produce 2 daughter cells (one generation); each daughter cell divides to produce 2 additional cells and so on. For example, if we assume that we have 1000 bacteria per gram of meat, and that all the bacteria multiplied as above, they would reach 1 000 000 (also written as $1x10^6$) bacteria per gram. In 10 generations it can multiply like this (1 000; 2 000; 4 000; 8 000; 16 000; 32 000; 64 000; 128 000; 256 000; 512 000; 1 024 000). This show that both the number of bacteria initially present as well as the number of multiplications they undergo determine the number of bacteria eventually present on the meat (Causin, 2005). Both initial numbers and growth of bacteria on carcasses must be kept low during abattoir processing. Generation time, i.e., the time necessary to produce a generation, is an important consideration in abattoirs. Some types of bacteria have a very short generation time; only a matter of minutes, while others have a generation time of hours. An important factor influencing the generation time of bacteria is temperature (Machida, 2010). The use of refrigeration to lengthen the generation time of unwanted bacteria (e.g. spoilage bacteria) and therefore slow down their multiplication is a common and most important method of extending the shelf-life of perishable products like meat (Abattoir Hygiene, 2007).

2.4 .2 **Growth Cycle**

The growth cycle of bacteria consist of a short period of little or no growth (lag phase), then the population increases rapidly (the phase of logarithmic growth or log phase) toward a maximum and reaches a plateau (stationary phase), and then decreases (death phase). The lag phase is a period of adjustment during which there is considerable cellular activity but little or no cell division. Providing a less than desirable environment for multiplication such as refrigeration usually prolongs the length of the lag phase (Machida, 2010). During the log phase, cell division occurs rapidly at a fairly constant rate. During the stationary phase, a balance between cell division and cell death maintains the maximum number of live cells. Cell death during the phase of death is caused by many factors, the most prominent of which is the accumulation of the cell's own products. An example would be, in the case of fermented meat products, the accumulation of lactic acid (Abattoir Hygiene, 2007).

2.4 .3 Temperature and Bacterial Growth (Abattoir Hygiene, 2007)

Most bacterial species have a minimum, maximum, and optimum temperature for growth.

Psychrotrophic bacteria – capable of growth at commercial refrigeration temperatures they grow best at around 25°C and at slower rates under refrigerated storage. These are especially significant because many of the common red meat and poultry spoilage bacteria are psychrotrophs.

Mesophylic bacteria – grow best at temperatures between 20°C and 45°C. Bacteria growing in the gastro-intestinal tract of the live animal are mostly mesophiles.

Thermophilic bacteria – grow best at temperatures above 45°C. Many will not grow below 40°C.

Thermoduric bacteria – capable of surviving mild heat treatments such as pasteurisation.

