

**ASSESSMENT OF MEAT PRESERVATION PRACTICES BY MEAT RETAIL  
STORES AND ESTIMATION OF LOSSES DUE TO SPOILAGE IN  
DAGORETTI SUB-COUNTY, NAIROBI KENYA**


**A THESIS SUBMITTED IN PARTIAL FULFILMENT OF REQUIREMENTS  
FOR MASTERS DEGREE OF UNIVERSITY OF NAIROBI**

**NADIA JAMES KILLA MAJAK, MSC  
DEPARTMENT OF PUBLIC HEALTH, PHARMACOLOGY AND  
TOXICOLOGY**

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## DECLARATION

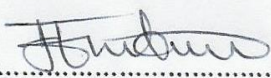
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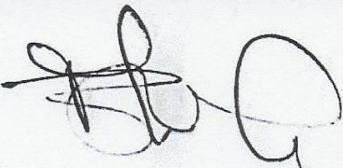
Dr. Nadia James Killa Majak

### Supervisor Approval

This thesis has been submitted for examination with our approval as University supervisors

Sign.......... Date.....23/01/2023.....

Prof. Jackson Ombui (BVM, MSc, PhD)

Sign.......... Date.....24/01/2023.....

Dr. Peter Gathura (BVM, MSc, PhD)

## **DEDICATION**

I dedicate this thesis to my daughters Sasha , Misha my niece Sarah . This one is for you, from me, your loving mother.

To my mother Zenab Ibrahim, Hon Deng Goc , my sister Dr Ghada James and my brothers for their love, encouragement and continuous support in my academic undertaking.

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My recognition further extends to any of those who have aided me in some way during the course of the venture; please accept my sincerest thanks. Notwithstanding, I am solely accountable for the opinions reflected in this Thesis.

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## **LIST OF ABBREVIATIONS**

ASAL	Arid and Semi-Arid Lands
CBK	Central Bank of Kenya
CDC	Center for Disease Control and Prevention
FAO	Food and Agriculture Organization
GDP	Growth Domestic Product
KAP	Knowledge, Attitude and Practices
KMT	Kenya Meat Trust
KNBS	Kenya National Bureau of Statistics
UN	United Nation
USD	United States Dollar
UV	Ultra Violet
WHO	World Health Organization

## ABSTRACT

Meat spoilage significantly reduces the quality of meat consumed as well as revenue generated from the meat industry. Research has demonstrated that the agents of spoilage are attributed mostly to microbial contamination during slaughter, transportation and retail of meat. The aim of this study was to assess the meat preservation practices by meat retail stores and the knowledge attitude and practices of meat handlers as well as estimate losses due to spoilage in Dagoretti sub-county of Nairobi County, Kenya. A crosswise analysis was completed in 87 butcher shops and 9 groceries from lower and middle income districts of the subdivision based on their varied economic spot through a systematized sampling model. The study used a structured questionnaire to collect the information from selected facilities. Data was analyzed using descriptive statistics to determine proportion of operators undertaking various activities. A chi-square test was used to establish the significance of association between operators meat handling practices and their demographic characteristics, knowledge, and attitude. A correlation analysis was used to estimate the strength of relationship between factors.

The study revealed that meat retail outlets including butcheries and supermarkets I. Dagoretti Nairobi sell mainly raw meat of various animal species, 73% of meat business operators used refrigeration methods for storing meat, and 27% kept the meat by hanging at room temperatures. The main reason for not using refrigeration facilities was high cost of electricity, customer's preference of non-refrigerated meat, as well as high cost of electricity, customer's preference of non-refrigerated meat, as well as high cost of deep freezers. Two thirds (67%) of the butcheries in Dagoretti sub-county observed and implemented public health hygiene protocols on meat handling including regular hand washing and equipment cleaning, premise hygiene and use of

protective gear. The majority (60%) of the meat handlers had the basic training on meat safety and hygiene and were aware of some risk factors of meat contamination. They were also able to associate diseases with meat consumption and had some knowledge of what was required to prevent meat spoilage as well as maintain clean working environment. Eighty two percent of operators were of the opinion that safe meat handling was an important responsibility that should be adhered to at all times, as required by the public health authority. About 31% did not have washing facilities, while 5% indicated that they do not wash their hands before handling meat. Retail stores lost meat estimated at USD 5.0 per week. The losses were mainly due to moisture loss (49%) and microbial spoilage (22%) which was blamed on poor storage and meat handling practices. Major challenges faced by meat retailers include fly menace and unreliable electricity supply. The study concluded that majority of meat business operators use refrigerators to preserve meat. Operators had good meat safety knowledge and appropriate attitude and they observed to a larger extent the recommended public health protocols. The study recommended that the County Department of Public Health need to conduct regular spot checks in order to enforce compliance with meat hygiene regulations by all operators. Further, the operators are encouraged to acquire refrigeration facilities for meat preservation and standby power generators to provide constant electricity in the event of blackouts. Business operators should also be encouraged to undertake regular food safety training courses to upgrade their own knowledge on aspects of meat hygiene, and preservation, and how to prevent moisture loss.

## CHAPTER ONE: INTRODUCTION

### 1.1 Background

Agriculture assumes a fundamental job in Kenya's money related structure amounting to 20 percent of the Gross Domestic Product (Central Bank of Kenya, 2022). The computed quantity of domesticated animals in Kenya is purported to be 17.5 million cattle, 19.3 million sheep, 28 million goats and 4.64 million camels (Kenya National Bureau of Statistics, 2020). Approximately 60% of this livestock population is found in the arid and semi-arid lands (ASALs). Livestock rearing therefore remain one of the most crucial socio-economic activity in Kenya (Amwata, 2020). Meat consumption is mainly concentrated in Kenya's major urban centers where the demand has been rising over the years driven by urbanization and a growing middle class consumers (Kenya Meat Trust, 2019). Animal slaughter takes place in a centralized slaughter facilities from where whole carcasses are transported to retail outlets for purchase by consumers (Rani, *et al.*, 2017).

Approximately 80% of all meat consumed in Kenya is red meat mainly from beef, mutton, goat and camel, while the rest is white meat from poultry and pork and fish (Kenya Export Processing Zones Authority, 2005). Butcheries are pivotal in providing meat to the public for purchase by consumers and in quantities that consumers want (Karki, 2015; Soyiri *et al.*, 2008). The meat sold to consumers by retail butcherries should be wholesome and free of biological, chemical or physical hazards that make meat unsafe for human consumption (Center for Disease Control and Prevention, 2022). Meat safety measures should be put in place to prevent, control or minimize biological, chemical and physical contaminants in meat, in order to achieve the expected safety. Further, butcherries in Nairobi may be classified into low, medium and high end depending on the location and income of the clientele (Gamba, 2005).

