BACTERIAL CONTAMINATION IN DRESSED CHICKENS IN ABATTOIRS AND OPEN MARKET OF LUSAKA PROVINCE, ZAMBIA

By

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A thesis submitted to the University of Zambia in fulfilment of the requirements for the degree of Masters in Public Health (environmental health)

THE UNIVERSITY OF ZAMBIA

LUSAKA

2017

DECLARATION

I declare that this dissertation is original and that it is the outcome of my own effort. The contents in this dissertation have never been presented elsewhere and I also declare that the narratives, figures, graphs or any statistics contained in this report were generated by me except for those whose origin have been acknowledged.

I further declare that the views and opinions contained in this dissertation do not in any way represent those of the University of Zambia (UNZA), but my own.

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ABSTRACT

The poultry industry has been expanding rapidly in Zambia with both eggs and table birds forming a major dietary protein source for the majority of the population. Despite this expansion, unhygienic rearing conditions have characterized the poultry industry at both small scale and commercial level. Of concern, is the high bacterial contamination, especially *Escherichia coli* and *Salmonella* that may have a serious public health implication. It was against this background that this study was formulated to assess the level of bacterial contamination and associated risk factors in dressed chickens at abattoirs and markets within Lusaka province.

A cross sectional study was conducted across two poultry abattoirs and one major poultry market in Lusaka Province. Sampling was done at two major possible contamination points; after evisceration and after washing. At the market samples were collected at the point of sale of dressed chickens by surface swabbing. Risk associated data was collected using 261 questionnaires. Overall, the results indicated that there was a statistically significant difference (p <0.05) in the mean values of Total Coliform Counts (TCC) and *E.coli* when the sample sources, time of swabbing, origin of chickens and point of swabbing were accounted for. Specifically, both TCC and *E.coli* levels after washing were higher than at evisceration in both abattoirs. Additionally, out of the 80 dressed chickens swabbed in abattoirs at post evisceration, 34.8% of the carcasses were found to be contaminated. Further, after washing, 65.1% of the carcasses were found to be contaminated.

The other 80 dressed chickens, swabbed at the market more contamination was observed on dressed chickens swabbed in the afternoon (100%) than morning (41.2%).Taking into account source of chickens, more contamination from chickens purchased directly from the farms 67.7% (p <0.001) than those that were purchased from abattoirs was observed. Potential risk factors that were identified to have significant influence to bacterial contamination at abattoir level were number of processed chickens per day. This was statistically significant even after adjusting for other variables (OR=4.5) at p<0.002. On the other hand at the open market only distance from water source was significant even after adjusting for other variables (OR = 0.79) at p<0.045.

The results show evidence of plausible bacterial contamination at both abattoir and market level, with higher levels of contamination being observed at open markets. Further, from the results, higher levels of contamination were found after washing than immediately after evisceration, a point which needs further investigation. High levels of TCC, (*E.coli*) and *Salmonella* indicate unhygienic practices. The presence of *Salmonella* and *E.coli* organisms beyond acceptable limits is of concern given their potential to cause food borne infections.

CERTIFICATE OF APPROVAL

This dissertation of **Prudence Mpundu** is approved as fulfilling the requirement for the award of the Degree of Masters of Public Health (Environmental Health) by the University of Zambia.

I have read this dissertation and approved it for examination

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Signature: ______________________ Date: 06/12/17

DEDICATION

I dedicate this dissertation to my Mother, Flavia Nachande who taught me hard work and always telling me in growing up, there are two things that will speak for you in life, that is God and the right education.

I also dedicate this dissertation to the one and only understanding, loving and caring husband whom God has given me as a life covenant partner NATHAN KAZUNGA ZIMBA, my two sweet children JOSHUA KAZUNGA ZIMBA and CONSTANCE JABULANI ZIMBA and above all the God Almighty for giving me the wisdom and strength to undertake this dissertation.

ACKNOWLEDGEMENTS

I know that this work was not going to be possible without the direction from the Lord God Almighty.

My heartfelt love and gratitude goes to my husband (Nathan) for his love, patience, tolerance, support, encouragements and for being my ever close and intimate friend who has always stood by my side all the way while writing this thesis.

Furthermore, thanks goes to Eastfield's Management Services for sponsorship and Chainama Hills Hospital for granting me study leave to pursue my career.

Thanks also goes to the Head of the Microbiology laboratory, Disease Control, School of Veterinary Medicine for allowing me to use the laboratory and its resources for testing the samples whose results are reported in this dissertation. Without this support, this work would not have been a success. In addition, thanks also goes to my supervisors Dr. M. Munyeme, Mr. A. Mbewe and Ms. J. Zgambo for sparing their most valuable time for my work and for guiding me through this work. I would like to express my sincere gratitude to Prof. Muma, Dr Wizaso Wiza Mwasinga, Mr. P. Kapila and the entire Laboratory staffs at UNZA Vet for helping me during my sampling period and helped me with laboratory works and materials.

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ABBREVIATIONS/ACRONYMS

APC	Aerobic Plate Count
CCPs	Critical Control Points
CDC	Center for Disease Control
DCA	Deoxycholate Citrate Agar
EMB	Eosin Methylen Blue
FAD	Foods and Drugs
FAO	Food and Agriculture Organization
HACCP	Hazard Analysis Critical Control Point
LCC	Lusaka City Council
MoH	Ministry of Health
MM	Millimetre
PCR	Polymerase Chain Reaction
RV	Rappaport Vasiliadis
SPP.	Species
SSU	Secondary Sampling Units
TPC	Total Plate Count
TVC	Total Variable Coilforms
µM	Nanometre
WHB	Wash Hand Basin
WHO	World Health Organization
XLD	Xylose Lysine Deoxycholate
ZBMS	Zambia Broiler Market Statistics

DEFINITION OF TERMS

Abattoir	The building that deals with meat and other meat products including dressed chicken processing.
Bacterial contamination	The presence of *Escherichia Coli* and *Salmonella*
Chicken trader	Any person involved in the selling of meat products including dressed chickens at the market
Dressed chickens	These are chickens that are slaughtered, feathers removed and ready for sell.
Food Handler	Any person employed in the abattoir who at any time may be involved in the manufacturing, preparation or packing of dressed chickens for sale.
Food Safety	The scientific discipline describing handling preparation and Storage of food in ways that prevent food borne illnesses.
HACCP:	A systematic preventive approach to food safety that identifies physical, chemical and biological hazards in production and processing of food.
P-Value-	Level of significance at alpha equal to 0.05

CHAPTER ONE

INTRODUCTION

1.1.Background

Chickens are a rich source of animal protein and highly consumed both in the developed and developing nations. According to the Economist newspaper Limited (2016), there are almost 19 billion chickens in the world making it the most common species of birds. European Union average consumption of chickens per capita, in a year is at 25kg while that of Africa is slightly lower with an average consumption per capita standing at 6kg according to Zambia broiler market statistic (ZBMS 2014).

Broiler meat consumption in Zambia per capita is at 4.8kg and an estimated national consumption is at 62.9 million kg making the annual production rate to be at 81.4million kg as reported by the Central Statistical Office (CSO, 2010). There is currently no updated literature which gives information on the consumption of chickens in Zambia up to 2017 .The CSO carries out the census of population and housing every 10 years. The next census is predicted to take place in the year 2020.

In most countries, poultry is termed to be amongst the affordable species to be slaughtered at home by most farmers and households (ZBMS 2014). On the other hand poultry meat is surrounded by few religious restrictions as compared to other animals (Loh et al., 2004).

Most of this poultry however, in the absence of stringent hygienic practices may be contaminated along the processing from primary, through secondary to the final product (Allen et al., 2007). Bacterial microorganisms of public health importance are coli-forms such as *Salmonella* and *Escherichia coli* (*E.coli)* these can be found as part of the normal flora in gastrointestinal tracts of several domestic animals including chickens. These bacterial coli forms have been described as leading causes of food borne diseases worldwide (Barham et al., 2002; Buncic and Sofos, 2012 Panisello et al., 2000). *Salmonella* and *E.coli* species are the major causes of both acute and chronic food borne diseases in both poultry products and humans worldwide (Panisello et al., 2000).

Cases of *Salmonella* are well documented in poultry products than any other animal species (Wingstrand et al., 2006). The prevalence of *Salmonella* in dressed chickens is an indication of poor farming practices. *Salmonella* infections can also be acquired from other sources such as untreated raw milk (Heuvelink et al., 2009) or untreated water (Abe et al.,2008), but consumption of poultry meat, mainly fresh chicken meat, constitutes the major risk factor for acquiring infection (Wingstrand et al.,2006). Different prevalence rates are documented in several countries, extremely high prevalence rates of *Salmonella* in other studies were recorded as high as 60%, 69% and 70%.These were all reported in Portugal (Bajaj et al, 2003).

The prevalence of *Salmonella* in dressed chicken has been documented in several studies including studies that were done in other countries, which found *Salmonella* species at 4.2% in greater Washington DC, USA (Zhao et al, 2001); 14.5% in Nepal (Padungtod et al., 2006; Maharjan et al., 2006) and 19% in the fresh and frozen chicken products in South Africa (Nierop et al., 2005) 20.5% dressed chickens in abattoirs in Zambia (Hang'ombe et al., 1998) in Sudan 44.4% (Shuaib et al., 2014)) .

E. coli like *Salmonella* is the bacterium that lives in the intestines of both humans and animals. It is usually used as an indicator of faecal contamination arising mostly from human beings. The presence of *E.coli* in chickens is an indication of poor hygienic practices in the abattoirs or trading areas. Many types of foods are potential sources of *E.coli* especially chicken. *E.coli* has been isolated worldwide from poultry meat products (Adesiji et al., 2011). Percentage prevalence's are different throughout different parts of the world in poultry products with high and low prevalence's.

Extremely high prevalence rates of *E.coli* in other studies were recorded as high as 98% this was reported in Asia India (Saikia and Joshi, 2010) while another study in the same country yielded a much lower prevalence of 34.5% ,(Sharma and Chahopadhyay, 2015),; In Africa prevalence percentages include studies done in Sudan 57.8%, (Shuaib et al., 2014), South Africa 19%, (Dahal, et al), Morocco 48.4% (Cohen et al 2007) and Nigeria 16% (Adesiji et al., 2011).

The findings of these recent surveys, in different countries, of both *Salmonella* and *E.coli* in fresh chicken meat indicate that a considerable proportion of chickens are contaminated above the acceptable limits across different countries (Meldrum et al., 2004). This makes chicken meat to be considered amongst the foods of public health concern. Man consumes different bacterial organisms from chicken which may be pathogenic, thus making raw chicken meat an ideal substrate which supports the growth of pathogenic organisms thereby pausing a major source of food-borne illnesses in humans (Adu-Gyamfi et al., 2012). Each year, millions of people worldwide get food borne infections as a result of different food consumption including chicken meat (WHO 2009). Therefore reduction of raw chicken contamination levels at different processing stages can have a significant impact on the reduction of the incidences of this food borne illness (Keener et al., 2004).

1.2. Statement of the problem

Globally it is estimated that the major cause of food borne illnesses is *salmonella* with 155,000 deaths which 80.3% are due to the consumption of contaminated chickens (FAO/WHO, 2009). *Salmonella* species are well known for being potentially pathogenic in humans and animals (Mead, 2004; Mohamed- Noor, 2012). These organisms are among the common causes of food borne illnesses such as gastro enteritis. Chickens have been identified as the major primary source of *Salmonella* and *E.coli* species (Buncic and Sofos, 2012).

It is also estimated that 48 million people fall sick and over 3000 die in America each year due to food borne related diseases (CRM, 2011). Diarrheal diseases and intestinal parasites which may be directly or indirectly related to food are among the top ten leading causes of outpatient cases in most African countries (Dewall, 2008).

In Zambia, the Ministry of Health reporting system does not specify the source and specific cause of diarrheal illnesses; the information available in the records has limited precision on the burden of illnesses by specific bacterial contaminants (LDHMT, 2013). This has an effect on planning and allocation of resources for prevention and control of food borne related diseases.

As it has been already stated, majority of poultry in Zambia is reared under poor hygienic environments (Allen et al., 2007). These are the same environments under which small holder and back yard poultry owner's process or dress their chickens for sale. Some of these chickens find their way to abattoirs as part of an out-grower scheme. Most of the chickens which are contaminated at primary production carry along with them the various pathogenic and spoilage organisms which were present at the source of production. This is critical as these biological hazards, in the absence of stringent control measures, and weak hygienic measures will allow for them to be passed on up to the point of consumption (Peyrat et al., 2008). This study was therefore, formulated to assess and identify the bacterial contaminants most commonly found in chickens that may not have undergone such stringent controls.

1.3. Rationale of Study

Food borne diseases have a significant negative impact on public health and this in turn has ripple effects and negative impact on the national economy.

After conducting literature review, no study to assess bacterial contamination and linking the associated risk factors in dressed chickens in Lusaka was found. It was against this background that the current study was conducted to bring out information on the status of bacterial contamination in dressed chickens and the associated risk factors in Lusaka Province.

By assessing bacterial contamination in dressed chickens and identifying the risk factors that may influence bacterial contamination, the study tried to provide a snap shot of how many dressed chickens were contaminated and the associated risk factors. Further, the study also added to the existing body of knowledge on the common bacterial contaminants in dressed chickens in Lusaka which may be useful for academic purpose. Additionally, this study will help policy makers to prioritize food safety through making decisions from an informed viewpoint and coming up with intervention, which are directly linked to food safety.

1.4. Research Question

What is the prevalence of bacterial contamination in dressed chickens and what are the associated risk factors in abattoirs and open market in Lusaka?

1.5. Objectives

1.5.1. General Objective

To determine the level of bacterial contamination and associated risk factors in dressed chickens at abattoirs and Lusaka Open Market.

1.5.2. Specific Objectives

1. To estimate the prevalence of bacterial contamination in dressed chickens in abattoirs and open market in Lusaka.
2. To identify risk factors for bacterial contamination of dressed chickens in abattoirs and open market in Lusaka.
3. To determine associations between risk factors and bacterial contamination in dressed chickens from abattoirs and open market in Lusaka.