2.4.4 Bacteria Growth Cycle

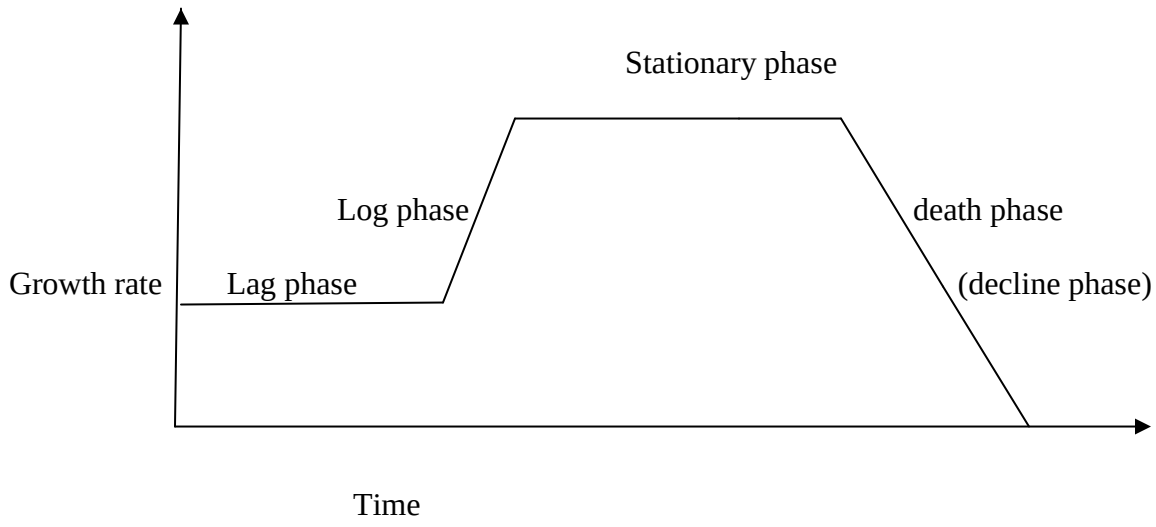

Figure 2.1: Bacterial growth cycle

2.4.5 Gaseous Atmosphere and Bacterial Growth

Aerobic bacteria grow only in the presence of oxygen. Anaerobic bacteria grow only in the absence of oxygen. Facultative anaerobic bacteria grow in the presence or absence of oxygen. Micro-auerophilic bacteria grow in an atmosphere containing less oxygen than in air.The fact that bacteria have varying gaseous atmospheric requirements is of great significance in the red meat and poultry industries (Machida, 2010). Meat is often wrapped in plastic that is readily permeable to oxygen. Here we expect the growth of psychrotrophic aerobes. However, on vacuum packaged meat products other bacteria, such as micro aerophilic bacteria or psychrotrophic facultative anaerobes, will grow better. The special plastic material used for vacuum packaging is not permeable to oxygen (Abattoir Hygiene, 2007).

2.4.6 Microbiology of Meat Production

The deep muscle tissues of healthy, slaughtered livestock contain few, if any, micro-organisms. However, their exterior surfaces (hide, hair, skin, feathers,) are naturally contaminated with a variety of microorganisms as are their gastro-intestinal tracts. From the moment of slaughter, each processing step subjects the carcass to opportunities for contamination with micro-organisms from the exterior surfaces, utensils and equipment and, most importantly, from the gastro-intestinal tract. Cutting of carcasses also involves the use of utensils and equipment and transfers micro-organisms to the cut surfaces (FAO, 2010). Theoretically removal of the skin should expose the sterile surface of the muscle but in practice the extra handling seems to contribute significantly to the bacterial load on the surfaces. This happens with meat production where the skin is removed early in the slaughtering process (beef, mutton, lamb, ostrich, and goat) or where the skin is removed later on (some pork cuts, skinned chicken portions) (Abattoir Hygiene, 2007). There is ample opportunity to contaminate the exposed tissues of the carcass with micro-organisms from: exterior surface of the animal , contents of the gastro-intestinal tract and equipment and utensils.

Meat with a good shelf-life has 10^2-10^4 organisms per cm^2. To put the numbers of organisms associated with some sources of contamination into perspective: the exterior surfaces (hide, hair, skin, feathers) of healthy, live animals and birds are naturally contaminated with large numbers

of a variety of micro-organisms. In a study of live cattle, 10^7 organisms were found per cm^2 of hide. The soil (ground) is also a major source of micro-organisms and has comparable numbers (107) of bacteria per gram of soil (Abattoir Hygiene, 2007).

All of these can therefore serve as sources of microbial contaminants of the meat. The hide, fleece or skin of the animal is known to be a major source of carcass contamination (pathogens and spoilage bacteria). Special care should be taken to avoid contact with the meat. Removal of hides or fleece should be carried out in a manner that avoids contact between the outside of the skin and the carcass (Machida, 2010). When the surface of the hide touches the surface of meat during removal, can cause transfer of significant numbers of organisms to the meat surface. Likewise, hands and equipment that touch the outside of the hide can serve to transfer organisms to the meat and should not come into contact with the underlying carcass meat before thorough cleansing.