Income has been proved to determine the type of meat products the consumer can buy and location to buy from. Bryant *et al.*, (2019) asserts that consumers from the high-end market are willing to pay a premium for quality and safe products. Majority of the butcheries in the low end market offer meat on bone, liver and tripe and meat is openly displayed without refrigeration. On the hand, medium and high-end butcheries offers boneless steaks and liver and the retailing of these products is done under refrigeration overnight (Gamba, 2005). However, concerns of meat safety is growing among consumers who are increasingly becoming aware of the food borne disease risks associated with consumption of contaminated meat (Bukachi *et al.*, 2021).

Adjei *et al.*, (2022) suggested that well-maintained sanitation standards in meat production plants are a necessity in order to ensure customer safety and combat the dangers of public health. The consumption of meat tainted with pathogenic microbes has been associated with numerous incidents of food-borne illnesses, constituting a large-scale health issue worldwide (Bean *et al.*, 1990; Center for Disease Control and Prevention, 2022). Improper cleanliness protocols and inadequate hygienic stipulations within the butchery plants and retail outlets add to the bacterial tainting of fresh meat, intensifying the wellbeing threat for those who consume it (Adjei *et al.*, 2022). Asuming-Bediako *et al.*, (2018)) discovered that the vast majority of beef sold in outdoor marketplaces in Accra had been tainted with coliform and pathogenic microbes, while Karki (2015) reported *Campylobacter* contamination of retail raw meat and poultry. The perpetuation of training for meat handlers in regards to alimentary security, in conjunction with the scrutiny of slaughtering and meat handling activities while in transit, is essential and retailers will reduce the rate of meat contamination and subsequent spoilage and transmission of foodborne diseases (Adjei *et al.*, 2022). Spoiled meat will lead to significant losses that reduces the

farmer and meat retailers' profit margins and contributes to food insecurity in the country (Lewa, 2010). According to reports, roughly 3.5 billion kilograms of meat and poultry are spoiled each year at the consumer, merchant, and food service levels impacting greatly on food security (Karki, 2015). This is because meat is an important source of critical bacterial nutrients such as proteins, amino acids, vitamins B-complex, and minerals (Heinz & Hautzinger, 2007). The FAO and WHO reports previously highlighted that one-third of the total food produced results into waste every year (Food and Agriculture Organization - UN, 2011). The hygiene circumstances in which the products of meat are produced, handled, transported, and stored directly determines their microbiological quality and rate of spoilage. Improper handling of meat post-slaughter lead to microbial contamination and increased microbial activity that renders 25% of meat products unsafe for human consumption (Gram *et al.*, 2002). As a result, a lack of an appropriate hygiene management in the abattoirs and retail outlets may potentially be a source of contamination and spoilage of meat (Kenya Meat Trust, 2019).

Meat preservation mechanisms including low temperature storage and chemical methods regulate microbial, chemical, and enzymatic activity by delaying the breakdown of nutrients in meat preventing spoilage. In addition, good food safety practices among the retailers or handlers are important in minimizing contamination and spoilage of meat. It's very important that meat retailers and employees are knowledgeable about good food safety and hygiene practices, which will positively influence their meat handling behavior (Griffith *et al.*, 2010). Previous studies have stressed the need for meat handlers to get regular meat hygiene and safety training to develop appropriate attitude and behavior to ensure hygienic handling of meat in their workplaces (Coleman & Roberts, 2005). The aim of this study was to assess the meat



preservation practices by meat retail stores, evaluate the safe meat-handling knowledge, attitudes and practices (KAP) of meat retailers and estimate losses due to meat spoilage in Dagoretti sub-county of Nairobi County, Kenya.

## 1.2 Study objectives

### 1.2.1 Overall objective

To identify meat preservation methods used by meat retail operators, and assess the knowledge, attitudes and practices of meat retailers and estimate losses associated with meat spoilage in Dagoretti sub-county of Nairobi County, Kenya.

### 1.2.2 Specific objectives

- i. To assess the preservation methods used by meat retail operators in Dagoretti sub-county of Nairobi County.
- ii. To assess the meat safety knowledge, attitudes and practices of meat retail operators in Dagoretti sub-county, Nairobi County.
- iii. Estimate economic losses incurred by meat retail businesses arising from meat spoilage in Dagoretti Sub-county of Nairobi County.

## 1.3 Research Questions

- i. Which are the preservation methods used by meat retailers in Nairobi County?
- ii. What is the meat handler's levels of knowledge, attitude and practices?
- iii. What is the estimated economic losses associated with spoiled meat?

## 1.4 Problem Statement

Meat is particularly sensitive to bacterial spoilage, leading to losses and spread of food borne diseases (Olaoye & Onilude, 2009). A Microbial analysis by Kyayesimira *et al.*, (2019) showed that the butchery had the highest microbiological incidence (70-100%), followed by slaughter (50-80%), and transportation (30-50%). The research recognizes that meat retailers bear a greater responsibility in meat losses due to

microbial contamination (Breidenstein, 1986). Spoilage factors reduce associated revenues and reliability in production chains, exacerbating the problem of household food insecurity (Chepkemoi, 2016). The far-reaching consequence of selling spoiled meat is massive loss of customer confidence on the affected retail outlets. Kenyans have asked that safety regulations on meat products be enforced to prevent shops from selling tainted meat. Despite this, some merchants continue to fall prey to unhygienic practices and offer spoiled meat to unwary clients (Oloo, 2010). This analysis endeavors to bridge the dearth of information regarding the methods of meat conservation utilized by meat vendors, information related to edibility, attitude and custom, as well as the decline in freshness due to rot in charcuteries and retail stores located in Nairobi County, Kenya. The study also sought to highlight the food safety challenges faced by meat retailers leading to meat spoilage which may be contributing to the losses.

### **1.5 Justification of the Study**

Unsafe meat practices and inadequate meat preservation by meat retailers are risk factors for meat contamination and spoilage. This poses a danger to meat consumers due to the possible spread of food borne disease pathogen through sale and consumption of contaminated meat (Rani, *et al.*, 2017). The study sought to examine if meat retailers use appropriate meat preservation methods and practice safe meat handling practices that guarantees the safety of the meat sold to consumers and prevent losses due to meat spoilage. The findings were expected to highlight meat safety and related public health risks and use the information to create awareness of the meat safety gaps in the meat retail business in order to develop strategies to guarantee safe meat for human consumption. This will ensure food security and promote the Kenya's meat industry.

## **CHAPTER TWO: LITERATURE REVIEW**

### **2.1 Introduction**

The meat sector in Kenya is chiefly comprised of livestock created in dry, parched, and semi-arid regions of the country. Livestock trade traders buy livestock from producers and transport them to Nairobi and other major towns where slaughter facilities as well as consumers are concentrated (Kenya Meat Trust, 2019). The industry has been described as very inefficient with high post-harvest losses resulting from inadequate use of cold retail chain, little value addition and inadequate food safety standards. About 3.5 billion kgs of meat and meat products are spoiled every year at the consumer, retailer and food service (Karki, 2015). The main factors responsible for meat spoilage are bacterial activity, chemical oxidation, and enzymatic autolysis. The high nutrient content of meat provide an ideal habitat for harmful bacteria to thrive and spoil meat (Gram *et al.*, 2002; Pighin *et al.*, 2016). Chemical and enzymatic spoilage of meat can also occur with breakdown of nutrients leading to development of off-odors, off-flavor and slim formation that makes meat unsuitable for human consumption (Dave & Ghaly, 2011). Natural oxidative deterioration of meat occur due to auto-oxidation, enzymatic and non-enzymatic hydrolysis of fats which leads to development of off-flavors in meat. In addition, degradation of complex carbohydrates, fats and proteins leads to softening and greenish discoloration of meat (Dave & Ghaly, 2011).