CHAPTER TWO

LITERATURE REVIEW

2.1. Overview

The two most common causes of food borne infections are *Salmonella* and *Escherichia coli* (*E.coli*). *Salmonella* which is a group of bacteria, mostly found in raw poultry, eggs, beef and could also be found in unwashed fruits and vegetables. The food borne symptoms could include, fever, diarrhoea, abdominal cramps and headache. These symptoms usually last between 4 to 7 days. Majority of the people normally get better without treatment but it can be more serious in the elderly, infants and some people with chronic conditions. It is also known to be very serious once it gets into the blood stream and can become life-threatening. In such circumstances the patient would need to be hospitalized and treated with antibiotics

E. coli is the name given to a group of bacteria that live mostly in the human intestines. Majority of the types of *E. coli* are harmless, only some few types make people sick and cause diarrhoea known as travellers' diarrhoea. Other worst type cause bloody diarrhoea and can also cause kidney failure and even death. People who suffer from these problems are usually likely to be children and adults with weak immune systems.

E. coli is transmitted by consuming foods, which are contaminated with human waste. Another way by which people can get the infection is by drinking or swallowing water contaminated with human waste (Zweifel et al., 2014).

In addition to the cross contamination introduced by poor hygiene handling, the major source of contamination is poultry from the live birds themselves and the environment (Bhaisaire, 2014).The important principle of controlling microbial contamination during slaughter is based on sanitary and hygienic processes and the application of the Hazard Analysis Critical Control Points (HACCP). Generally operations should aim at reducing microbial load on the final product (Peyrat, et al., 2008).

2.2. *Salmonella* Biological characteristics

Salmonella species (spp.) are bacteria that cause *Salmonellosis*, a common form of food borne illness in human's which comes as a result of the exposure to *Salmonella* spp. The symptoms can range from mild to severe symptoms and sometimes can be fatal. *Salmonella* spp. are carried by a range of domestic and wild animals including poultry. *Salmonella* spp. are gram-negative non-spore forming rod-shaped bacteria and are members of the family Enterobacteriaceae (Jay et al., 2003). The genus *Salmonella* is divided into two spp. *Salmonella enterica* and *Salmonella bongo*ri. Infections are caused by *Salmonella enterica* sub spp. of *enteric* (Bell and Kyriakides, 2002; Crum-cianflone, 2008).

Salmonella typhi and *Salmonella paratyphi* are specifically associated with infections in humans, leading to severe disease called enteric fever. *Salmonellosis* is one of the most commonly reported enteric illnesses worldwide.

Colonies of *Salmonella* appears and forms shine, convex colonies with the entire margins. These colonies are generally 2 - 4 millimetres in diameter. These are then further confirmed by doing biochemical tests.

There are many biochemical tests widely used for classification of *Salmonella* and these are; Indole, citrate utilization, Triple Iron Sugar (TSI), Hydrogen sulphide, Gas production, Lactose fermentation, Mannitol fermentation (MF), Sucrose, Motility and Salmonella Poly-"O" Antiserum among many others

Typical *Salmonella* bio-chemical reactions are presented as follows: Nitrates are reduced to nitrites, gas is usually produced from glucose, Hydrogen sulphide is usually produced on TSI agar and *Salmonella* is usually Indole negative. On the other hand, Citrate is usually utilized as a sole carbon source, Lysine and ornthine decarboxylase reactions are usually positive. Urease is negative; Phenylalanine and trptophan are not fermented. Lipase and deoxyribonuclease are not produced. Salmonella Poly-"O"

Antiserum is positive for a typical *Salmonella* isolate and is termed to be a final confirmatory test for *Salmonella* Spp.

2.3. *E.coli* Biological characteristics

E.coli is an intestinal pathogen or commensally of the human or animal origin and is passed through faeces and remains in aquatic and terrestrial environment for varying periods of time (Jan et al, 2011). It is usually abbreviated as *E.coli,* and a gram-negative, straight rod-shaped bacterium of about 1.1-1.5 Nanometer (μm) x 2.0 - 6.0 μm that is found in the lower intestine of warm- blooded animals also known as (endo-therms) with the optimum growth temperatures of 37^{o}C.

Most *E.coli* strains are none pathogenic but some serotypes can cause serious food borne illness in humans. The harmless strains are part of the normal flora of the gut and can benefit their hosts by producing vitamin $K_{2.}$.*E.coli* and other related bacteria constitute about 0.1% of gut flora and faecal-oral transmission as the major route through which pathogenic strains of the bacterium cause disease.

Colonies of *E.coli* dominate a periodic growth pattern, growing in waves that result in concentric growth rings in the colony. Bacteria colonies also display variety of forms of shapes and textures ranging from round to filamentous. These are then further confirmed by doing biochemical tests.

There are many biochemical tests widely used for entero-bacteriaceae classification and these are; Indole, Methyl Red (MR), Voges-Roskaner (VR),citrate utilization, Triple Iron Sugar (TSI), Hydrogen sulphide, Gas production, Lactose fermentation, Sucrose and Motility among many others.

The following are the bio-chemical reactions for the typical *E.coli* isolate: It is oxidase negative, acetate is usually utilized as a sole source of carbon but citrate cannot be used.

Glucose and other carbohydrates are fermented with the production of pyruvate which further converts into lactic, acetic and formic acids. Part of the formic acid is spit by a complex hydrogenlyase system into equal amounts of Co_2 and H_2. Fermentation may be delayed or absent.

2.4. Prevalence of *E.coli* and *Salmonella* globally

Several studies have been done in different countries such as in **Chitwan- Nepal,** Bhandarai et al., (2013), assessed the bacterial load in broiler chicken in retail shops of Chitwan Nepal. A total of 26 samples were tested and none of these samples were found to be within permissible limits provided by different agencies of Nepal. The high counts of bacteria were mainly attributed to poor, unhygienic as well as unsanitary practices.

In India, Saikia and Joshi, (2010) conducted a microbiological survey for pathogenic contaminants in market poultry meats. The study showed a high level of bacterial counts compared to yeast and fungal counts.

They concluded that the high bacteria counts were mainly due to the chicken meats being kept in an open environment, unregulated temperature which favours bacterial growth as compared to yeast or fungal. The results obtained showed that *E.coli* were the most prevalent in the sample than other spp. (Saikia and Joshi, 2010). These results were in agreement with Zhao et al., (2001) who conducted a similar study and reported high prevalence of *E.coli* compared to *Salmonella* spp. High contamination levels of *E.coli* in markets were also reported by (Kumar et al., 2001; Maharjan et al., (2006).

In Moroco, Cohen et al., (2007) found that majority of the dressed chicken samples collected during the hot season from traditional shops had a higher bacterial contamination load compared to super markets. In the cold season the results were lower but the difference between the two environments remained the same. The results were attributed to favourable temperatures in the hot season that supported microbial growth and poor hygienic conditions in traditional shops as compared to super markets.

In Khartoum state (Sudan), Awadallah et al., (2014), conducted the study in Africa in abattoirs of Khartoum and the results revealed that the most prevalent bacteria were *E.coli*. S*almonella* spp. were only isolated after evisceration and spray washing of chicken meat. This was attributed to the contamination by the spray wash and the handling during the refrigeration that takes place before final packaging of the dressed chicken (Chen et al., 2010).

In Portugal, Adu-Gyamfi et al., (2015) tested 219 poultry of which 207 were found to be contaminated (94.5%) with *Salmonella*. The rates of microbial load ranged from 12% in turkey to 39% in chickens.

However another study prior to Adu-Gyamfi and others, showed extremely high prevalence rates of *Salmonella* as high as 60%, 69% and 70% (Bajaj et al, 2003). Comparing the prevalence estimates might not be able to explain the variations due to the differences in sampling methods, characteristics of the slaughtered chickens and the differences of investigation establishments and the sample size.

The evidence from literature suggests that *Salmonella* species were lower in countries with high standards of food hygiene in abattoirs as these figures show: 4.2% in Washington DC, USA (Zhao et al, 2001) as compared to 14.5% in Nepal (Padungtod et al., 2006; Maharjan et al., 2006); 19% in the fresh and frozen poultry products in South Africa (Nierop et al., 2005); 20.5% dressed chickens in abattoirs in Zambia (Hang'ombe et al., 1998) and Sudan 44.4% (Shuaib et al., 2014).

High prevalence was further demonstrated by Lyhs et al., (2012) who did Polymerase Chain Reaction (PCR) methods for phylogenetic groups and the susceptibility of the isolated for nalidixic acid and ciprofloxacin were also performed. In the same study the Total Variable Counts (TVCs) obtained from the chicken carcasses in the different Critical Control Points (CCPs) after removal of feathers, evisceration, after spraying, washing of hands by workers were similar to those found by (Kabour, 2012). High prevalence in CCPs was suspected to be due to the distribution of the organisms especially *E.coli by* workers due to unhygienic practices such as entering the production area without wearing protective gloves and washing hands without soap or disinfectant after leaving the toilet.

Over all, washing hands with cold water without chemicals like soap yielded mainly redistributions than reductions of bacterial loads (Zweifel et al., 2014). Additionally random movement of workers in and outside the abattoir and from the dirty side to the clean side of the abattoir was another contributing factor. The low contamination levels in some CCPs were attributed to the use of automatic machines that reduced worker involvement (Chen et al., 2010). On the other hand, other studies have reported otherwise saying that automated evisceration increases the surface contamination because the machine fails to adapt itself to the natural size due to variation of carcasses. This results in the rapture of internal organs and the liberation of faecal on the surface of the dressed chicken (Iroha et al., 2011).

2.5. Factors that may influence *E.coli* and *Salmonella* contamination

According to Egan et al., (2007) having the presence of trained managers and enforcement of food safety procedures helped to lower the levels of contamination. This view was supported by Griffith, (2010) who concluded that the risk of business causing food borne illness is to a large extent, a consequence of lack of trained managers and food handlers in a food processing industry. In a similar study done in Zambia by Chipabika et al., (2015), it was also observed that there was a relationship between the level of knowledge and hygienic practices among food handlers. Food hygiene training was seen to be significant in order to ascertain hazards and control food safety in the long run. The abattoir was considered to be the major source of contamination especially if the environment was not maintained in a hygienic way.

Cross-contamination in abattoirs comes from several sources. Hinton et al., (2004) and McNamara, (1997) have cited scalding as a risk factor. During scalding the birds are most likely to transfer bacteria to the scalding tank. The way to reduce bacterial contamination was to continuously replace the dirty water with fresh water,

Powell et al., (2011), further highlighted as follows that “best food producers, processors, retailers and restaurants should go above and beyond minimal government and inspection standards required” in order to reduce food borne illness. This view supports those of (Peyrat, et al., 2008; FDA, 2009 and PHA, 1995).

A study done by Zweifel et al (2014) and Cason et al, (2000) also indicated that the machinery used in the abattoirs can bring about variations in contamination levels. The studies further revealed that more contamination levels were observed in abattoirs using single scalding tanks as compared to those that utilized multistage. Multistage scalding tanks were seen to significantly contribute to bacteria reduction as compared to a single scalding tank especially on the final product. In most abattoirs as reported by Hue et al., (2010); Peyrat et al., (2008) ;Zweifel et al., (2014) the cleaning time reduced as the number of processed chickens increased because abattoirs run in more than one shift this later influenced the quality of the final product because of the little time to clean and disinfect equipment.

2.6. Conceptual Framework

Based on a review of literature, a conceptual framework was developed which provides for a clear analysis of the problem. The Conceptual framework shows how the environmental, service and economic factors interplay in bacterial contamination of dressed chicken.

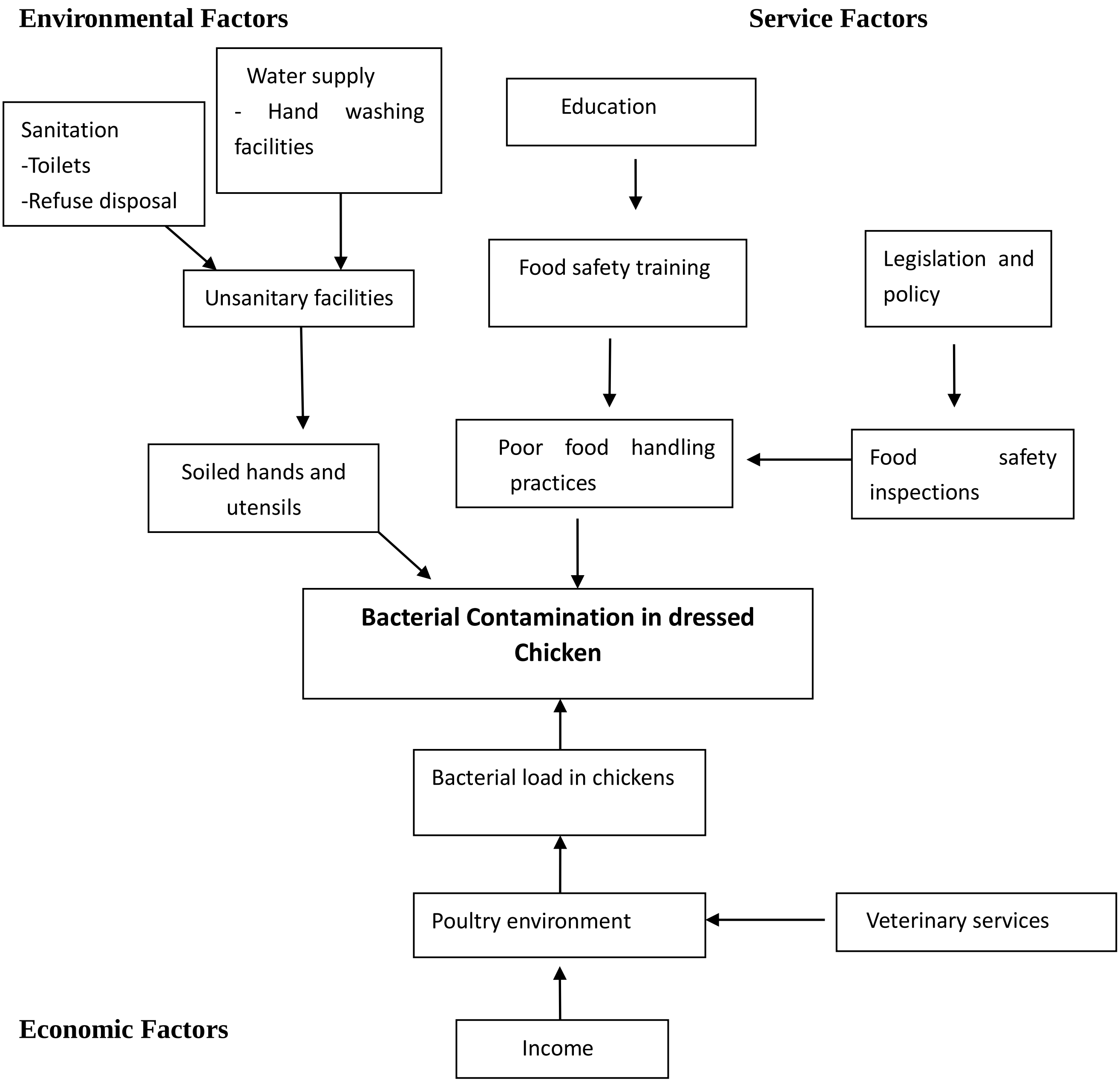

Figure 2.1: Conceptual framework Jan et al., (2011).