Since it is extremely difficult to obtain clean meat from dirty animals or birds, it is important that only relatively clean animals are presented for slaughtering. The cleanliness of livestock depends on husbandry, weather and climate (rainy, dry), methods of transport (stress causes defecation and urination) and holding conditions at the abattoir. Cattle from feedlots may carry more faecal bacteria and less soil organisms than those from pastures (FAO/WHO, 2003). The modern trend is that excessively dirty animals should not be slaughtered until action has been taken to clean them. Also, strategies should be developed to reduce the number of such animals presented for slaughtering.

From the figures quoted above, it is clear that under normal conditions, the heaviest and potentially the most dangerous load of bacteria is in the animal's digestive tract. Already a small volume of material from the intestinal tract can contaminate the carcass with sufficiently high numbers of "coli forms'" to cause problems so that rupturing of the intestines or spillage of the intestinal content would cause severe contamination of the carcass.

It is essential that great care be taken during evisceration to keep the viscera intact. In addition to the skin, the gastro-intestinal and respiratory tracts, urine and milk are other important animal sources of contamination (Machida, 2010). Meat handling and preparation involves contact with knives, hands and clothing of workers, processing equipment, (e.g. saws, hooks, boning tables,

conveyers) and water used to wash carcasses, hands and equipment. Airborne spread of particles and aerosols will also occur in the abattoir. All of these factors can lead to the transmission of potentially hazardous organisms and contamination of carcasses. To minimise contamination, it is logical that attention should be paid to sanitation of all equipment (e.g. knife-sterilizers), well-chlorinated water, personal hygiene, hand-washing facilities near worker stations as well as the other methods of hygienic slaughtering. An important point to remember is that microbes firmly attach to meat and skin (FAO, 2010). This process is not yet well understood but it appears to become irreversible with time – the longer organisms remain on the meat the more difficult it becomes to remove them.

With any delay between consumption or further processing, it is essential to cool the carcass. As far as the microbiological quality of the carcass is concerned, fast chilling is indicated to restrict microbial growth (Cousin, 2005). However, too rapid chilling can lead to cold-shortening of pre-rigor muscle and a loss of tenderness. With these conflicting requirements, optimal conditions for chilling must be a compromise. During chilling, contamination may occur by carcasses touching one another, by contact with dirty floors and walls, by splashing if cleaning is carried out in a loaded chiller and from the air, especially if the filters are not regularly cleaned (Cousin, 2005).

Cutting of carcasses also involves the use of utensils and equipment that transfer micro-organisms to the cut surfaces. This happens with meat production where the skin is removed early in the slaughtering process (e.g. beef, mutton, lamb, ostrich, and goat) or where the skin is removed later on (e.g. some pork cuts, skinned chicken portions). The main challenge to the meat industry in relation to hygiene is to minimise external contamination of meat with micro-organisms during all stages of the production chain (Abattoir Hygiene, 2007

2.4.7 Minimising Bacterial Contamination During Slaughtering

The meat under the skin of a healthy animal is sterile. The slaughtering process must be aimed at keeping the bacterial load on the newly exposed meat surface as low as possible and all efforts should be made to prevent bacteria from being deposited on the carcass. It is necessary to ensure

that nothing that touches the exposed meat is contaminated with micro-organisms. By using the correct slaughtering techniques with this aim in mind, a high degree of sterility is indeed possible under commercial conditions (FAO/WHO, 1979).

2.4.8 Effects of Pathogens on Meat Handler's Hands and Abattoir Equipment

Meat handlers' hands and equipment are frequently in contact with meat or carcasses therefore there is a greater risk of meat contamination if they are contaminated. Pathogens affect the quality and organoleptic nature of meat, thus rendering it unwholesome for consumption. If meat is contaminated it has a greater potential of causing human problems such as diarrhea in the case of salmonella, shigella or escherichia coli contamination (Abattoir Hygiene, 2007). The shelf life of the meat, generally, can be reduced if it has been contaminated with pathogens.

2.4.9 Abattoir Pathogen Surveillance

Pathogen monitoring and surveillance at abattoir should be carried out periodically to monitor hygiene levels and noting the emerging of pathogens which require specific action and notifying the relevant authorities at earliest time before the problem become overwhelm and difficult to control and even before being delivered to the market for human consumption (Nishibuchi, 2005).