### **2.2 Sources of microbial contamination of meat**

Sources of microbial contamination of meat include water, air dust, vermin, hides and skin, intestinal content of infected animal, slaughter equipment, meat carrying containers, display tables and meat handlers (Fasanmi *et al.*, 2010; Paramithiotis *et al.*, 2009). Microbial contamination of meat occurs often during slaughter, dressing

operations, carcass washing, transportation, in retail and during storage (Niyonzima *et al.*, 2013; Rani *et al.*, 2017). Spoilage microflora which are indigenous to meat animals contaminate the carcass during slaughter (Paramithiotis *et al.*, 2009). A Microbial analysis of meat by Kyayesimira *et al.* (2019) showed that retail butchereries had the highest microbiological contamination incidence (70-100%), followed by slaughterhouse (50-80%), and transportation (30-50%). Improper cleaning procedures expose meat to contaminations with harmful microorganisms (Chepkemoi, 2016; Rani *et al.*, 2017).

Niyonzima *et al.*, (2013) found the highest contamination of meat to occur during marketing. Rani *et al.*, (2017) observed that poor handling practices during transportation related considerably to meat contamination and degradation. The slaughter environment and meat handling practices influence the type and number of microorganisms found in meat (Borch *et al.*, 1999). According to Joint (2004), various pathogenic bacteria can contaminate or cross-contaminate meat after procedure of butchery, so as during the cooling, sectioning, dismemberment, and chopping stages. Meat handlers were identified as a risk point for Salmonella contamination of carcasses in the study by (Aburi, 2012). Persons who work pack and unpack meat are obligated to follow all applicable hygiene regulations (Joint, 2004). High levels of microbial infestation linked to inappropriate approaches to food processing can be seen as the cause of roughly 600 million food poisoning incidents and around 420,000 mortalities each annum (Yenealem *et al.*, 2020). Meat handlers should maintain good hygiene to prevent cross-contamination of beef products and protect customers from food borne illnesses (Abdul-Mutalib *et al.*, 2012).

### **2.3 Cross contamination of meat**

Transmission of microorganisms between different types of meat products is referred to as cross contamination. This may occur by way of direct contact with the animal that is ill or through contact with hands and surrounding surfaces. Direct transmission of microorganisms necessitates close contact between the source of the bacteria and the meat. Indirect contamination relies on the germs being transported by a vehicle, for example, when raw meat is processed on a chopping board using tools that are later used for high-risk meat, or through vermin such as flies, cockroaches and rodents (Fukuda *et al.*, 2019). Propagation of *Listeria monocytogenes* from unprocessed to pre-prepared (RTE) commodities has triggered several alimentary afflictions (Zhang *et al.*, 2022). Further, the assessment of cross-contamination of *Listeria monocytogenes* through meat chopping board found minimum cross contamination when cutting boards were cleaned with tap water at temperatures above 70 °C compared to use of cold water. Therefore, meat cutting board should be thoroughly cleaned preferably using hot water and detergent, or disinfected cold water. A study by Chung & Hellberg (2020) on the effects of poor sanitation procedures on cross-contamination of animal species in ground meat products, found that incomplete cleaning of grinding equipment led to microbial cross-contamination of about 1% of meat products. Microbial contamination of meat causes meat spoilage reducing the shelf-life of the meat causing heavy economic losses (Elkhishin *et al.*, 2017). In addition meat contamination with pathogenic microorganism cause outbreak food borne illnesses (Archer & Kvenberg, 1985).

### **2.4 Factors affecting microbial growth in meat**

Several factors such as pH, moisture content and physical state are known to promote their growth. Endogenous enzymes, warmth, humidity, nutrients level and UV

exposure are the factors that cause bacteria to proliferate and, as a result, reduce the quality of beef products (Faustman & Cassens, 1990). Meat retailer actors often complain of losses due to meat deterioration caused by temperature variations. Keeping fresh meat around 20-30 degrees Celsius, for example, gives it a one-day shelf life, beyond which meat deteriorates and spoils. According to Aburi (2012), high temperatures hasten the deterioration process of meat, making meat unfit for human consumption. The shelf-life of beef products is influenced by a number of elements including environmental temperatures and the physical state at the point of packaging and sale. Moreover, the conditions also determine the rate of growth of microorganisms. For example, grinding beef increases surface area, releases moisture and nutrients from muscle fibers, and uniformly disperses surface germs across the meat (Belloir *et al.*, 2017). Meat quality is closely linked to microbial proliferation in the meat and this is arrested by keeping meat at low temperatures (Belloir *et al.*, 2017). Some meat retailers in addition cover meat with protective plastic sheets in order to prevent microbiological contamination and excessive moisture loss (Heinz & Hautzinger, 2007).

## **2.5 Meat preservation**

Traditional methods of meat preservation include; drying, salting smoking, brining and canning. These methods focus on decreasing the moisture content of meat. In addition, the techniques have bacteriostatic effect due to chemicals such as formaldehyde and phenolic compounds, which is present in the smoke. Present techniques of flesh conservation comprise of regulating temperature with refrigerating, deep freeze and extreme chilling, adjusting humidity levels by using sodium chloride and saccharide as well as a range of chemicals e.g. chlorides, nitrites, sulfides, organic acids, phenol antioxidant and phosphates to obstruct the propagation

of microbes and to combat the consequences of oxidative degradation, and to control autolytic catalytic deterioration. Meat preservation methods prevents the spoilage of meat by inhibiting enzymatic and microbial activity hence delaying the breakdown of nutrients responsible for development of off-flavors as well as limiting fat oxidation, which causes rancidity (Dave & Ghaly, 2011; Luong *et al.*, 2020). Therefore, use of proper handling and preservation techniques prevents meat spoilage hence improves the shelf life and safety of meat, as well as prevent meat losses.

Meat preservation can be achieved by lowering of temperature which inhibits microbial activity. Two methods are used namely freezing and chilling are based on lowering of temperature to inhibit microorganism growth (Mbugua & Karuri, 1994). They are most frequently used techniques of limiting microbial development in perishable meat. Raw meat may be kept at a low temperature of -2-4°C to prevent spoiling for a short period (3-4 days). Freezing meat at -10°C to 20°C is used when there is need to retain meat quality for a long period of time. It is preferable to freeze meat quickly before microbial multiplication takes place. However, chilling or freezing does not kill microorganisms; they just go dormant, hence meat spoilage process can continues when the freezing temperature is not maintained and meat thaws (Mbugua & Karuri, 1994). Therefore, fluctuation in freezing temperature during power blackouts can lead to meat spoilage. Temperature monitoring is very important if the freshness of meat is to be maintained in cold storage.