CHAPTER THREE

MATERIALS AND METHODS

3.1. Study Design

This was a cross sectional study in nature and it was selected as it provides estimates of factors in a study population at one point in time (Kirkwood and Sterne, 2003). It was designed to determine the level of bacterial contamination and associated risk factors in dressed chickens at abattoirs and Open Markets in Lusaka. The study was carried out from December 2016 to March 2017.

3.2. Study Site

The study was conducted in the Capital City of Zambia, which is Lusaka and it is located by coordinates; 15°25' South of the equator and 28° 17' east of Greenwich. According to Lusaka and Chilanga City Councils, (2016) there are four abattoirs involved in chicken production in Lusaka Province and the two abattoirs in this study were conveniently sampled because of accessibility and cost. These abattoirs are identified as abattoir A and B. The study site also included an open market in Lusaka which has traders selling dressed chickens inside and outside the market. The stands inside which were considered, was the section that deals in chickens and meat products. On the other hand the outside stands included chicken traders who were selling along the road but within the surrounding of the market. These sites were identified as site A and B. The market was picked because it is at the centre of the city of Lusaka and has a lot of vast trading spaces for a number of farmers to bring and trade their merchandise including chickens.

On the other hand, traders in this market are supplied with chickens from different sources which include abattoirs and back yard chicken keepers. Additionally, a number of customers that go to this particular market come from different parts of the city, because chickens and meat products are perceived to be cheaper at this market than other places. Thus, allowing for it to be purposively selected. Knowing the bacterial levels of contamination of the dressed chickens sold in this market, can give a glimpse of how many people are potentially exposed

3.3. Study Population

The secondary sampling units (SSU) consisted of dressed chickens, whilst the primary sampling units (PSU) were sample swabs. Additionally food handlers, market traders and abattoir managers were interviewed. Information was collected from these participates.

3.4. Sample Size consideration

This research was carried out in 2 commercial abattoirs and one open market. The total through-put of these abattoirs was about 8,000 and 20,000 birds per day for abattoir A and B respectively while at the market an average of 50 birds per stand were being processed. The food inspection manual of the food and Drugs Act 2009 was used to determine the sample size required. According to the inspection manual guideline 2009 the recommended sample size using this range was 5 dressed chickens per batch. A batch at the two abattoirs was defined as chickens that were coming from the same flock with homogenous characteristics and the total number being 1000 birds per day. At the market a batch was defined as flocks with both homogenous or heterogonous characteristics and the total being a maximum of 50 birds processed per stand. A total number of 80 dressed chickens were collected both at the abattoir and the market.

Data collection techniques and tools

Data collection was based on bacteriological sample collection for bacterial contamination, interviews by means of structured questionnaires for assessing risk factors and a checklist was used for triangulation including taking pictures at the abattoir and market. The tools were pre-tested and collection of reliable information was determined. This helped to know if the sequence of questions was logical, wording of the question translations were accurate, language used and if spaces for answers were sufficient. Pre-testing was done at Country choice abattoir in Chongwe District. This was because the food handlers working in this abattoir had similar characteristics to the study sites abattoir A and B which included; education levels, food safety training and work experiences in chicken processing among others.

Further, more the machinery used for processing chickens was another factor which was considered including the source of water supply. At the Market pre-testing was done at Mtendere market, which is in the capital city of Lusaka. The market was picked because the traders have similar characteristics to the study site A and B which included: the trading area, source of water, age distribution and educational levels among others. This was important in order to reduce the information bias that can be introduced due to differences in participates, environmental factors and the machinery used in processing of chickens at both abattoirs and market.

3.5.1. Collection of samples from chicken carcasses / Sampling method

Sampling was carried out in two abattoirs and the market on four separate visits for each site for over one month period. A total of 80 carcass swabs were collected randomly from dressed chickens at the two abattoirs from two processing points; of which 20 carcass swabs were collected after evisceration at the cloaca region and 20 carcass swabs were collected after washing on the exterior surface. Circular systematic random sampling was used and serial numbers were assigned to a batch of 1000 chickens. A sampling interval was calculated using the formula of total population divided by the sample size required, which was 200. Later a random between function in excel was used to come up with the random start number 694. The sequence continued were a sampling interval 200 was being added to the random start number to get the next pick of the dressed chicken to be swabbed. The second pick was 894, the third one was outside the sampling frame of 1000 chickens and this was 1094 since this was a circular systematic sampling, 1000 which was the batch number was subtracted from the total 1094. This later gave 94 as the third pick and 294 as the fourth pick. The last pick was 494 giving the desired 5 dressed chickens, needed for swabbing at two points after evisceration and after washing.

At the open markets, 80 exterior carcass swabs were collected at the point of sell from both inside and outside of the markets from traders dealing with dressed chickens including those selling other meat products. The 40 swabs were sampled at different times in the morning and afternoon from the same stalls. There were 20 swabs collected in the morning and 20 swabs afternoon. Simple random sampling was used to select the stalls; where a list was generated indicating the stall numbers for all market stands. Pieces of paper with the stand numbers were put in an opaque bag which was shaken before a piece of paper with a number was picked. The 5 dressed chickens or pieces were picked using circular systematic sampling and serial numbers were assigned to a batch of 50 dressed chickens or pieces. A sampling interval was calculated using the formula of total population divided by the sample size required, which was 10.Later a random between function in excel was used to come up with the random start number 6. The sequence continued where a sampling interval 10 was being added to the random start number to get the next pick of the dressed chickens or pieces to be swabbed. The second pick was 16, third was 26, fourth 32 and the last pick was 38 giving the total of 5 dressed chickens swabbed at different timings.

A sterile metal template was used to outline a $10cm^2$ area on the dressed chicken carcass. The parts which were swabbed at the two abattoirs were the cloaca region and the exterior surface of the skin of the chicken or chicken parts. Whilst at the market exterior surfaces of the skin were swabbed at the point of sell. The outlined area was swabbed with sterile cotton gauze wrapped around the end of a flat swab-stick. The swabs were then transferred into a tube containing transport media (Cary-Blair Transport Media). Each tube containing the carcass swab was marked by numbering and transported promptly in an ice cold cooler box to the Microbiology, Disease Control Laboratory in the, School of Veterinary Medicine at the University of Zambia. The samples were kept at 4^{o}C in order to prevent rapid growth of bacteria

prior to culture for isolation and identification of organisms. In the laboratory before isolation of *Salmonella* and *E. coli* the swabs were removed from the transport media and put in test tube containing 0.5% peptone water and mixed using a vortex machine.

3.5.2. Laboratory Analysis

3.5.2 .1. Isolation and identification of *Salmonella*:

Each sample swab was inoculated into 9.0 ml sterile peptone water and incubated at 37^{o}C for 3hrs for the purpose of resuscitation. A loop full of the peptone broth culture was transferred to *Salmonella* enrichment Rappaport broth (HIMEDIA) and incubated at 44 ^{0}C for 24hrs. Thereafter, a loop full of the broth culture was streaked on Xylose Lysine Deoxycholate (XLD) (HIMEDIA) agar and incubated at 37^{0}C for 24hrs. Suspect *Salmonella* colonies with black centres on XLD agar were picked and sub cultured on Nutrient (HIMEDIA) agar at 37^{0}C for 24hrs.

Salmonella suspected colonies were confirmed biochemically by inoculating into Triple Iron Sugar (HIMEDIA), urea (Central Drug House), citrate (HIMEDIA) and Sulphide Indole Motility (SIM) medium (HIMEDIA). This was done by using a straight wire and streaking on the slant (Shuaib et al 2014)

3.5.2.2. Total bacterial count

Each sample swab was placed in sterile 0.5% peptone water, and then incubated for 3hrs at 37^{0}C. Serial dilution from 10^{1} to 10^{3} was prepared of each sample broth culture. 1.0 ml of each dilution was transferred to sterile Petri dishes in duplicates and sterile molten agar was added using pour plate method. The plate cultures were incubated at 37^{0}C for 24hrs. Colony forming unit (CFU) was determined from appropriate dilutions (Shuaib et al, 2014).

3.5.2.3. Enumeration of Escherichia coli:

E. coli were enumerated by Eosin Methylene Blue agar (EMB) (HIMEDIA) using pour plate method and appropriate dilution factor. Plate cultures were aerobically incubated at 44°C for 24hrs. Colonies with a distinct metallic shine were counted as CFU (Shuaib et al., 2014).

E.coli suspected colonies were confirmed biochemically by inoculating into Triple Iron Sugar (HIMEDIA), urea (Central Drug House), citrate (HIMEDIA) and Sulphide Indole Motility (SIM) medium (HIMEDIA). This was done by using a straight wire and streaking on the slant (Shuaib et al., 2014).

3.5.3. Risk factor associated data

A total of 261 questionnaires were administered calculated using a prevalence of 57.8% (Awadallah et al., 2014) at 80% power and 5% level of significance to the food handlers at the two abattoirs and Lusaka Open Market. Of the total 261 questionnaires, 174 questionnaires were administered to food handlers at the two abattoirs, with each abattoir being allocated 87questionnaires. Simple random sampling was used to select participants who were the food handlers and this was done using a list of numbers generated from the employee list of the company. Firstly the food handlers were identified from the list of employees given. Later the food handlers identified were confirmed if present on duty, then allocation of numbers was done on food handlers present that day. Pieces of paper with the employee numbers were put in an opaque bag which was shaken before a piece of paper with employee number was picked. The 87 food handlers were randomly picked from the list through shuffling before the next pick was made. Additionally, purposive sampling was used to administer 1 questionnaire for each abattoir representative as key informant.

A total of 87 questionnaires were administered to the market traders who were involved in selling of dressed chickens including the stands were swabs of dressed chickens were not collected. Of the total 87 questionnaires, 44 were allocated to the inside traders (A) and 43 to the outside traders (B).

Inclusion Criteria

All the food handlers who were on duty during the period of the study and all the traders selling dressed chickens, including those who were also selling other meat products.

Exclusion Criteria

Workers and traders not involved in handling of the dressed chickens with an exception of abattoir managers.

3.6. Data Analysis

The data obtained from the study was entered in the excel spread sheet (here necessary handling and cleaning of data was done) and imported in Stata software for analysis. Stata 14.0 was used for all analysis.

In addition, Stata was used for computing descriptive and survey statistics which encompassed assessing frequencies, percentage distribution and determining confidence intervals. These were used to describe the study variables which were generated from the study. The chi-square analysis was used as a pre-screening for identification of risk factors that had an association with bacterial contamination at the market and the abattoirs. A cut-off point of $p<0.05$ for significance was used. Risk factors found to have an association with bacterial contamination were included in the respective logistic models as explanatory variables.

Firstly, unadjusted logistic models were fitted for each risk factor, one by one, identified at each site. Secondly, adjusted logistic models were fitted for each site accounting for all identified risk factors that were significant at bivariate analysis. The strength of association between bacterial contamination and risk factors at abattoir and market level was determined using multiple logistic regression models which also explored the relationship between the odds of obtaining bacterial contamination. The odds ratios, indicating the likelihood of bacterial contamination, *p*-Values and confidence intervals at 95% were reported. Only, those risk factors found to be statistically significant at 5% under both unadjusted and adjusted logistic models were interpreted and discussed.

3.7. Ethical Considerations

Ethical approval to conduct this study was sought from Excellence in Research Ethics Committee. Permission from Lusaka City Council and Chilanga City Council was equally sought. The purpose and importance of the study was explained to the study participants before being invited to participate. Consent was obtained from all participants prior to commencement of the study.

This particular study involved collection of swabs from dressed chickens from the abattoir and Lusaka Open Market. Questionnaires were also administered during the study. The study had minimal ethical issues that were addressed accordingly and this reduced the adverse effects. The identified ethical issues of concern patterning this study involved the following.

Psychological discomfort: to the person being interviewed and the owners of the business because they would have felt judged by others that they may have been selling contaminated dressed chickens. In order to reduce this effect, records of all information that was collected from respondents and from the dressed chickens was kept strictly confidential. The interview was conducted in a private place to preserve the identity of the respondents.

Possible economical loss to the business: It was likely that a respondent or an abattoir may experience economic loss if their dressed chickens were found to be contaminated. To address this; the abattoirs in question remained anonymous and only the researcher had knowledge of their location and actual identities, the researcher visited the abattoirs outside the study to give them her results and discussed what they needed to do. They were assured that their identities were kept confidential, even to Lusaka city council.