2.5.0 Legislation on the Prevention of Abattoir Pathogens (S.I 50, 1995)

Zimbabwe statutory instrument number 50 of 1995 regulates the operations of abattoirs in such a way that it reduces the prevalence of pathogens in these places.

It states that:

Part IV - slaughtering

14(1) no person shall send or permit to be sent on his behalf to any slaughterhouse any animal or bird which is:-

(c) is diseased or had been in contact with a diseased animal or has any conditions which may render the meat, offal or product of the animal or bird unwholesome or unsound ; or

(d) is clinically infected with salmonella or tuberculosis or which has been in contact during the last four days with any animal which has been clinically infected with salmonellosis or in which reacts positively to a tuberlin test, unless prior arrangements have been made with the meat inspector.

17(7) offal shall be removed from a carcass in such a manner as not to cause contamination

Part V- Handling, dressing and inspection of carcasses and by-products

28 (1) Cutting plants

In the slaughterhouse or other premises where the cutting of fresh meat takes place, the cutting plant shall have; instruments and working equipment such as cutting tables, meat containers, conveyor belts and saws made of durable and impervious material, which is liable to taint meat and is easily cleaned and disinfected.

Part V11 – health and hygiene requirements of personnel

35 (1) the operator of a very approved slaughterhouse shall ensure that all persons who are ill or injured receive adequate medical treatment.

(2) A person shall not be allowed to handle carcasses, meat, offal or other products if (s)he is known or suspected to be suffering from a disease which is notifiable in terms of the Act, in particular-

a) Typhoid, paratyphoid A or B, salmonella or any abdominal disorder accompanied by diarrhea, vomiting or feverishness; or

b) contagious tuberculosis; or

c) septic sore throat or any other infection of the mouth, throat ears and eyes; or

d) any venereal disease; or

e) any contagious skin disease; or

f) any infected hand, arm or face, injury or skin condition or infected part of the body, other than a clean wound which is covered by a clean waterproof dressing or glove.

(4) Adequate health records of all employees at a slaughterhouse, and shall be available for inspection by a meat inspector when required.

(5) All persons working in a slaughter house shall wear clean protective clothing, including head covering, appropriate to the type of work done at all times.

36 Equipment cleaning and disinfection

(1) In rooms where carcasses, meat and offals are handed, processed or stored:-

(a) all machinery, tables, conveyors and equipment shall:-

(i) be so arranged and constructed as to be easily cleaned; and

(ii) be kept clean, properly protected when not in use, and in a good state of repair.

(b)tables, knives, steels, conveyors and other equipment shall be thoroughly cleaned several times during the day, or as prescribed by the meat inspector, and an ample supply of hot water of at least 82^{o} C shall be available at all times, as well as detergents and other materials suitable for the cleaning of such equipments; and

(c) all knives, tables, stools and other equipments shall, after being cleaned, be exposed to hot water of a temperature not less than 82^{o} C, or be treated by another method specified by the director; and

(d) any machinery, tables, equipment or other object contaminated shall be disinfected immediately after such contamination.

CHAPTER THREE

Research Methodology

3.1 Study Site

The study site included Koala Park, Pama, Meatfield, Rainham and Lisheen abattoirs which are all found in the Harare province .The abattoirs are grouped as group B abattoirs which does not exceed a total kill of 120 bovine carcasses per day. They are found in the agro ecological region 2A. Average rainfall ranges between 800-1200mm per annum, the temperature ranges between 18-30 ^{0}C during summer and may drop to 2^{0}C during winter**.**

3.1.0 Sampling

The two sets of three swab samples were collected from meat handler's hands and equipments (hooks and on working knives) from the following abattoirs; Koala Park, Rainham, Lisheen, Pama and Meatfield Abattoirs. They were collected on same week, 25 July to 29 July 2015 and were sent to the laboratory for analysis

3.1.1 Sampling Procedure

The sampling was a purposive sampling and samples were randomly collected from abattoir equipment and meat handlers hands. The choice of site for sampling was determined by the analysis of the point where there was highest probability of having carcasses or offals passing that point or hazardous critical control points

Path-Check Hygienic Detection broth was used as the broth media for preserving and enriching the pathogens. Swabs were moistened in the path-check hygienic broth before rubbing the meat handlers' palms, fingers and nails, and equipment.