Other methods of meat preservation involve use of chemical substances. Meat curing is the process of adding salt nitrite and other preservatives to products such as ham and sausage (Honikel, 2008). Salt reduces the moisture in the meat, which discourages the development of microbes. Nitrite stops bacteria from growing and

keeps meat from going rancid. It also attaches to myoglobin and produces the pink hue associated with cured products (as nitric oxide). However, because of its possible carcinogenic properties, its use is contested. Another popular curative ingredient is sodium erythorbate, often known as ascorbate (Choi *et al.*, 2017). Ascorbate inhibits microbial activity, improves the color development of cured meat, but is not carcinogenic, a problem that associated with nitrite usage. Cooling and curing procedures are the most frequent preservation methods used in Nairobi, especially in modern processing factories (Gichure *et al.*, 2014; Kerry & Tyuftin, 2017).

The development of novel thermal and non-thermal techniques in meat processing and preservation has also been investigated. These advanced methods maintain the meat quality, wholesomeness, and superior safety that customers expect. Incorporated amongst the most current and innovative approaches to sustaining and augmenting the shelf resilience of meat are supercooling, turbo-cooling, concealing within a vacuum, hydrofluidization freezing, collision freezing, assisted freezing with electrostatic force, pressure-shift freezing, cooling through the utilization of acidic electrolyzed water in combination with elevated hydrostatic pressure, and non-thermal plasma technique (Kerry & Tyuftin, 2017; ur Rahman *et al.*, 2018). Furthermore, advancements in packaging technology, such as the use of linear low-density polyethylene-based active clay nanocomposite films, have been used (Onopiuk *et al.*, 2021).

## **2.6 Meat Handlers Knowledge, Practices and Attitude**

Meat handlers can be a source of meat contamination (Greig *et al.*, 2007). In addition, meat can get contaminated when sick handlers cough or sneeze, touch meat with dirty hands or when they handle food improperly. Food safety regulation recommend that



sick persons do not handle food until they are properly healed, do not touch food with bare hands, should use protective clothing when handling food and well as observe good personal hygiene (FAO, 2003). To prevent food contamination, the food handler should understand their role in food contamination and in prevention of contamination (CAC, 2020). They should have good knowledge, display a positive attitude, and practice proper food handling practices. Putri & Susanna, (2021) concluded that there was a considerable connection between the understanding and outlook of food handlers; yet, no noteworthy association between understanding or disposition and food handling skills was ascertained. The inquiry indicated that exercising programs for food handlers be conducted incessantly, since the alimentary security cognition gained from the exercises could be converted into the enhancement of mentalities and food handling processes.

Tegegne & Phyto, (2017) found food handlers' knowledge and practices to fall short of minimum standards and stressed the need to provide meat workers with regular practical training in order to foster a culture of safety via improved knowledge and attitude. Jianu & Golet, (2014) indicated that one's education level determined their hygiene practices when handling meat products. In addition, a high level of knowledge among meat handlers aided them to identifying risks to food safety and enhanced hand hygiene practices. An investigation into the behavior of meat handlers in Gondar Town, Ethiopia, concerning their food safety practices concluded that their actions and the standard of their dietetic conduct were inadequate, and thus called for investments in activities that can bring about a mental modification and consequently upgrade the attitudes and practices of meat handlers (Yenealem *et al.*, 2020).

## **2.7 Economic losses of meat spoilage**

Food losses occur at all stages of the agri-food chain, from primary production (agriculture) through processing, transportation, distribution, to storage (Karwowska *et al.*, 2021). According to Kyayesimira *et al.*, (2019), the origins of meat reduction in the slaughterhouse may be attributed to beef consumption, moisture dissipation, and beef decrepitude. Microbial contamination on carcass leads to spoilage which leads to high financial losses to retail businesses annually (Dikeman & Devine, 2014). Meat has a short shelf life and must be carefully preserved to extend its life. According to a research done by Waldman *et al.*, (2020), traders have the problem of keeping their meat safe hence experience great losses. The American Meat Institute estimated a loss of up to 20 million pounds of meat due to microbiological deterioration in 1983 (Breidenstein, 1986). A study by Kyayesimira *et al.*, (2019) estimated an average daily financial loss of USD 787.5 due to beef waste and drip loss.

## **CHAPTER THREE: MATERIALS AND METHODS**

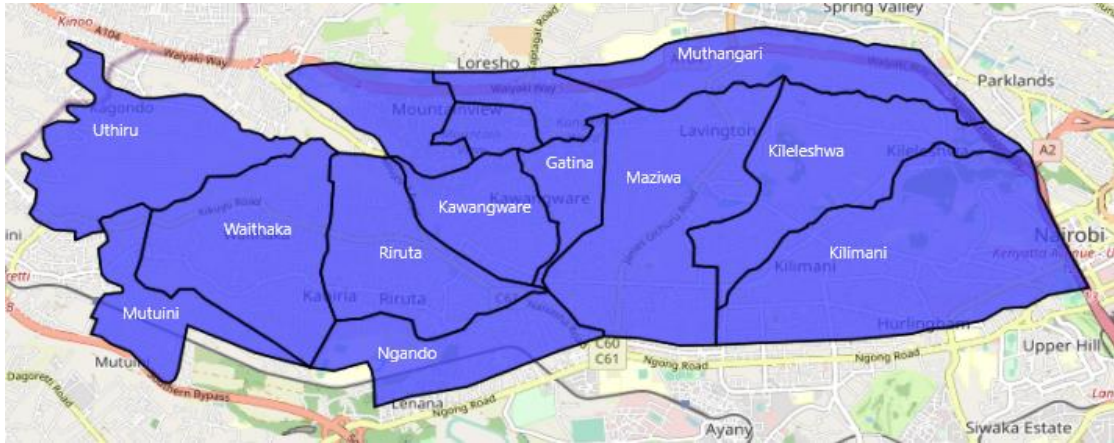
### **3.1 Study design**

The study adopted a cross sectional survey plan in carrying out the research work including collecting, and analyzing data. A research design lays the strategy that integrates the different components of the study in a coherent and logical way, thereby ensuring redress of the research problem. The design also allowed for collection of both qualitative and quantitative evidence for a richer analysis.

### **3.2 Study area**

The study was carried out in Dagoretti Region of Nairobi County. The sub-counties that make Dagoretti Region include Dagoretti North and Dagoretti South. The research targeted meat retail outlets in the geographical location, which were purposively selected because they represented the county's low income, middle income and high income population. The study area is divided into ten wards, namely Kabiro, Kawangware, Gatina, Kileleshwa, Kilimani, Mutu-in, Ngando, Riruta, Uthiru, and Waithaka (Ben-Hafaïedh & Cooney, 2017). The area covers 54.3 km<sup>2</sup> and has a population of 360,056 people, half of whom live in slum areas (KNBS Census, 2019). The region is home to the county's lower income, middle-, and high-income population.