Dissemination plan

The researcher made available summary copies of the final report to the relevant stakeholders who had the authority to act on the recommendation given in this study. The identified stake holders were: Ministry of Health, Ministry of Livestock and Fisheries, Chilanga City Council, Lusaka City Council and abattoirs. Other copies were submitted to the University of Zambia library for academic references.

Ultimately, the study was submitted to a local and international journal for publication to provide information to the general public.

CHAPTER FOUR

RESULTS

4.1. Descriptive results

4.1.1. Descriptors on bacterial prevalence

Out of 160 chicken carcasses sampled, 129 were contaminated representing 80.6%. When specific bacteria causing contamination were enumerated, it was found that *Salmonella* accounted only for 2 (1.3%) whilst *E. coli* contamination accounted for 114 (71.3%).These contamination levels were all beyond the tolerable limits according to the Australian standards and International commission on microbiological specifications for dressed chicken carcasses.

4.1.2. Comparative bacterial contamination between Abattoirs by Market processed chickens

When source of chickens was considered abattoir contamination revealed lower levels of uncontaminated carcasses compared to markets see Table 4.1.

Table 4.1. Comparative bacterial contamination between Abattoirs and Markets processed chicken

Site	*E.coli*		Frequency (%)	χ^2	P value
	Not contaminated	**Contaminated**		16.3636	<0.001
Abattoirs	27 (75.0%)	13 (25.0%)	40 (50.0)		
	9 (63.4%)	31 (36.6)	40 (50.0)		
Total	36	44	80		
Market	7 (75.0%)	33 (45.2%)	40 (50.0)	7.6712	<0.006
	0 (0.0%)	40 (54.8)	40 (50.0)		
Total	7	73	80		

When source of sample was taken in to consideration, a chi-square analysis showed that the relationship between bacterial contamination and the source of samples was significant as shown in table 4.2.

Table 4.2. Association of dressed chicken contamination across different source of samples

Source	*E.coli*		Frequency (%)	χ^2	P value
	Not contaminated	**Contaminated**			
Abattoir A	27 (75.0%)	13 (25.0%)	40 (50.0)	16.3636	<0.001
Abattoir B	9 (63.4%)	31 (36.6)	40 (50.0)		
Total	36	44	80		
Market A	7 (75.0%)	33 (45.2%)	40 (50.0)	7.6712	<0.006
Market B	0 (0.0%)	40 (54.8)	40 (50.0)		
Total	7	73	80		

4.1.3. Bacteria contamination at two processing points at the abattoirs

When bacteria type was adjusted by point of swabbing at the abattoirs, there was a significant difference χ^2= 9.3874, p=0.025.Dressed chicken contamination increased through the process line see Table 4.3.

Table 4.3. Bacteria contamination at two processing points

Bacteria type	After evisceration		After washing		Total
	Frequency	Percent	Frequency	Percent	Frequency
E.coli	15	34.88	28	65.12	43
Salmonella	1	100.0	0	00.0	1
E.coli and *Salmonella*	1	100.0	0	00.0	1
None	23	50.0	12	50.0	35
Total	40	50.0	40	50.0	80

χ^2= 9.3874, p=0.025

4.1.4. Bacterial contamination according to time swabbed at the markets

At the markets when time of swabbing was taken into consideration, the proportion of contaminated chickens was higher in the afternoon 40 (100.0 %) than in the morning 33(41.2 %). The overall chi-square statistic χ^2= 7.67712 was statistically significant at p=0.006.

4.1.5. Origin of Chickens sampled and bacterial contamination

A total of 160 chickens were sampled with 31(19.4%) coming from commercial in grow (grown by the abattoir) whilst 10 (6.3%) were from commercial outgrow (grown by other chicken farmers). Further 107(66.9%) chickens came from various local small scale farmers (inclusive back yard poultry) with only 12 (7.6%) from an assortment of various suppliers and middle traders, who didn't know the exact source. From all these sources, chickens from farms were more contaminated 107 (66.7%) compared to the other sources. When statistical consideration was done a highly significant association between bacterial contamination and the origin of chickens was $\chi2$= 163.9964, p< 0.001.

4.2.1. Socio-Demographic Characteristics of Participants

The socio-demographic characteristics of the study participants from all data collection sites have been outlined in table 4.4.

Table 4.4. Demographic variables for chicken traders and abattoir food handlers

Baseline Characteristics	**Market (n=87)** (%)	**Abattoir A (n=87)** (%)	**Abattoir B (n=87)** (%)	**Abattoir A and B (n=174)** (%)
Sex				
Female	73 (83.9)	44 (50.6)	39 (44.8)	83 (47.7)
Male	14 (16.1)	43 (49.4)	48 (55.2)	91 (52.3)
Age				
Below 20 Years	4 (4.6)	1 (1.2)	21 (24.1)	22 (12.6)
21 to 30 Years	13 (14.9)	55 (63.2)	41 (47.1)	96 (55.2)
31 to 40 Years	40 (45.9)	25 (28.7)	18 (20.7)	43 (24.7)
Above 41 Years	30 (34.5)	6 (6.9)	7.4 (8.1)	13 (7.5)
Mean Age (SD)	38.9 (10.4)	30.9 (7.5)	28.5 (9.0)	29.7 (8.35)
Education level				
Never attended	15 (17.2)	1 (1.2)	--	1 (0.6)
Primary	38 (43.7)	14 (16.1)	16 (18.4)	30 (17.2)
Secondary	34 (39.1)	68 (78.2)	66 (75.9)	134 (77.0)
Tertiary	--	4 (4.6)	5 (5.8)	9 (5.2)

4.2.2. Age characteristics of abattoir and market workers

At the abattoir, the average operative age was 30 years and at the market 39 years in Figure 4.1 and 4.2.

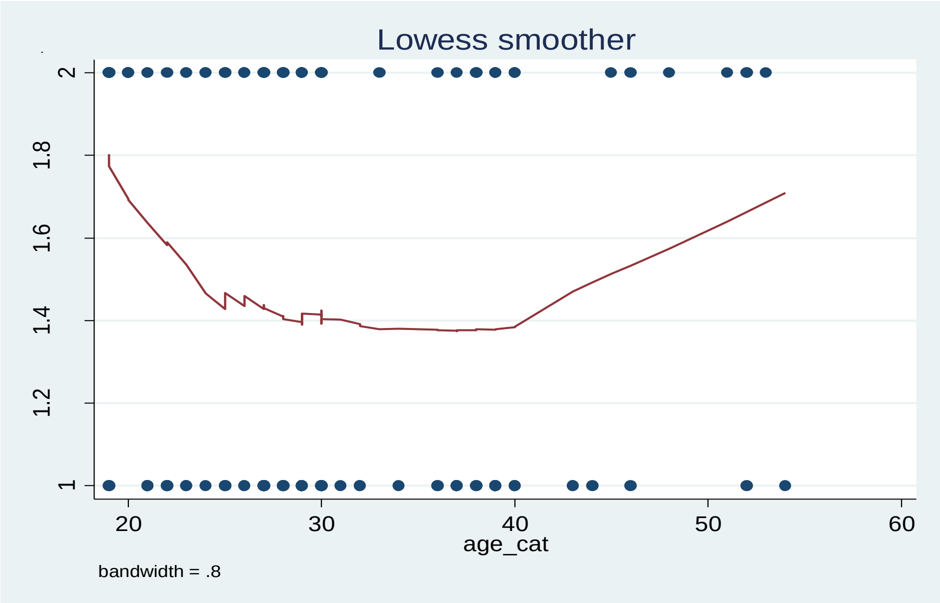

Figure 4.1: The figure shows lowess smothers of the age at the two abattoirs combined. The young age range and the adult age ranges formed the majority, but the average range was 30 years.

When age was considered between abattoir workers and market workers, a considerable siginificant difference ($p<0.001$) was found, with abattoir workers being younger with a few aged workers, whilst those at the market were mostly around the age of 40 as shown in Figure 4.2.

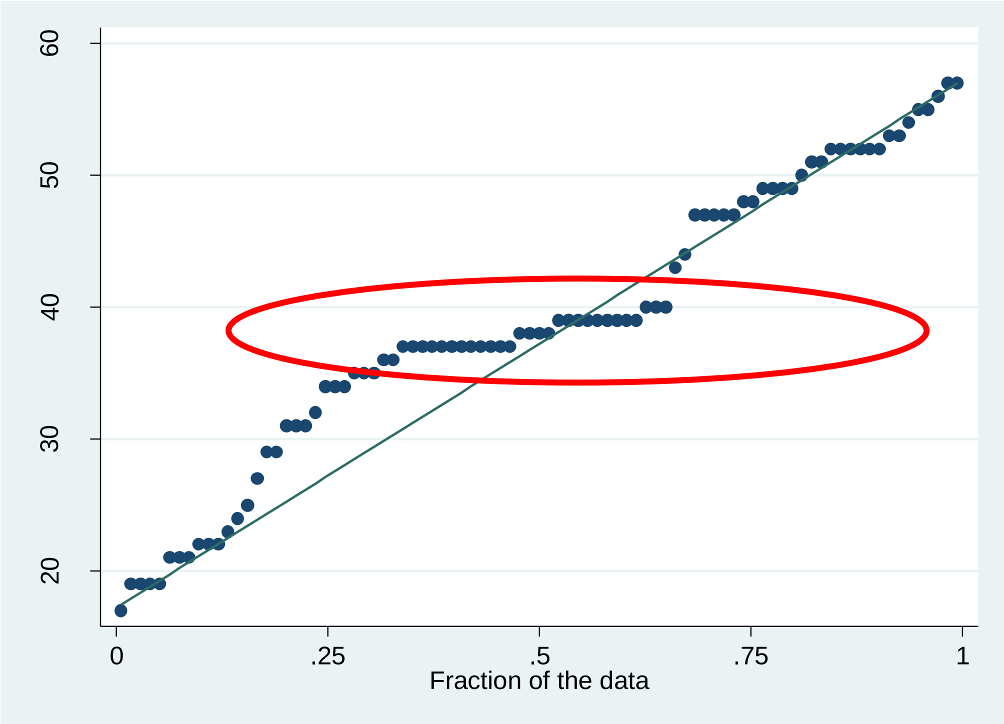

Figure 4.2: The figure shows age quartiles from the market, with the most dots being clustered around the age range of 39 years (*red circle*)

4.2.2. Educational characteristics of abattoir and market workers

With regards to education, the majority of food handlers had attained secondary level of education 134 (77.0) while at the market majority of the chicken trader's attained primary 38 (43.7) and secondary education 34 (39.1) (Table 4.4 above).When education was considered between abattoir workers and market traders, a considerable significant difference $\chi 2= 24.6772$, $p< 0.001$.

4.2.3. Key Informants interviews for risk factors

Two abattoir staff were interviewed from abattoir A and B these were aged 56 and 29 years respectively. Both had attained tertiary education level. The one from abattoir A had served relatively longer (14 months) compared to the one in abattoir B (6 months). When asked about the source of the chickens, the respondent from abattoir A indicated both in-grow (*originating from the abattoirs' own farms*) and out-grow (*chickens originating from other farms*), whilst the other stated in-grow only. Abattoir A employed a manual method when processing the chickens, whilst abattoir B used both automated and manual methods. The scalding temperature in abattoir A ranged from 55 to 56 degrees Celsius. This range was similar to that reported by the respondent from abattoir B, 55 to 60 degrees Celsius. The scalding water was changed on a daily basis for abattoir A and after a day for abattoir B. The scalding process took at least two minutes for both abattoirs and an hour for chicken process to be completed.

The workers in each abattoir are trained in food safety but abattoir B had some food handlers who were not trained. They also went for medical check-ups at least once a year. To ensure that the dressed chickens in the abattoir are of good quality, abattoir A uses a quality control program based on international standards as per manual. Similarly, abattoir B processes chickens under industrial regulated temperature. The main disinfectant that was being used in both abattoirs was chlorine where abattoir A using a dose measure of 750 to 850 millivolts and abattoir B used 50ppm dose measure.

The main sources of water for the two abattoirs were borehole from their own source and water from the utility company. Waste generated by the processing of dressed chickens was collected by a private company, which according to the two respondents was the best method of disposal. With respect to cleaning the abattoirs, they were cleaned in the morning before operations commenced and in the afternoon post-operation in abattoir A only. On the other hand, for abattoir B, the cleaning was done all night by the night cleaning team. There was also some cleaning that was done all the time throughout the day by cleaners in abattoir B. The respondent from abattoir B highlighted several challenges such as (i) *rotting of stock that overstays in the cold rooms,* (ii) *lack of proper sewer line for the disposal of influent water,* (iii) *high mortality rate of chickens during hot seasons and waste disposal (the drains usually block).*

4.3. Risk factors for bacterial contamination of dressed chickens in abattoirs and open market

4.3.1. Abattoir risk factors

The results show that there is an association between each risk factor and the swabs testing positive for the presence of *E.coli* and *Salmonella* .Specifically, the risk factors found to be associated with this outcome variables included: process through-put per day (p<0.001), having washed hands with soap (p<0.001), lack of training on chicken handling ($p<0.001$), lack of inspection of dressed chickens (p<0.001) and its frequency of inspection (p<0.001) see table 4.5.