The sampling sites, equipment and meat handlers' hands were asked to wash their hands following their normal equipment and hand washing procedures prior to swabbing. The used swabs were then placed in the path-check hygienic broth, the growth containers with specimen were labelled indicating source of specimen whether from meat handlers' hands or equipment, sample number, abattoir name and date into the bacterial transmitting cooler boxes prior to transporting them to the laboratory for testing.

3.1.2 Testing techniques

The solution used to moisten swabs neutralized any detergents and sanitisers employed.

- Swab moisturizer solution preserved the integrity of the sample i.e. bacterial numbers should remain constant until the sample collected onto the swab can be evaluated.
- The analysis of the samples for specific pathogens was achieved by transferring the swabs into an appropriate enrichment broth.
- After enrichment the samples had to be transferred to an agar plate medium for the target organism being sought.
- Targeted microorganism was reported as present or absent.

3.2 Analysis of results

To determine the presence and prevalence of the microbes associated with meat spoilage, the collected data was sorted according to the type of pathogen against the source of specimen, whether meat handlers' hands or equipment for a given abattoir. Prevalence for each isolated pathogen was calculated to indicate the degree of occurrence for each pathogen. Both quantitative and qualitative analysis of results was carried out to enrich the researcher with factual and well founded arguments and discussions. Timely and constructive information was discussed with recommendations meant to improve the quality of service delivery system from abattoirs and improving human health by supplying them with pathogen free meat and meat products.

3.3 Ethical Considerations

The researcher valued the participants' privacy, confidentiality and respect dully deserved by keeping their identity private and the findings were only disclosed to relevant authorities.The researcher valued the requirement for professionalism by shunning plagiarism and data manipulation

Sampling, sample preservation and sending of the samples to the laboratory was carried out by the researcher with due precautions so as to reduce external introduction of pathogens thereby reducing false data derivatisation.

CHAPTER FOUR

Results

This chapter is about data presentation and the interpretation of the research findings. Data was presented in a tabular form.

4.1 Data Presentation

Table 4.1: Data presentation from laboratory findings.

This table shows the pathogens that were identified in Harare abattoirs.

PATHOGENS / ABTTOIR / SAMPLING SITE	A		B		C		D		F	
	E	H	E	H	E	H	E	H	E	H
GIADIA AND CRYPTOSPORADIUM	+	-	-	-	-	-	+	-	-	-
BACILLUS	+	-	-	-	-	-	+	-	-	-
STAPHYLOCOCCUS AEREUS	-	+	-	+	-	+	-	-	-	-
STREPTOCOCCUS GROUP D	-	+	-	-	-	-	+	+	-	-
SHIGELLA	+	-	-	-	-	-	-	-	-	-
ESCHERICHIA COLI	+	+	-	+	-	-	+	-	-	+
YEASTS	+	+	+	+	+	+	+	+	+	+

A Koala Park Abattoir C Meatfield Abattoir F Pama Abattoir

B Lisheen Abattoir D Rainham Abattoir H Hand and E Equipment

Table 4.2: Determining the prevalence of pathogens associated with meat spoilage per abattoirs**.**

	A	**B**	**C**	**D**	**F**
H (%)	**66.7**	**0**	**0**	**66.7**	**0**
E (%)	**50**	**33.3**	**16.7**	**16.7**	**16.7**
AVERAGE (%)	**58.3**	**16.7**	**8.3**	**41.7**	**8.3**

A Koala Park Abattoir C Meatfield Abattoir F Pama Abattoir

B Lisheen Abattoir D Rainham Abattoir H Hand and E Equipment %

Table 4.3: Prevalence of each pathogen in all abattoirs on hands and equipments.