Both low- and middle-income neighborhoods feature small-scale butcheries while high income estates had high end standalone butcheries and those associated with supermarket outlets. The slaughterhouses, which supply meat all the butcheries are located in Nairobi County (Njiru) and in neighbouring counties (Dagoretti in Kiambu county, and Kiserian in Kajiado County).



**Figure 3.1: Map of the study area**

Source: Google (2022)

### 3.3 Target population

The specified group in focus was comprised of all meat enterprises situated in both Dagoretti North and Dagoretti South sub-county, ranging from butcher's shops to supermarkets. The establishments were targeted because they sell fresh meat and meat products. Butcheries and supermarkets sell fresh meat products including beef, chicken, pork and fish. Hence, these retail establishments provided a better profile of meat handlers residing in the study area.

### 3.4 Sampling and sample size

The sample size was derived from the formula  $n = Z_{\alpha}^2 pq / L^2$  (Dohoo et al., 2010). A 95% confidence interval and desired accuracy of 10% Kongkaew *et al.* (2004) was used.

- $n$  = sample size
- $z$  = level of confidence according to the standard normal distribution (for a level of confidence of 95%,  $z = 1.96$ )

- $p$  = estimated proportion of the population that presents the characteristic (when unknown we use  $p = 0.5$ )
- $q = (1-p)=0.5$
- $L$  = tolerated margin of error (for example we want to know the real proportion within 10%)

Reasonable precision to attain saturation in sample size for a qualitative data.

$$p = 0.5, q = 0.5, z = 1.96, L = 0.1$$

$$n = (1.96^2 \times 0.5 \times 0.5) / 0.1^2 = 96$$

- A minimum sample size of 96 meat retail outlets were identified for sampling to inform the study, from the population of 273.

### **3.5 Selection of study units**

In making the study representative and less expensive to conduct, the study purposively selected three wards within Dagoretti region, because of its diverse socio-economic zones. Dagoretti region represents the diverse demography and thus the findings would inform appropriately the context of Nairobi. It has wards such as Kileleshwa, Kilimani, Gatina, Kabori and Kawangware, out of which, Kileleshwa is ranked as high-end estate, Kilimani as middle-end estate and Kawangware as low-end area, in terms of socioeconomic status (high, middle and lower status). The study region has 273 meat retail outlets, according to the Nairobi County department of health record (DOH-NMS, 2021).

Systematic sampling was applied in sampling meat retail outlets within the identified zones. The researcher selected every 3<sup>rd</sup> outlet until the desired number of 96 outlets was achieved (Saunders, 2012). In cases where the identified respondents refused to participate, the researcher considered the next outlet for participation.

In selected butcheries, the proprietors and managers were purposely sampled to participate in the study. This is because they were considered informative and conversant with the meat preservation techniques and associated losses (Tosun & Yücecan, 2008).

### **3.6 Research instruments**

The study utilized structured questionnaires (Appendix A) to cull information from the research sample. The questionnaire was used owing to its ability to collect massive data from a large population within a short period of time. The questionnaire was structured to capture the information on meat preservation techniques they used as well as the information on meat safety knowledge, attitude and practices of respondents applied by the meat outlets in terms of handling, safety and hygiene and storage. The third component of the tool captured data on associated losses and how butchery owners manage spoiled meat. The researcher also used closed questions so as to restrict respondent's opinion and to capture only relevant information. Perceptions statements was measured using a 5-point Likert scale.

In addition, a checklist (Appendix B) was designed to check the various aspects of health including the fitness of the meat handlers and the application of the requirements of health, and other factors that may lead to meat spoilage in retail stores.

### **3.7 Data collection**

The researcher conducted a pilot survey before the actual data collection so as to familiarize with the place and used the findings to gauge reliability and validity of the research instruments. The researcher targeted 15 meat retailers (approximately 10-20% of the sample size) in Gatina, which was not one of study areas, to inform the pilot study. The results of the pilot study produced a Cronbach's Alpha reliability coefficient of 0.689, which according to Kothari (2010), was above the threshold value 0.6, and therefore rendered the research tool highly reliable in achieving the study goals.

The researcher sought the relevant research permits from National Commission for Science, Technology and Innovation (NACOSTI-Reference number 415640) and the University's Faculty of Veterinary Medicine ethics and biosafety committee and Department of Public Health (Reference number FVM BAUEC/2022/356) to facilitate introduction and data collection exercise. In addition, the investigator trained two research assistants on consent, ethics, quality of data-related exercises and questionnaire administration. The data collection process involved administering the structured questionnaire through interviewing the respondents and their answers recorded in the questionnaire.

### **3.8 Data management and statistical analysis**

Data was analyzed using SPSS version 26. The frequency distribution table was created to inform the quantitative statistics of the dataset. Using Pearson's Chi-square test, the amount of relationship between training and education characteristics among butchery and supermarket operators and meat handling methods was assessed.

## **CHAPTER FOUR: RESULTS**

### **4.1 Introduction**

The chapter presents the research findings and the interpretation. It is organized into sections according to study objectives. The first section is descriptive analysis, which includes an illustration of demographic findings of the responses in terms of age, business ownership, gender, education level and medical certifications. The subsequent sections include analysis on meat preservation and storage, meat safety knowledge, attitude, practices of respondents, and associated losses.

### **4.2 Descriptive statistics**

The sections below present the descriptive results of the study variables.

#### **4.2.1 Demographic information**

A total sample of 96 survey responses were included in the data analysis, with 9 participants drawn from the meat retailers in supermarkets. The other 87 respondents were drawn from butcheries. In particular, the study considered factors such as gender, age group, working duration, education levels, status in the business and medical certificates. The results are shown in Table 4.1.



**Table 4.1: Summary of socio-demographic information of respondents**

Questions	Response	Frequency	Percentage
Gender	Male	85	89
	Female	11	11
Age (Years)	15 to 20	4	4
	More than 20	91	95
Daily working duration	At most 10hrs	36	39
	Above 10hrs	57	61
Educational level	Primary	21	26
	Secondary	52	63
	University	9	11
Status in business	Owner	47	51
	Partner	4	4
	Employee	42	45
Do you have a business license	Yes	96	100
Do you have county public health certificate	Yes	37	39
	No	59	61
Do you have a medical certificate	Yes	68	71
	No	28	29
How often do you go for medical checkup	Every 3 months	20	32
	Every 6 months	37	60
	Every 12 months	5	8
Type of retail business	Supermarket	9	9
	Butchery	87	91

In relation to gender, the study included 85 (89%) males and 11 (11%) females. The study revealed that majority of meat handlers, either as owner, partner or employee were males. In terms of age, the results showed that four (4%) of the study participants were aged between 15 and 20 years while 91 (95%), aged above 20 years. This revealed that there were very few occasions where teenagers worked as meat handlers in the sampled area. Many of the employees were adults as demanded by law. In addition, the study showed that 36 (39%) worked for at most 10 hours while 57 (61%) worked in their premises for more than 10 hours. Concerning level of education, the study showed that 21 (26%) had primary level of education, 52 (63%) had secondary education and 9, (11%) had university or college education. This

showed that majority of the meat handlers had secondary education or higher, hence, they were able to understand the health and business aspects of handling, storing and selling meat.