Table 4.5. Cross tabulations of risk factors identified at abattoir level

Site	Independent variables	Scale Of Measurement					χ^2	p-Value
Abattoir	Education levels	Never attended school	Primary	Secondary	Tertiary	Total		
	A	15 (100.0)	38 (70.4)	34 (34.0)	0 (0.0)	30 (100)		
	B	0 (0.0)	16 (29.7)	66 (66.0)	5 (100.0)	10 (100)	13.41	0.001
	Total	15 (100.0)	54 (50.0)	100 (100.0)	5 (100.0)	174 (100)		
Abattoir	Process Through-Put	Daily processed chicken Below 15,000	Above 15,000	Total			χ^2	p- Value
	A	87 (100)	0 (0.0)	87 (100)				
	B	0 (0.0)	87 (100)	87 (100)			174	0.001
	Total	87 (50)	87 (50)	174 (100)				
Abattoir	Washed hands with soap	Used soap for hand washing Yes	No	Total			χ^2	p- Value
	A	87 (100)	0 (0.0)	87 (100)				
	B	0 (0.00)	87 (100.0)	87 (100)			174	0.001
	Total	87 (50)	87 (100.0)	174 (100)				
Abattoir	Training	Yes	No	Total			χ^2	p- Value
	A	87 (58.4)	0	87 (50.0)				
	B	62 (41.6)	25 (100.00)	87 (50.0)			29.1	0.001
	Total	149 (85.6)	25 (14.3)	174 (100)				
Abattoir	Inspection of Chickens	Inspection Yes	No	Total			χ^2	p- Value
	A	85 (60.3)	2 (6.06)	87 (50.0)				
	B	56 (39.7)	31(93.9)	87 (50.0)			31.4	0.001
	Total	14 (81)	33 (18.9)	174 (100)				
Abattoir	Frequency of inspection	On arrival	On arrival and after processing	Total			χ^2	p- Value
	A	30 (34.5)	57 (65.5)	87 (100)				
	B	62 (71.3)	25 (28.7)	87 (100)			23.6	0.001
	Total	92 (52.8)	82 (47.1)	174 (100)				

4.3.2. Risk factors at open market

Among the supposed risk factors at the open market only chicken cleaning ($p<0.001$) and distance from the source of water ($p<0.001$) were found to have a significant association with bacterial contamination at 5% levels of significance see table below 4.6.

Table 4.6.Cross tabulations of risk factors identified at the market Level

Site	Independent variables	Scale of measurement				**χ^2 and p-Value**	
Market	Education levels	Academic achievement				χ^2	**p-Value**
		Never attended	Primary	Secondary	Total		
Market	A	8 (18.18)	20 (45.45)	16 (36.36)	44 (100)	0.2781	0.870
	B	7 (16.3)	18 (41.9)	18 (41.9)	43 (100)		
	Total	15 (17.2)	38 (43.7)	34 (39.1)	87 (100)		
		Independent variables					
Market	Cleaning dressed Chicken	Cleaning chickens after plucking				χ^2	**p-Value**
		Cleaned	Not-Cleaned	Total			
	A	37 (84.1)	18 (15.9)	55 (63.2)			
	B	7 (41.9)	25 (58.1)	32 (36.8)		16.6793	0.001
	Total	44 (63.2)	43 (36.8)	87 (100)			
Market	Refrigeration	Refrigeration of chickens before sale takes place				χ^2	p-Value
		Yes	Not	Total			
	A	43 (97.7)	39 (32.6)	82 (94.3)			
	B	1(2.3)	4(67.4)	5 (5.8)		3.2920	0.070
	Total	44 (100)	43 (100.0)	87 (100)			

Market	Time of refrigeration	Time of refrigeration			χ^2	p-Value
		Immediately after plucking	After end of sale day	Total		
	A	7 (15.9)	14 (32.6)	21 (24.1)		
	B	37 (84.0)	29 (67.4)	66 (75.9)	3.2920	0.070
	Total	44 (100.0)	43 (100.0)	87 (100)		

Market	Adequate of refrigeration	Availability of refrigerator on site			χ^2	p-Value
		Adequate	Inadequate	Total		
	A	42 (95.5)	39 (90.7)	81 (93.1)		
	B	2 (4.6)	4 (9.3)	6 (6.9)	0.7664	0.381
	Totals	44 (100.0)	43 (100.0)	87 (100)		

Market	Chicken inspection	Inspection of chickens before sale			χ^2	p-Value
		Inspected	Not inspected	Total		
	A	7 (45.5)	14 (32.6)	21 (24.1)		
	B	37 (54.6)	29 (67.4)	66 (75.9)	3.2920	0.070
	Totals	44 (100.0)	43 (100.0)	87 (100)		

Market	Source of chickens	Source of chickens			χ^2	p-Value
		Abattoir	Local chicken sellers/farms	Total		
	A	20 (45.5)	22 (51.2)	42(48.3)		
	B	24 (54.6)	21 (48.8)	45 (51.7)	0.2838	0.594
	Totals	44 (100.0)	43 (100.0)	87 (100)		

Market	Distance from water source	Distance from water sources			χ^2	p-Value
		Within the business	Not Within the business	Total		
	A	44 (100.0)	0(0.0)	44(50.6)	87.00	0.001
	B	0 (0.0)	43 (100.0)	43 (49.4)		

	Totals	44 (100.0)	43 (100.0)	87 (100)

Market	Training	Training in food safety			χ^2	p-Value
		Trained	Not-Trained	Total		
	A	12 (12.3)	11 (0.0)	23 (26.4)		
	B	32 (72.7)	32 (74.4)	64 (73.6)	0.0320	0.858
	Totals	44 (100.0)	43 (100.0)	87 (100)		

4.4. Associations between risk factors and bacterial contamination in dressed chickens from abattoirs and open market

4.4.1 Strength of association between risk factors and bacterial contamination at abattoir level

To determine the strength of the association between the abattoir risk factors most likely to influence bacterial contamination, a logistic regression was employed. Both unadjusted and adjusted odds ratios (OR) are presented. In the adjusted model, all risk factors were controlled for (Table 4.7). High process through-hput, was a significant risk factor for contamination, with Abattoirs processing more than 15,000 chickens and above per day being four times more likely to be contaminated than those which had lesser throughputs (OR=4.5; 95% CI: 77.2-1757.6) These odds ratio figures remained significant even after controlling for the other risk factors (OR=4.5; 95% CI: 1.7-11.7) at $p<0.002$ under the adjusted model.

Table.4.7. Logistic regression of bacterial contamination and risk factors at abattoir level

Variables	Scale of measurement	Unadjusted			Adjusted (n=130)		
		OR	p-value	95% CI	OR	p-value	95% CI
Process through-put	10,000 - 15,000	(ref)			(ref)		
	>15,000	4.5	<0.001	77.2-1757.6	4.5	<0.002	1.7-11.7
Washed hands with soap	Did not use anything	(ref)			(ref)		
	Used Soap	0.0	<0.002	1.7-11.7	1		
Trained in food safety	Trained	(ref)					
	Not trained	1					
Inspection of dressed	Inspected	(ref)					
	Not inspected	3.8	<0.078	8.6-17.1			
Frequency of inspection	On arrival	(ref)					
	On arrival and after processing	1.3	0.367	0.6-2.7			

**Note: (ref) — represents the "reference category" when interpreting the OR*

4.4.2. Strength of association between risk factors and bacterial contamination at market level

To determine the strength of the association between the market risk factors most likely to influence bacterial contamination, a logistic regression was employed. Both unadjusted and adjusted odds ratios (OR) are presented. In the adjusted model, all risk factors were controlled for as indicated in Table 4. 8. Only distance from source of water was significant in both the unadjusted and the adjusted model OR is 3.5 (95% CI: 0.04-1.67) at (*p*<0.045).

Table 4.8. Logistic regression of bacterial contamination and risk factors at open market level

Variables	**Scale of measurement**	**Unadjusted**			**Adjusted (n=74)**		
		OR	**p-value**	**95% CI**	**OR**	**p-value**	**95% CI**
Chicken cleaning	Cleaned	(ref)					
	Not cleaned	1	0.924	0.4-2.7			
Distance to water sources	Outside business premises	3.5	0.014	1.3-9.7	0.79	0.045	0.04-1.6
	Within business premises	(ref)			(ref)		

**Note: (ref) — represents the "reference category" when interpreting the OR*

CHAPTER FIVE

DISCUSSION

5.1. Prevalence of *Salmonella* and *E.coli* contamination

In a chicken processing abattoir, bacterial contamination such as *Salmonella* and *E.coli* cannot be avoided. Efforts should be put in place to reduce the levels of contamination found on the final product. The major emphasis should be the good hygiene and food safety practices that aim to achieve minimal contamination of the chicken carcasses.

From our present study, a total of 160 chicken carcasses were sampled, representing individual carcasses which were obtained from the abattoir and the market. These were tested and analysed for the prevalence of *Salmonella* and *E.coli*.

The results in this current study have demonstrated that contamination levels with Total coliforms (TCC) and *E.coli* were prevalent across the investigated abattoirs and markets. TCC accounted for 80.6% while *E.coli* was at 71.3% further, the results indicated lower levels of *Salmonella* contamination at 1.3%. The results show that most of the samples were beyond tolerable limits with regards to the Australian and International commission on microbiological specifications for foods. The current findings are congruent with earlier findings by Shuaib et al., (2014) and Kabour, (2012) who found that *E.coli* was a major contaminant at all critical control points (CCP) than *Salmonella*, which was also the finding in this particular study. Chickens coming to the abattoirs for processing and those at the market are generally contaminated with bacteria especially those that are pathogenic such as Coliforms, *E.coli* and *Salmonella* (Goksoy et al., 2004). This may partially be attributed to the rearing system, especially the deep litter system, which allows the chicken droppings to be soaked within the deep litter system, thereby allowing for enteric microbial contamination to occur on the chickens. Isolation of TCC in this current study may include both pathogenic and non-pathogenic bacteria and this act as an index of hygienic quality (Nychas et al., 2007). In this study *Salmonella* species were only isolated at the abattoirs after evisceration and the results are in agreement with Kabour, (2012); Mohamed-Noor, (2012) and Shuaib, (2014) who also isolated *Salmonella* species only after evisceration. As already indicated, mostly chickens coming in abattoirs carry along different bacterial contaminates. The major source of these bacteria is mainly from the environments where these chickens are reared. Mostly there is a relationship between the environmental conditions and bacterial contamination especially in chicken rearing.

Lower estimates of *Salmonella* were characterized in this current study as indicated above (1.3%) compared to Hang'ombe et al., (1998) who equally did a study in Zambia and isolated a relatively high prevalence of 20.5%. The differences in prevalence rates can be attributed to differences in the sample size and techniques used between the two studies. The results from this current study further agree with the findings of Mohamed-Noor et al., (2012) who equally reported lower estimates of *Salmonella* in chicken carcasses. Lower prevalence estimates of *Salmonella* were also reported in other countries. *Salmonella* isolates were 4.2% in a study done by Zhao et al, (2001) in the United States of America, 14.5% was recorded by Maharjan et al., (2006) in Nepal, Nierop et al.,(2005) recorded 19% in South Africa and 44.4% was recorded by Shuaib et al., (2014) in Sudan.

According to Bajaj et al. (2003) extremely high prevalence rates of *Salmonella* in other studies were also recorded as high as 60%, 69% and 70% in Portugal. The variations in *Salmonella* prevalence is not well known, whether this is giving a true actual distribution across different countries or merely an artificial relationship resulting from sample size differences, characteristics of the slaughtered chickens, differences in sampling methods and the differences of abattoir processing plants.

Like *Salmonella, E.coli* was equally isolated in this study and emerged as the major contaminating bacterial compared to *Salmonella.* Other authors have documented variations in *E.coli* contamination levels and these were recorded in Asia India by Sharma and Chahopadhyay, (2015) with a prevalence of 34.5%: In Africa Sudan Shuaib et al., (2014) with a prevalence of 57.8%. The prevalence in this study is higher than the above recorded results. The observed high levels of *E.coli and* Coliforms in the present study could be as a result of contamination of carcasses during the process of evisceration and their passage though the scalding tanks. Generally there are more coliform bacteria that are discharged from intestinal tracts of poultry through faecal matter than *Salmonella* pathogens which are intermittently shed and also being known to have a higher affinity of being intracellular.

5.2. Comparative bacterial contamination of abattoir processed dressed chickens and market processed

The current study revealed significant difference ($p < 0.001$) between abattoir and the open market processed dressed chickens in terms of contamination levels. Overall higher contamination levels were recorded from open markets compared to abattoirs, this finding is contrary to the findings of (Adu-Gyamfi et al., 2015). Adu-Gyamfi and co-workers recorded no significant differences between TCC and *Staphylococcus* at the market and from established processing abattoirs. They attributed these findings to improved storage methods despite the prevailing general hygiene practices found at the markets. No *Salmonella* spp. were isolated at the market, these results are contrary to the finding of Sharma and Chahopadhyay, (2015), these authors managed to isolate *Salmonella* spp. at the market. As indicated by other writers *E.coli* was recorded to be the most prevalent bacteria in many studies and in this study the majority of *E.coli* was isolated at the market. None isolation of *Salmonella* spp. can be attributed to the differences in the shedding patterns of the two bacteria *Salmonella* and *E.coli*, as well as the fulminating nature of *E.coli*. *Salmonella* spp. is intermittently shed and *E.coli* is continually discharged in the intestinal tract making it the major bacteria present.

The differences in contamination levels in this current study can mainly be attributed to poor trading environments for the market traders, poor meat storage facilities and lack of training in food safety hygiene across the sampling strata. The other factor that may have influenced increased bacterial contamination at the market was that majority of dressed chickens from the market were coming from the farms as opposed, from the abattoirs. The hygienic status from farms including backyard chickens is not well known, the quality of the live birds influences the quality of the final product of the slaughtered chickens (Bhaisaire, 2014). These results are similar to the finding of Omorodion and Odu, (2012) who equally recorded different contamination levels by source of sample. Furthermore sampling at the markets was not done from homogenous dressed chickens as compared to abattoirs. This may have influenced the high contamination levels at the market than at the abattoir due to differences in the sampled birds. On the other hand the presence of *E.coli* in chickens is an indication of poor hygienic practices in the trading areas (Adesiji et al., 2011). The presence of *E.coli* is usually used as an indicator of faecal contamination arising mostly from human beings. Therefore, it is important during processing that good hygienic standard and food safety practices are up held to reduce contamination of the chicken carcasses especially the final product (Adesiji et al., 2011). Equally a significant difference in education levels between the two sites may also have contributed to isolating more bacterial contamination at the market. Education in most cases influences, how much one will appreciate the hygienic practices as compared to someone without a bases of education.