	ESCHERICHIA COLI	SHIGELLA	STREPTOCOCCUS GROUP D	STAPHYLOCOCCUS AEREUS	BACILLUS	GIADIA AND CRYPTOSPORADIUM
H (%)	**60**	**0**	**66.7**	**100**	**0**	**0**
E (%)	**40**	**100**	**33.3**	**0**	**100**	**100**

Table 4.4: Prevalence of pathogens as a function of total prevalence.

	ESCHERICHIA COLI	SHIGELLA	STREPTOCOCCUS GROUP D	STAPHYLOCOCCUS AEREUS	BACILLUS	GIADIA AND CRYPTOSPORADIUM
H (%)	**18.75**	**0**	**12.5**	**18.75**	**0**	**0**
E (%)	**4012.5**	**6.25**	**6.25**	**0**	**12.5**	**12.5**
Total	**31.5**	**6.25**	**18.75**	**18.75**	**12.5**	**12.5**

Table 4.5 Prevalence of pathogens as a function of each category (meat handler' hands and equipment.

	ESCHERICHIA COLI	SHIGELLA	STREPTOCOCCUS GROUP D	STAPHYLOCOCCUS AEREUS	BACILLUS	GIADIA AND CRYPTOSPORADIUM
H (%)	**37.5**	**0**	**25**	**37.5**	**0**	**0**
E (%)	**25**	**12.5**	**12.5**	**0**	**25**	**25**

CHAPTER 5

Discussion of the Results

From table 4.1, yeasts are dominant pathogens, they do not have health impact of much concern instead they are needed in all living organisms as they help in everyday life function of metabolic processes. They were not further analysed in this research result discussion.

The presence of escherichia-coli at Koala Park Abattoir, Pama Abattoir, Lisheen Abattoir and Rainham Abattoir indicates that in these abattoirs they have poor separation of offals from the rest of the carcasses since the pathogens are mostly isolated from the gut systems of warm blooded animals. On the other hand, the spreading of these pathogens to the meat handlers, hands and equipments shows that there is the highest potential of transferring them to other parts of the slaughtered animal causing meat contamination from the initial processing stages. Besides that, improper disinfection techniques might be the cause of having these pathogens being isolated from the abattoir equipments.

Escherichia coli is an indicator pathogen for the presence of other pathogens such as shigella and salmonella though salmonella was not isolated, maybe it was not present on the surfaces that was swabbed but serious pathogenic interventions must be employed in these abattoirs to monitor if these pathogens can be isolated. Shigella which was isolated from Koala Park abattoir indicates that the abattoir must disinfect animals before slaughtering as the shigella pathogen can be carried from the skins of animals for slaughter which might have been originated from the feed stock.

The presence of staphylococcus aereus in the following abattoirs; Koala Park abattoir, Lisheen abattoir and Meatfield abattoir, and bacillus ceres Koala Park abattoir and Rainham abattoir, indicate that in these abattoirs there do not have an effective hygiene systems because, staphylococcus aereus habitate on human or pigs' skins. Its isolation indicates that disinfection techniques employed do not have the capacity to kill these pathogens and on the other hand there is highest potential that these pathogens might have been transferred from carrier meat handlers' hands or cross contaminated from infected slaughtered animals.

Giadia and cryptosporidium, and streptococcus group D pathogens were isolated from Koala Park and Rainham abattoirs these abattoirs use raw water during meat processing dam water.. The pathogens are introduced to the abattoir from the raw dam water which does not undergo pretreatment prior to use in the abattoir.

Table 4.2 depicts the prevalence of pathogens within an abattoir. Koala Park abattoir has the highest prevalence of pathogens on equipment as compared to meat handlers' hands. The existence of higher prevalence of pathogens on equipment may indicate that the abattoir applies poor equipment cleaning standards; on the other hand, they are using unboiled raw dam water and this posses as high risk for rmeat contamination which leads to high microbial load and low shelf life.

Lisheen, Meatfield and Pama abattoirs had no pathogens isolated on equipment. Lisheen abattoir had the highest prevalence of pathogens on meat handlers' hands of 33.3% as compared to Meatfield, Pama and Rainham abattoirs which had the lowest prevalence of 16.7%.