The results on the type of meat mostly sold by the meat handlers is presented in table 4.2.

**Table 4.2: Summary of meat sources and types**

<b>Questions</b>	<b>Response</b>	<b>Frequency</b>	<b>Percent</b>
Nature of business	Raw meat	74	77
	Processed meat	2	2
	Raw & processed	20	21
Source of meat	Public abattoir	78	81
	Private abattoir	14	15
	Public & abattoir	4	4
Type of meat sold	Beef	70	46
	Pork	21	14
	Chicken	27	18
	Goat	26	17
	Fish	7	5

The results indicated that among the 96 study participants, 74 (77%) handled raw meat, 2 (2%) dealt in processed meat and 10(21%) handled both raw and processed meat. The results revealed that the meat handlers mostly dealt in raw meat, and that very few transacted processed meat. With regard to the sources of meat, majority (78, 81%) sourced their meat from public abattoirs, while 14 (15%) sourced the meat from the private ones. The results showed that the most preferred type of meat handled was beef (46%), followed by chicken (18%), goat (17%), pork (14%) and fish (5%).

#### **4.2.2 Preservation of meat**

The results of methods of meat preservation and storage that the meat retailers used, and the associated challenges they faced are presented in Table 4.3.

**Table 4.3: Summary of preservation methods**

<b>Questions</b>	<b>Response</b>	<b>Frequency</b>	<b>Percentage</b>
How do you store meat?	Hanging (Room temperature)	26	27
	Hanging & refrigeration	16	17
	Refrigeration	54	56
Type of refrigeration facilities	Cold room	4	6
	Refrigerator	61	87
	Cold room & Refrigeration	5	7
Types of display	Refrigerated counter	47	49
	Hanging at room temperature	47	49
	Refrigerated counter and hanging at room temperature	2	2

The results indicate that majority (54, 56%) of meat handlers relied on refrigeration methods for storage purposes. Twenty-six (27%) said they hanged the meat products at room temperature, while 16 (17%) said they used both refrigeration and hanging techniques of storing meat. With regard to types of refrigeration facilities, 61 (87%) said they had refrigerators while 4 mentioned they had cold rooms. In addition, 47 (49%) respondents stated they had refrigerated counters and 47 (47%) stated they hanged the meat at room temperature.

#### **4.2.3 Challenges in preservation of meat products**

The challenges faced by the meat handlers with regard to storage of meat are given in Table 4.4 below.

**Table 4.4: Challenges in preservation of meat**

<b>Questions</b>	<b>Response</b>	<b>Freque ncy</b>	<b>Perc ent</b>
<b>What challenges do meat handlers face?</b>	Lack of cold facilities -meat spoilage	12	10
	Unreliable power supply	14	12
	Flies	43	35
	High competition leading to low demand	52	43
<b>Are there flies problem?</b>	Yes	67	70
	No	29	30
<b>How do you keep the flies away?</b>	Use of anti-flies coil	43	45
	Cleanliness	23	24
	Cleanliness & use of anti-flies coil	1	1
	Fumigation, sprays	7	7
	Manually by use of cow tail & use of anti-fly coil	2	2
	Manually by use of cow tail	9	9
	Smoking and spray	3	3
Fly traps	1	1	

The results indicate that 12 (10%) meat retailers mentioned they faced challenges with the cold facilities which led to spoilage of meat products. Fourteen (12%) of the responses indicated unreliable power supply to be challenge they faced, while 43 (35%) noted flies was a big problem in their businesses. The majority of 52 (43%) mentioned they faced low demand of their meat products.

Regarding flies, 67 (70%) of the respondents admitted that flies were a problem in their meat retail business. When asked how they remedied the problem, many 43, (45%) used anti-fly coil to repel the flies away from their businesses. In addition, 23 (24%) said they maintained high level of cleanliness around the meat counters so as to keep the flies off their business. Nine respondents manually kept the flies away using the cow tail.

#### 4.2.4 Knowledge on meat handling and safety

The analysis on meat handlers' knowledge on hygiene and causes of meat spoilage are presented in Table 4.5.

**Table 4.5: Summary of knowledge on meat handling and safety**

Questions	Response	Frequency	Percent
Do you have basic meat hygiene and safety training?	Yes	56	60
	No	38	40
Is There any relationship between meat and disease?	Yes	77	80
	No	15	16
	Don't know	4	4
Do you know how meat becomes contaminated?	Yes	87	91
	No	2	2
	Don't know	7	7
Is it necessary to separate the meat types in storage?	Yes	73	76
	No	11	11
	Don't know	12	13
Do you know the dry, chill and frozen storage temperatures?	Yes	57	59
	No	19	20
	Don't know	20	21

The data exhibited in Table 4.5 demonstrates that 60% of the participants possessed the requisite know-how regarding meat hygiene and safety while 40% did not, indicating that a number of meat handlers did not have formal training but learned about cleanliness of meat products on the job. Similarly, 77 (80%) believed there was a relationship between meat and diseases, while 4 (4%) had no idea whether meat was a risk factor for illnesses. Based on this, 15 (13%) mentioned cholera as one of the diseases associated with consumption of contaminated meat and 68 (61%) said food poisoning. In addition, twenty-two cited Trichinellosis worms while seven mentioned typhoid. The results on awareness of meat contamination means showed that majority of 87 (91%) were knowledgeable on factors of meat contamination while 2 (2%) did not know. This revealed that majority of the meat handlers were knowledgeable of the diseases associated with ingestion of tainted meat product. Further analysis showed

that 73 (76%) of the responses believed that it was necessary to separate the meat types during storage. Moreover, fifty-seven (fifty nine percent) admitted to knowing the dry, chill and frozen temperatures of storing meat.

**Table 4.6: Diseases associated with meat**

<b>Questions</b>	<b>Response</b>	<b>Frequency</b>	<b>Percent</b>
Diseases related to meat consumption	Cholera	15	13.4%
	Typhoid	7	6.3%
	Food poisoning	68	60.7%
	Worms	22	19.6%
Signs of meat spoilage	Smell	100	54.9%
	Color	63	34.6%
	Slime	13	7.1%
	Molds	6	3.3%

With regard to signs of meat spoilage, the results indicated that 100 (54%) responses quoted smell as one of the indicators of spoiled meat, while color was mentioned by 63 respondents. Similarly, 13 (7%) and 6 (3%) of the responses said that a contaminated meat could be detected by the presence of slime and molds respectively. The results reveal that a significant proportion of the meat handlers were aware of the signs of meat spoilage.

#### **4.2.5 Attitude on meat handling and safety**

The results on the attitude of meat handlers are presented in Table 4.7.