5.2.1. Differences of bacterial contamination levels between abattoir A and B

A variation of *E.coli* contamination was observed between the two abattoirs with abattoir A recording 25% and abattoir B 36.6% .These differences can be attributed to the environmental factors and the machinery used in the two abattoirs: abattoir A uses multistage scalding tanks which has been reported by others to have significant contribution in terms of bacteria reduction as compared to single scalding tanks being utilized by abattoir B (Zweifel et al 2014; Cason et al., 2000). Scalding water is changed on a daily basis for abattoir A and after a day for abattoir B. During scalding, massive cross-contamination takes place because each bird transfers bacteria to the scalding tank (Hinton et al., (2004). McNamara, (1997) reported that scalding tanks can reduce bacterial contamination if the water in the scalding tanks is continuously replaced with fresh water. These results are in agreement with what was observed in this study hence the difference in contamination levels with abattoir B yielding more *E.coli* because of not changing the scalding water frequently.

As reported by the key informants; Abattoir A utilized manual evisceration while Abattoir B utilized both manual and automated method and this can partly explain the differences in the contamination levels between the two abattoirs. Some studies done indicated that the use of automated evisceration machines reduces bacterial contamination because of reduced workers involvement on the dressed chicken (Chen et al., 2010). In contrast, Iroha and others (2011) reported otherwise that automated evisceration increases the surface contamination because the machine fails to fit to the natural size due to differences in carcass sizes. This results in the rapture of internal organs and liberation of faecal on the surface of the dressed chicken. Abattoir A had a manager who was trained in food safety and had worked in the abattoir for a relatively long period of time. These results are in line with a review done by (Egan et al., 2007). Egan and Co-workers observed in their study, that the presence of trained managers improved food safety procedures. The results were also in agreement with the report done by Griffith, (2010) who indicated that lack of trained managers and food handlers was a risk to having food borne illness.

In line with the same food safety training, the current study further revealed that all the food handlers 87(58.4%) in abattoir A , were trained in food safety as opposed to Abattoir B which had some food handlers not trained in food safety 62 (41.6%). As earlier indicated this brings in lapses in ensuring that chickens are of good quality. As indicated by Peyrat et al., (2014) generally, slaughter operational hygiene and quality managements are closely related with reduction in the overall contamination of the carcasses. Bhandare et al., (2009) found different results from this current study, their results indicated that food handlers working in the abattoirs in most cases especially in developing countries were untrained and paid no attention to the hygienic standards and as the result this contributed immensely to bacterial contamination thus this can explain the reasons of different contamination levels between the two sites because of differences in food safety training.

5.2.2. Differences of bacterial contamination levels between market A (inside) and B (outside) market

The study also revealed variations in terms of *E.coli* contamination between the market A and B with 33 (45.2 %) and 40 (54.8%) respectively. The study revealed that more *E.coli* was isolated from the market B as compared to market A at ($p < 0.006$). This difference in contamination levels could be attributed to increased exposure time to bacterial contaminates of dressed chickens in market B and mainly these dressed chickens are refrigerated at the end of sell day. Lusaka is a tropical city, with ambient temperatures conducive for growth of microorganism, which can render meat unsafe for human consumption once left unrefrigerated for a long time. Other writers emphasized the importance of the effectiveness of the refrigeration facilities in dressed chicken contamination (Adu-Gyamfi et al., 2015). On the other hand the chicken traders at market B start selling their dressed chickens in the morning through to the afternoon; this increases exposure time for bacterial multiplication. Some Traders at market B, start selling their dressed chickens from the inside market in the morning and later move to the outside market to continue selling. The movement involves packing the dressed chickens in different containers including buckets to transport to the outside stands. Mostly the vessels used are dirty and the dressed chickens are sometimes even put on sacks, on the floor without a table when selling. The above movements that take place may contribute immensely to increased presence of bacterial, due to unhygienic practices that are under taken. Similarly other authors have documented different contamination levels in relation to the location of the chicken traders Omorodion and Odu, (2016) .They attributed the differences in contamination levels because of busy roads and traffic of people in the trading areas.

5.3. Bacterial contamination after evisceration and carcass wash

The results from the study indicated that *E.coli* increased significantly at both abattoirs after the dressed chickens passed through the process line to the final product. This finding is similar to the results of Hue et al., (2010) who equally isolated more campylobacter on the surface at the final point than at cloaca after evisceration. Hue and others (2010) indicated the difference to be due to possible cross contamination at the abattoirs. They further indicated that good management and improvement of processing line and operations could reduce the contamination levels of the finished product.

High levels of *E.coli* contamination after dressed chicken wash, was as a result of slaughter dressing procedures and possible low hygienic practices in the abattoirs. Abattoir processing plants have many routes for cross-contamination among the many is the slaughter and dressing procedures in the process flow for chicken production at abattoir level (Hue et al., 2010).

The use of chlorine is recorded to be associated with reduction of bacterial contamination especially in food premises including abattoirs. Chlorine is among the approved chemical disinfectants mostly used in processing abattoirs (Rejab etal, 2012). This is because it possess a number of advantages as compared to other chemicals these are; it has the ability to kill bacteria, it controls saline and algae, enhances shelf life of most meat products including dressed chickens, it removes costly hand cleaning therefore reducing labour and materials involved, it is able to treat water for sterilization and treats chilling water/ plant washes (Seven Treat Services, 2002). Despite the advantages tabulated above, the current study results are indicating otherwise because both abattoirs were seen to be using chlorine. High levels of *E.coli* were still isolated after washing the chickens, indicating that the effect of chlorine was limited especially on the final product. This could partially be attributed to a number of factors such as, luck of approved machinery being used in the abattoirs and inadequate supervision of people in charge of dosing chlorine chemical to ensure right measurements are being used. The processes employed at the abattoirs should aim at reducing the bacterial load on the final product. Oyarzabal, (2005) indicated that effectiveness of disinfection depends on the volume of water, pressure and the level of chlorine in the water used for processing.

5.3.1 Bacterial contamination in relation to time of swabbing at open market

At the market majority of *E.coli* was isolated on the samples that were swabbed in the afternoon 40 (100.0%) ,which indicated that all the samples were contaminated as opposed to those sampled in the morning 33 (41.2%). This was statistically significant at (p = 0.006). The results above mainly may be due to increased exposure time of bacteria multiplication as compared to dressed chickens sold in the morning. Considering the fact that mostly dressed chickens at the market was reported to be refrigerated at the end of sell day as indicated from the Respondents. This may have an effect on observed increased bacterial contamination in the afternoon as compared to the morning. Cohen et al., (2007) recorded in their study, that bacterial contamination increased in the hot season as compared to cold season this observation is similar to the contamination pattern in this current study. Bacterial contamination increased mostly as the temperature rose. Bacteria growth patterns are determined by specific temperature range with some seasons or timings having more contamination than others depending on the seasonal pattern and temperature variation within the day.

5.3.2. Bacterial contamination in relation to origin of chickens

The study revealed different contamination levels depending on the origin of chickens and the results showed that more *E.coli* contamination were isolated from dressed chickens bought from the farms, inclusive of back yard poultry, which accounted for

107 (66.7%) as compared to abattoirs 10 (6.3%) and others. This was significant at (*p* <0.001). A study done by Goetz, (2013) linked the bacteria in processed chickens to contamination on the farms which supports the current finding of this study. In Most cases increased bacterial contamination is observed as chicken carcasses pass through the processing line to the final point. This is because of possible cross contamination during the process, which brings about increased bacterial load which was not present at the beginning of the process (Miettinen et al., 2001). In this study since the highest percentage of chickens were coming from the farms not abattoirs, indicating that due to under presentation of chickens from abattoirs a bigger portion of contaminated dressed chickens is likely to be found in the majority of the population sampled.

5.4. Risk factors identified to contribute to bacterial contamination at both abattoir and market level

5.4.1. Demographic factors at abattoir and market

At the abattoir, the minimum age of the abattoir operative was 19 years old with the maximum age of the abattoir operative being 54 years and the average was 30 years.
The results from this study are different from what was reported in Ghana by Adzitey et al., (2011) who found that 45% of the food handlers were in the age range of 41-50 years followed by 31-40 (23%), 51-60 (16%) and 21-30 (13%). From this study, at the markets, the minimum age was 17 years with the maximum being 57, whilst the average was 39 years old. Adzitey et al (2011) reported that the abattoir work is more dominated by the youth and middle aged workers who are more active, energetic because abattoir work demands much physical strength, which is congruent to our current findings.

In terms of education levels, more abattoir workers attained higher level of education in comparison to chicken traders at the market. This somewhat indicates the likelihood of bacterial contamination to be less among the abattoirs. This is because the higher level of education attained by the majority is likely to influence their day to day handling and processing of chickens. Thus, the degrees to which good hygiene practices are to be observed in abattoirs is likely to be high in food handlers as compared to chicken traders at the market. Other writers like Chipabika et al., (2015), found a relation between the education levels and hygienic practices among the food handlers. This is because the higher level of education attained by the majority is likely to influence their day to day handling and processing of chickens. Thus, the degrees to which good hygiene practices are to be observed in abattoirs is likely to be high in food handlers as compared to chicken traders at the market (Bhandare et al., 2009).

5.4.2. The risk factors of bacterial contamination identified at abattoir level

The risk factors that were identified to contribute to bacterial contamination were process through-put per day, washing hands with soap, lack of training in food safety, inspection and frequency of inspection. All these factors were significant at ($p < 0.05$). The results showed that the abattoir with a higher process through-put had higher likelihood of having contaminated chickens as compared to the abattoir with a lower process through-put per day, these results are in agreement with the finding of (Zweifel et al., 2014). The other factor was the use of soap when washing hands, other writers have confirmed the significance of washing hands with soap as opposed to not using soap or disinfectant (Chent et al ., 2010). It was indicated that over all, washing hands with cold water without chemical compounds like soap yields mainly redistributions rather than reductions of bacterial loads (Zweifel et al., 2014).

Training in food safety is important in terms of prevention of bacterial contamination, in this study about 87% of food handlers were trained in food safety, indicative of the likelihood of increased hygienic practices in abattoirs. The results are however, contrarily to Bhandare et al., (2009), who found that actually a number of food handlers not trained in food safety despite handling food. They indicated that lack of training in food safety had an effect on hygienic standards and as a result contributed immensely to bacterial contamination. Inspection and the frequency of inspection are important in ensuring that hygienic standards are maintained. In this study, majority (80%) of the food handlers indicated that their dressed chickens were being inspected and when asked about the frequency, about 74% indicated upon arrival and after processing. Buncic, (2014) revealed that ante-mortem inspection is important as it helps to identify visually unclean animals and also identifies animals that have clinical signs of zoonotic nature. On the other hand inspection can bring about change in policy as indicated by (FAO/WHO, 2009).

5.4.3. The risk factors of bacterial contamination identified at market level

Risk factors identified at the market level were chicken cleaning and distance from the water source these were significant at $p < 0.05$. Chicken cleaning is important in reference to bacterial contamination, from this study 63% indicated having washed their dressed chickens and 36.8% responded otherwise.

5.5. Risk factors associated with bacterial contamination at abattoir level

The major risk factor that was found to be significantly associated with bacterial contamination was the number of process through-put of chickens per day. This was significant at $p < 0.002$ under the adjusted model, the statistical analysis showed that as the number of process through-put increased the Odds of contamination also increased even after controlling for training, method of washing hands, inspection of dressed chickens and frequency of inspection. These results are in agreement with Hue et al.,(2010); Peyrat et al., (2008) ; Zweifel et al., (2014) who documented in their results that cleaning time reduces as the number of processed chickens increases. This is because processing plants run in more than one shift which later influences the quality of the final product. The study indicates that increased process through–put is a major risk factor in terms of dressed chicken contamination. Further the odds of bacterial contamination of weather one used soap or not indicated no difference in bacterial contamination by the odds ratio figure which was equal to one (1). The result in this study revealed no difference in bacterial contamination in terms of use of soap.

Washing hands with soap or not did not play a role in bacterial contamination, after adjusting for process through-put. Other studies reported contrary to the finding of this study, authors like Chent and others (2010) documented, washing hands with soap or disinfectant was directly related to bacterial contamination in processing abattoirs. In this study, the effect of use of soap was no longer effective to be associated with bacterial contamination especially in abattoirs with a higher process through-put.

5.5.1. Risk factors associated with bacterial contamination at market level

For the market the major risk factor that was found to be significantly associated with bacterial contamination was the distance from the water source. This was significant at $p < 0.045$ under the adjusted model, the statistical analysis showed that as the distance from the water source increased the Odds of contamination remained significant even after controlling for source of chickens. The finding of this study can mainly be attributed to the fact that the stalls that had source of water far, where mainly using communal buckets for cleaning the dressed chickens including other meat products. Further the water used for cleaning the dressed chickens was kept for a long period of time without being changed. In an event where the trader was selling other meat products, no separation was done when cleaning different meat products thus increasing the bacterial load on the final product. The other observation was the use of disinfectants generally at the market was very limited. This in a way may influence increased high cross contamination from utensils or instruments used on dressed chickens. Rinsing the utensils or instruments with water only is not adequate without sterilization. Studies have shown that most pathogens are able to survive in water, in aerosols and on equipment (Figueroa *et al.*, 2009). Adentunji and Awosanya (2011) also reported that portable water was an essential requirement in quality assurances of meat produced at trading areas. Mainly if the water being used is clean, the chances of having uncontaminated dressed chicken are high because as earlier mentioned the quality of the processed chickens is highly dependent on the quality of water used.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The results show evidence of plausible bacterial contamination at both abattoirs and market level. It can be concluded that the prevalence established in this study is similar to what other authors found including a study done in Zambia by (Hang'ombe et al., 1998). The risk factors were identified and the significant predictors found were process through- put per day for the abattoirs and for the market the distance from the water source.

These findings are worrying because of the ability of these contaminates to cause diseases. Implementation of Hazard Analysis at Critical Control Points (HACCP) in chicken abattoirs is very important at all times especially abattoirs with high process through-put per day because it involves continuous monitoring of the processing system. On the other hand, the water source at the market should be kept clean to avoid cross contamination of bacteria in dressed chicken. Another major aspect which was observed was the lack of quality control monitors (inspectors), from government regulatory bodies.