Rainham abattoir had the same equipment pathogens prevalence level of 66.7% with Koala Park abattoir. On average, Koala Park abattoir had the highest pathogens prevalence of 58.3% followed by Rainham abattoir with 41.7% then Lisheen abattoir with 19.7% and lastly had both Meatfield and Pama abattoirs had the minimum prevalence of 8.3%.

Table 4.3 indicates the distribution of each pathogen on equipment and on meat handlers' hands. Escherichia coli had 60% prevalence on meat handlers' hands and 40% on equipment. Shigella was isolated from equipments only at Koala Park abattoir, streptococcus group D had a prevalence of 66.7% on hands and 33.3% isolated from equipment, staphylococcus aereus was isolated from hands whereas bacillus, and giadia and cryptosporidium were isolated from equipment.

Table 4.4 shows the prevalence of each pathogen as a function of total prevalence and it can be viewed as the analysis of each pathogen on each category (hands or equipment) against the total number of isolated pathogens. Escherichia coli existed more frequently with an average of

31.25% distributed as 18.75% on meat handlers; hands and 12.5% on equipment from a total number of isolated pathogens.

Streptococcus group D and staphylococcus aereus had the second highest average prevalence of total isolated pathogens both had 18.75%, of which streptococcus aereus had 12.5% for meat handlers' hands and 6.25% for equipment whereas staphylococcus was not isolated from the equipment.

Bacillus, and giadia and cryptosporidium all has an average of 12.5% which was isolated from equipment only. Shigella had the least prevalence of 6.25 isolated from equipment only.

Escherichia coli and staphylococcus group D had the highest frequencies of 37.5% each to the total pathogens isolated from hands whilst streptococcus aereus contributed 25%. Shigella, bacillus, giadia and cryptosporidium were not isolated from hands. Escherichia coli, bacillus, giadia and cryptosporidium had the highest frequencies of 25% each to the total pathogens isolated from equipment. Shigella and streptococcus group D had 12.5% each frequency whereas staphylococcus aereus isolated from the equipment.

Laboratory data was further processed to give synthesised data which was presented in table 4.2 to 4.5. Synthesised data was statistically analysed and interpreted.

CHAPTER SIX

Conclusions and Recommendations

6.1 Conclusion

The results obtained from the laboratory indicate that an abattoir is a silent and unforeseen port of entry for human health problems. Abattoirs if not properly managed and proper hygienic techniques are ineffectively employed several pathogens can grow and spread throughout the abattoir up to until reaches the consumers thereby causing health problems.

Escherichia coli is an indicator pathogen for the presence of other pathogens such as shigella and salmonella though salmonella was not isolated, maybe it was not present on the surfaces that were swabbed but serious pathogenic interventions must be employed in these abattoirs to monitor if these pathogens can be isolated and proper action be employed.

It can be safely concluded that most abattoirs do not properly train their employees about the effect of improper hygiene practices as evidenced by the presence of staphylococcus aereus which can be transmitted by carrier meat handlers and some abattoirs still do not comply with international and national regulations which entails that only potable water must be used in abattoirs. Their ignorance on this call can be linked to the nature of their business objectives which give value to profit on the expense of human life and loss to the producers due to meat spoilage.

6.2 Recommendations

The following recommendations can be drawn from the research, findings:

- A minimum national requirement for an abattoir to operate must be fully implemented and those abattoirs which do not meet then must be penalized.
- An in-house pathogens monitoring system must be constituted and monitored by relevant authorities on daily basis.
- Abattoirs must properly train their workers proper hygiene practices and good slaughtering practices, records of training must be safely kept for inspection by relevant authorities.
- Pre-employment, routine and periodical medical check-up must be practiced in abattoirs and records must be safely kept for inspection by relevant authorities.
- Periodical abattoir inspection and compliance monitoring must be effected and proper procedures be implemented by relevant authorities.
- Abattoirs must reduce in house contamination by ensuring that the abattoir is properly cleaned/sanitised, cleaning utensils at appropriate intervals during the process and applying a high standard of personal hygiene.

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