**Table 4.7: Summary information on attitude of meat handlers**

Questions	Strongly Agree		Agree		Disagree		Neutral	
	N	%	N	%	N	%	N	%
Safe meat handling is an important part of your job responsibilities	79	82	17	18	0	0	0	0
Using common knives and cutting boards to cut different raw meat may lead to food poisoning	46	48	35	37	7	7	8	8
Pest and pets play role on meat spoilage	49	51	24	25	19	20	4	4
Training and learning about meat safety is important to me	77	80	15	16	0	0	4	4
Using hairnet, masks, protective gloves and adequate clothing reduce the risk of meat contamination (spoilage)	46	48	31	32	17	18	2	2
Improper storage of meat may lead to spoilage and hazardous to health	68	71	23	24	3	3	2	2
Meat handler with abrasion or cuts finger or hand should not touch un wrapped meat	71	74	16	17	3	3	6	6

With regard to safe meat handling as an important aspect of their job, 79 (82%) strongly agreed, while 17 (18%) agreed. Similarly, 46 (48%) strongly agreed that using common knives and cutting boards on different foodstuff may lead to food poisoning while 35 agreed. On the aspect of pests and pets being risk factors of meat contamination, 49 (51%) strongly agreed and 24 (25%) agreed with the assertion. Many respondents also believed that training and learning about meat safety was important in their line of work while four (4%) neither agreed nor disagreed. Forty six (48%) and 31 (32%) strongly agreed and agreed respectively that using hairnets, masks and protective gloves reduced the risk of meat contamination, while 68 (71%), 23 (24%) and 3 (3%) strongly agreed, agreed and disagreed respectively that meat spoilage was a consequence of substandard storage methods of meat and thus posed health risk to humans. Equally, 71 (74%) strongly agreed and 6 (6%) each neither agreed nor disagreed that meat handlers with abrasion or cut fingers should not be allowed to handle meat.

#### 4.2.6 Meat handling practices

The results of responses on meat handling practices by the meat handlers is shown in Table 4.8 below.

**Table 4.8: Summary information on meat handling practices**

Questions	Response	Frequency	Percent
Presence of washing facilities	Yes	66	69
	No	30	31
Wash hands before handling meat	Yes	91	95
	No	5	5
How they clean hands	Cold & plus soap	52	54
	Warm water only	6	6
	Warm water & soap	38	40
How they clean knives before cutting Meat	Cold water only	5	5
	Cold water & soap	38	40
	Hot water only	11	11
	Hot water & soap	41	43
What to do after hand injury	Wipe with cloth	1	1
	See a doctor	19	20
	Dress wound and continue working	75	78
Frequency of cleaning butchery/ supermarket?	Ignore and continue with work	2	2
	Continuously	43	45
	Once a day	21	22
	Twice a daily	28	29
Presence of a meat working table	Others	4	4
	Yes	96	100
Type of meat working table used	Wooden	74	77
	Metallic	7	7
	Plastic	3	4
	Others	2	2
	Wooden & metallic	3	4
	Wooden & plastic	5	5
	Metallic & plastic	2	2
Frequency of cleaning meat-working table	Immediately after use	42	44
	Daily	41	43
	Twice a day	9	9
	Weekly	4	4

The results indicate that 66 (69%) butcheries and supermarkets had washing facilities that allowed to properly clean meat and surfaces properly. The results also show that 91 (95%) washed their hands before handling meat. This revealed that even though 30



(31%) of the meat handlers did not have washing facilities, they constantly cleaned their hands with cold water plus soap (52, 54%) before handling meat. Moreover, 38 (40%) also cleaned their hands with warm water and soap. Majority of the respondents (41, 43%) used the warm water and soap to clean the knives they used in the course of their work.

When asked what remedy they used in managing an injured hand during work, 75 (78%) said they dressed the wound and continued with their work while 19 (20%) said they first sought proper treatment from a doctor before continuing with their work. Forty-three (48%) noted they continuously cleaned their butchery premises, while 28 (29%) said they cleaned the premises twice a day. Twenty-one respondents said they cleaned their premises once a day. The results thus indicate that meat handlers maintained a clean premise for their meat products.

With regard to meat working table, all the 96 respondents admitted to having one, with majority having a wooden one (74, 77%) as shown in table 4.9. Wooden working tables are deemed cheap and more accessible than the metallic ones. Forty-two (44%) said they cleaned the meat working table immediately after use and 41 (43%) said they cleaned the table once every day. The results thus show that many meat handlers also upheld clean working tables to minimize chances of contamination. Additional information on meat handling practices is given in the Table 4.9.

**Table 4.9: Summary information on practices of meat handlers**

<b>Questions</b>	<b>Response</b>	<b>Frequency</b>	<b>Percent</b>
Do you have a meat chopping board?	Yes	96	100
Do you clean meat-chopping board?	Yes	91	95
	No	5	5
How do you clean your equipment's	Hot water	36	38
	Disinfectant	9	9
	Cold water & soap	51	53
What type of weighing scale do you use?	Mechanical	15	16
	Digital	79	82
	Both mechanical & Digital	2	2
Do you clean your meat weighing scale in the evening before leaving the butchery?	Yes	96	100
Do you always wear gloves when handling meat?	Yes	16	17
	No	80	83
Do you always wear head cover while selling meat?	Yes	35	37
	No	60	63
Do you always wear a white protective coat while selling meat?	Yes	90	94
	No	6	6
Do you always wash your protective coat?	Yes	94	93
	No	2	2
How many overcoats do you have?	1	12	13
	2 To 5	71	74
	More than 5	13	13
How often do you wash your protective coat?	Daily	82	85
	Twice a day	4	4
	Weekly	9	9
	Twice a week	2	2
Do You Wash Your Hands After Using The Bathrooms?	Yes	96	100
Do you handle meat when you have any following disease signs: - diarrhea, cough, vomiting?	Yes	10	10
	No	86	90
Is it important to keep your fingernails short?	Yes	96	100
Do you keep beards?	Yes	21	22
	No	75	78

With regard to having a meat chopping board, all the 96 respondents admitted to owning one, indicating that the equipment was an essential component of their business. In addition, 91 (95%) noted they constantly cleaned the equipment. The analysis further showed that 51 (53%) and 36 (38%) used cold water and soap and hot water respectively, to clean the meat chopping board and other equipment in the butchery.

When asked about the type of weighing scales they have, 15 (16%) mentioned mechanical, 79 (82%) said digital and two (2%) had both mechanical and digital weighing scales. All the respondents also admitted to cleaning the weight scales at least once every day to reduce risks of pathogen transmission. The results reveal that many meat handlers preferred the digital weighing scale and not the mechanical one, owing to its accurate measurement. In relation to wearing gloves, head cover and white protective coat when handling meat, the results showed that majority of 90 (94%) wore the white protective coat while few had head cover (35, 37%) and gloves (16, 17%). The results reveal that while the white protective coat was a common attire among the meat handlers, head covers and gloves was not. In the same regard, only one out of ten respondents did not always wash the coat, while 82 (85%) said their washed their protective attire on a daily basis. Four of the respondents washed their work clothing twice a day and nine (9%) washed them on weekly basis. Additionally, 71 (74%) had between two and five coats, while 12 (13%) respondents owned only one protective coat. The results indicate that wearing the protective clothing was a common practice among the meat handlers in Nairobi.