6.2. Recommendations

The following recommendations are directed to; Central government, Local Authority, Abattoir management and the consumers of chicken and poultry products:

A. Central government

1. The Ministry of Livestock and Fisheries should ensure that poultry farmers are trained in poultry management in order to reduce contamination of dressed chicken from the farms. This is because chickens that are

contaminated at source are believed to carry along the same bacteria through to the final point

B. Local Authority

1. In the desire to reduce chicken contamination at the retail trading markets, the local authority should ensure that dressed chickens are not cleaned from communal containers.

2. The local authorities should ensure that all operating abattoirs use multistage scalding tanks to reduce contamination of the final product as opposed to use of single scalding tanks.
3. There an urgent need for quality control officers from local authorities to regularly visit food establishments in order to ensure quality control is in place.

C. Abattoir Management

1. Managers of abattoirs during poultry processing should ensure that scalding water is changed frequently as opposed to changing it after a day's work, as this may result into being the main source of bacterial contamination of the final product.
2. Management of abattoirs should ensure that poultry processing does not take place in absence of adequate disinfectants.

D. Consumers

The consumers should ensure that dressed chickens in the refrigerator are stored in the right compartment away from ready to eat foods to avoid cross contamination of *E.coli* bacteria as a result of thawing due to malfunctioning of the refrigerator or electrical fault.

E. Areas for further studies

1. Further studies should be done to serotype specific bacterial isolates. Thus because bacteria that were isolated have the ability to cause food borne illnesses, it is important to determine antibiotic resistance for isolated bacteria.
2. In this study swabs were only collected from the dressed chickens excluding; instruments, scalding water or hands of workers that could have increased the risk factors that could have contributed to bacterial contamination therefore another study be conducted that will include these predictors.

6.3. Limitation and strength of the study

The findings of this study will help inform policy in the intervention measures to address bacterial contamination in dressed chickens. In addition, the study findings has helped to bring out the bacterial prevalence which may be useful for academic purpose as well as in national planning

- This was a cross-sectional study and was only able to measure proportions of bacteria at one point in time and difficult to determine whether the outcome followed exposure in time or exposure resulted from the outcome.
- The study only focused on two bacterial contaminations even if many other bacterial contaminations could have been isolated, this limits the knowledge of different bacterial prevalence found in dressed chickens.
- Serotyping was not done making it difficult to know the specific strains of bacteria isolated.

- In this study swabs were only collected from the dressed chickens not on instruments or hands of workers that could have increased the risk factors that may contribute to bacterial contamination.

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LIST OF APPENDICES

Appendix: A

Variable and indicator scale of measurement

	Variable	**Indicator**	**Scale of Measurements**
Dependant Variable	Level of bacterial contamination in commercially dressed chickens	Bacterial count of colonies in dressed chicken samples	Satisfactory Unsatisfactory
Independent Variables	Poultry environment	Evidence of a clean environment	Present = 1 Not present =0
	Soiled hands and utensils	Evidence of washing hands and disinfection of utensils	Available = 1 Not Available = 0
	Water supply	Availability of water	Yes = 1 No = 0
	Toilets available	Evidence of adequate number of toilets	Available = 1 Not Available = 0
	HACCP application	Evidence of HACCP application in the process	Available = 1 Not Available = 0
	Food safety inspections	Evidence of the reports	Present = 1

			Absent = 0
	Food safety training	Evidence of certificates of training	Present =1 Absent =0
	Food handlers certificates	Evidence of food handlers certificates	Available = 1 Not Available =0
	Food safety policy	Evidence of food safety policy	Available =1 Not Available =0

Appendix: B

QUESTIONNAIRE FOR CHICKEN TRADERS

INTRODUCTIONS

Please tick or fill in the blank space of your choice.

SECTION A

SOCIAL DEMOGRAPHICS

1. Gender 1.Female [ ]

2. Male [ ]

2. Age at last birthday ___________

3. Level of education

1. Never attended school [ ]
2. Primary [ ]
3. Secondary [ ]
4. Tertiary [ ]

SECTION B

GENERAL INFORMATION

4. How long have you been doing this kind of business?

1. 1 Month to 6 months [ ]
2. 6 Months to 12Months [ ]
3.12 months to 18 Months [ ]
4.18 Months and above [ ]

5. Where do you buy your chickens?

1. Abattoir [ ]
2. Local chicken sellers from the market [ ]
3. from the farms
4. Others specify …………………………………………………………… [ ]

6. Why do you buy the chickens from the named source above?

   1. Cost [ ]
   2. Convenient [ ]
   3. Others specify ……………………………………………………….. [ ]

7. Do you buy already dressed chickens?

   1. YES [ ] ***if yes proceed to question 9***
   2. NO [ ]

8. If not where do you dress them from?

   1. Home [ ]
   2. At the market [ ]
   3. Others specify ……………………………………………….. [ ]

9. How do you transport the dressed chickens?

   1. Using a vehicle with a cold chain [ ]
   2. Wheelbarrow [ ]
   3. Using an ordinary vehicle [ ]
   4. Others specify ………………………………………………………… [ ]

10. How many chickens do you sell in a day?

   1. 1 Bird to 10 Birds [ ]
   2. 11 Birds to 20 Birds [ ]
   3. 21 Birds to 30 Birds [ ]
   4. 31 Birds to 40 Birds [ ]
   5. 50 Birds and above [ ]

11. When do you have the most sells?

   1. Morning

      Specify time……………………………………………………………

   2. Afternoon

      Specify time ……………………………………………………..

   3. Evening

Specify time………………………………………………………… [ ]

HYGIENE PRACTICES

12. Do you wash your chickens before selling?

1. YES [ ]
2. NO [ ]

13. If no why is it that you don't wash the dressed chickens?

1. We sell them immediately after plucking [ ]
2. Lack of enough water [ ]
3. There is no need of washing the chickens [ ]
4. Others specify………………………………… [ ]

14. If you do, where do you wash the dressed chickens?

1. Using the buckets [ ]
2. In the sinks provided [ ]
3. Others specify………………………………………… [ ]

15. Do you refrigerate your chickens?

1. YES [ ]
2. NO [ ]

If no, go to question 19

16. If you do, how do you refrigerate them

1. In ice buckets [ ]
3. In cooler boxes [ ]
4. In public cold rooms [ ]
5. Others specify ………………………………………………. [ ]

17. When do you refrigerate the chickens?

1. Immediately after plucking [ ]
2. After end of sale day [ ]
3. Others specify ……………………………………………………… [ ]

18. Do you feel that what you use to refrigerate is adequate?

1. YES [ ]

2. NO [ ]

19. Why is it that you do not refrigerate your chickens?

1. The chickens finish before the end of the day [ ]

2. There is no need of refrigerating them [ ]

3. Inadequate space for refrigeration [ ]

4. Others specify………………………………………………………… [ ]

20. Do you wash your hands before handling, dressed chickens?

1. YES [ ]

2. NO [ ] If no, go to question 23

21. Where do you wash your hands from?

1. In the buckets [ ]

2. Tap [ ]

3. Containers [ ]

22. What do you use when washing hands?

1. Soap [ ]

2. No soap [ ]

23. How often do you wash your hands?

1. Each time the hands are dirty [ ]

2. Before handling the chickens [ ]

3. After the end of the sells [ ]

24. Is it necessary for you to wash your hands before handling the chickens?

1. YES

2. NO

25. If yes, why is it necessary?

1. To prevent spreading of infections

2. To prevent cross contamination

3. To promote food hygiene

26. If no, why is it not necessary?

1. Lack of enough water [ ]
2. We use gloves when handling the chickens [ ]
3. No time to wash the hands before of demand [ ]

27. Do you know if you can prevent any diseases by washing your hands?

1. YES [ ]
2. NO [ ]

28. If yes, what diseases can one prevent?

1. Cholera [ ]
2. Diarrhoea [ ]
3. Typhoid [ ]
4. Others specify ……………………………[ ]

WATER SUPPLY AND WASTE MANAGEMENT

29. How far is your source of water? (For washing dressed chickens)

1. Not far [ ]
2. Within the business premises [ ]
3. Far [ ]

30. Do you have interruptions in the supply of water?

1. Yes [ ]
2. No [ ]

31. I f yes, how often do you experience this?

1. Everyday [ ]

2. After a mouth [ ]

3. Others specify ………………………………………………….[ ]

32. Where do you throw waste coming from your stand? (Dressed chickens)

1. Pit [ ]

2. The company comes to pick the waste [ ]

3. Others specify ……………………………………….. [ ]

33. Why have you picked on the option above?

1, that's what is available [ ]

2. It's cheap [ ]

3. Others specify …………………………………………….. [ ]

34. Are you satisfied with how waste is being deposed?

1. YES [ ]

2. NO [ ]

35. If no, give a reason?

1. The waste is kept for a long period before being disposed [ ]

2. The location of disposal site is not ideal [ ]

3. it's expensive to pay for the service [ ]

4. The bins provided are not adequate [ ]

36. If yes, give a reason?

1. The waste is disposed within the shorted period of time [ ]

2. The location of disposal site is ideal [ ]

3. it's affordable to pay for the service [ ]

4. The bins provided are adequate [ ]

HEALTH KNOWLEDGE AND TRAINING

37. Have you ever been trained on how to keep the chickens safe for people to eat?

1. YES

2. NO

38. If you have, where did you get this training?

1. From the people who supply chickens [ ]

2. I took my self for training [ ]

3. Others specify ………………………………………….. [ ]

39. Do you feel it is necessary for you to be trained on how to handle chickens?

1. YES [ ]

2. NO [ ]

40. Do you know of any diseases that can be as a result of eating chicken that has not been handled properly?

1. YES [ ]

2. NO [ ]

41. Do you know of anything that can be done to prevent the spread of these diseases?

1. YES [ ]

2. NO [ ]

42. Do you know of anyone who got sick because of eating chicken that was not good?

1. YES [ ]

2. NO [ ]

43. In this market, are there people who have complained about being sold chickens that are not good?

1. YES [ ]

2. NO [ ]

44. Do Health inspectors come to teach you on what to do when handling chicken?

1. Yes [ ]

2. No [ ]

If no, proceed to question 44

45. If yes, to the above answer how often do they come?

1. Every day [ ]
2. Once every week [ ]
3. Others specify ………………………………………………… [ ]

46. Do you know of anything that you should wear when handling chicken?

1. YES [ ]
2. NO [ ]

47. If you do, what should one wear when handling chicken?

1. Apron [ ]
2. Hair nets [ ]
3. Boots [ ]
4. Others specify……………………………… [ ]

48. Do you feel it is necessary to wear anything?

1. YES [ ]
2. NO [ ]

49. Why do you think it's important to have protective clothing?

1. To prevent cross-contamination [ ]
2. It promotes hygiene [ ]
3. It attracts customers [ ]
4. Others specify [ ]

INSPECTION OF CHICKENS

50. Are your dressed chickens inspected?

1. Yes [ ]
2. No [ ]

If no, proceed to question 53

51. If yes, who inspects them?

1. Inspectors from the local authority [ ]
2. Local inspectors [ ]
3. Private inspectors [ ]
4. Others specify …………………………………………… [ ]

. How often are they inspected?

1. Every day [ ],
2. Once every week [ ],
3. Never [ ]
4. Others Specify ………………………………………………………….. [ ]

CHALLENGES AND RECOMMENDATIONS

49. Are there any challenges that you face in this business?

1. The power cuts which is affecting the storage of the chickens [ ]
2. The trading surrounding is usually dirty [ ]
3. Shortage of chickens because of high demand [ ]
4. The bins are not adequate [ ]

50. What could be your recommendations to the above challenges?

1. The power cuts should be reduced [ ]
2. More works should be employed to ensure that the surrounding should be clean [ ]
3. To provide training to chicken traders [ ]
4. More chicken production to be promoted [ ]
5. More bin to be provided [ ]

1.Completed		
2.Partially done		
3.Not done at all		

Thank you

End of questions

Appendix: C

QUESTIONNAIRE FOR FOOD HANDLERS

INTRODUCTIONS

Please tick or fill in the blank space of your choice.

SECTION A

SOCIAL DEMOGRAPHICS

1. Gender

   1. Female [ ]
   2. Male [ ]

2. Age at last birthday _______________

3. Level of education

   1. Never attended school [ ]
   2. Primary [ ]
   3. Secondary [ ]
   4. Tertiary [ ]

SECTION B

GENERAL INFORMATION

4. How long have you been working in this abattoir?

   1. 1 Month to 6 months [ ]
   2. 6 Months to 12Months [ ]
   3. 12 Months to 18 Months [ ]
   4. 18 Months and above [ ]

5. How many chickens do you process in a day

   6. 10000 Birds to 15000 Birds
   7. 15000 Birds and above

6. When do you process more chickens?

   1. Morning

      Specify time……………………………………………………………

2. Afternoon

Specify time …………………………………………………………..

3. Evening

Specify time………………………………………………………

HYGIENE PRACTICES

7. Do you clean your chickens?
   1. Yes
   2. No
8. How do you clean your chickens?
   1. Using chlorinated water in the Spin Chiller [ ]
   2. Using cold water [ ]
   3. Using hot water [ ]
9. What type of instruments do you use when processing the chickens?
   1. Knives
   2. Cutters

   3 Shoves

   3. Spin chillers
   4. Others
10. Do you feel that the instruments you have are adequate?
    1. Yes [ ]
    2. No [ ]
11. Do you sterilize your instruments?
    1. Yes [ ]
    2. No [ ]
12. If yes, what methods do you use to sterilize the instruments?

    1. Using water [ ]

    2. Using Hot water [ ]

    3. Using Chlorine [ ]

4. Using Disinfectants [ ]

13. If no, why don't you sterilize?

1. We don't know that we need to sterilize the instruments [ ]
2. No provision of sterilizing equipment [ ]
3. Others specify………………………………………………………….[ ]

14. Do you think that the method you are using for sterilization is adequate?

1. Yes [ ]
2. No [ ]

15. If no, why is it that it's not adequate?

1. The instruments are not adequate [ ]
2. There is no need of sterilization [ ]
3. No adequate time to sterilize [ ]
4. Others specify …………………………………… [ ]

16. How do you ensure to prevent poultry cross-contamination?

1. Not moving from the Dirty to clean areas [ ]
2. Using different color codes for different departments [ ]
3. Washing hands before and after leaving the plant [ ]
4. Others Specify………………………………………………………… [ ]

17. Do you refrigerate your chickens?

1. Yes [ ]
2. No [ ]

If no, proceed to question 22.

18. What refrigeration facilities do you use?

1. Cold rooms [ ]
2. Blasting freezers [ ]
3. Holding freezers [ ]
4. Carrier containers [ ]

19. When do you refrigerate the chickens?

1. Immediately after plucking [ ]

2. After end of processing [ ]

3. Others specify ……………………………………………………… [ ]

20. How long do you refrigerate them?

1. Until they are frozen [ ]

2. Overnight [ ]

3. Till they are dispatched [ ]

21. Do you feel that what you use to refrigerate is adequate?

1. Yes [ ]

2. No [ ]

22. If you don't refrigerate, why don't you do so

1. All the chickens are dispatched immediately after processing [ ]

2. No refrigeration facilities provided [ ]

3. The refrigeration facilities are not adequate [ ]

4. Others specify…………………………………….[ ]

23. Do you check for the general cleanliness in the processing areas of the abattoir before and after operation?

1. Yes [ ]

2. No [ ]

24. If yes, who is in charge of checking?

1. Quality controller

2. Supervisor

3. Others specify………………………………………..[ ]

25. Do you have people in charge of temperature regulation?

1. Yes [ ]

2. No [ ]

26. Do you happen to know the recommended temperature required in the processing area?

1. Yes [ ]

2. No [ ]

27. Is it necessary for you to wash your hands before handling the chickens?

1. Yes [ ]
2. No [ ]

28. Do you know if you can prevent any diseases by washing your hands?

1. Yes [ ]
2. No [ ]

29. If yes, what diseases can one prevent?

1. Diarrhoea [ ]
2. Cholera [ ]
3. Typhoid [ ]
4. Others specify…………………………………………………………… [ ]

30. Where do you wash your hands from?

1. Tap [ ]
2. Bucket [ ]
3. Others specify………………………………..[ ]

31. What do you use when washing your hands?

1. Soap [ ]
2. N o soap [ ]

32. How often to you wash your hands

1. Each time the hands are dirty [ ]
2. When coming inside the plant [ ]
3. Before handling the chickens [ ]

WATER SUPPLY AND WASTE MANAGEMENT

33. Where do you normally draw the water you use in this abattoir? (Dressed chickens)

1. Tap [ ]
2. Borehole [ ]
3. Others specify…………………………………………………….. [ ]

34. Do you have interruptions in the supply of water?

1. Yes [ ]
2. No [ ]

35. If yes, how often to you experience this?

1. Everyday [ ]
2. After a mouth [ ]
3. Others specify …………………………………………………….[ ]

36. Where to you throw the waste in this abattoir including waste coming from chickens?

1. Pit [ ]
2. The company comes to pick the waste [ ]
3. Others specify ………………………………………..[ ]

37. Why have you picked on the option above?

1, that's what is available [ ]
2. It is cheap [ ]
3. Others specify …………………………………………….. [ ]

38. Are you satisfied with how waste is being deposed?

1. Yes [ ]
2. No [ ]

39. If no, give a reason

1. Waste is not picked on time [ ]
2. The Disposal site is not ideal [ ]
3. No provision of bins [ ]

40. If yes, give a reason

1. The waste is disposed within the shortest period [ ]
2. The bins provided are adequate [ ]
3. The disposal site is ideal [ ]

<u>HEALTH KNOWLEDGE AND TRAINING</u>

41. Have you ever been trained on how to keep the chicken safe for people to eat?

1. Yes [ ]
2. No *proceed to question 43* [ ]

42. If you have, where did you get this training?

1. In house Training [ ]
2. Outside training [ ]

43. Do you feel it is necessary for you to be trained on how to handle chickens?

1. Yes [ ]
2. No [ ]

44. Do you know of anyone who got sick because of eating chicken that was not good?

1. Yes [ ]
2. No [ ]

45. In this abattoir are there people who have complained about buying chicken that is not good for people to eat?

1. Yes [ ]
2. No [ ]

46. Do Health inspectors come to teach you on what to do when handling chicken?

1. Yes [ ]
2. No [ ]

If no. proceed to question 48

47. If yes, to the above answer how often do they come?

1. Every day [ ]
2. Once every week [ ]
3. Others and specify ……………………………………………………… [ ]

48. Do you know of what you should wear when handling chicken?

1. Yes [ ]
2. No [ ]

49. Do you have any protective clothes you wear before handling the dressed chicken?

1. Yes [ ]

2. No [ ]

50. If yes, what kind of protective clothing do you have?

1. Aprons

2. Head gears

3. Gloves

4. Boots

5. Others

51. Why do you think it's important to have protective clothing?

1. To prevent contaminations [ ]

2. To prevent dirty getting to the personal clothing [ ]

3. To prevent foreign item from getting to the chicken [ ]

4. Others specify ………………………………………….. [ ]

INSPECTION OF CHICKENS

52. Are your dressed chickens inspected?

1. Yes [ ]

2. No [ ]

If no, proceed to question 55.

53. If yes, who inspects them?

1. Inspectors from the local authority [ ]

2. Local inspectors [ ]

3. Private inspectors [ ]

4. Others specify ……………………………………………… [ ]

54. How often are they inspected?

1. Upon arrival [ ],

2. Upon arrival and after processing [ ],

3. Others Specify ……………………………………………………………….. [ ]

55. Why are they not inspected?

1. It is expensive to hire inspectors [ ]

2. No internal inspectors [ ]

3. It is not necessary to have inspectors [ ]

CHALLENGES AND RECOMMENDATIONS

56. What challenges do you face in terms of chicken hygiene?

1. The method of disposal is not ideal [ ]

2. Power cuts which affects the cold chain [ ]

3. Not having adequate disinfectants in the plant [ ]

4. Others specify………………………………………………………………… [ ]

57. What could be your recommendations from the above challenges?

1. Hiring a company that has adequate services [ ]
2. The company to have alternative power sources [ ]
3. The company to train their staffs all the time [ ]

1.Completed		
2.Partially done		
3.Not done at all		

End of questions

Thank you.

Appendix: D

Questionnaire for Member of Staff

QUESTIONNAIRE

INTRODUCTIONS

Please tick or fill in the blank space of your choice where appropriate.

SECTION A:

1. Gender

    1. Female [ ]

    2. Male [ ]

2. Age at last birthday ………………………….

3. Level of education

    1. Never attended school [ ]

    2. Primary [ ]

    3. Secondary [ ]

    4. Tertiary [ ]

SECTION B:

4. How long have you been working in this abattoir? ....

5. Where do you buy your chickens from?

    1. Outgrow [ ]

    2. You grow your own [ ]

    3. Others specify ………………………………………………………… [ ]

6. Why do you buy the chickens from the named source above?

    1. Cost [ ]

    2. Convenient [ ]

    3. Others specify ……………………………………………………….. [ ]

7. What method do you use when processing your chickens?

1. Automated [   ]

2. Manually [   ]

8. Are your workers trained in food safety?

1. Yes [   ] ***if yes proceed to question 10***

2. No [   ]

9. If no, why give reasons?

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

10. If yes, how many workers are trained in food safety?

Specify number: ……………………………

11. Do your food handlers go for medical checkups?

1. Yes [   ]

2. No [   ]

12. If yes, how often do they go for these checkups?

1. Once in a year [   ]

2. Twice in a year [   ]

3. Others [   ]

13. If no, why give reasons?

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

SECTION C:

QUALITY CONTROL

14. How do you ensure that the dressed chickens in this abattoir are of good quality?

…..……………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

15. If you do, what quality control system is in place?

1. Internal laboratory [ ]
2. External laboratory [ ]
3. External inspectors [ ]

16. If no why don't you have?

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

17. What is the scalding temperature? ....

18. How often do you change the scalding water? ……………………………

19. How long is your scalding process? ……………………………………

20. How long does it take for the chicken to be done? ………………………………

21. Are your chickens inspected when they are bought to the abattoir?

…………………………………………………………………………………………

22. Do you perform ante mortem inspection before the chickens are slaughtered?

………………………………………………………………………………………..

23. Do you have brought in dead chicken carcasses?

1. Yes [ ]

2. No [ ]

24. If yes to the above answer how do you treat them?

1. Give the workers [ ]
2. Sell them off [ ]
3. Sell them for animal feed [ ]
4. Dispose them [ ]
5. Others specify ……………………………………………………………. [ ]

25. Are your dressed chickens inspected?

1. Yes [ ]
2. No [ ]

26. If yes, how often are the dressed chickens inspected?

1. Immediately after dressing [ ]
2. At the end of the day [ ]
3. Others specify ……………………………………………………………[ ]

WATERSUPPLY AND WASTE MANAGEMENT

27. What is the main source of water in this abattoir?

1. Borehole [ ]
2. Tap water [ ]
3. Protected well [ ]
4. Others ……………………………………………………. [ ]

28. Where do you discard the waste from the dressed chickens?

1. Oxidation pond [ ]
2. Pit [ ]
3. Incineration [ ]
4. Private company collects the waste [ ]
5. Others specify …………………………………………………………… [ ]

29. Give a reason(s) for the above answer?

1. That's what is available [ ]
2. Its Cheap [ ]
3. it’s the best method of disposal [ ]

4. Others specify ………………………………………………………. [   ]

SECTION D:

30. Do you clean the abattoir?

1. YES [   ]

2. NO [   ]

31. What time do you clean this abattoir?

1. Morning

Specify time…………………………………………………………

2. Afternoon

Specify time ……………………………………………………..

3. Evening

Specify time……………………………………………………

4. Others specify ……………………………………………………….

32. Do you check for the general cleanliness in the processing areas of the abattoir before and after operation?

1. YES [   ]

2. NO [   ]

33. Are there any challenges that you face in this business?

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

34. What could be your recommendations from the above challenges?

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

1.Completed		
2.Partially done		
3.Not done at all		

End of questions

Thank you.

Appendix: E

Checklist for Physical Observation

Name of the Abattoir: …………………………………………………………………..…

District/(code) : …………………………………………………………………………..

Date of Observation: ………………………………………………………………………..

Name of Observer: …………………………………………………………………………..

Particulars	Comments
1. Solid waste storage bins a) No. of bins present inside the abattoir	
b) No. of bins present outside the abattoir	
2. Medical Certificates a) No. of Food Handlers with valid Medical Certificates	
b) No. of Food Handlers without Medical Certificates c) Evidence of the medical certificate	
3.Presence of animal movement permits (inclusive poultry)	
4. Abattoir Design a) Wind direction	
b) Condition of the structure (good or bad)	
c) Location in relation to other developments	
d) Flow chart from receiving bay to package	
e) Presence of scavengers (both human & animals)	
5. HACCP Application (YES_/_NO) a) Free movement of workers from dirt to clean side	
b) Evidence of sterilization/disinfection of contaminated utensils	
c) Temperature reading before packaging	
d) Food handlers wearing personal protective clothes (PPC) e) State of the protective clothes (good or bad)	

f) Colour coded Worker separation [clean_from_Dirty sections]	
g) Evidence of separation from CCP	
h) Presence of a change rooms in relation to sex distribution i) Condition of the change room (good or bad)	
6. Presence of lockers (lockable or non- lockable)	
7. Valid Trading licenses [fire, inspection, occupancy etc]	
7. Presence of refuse disposal	
8. Sanitary facilities a) Type of Toilets [Separate for Clean & Dirty workers]	
b) The number of toilets in relation to sex	
c) The condition of the toilets	
d) Urinals present	
e) The condition of the urinals	
f) Wash hand basins (WHB)	
g) The condition of the WHB	
Quality control system	
a) Availability of safe water supply (cold and hot) b) Evidence of the report (results from the lab)	
c) Availability of Soap/Sanitizers	
d) Availability of disinfectant	

Comments and observation

Appendix: F

Checklist for Physical Observation

Name of the Market: …………………………………………………………..…

District/(code) : ……………………………………………………………………..

Date of Observation: ………………………………………………………………..

Name of Observer: …………………………………………………………………..

Particulars	Comments
2. Solid waste storage bins c) No. of bins present inside the market	
d) No. of bins present outside the market	
2. Medical Certificates d) No. of marketers with valid Medical Certificates	
e) No. of marketers without Medical Certificates f) Evidence of the medical Certificates	
3.Presence of animal movement permits (inclusive poultry)	
4. Location of the stands j) Wind direction	
k) Condition of the structure (good or bad)	
l) Location in relation to the disposal site	
m) Location in relation to the main road	
n) Location in relation to other developmental projects	
5. HACCP Application (YES_/_NO) o) One person handling the chicken through to final package	
p) Evidence of sterilization/disinfection of contaminated utensils	
q) Type of packaging used on the dressed chicken (clean or dirty)	
r) Marketers wearing personal protective clothes (PPC)	

s) State of the (PPC) (good or bad)	
t) Condition of the trading area	
u) Evidence of separation from dirty to clean (not raising in the same basin)	
v) Presence of cold storage facilities (fridge) w) Condition of the cold storage (good or bad)	
6. Valid Trading licenses [fire, inspection, occupancy etc]	
7. Presence of refuse disposal	
8. Sanitary facilities h) Type of Toilets	
i) The number of toilets in relation to sex	
j) The condition of the toilets	
k) Urinals present	
l) The condition of the urinals	
m) Wash hand basins (WHB)	
n) The condition of the WHB	
Quality control system	
e) Availability of Water (cold and hot)	
f) Availability of Soap/Sanitizers	
g) Availability of disinfectant	

Comments and observation

Appendix: G

Appendix: H