The results also showed that all the respondents admitted to washing their hands after using the washrooms, and kept their fingernails short. In addition, most of the respondents (86, 90%) did not handle meat when presenting with the symptoms of diarrhea, cough and vomiting. Many of the respondents (75, 78%) also did not keep beards.

### 4.3 Meat losses

The results in Table 4.10 shows the results of losses associated with meat spoilage.

**Table 4.10: Summary information on losses associated meat spoilage**

Questions	Response	Frequency	Percent
Do you incur any meat spoilage?	Yes	71	74
	No	25	26
What do you think is the cause of meat spoilage?	Poor handling	29	30
	Poor storage	67	70
How many kilograms of meat do you normally lose per week?	Less than 1 kg	29	30
	2 kg	14	15
	3kgs and above	53	55
What do you do with spoiled meat?	dispose	57	59
	sell at a cheaper price	39	41
If dispose, how?	Burry	5	12
	animal feeding	24	88
If you sell the spoilt meat to dog owners at a cheaper price, how much per kg?	Less than Ksh100	1	4
	Ksh100 to Ksh200	20	87
	Above Ksh200	3	9
What are the major causes of meat losses in your butchery?	chopping/ splitting	7	13
	microbial spoilage	12	22
	moisture loss	27	49
	chopping & moisture loss	8	15
	Microbial spoilage & moisture loss	1	2

The results on meat losses show that 71 (74%) of the meat handlers incurred losses related to meat spoilage, while 25 did not. Also, 67 (70%) said that the major cause of meat spoilage was due to poor storage, while 29 (30%) mentioned poor handling. Therefore, these results reveal that storage factors were essential in the course of meat business. More than half (53, 55%) of the survey respondents said they lost at least

3kg of meat every week while only one third mentioned they lost less than a kilo of meat within the same time span.

The results showed that many (57, 59%) of the meat handlers disposed the spoilt meat by either burying (5, 12%) or feeding animals (24, 88%) such as dogs with it, while 39 (41%) sold the bad meat a cheaper price (20, 87%) of between Ksh100 and Ksh200 per kilogram. The results reveal that even though many of the meat handlers experienced meat spoilage, mostly due to improper storage, they mostly sold it a cheaper price to reduce their losses. Further analysis showed that moisture loss (27, 49%) and microbial spoilage (12, 22%) were the major factors of losses associated with meat handling.

#### **4.4 Analysis of financial losses associated with meat spoilage**

The results show that the average quantity (in kilograms) of spoilt meat reported by traders in a week is 2Kg, with a maximum of 3Kgs and a minimum of 1kg. Cumulatively, 69 responses generated 158kgs of spoilt meat in one week. Consequently, the results show that the average price of spoilt meat is Ksh159, with a minimum of Ksh20 and a maximum of Ksh300 per Kg. This revealed that the price of spoilt meat was not standard and depended mostly on individual agreements with the potential customer.

The results further show that the average financial losses incurred by the traders as a result of the spoilt meat was estimated to be Ksh546 in one week, with some incurring as much as Ksh1140 within the same period. The minimum loss amount recorded was Ksh100 while the cumulative loss reported by 32 responses was Ksh17480. The analysis prove that losses associated with meat spoilage was huge and necessary steps need to be taken to limit the impact.

**Table 4.11: Losses estimates**

	N	Range	Min	Max	Sum	Mean	Std. D.	Var.
Kilograms of meat lost per week	69	2	1	3	158	2	1	1
Price per Kg of spoilt meat	36	280	20	300	5710	159	67	4538
Total price sold per week	32	710	40	750	10520	329	195	38140
Loss made (Ksh.)	32	1040	100	1140	17480	546	282	79624
Average meat sold per week	42	300	120	430	6006	143	82	6724
Proportions			0.83%	0.70%	2.63%	1.40%	1.22%	0.01%

## **CHAPTER FIVE: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS**

### **5.1 Discussion of the findings**

#### **5.1.1 Findings on the demographic factors**

The study established that gender was a significant factor in the meat handling business as a majority of the respondents were men (89%) aged over 20 years (95%). This showed that men play a significant role in the meat business in Nairobi. Similarly, nearly all meat workers were adults over the age of twenty-five (95%). These findings agree with those of Asuming-Bediako *et al.* (2018) who reported that butchery business in Ghana is dominated by adult men. Similarly, Adesokan & Raji, (2014); Tegegne & Physo, (2017), also found that the majority of meat handlers (70%) were men between the ages of 31 and 50, had a low level of education, and had between 11 and 26 years of experience in the industry. Akabanda *et al.* (2017) also found that most meat workers were between the ages of 30 and 50.

On education level, the study found that 95% of meat handlers were secondary school leavers (63%) aged 20 years and above. High school dropouts dominated the meat retail industry since few college graduates saw it as a promising career path. This finding were in agreement with a report by Asuming-Bediako *et al.* (2018) which ascertained that around three-fourths of the butcher workers in the Accra Metropolis had had at least some kind of educational qualification, with near half possessing a basic level education, while roughly one-third had not obtained any formal education. Adzitey (2011) in response, observed that the proportion of butchers in the Bawku Municipality, Ghana lacking formal education was resoundingly high, amounting to 64 percent. This shows that butchery business is a promising industry that can

employs a large number of youth who do not find opportunities to progress with their studies.

This study also found that majority of Nairobi's meat retail businesses (51%) are owned and operated by business owners and their families, while the remaining 49% are run by staff employees. However, in Uganda, Lamunu *et al.* (2022) found that butcheries are managed by owners (38%) and employees (61.2%). All the meat retail business were found to have a valid business license, but only 39% of them confirmed to have a county public health certificate indicating laxity in enforcement of public health regulations by concerned agencies. About 71% of respondents reported that they had valid medical certificates and 60% of them reported undertaking a medical examination once every six months. The law requires that all food handlers in food retail businesses undergo medical examination every six months and be in possession of a valid medical certificate. In Ghana, Asuming-Bediako *et al.* (2018) found that 80% of Ghanaian meat handlers undertook the recommended yearly medical examinations, while 20% undertook the medical examination only sporadically. In Uganda, butchery operators were found to have business registration certificate but only 55% of butchers had medical certificates (Lamunu *et al.*, 2022). In Ethiopia, approximately 84.6% of the abattoir workers were found to have health certificates (Haileselassie *et al.*, 2013). Unhealthy meat handler can be a source of food borne pathogens and a great risk to meat consumers. Therefore, the requirement for food handlers to undergo regular medical examinations is a measure to protect consumers against the potential risks. Unlicensed meat sellers are not likely to comply with regular medical examination requirement and hence represent a threat to meat consumers, hence it is imperative that the public health authorities in Nairobi County perform random inspections on a regular basis to ensure compliance.



The study also confirmed that meat retail business was mostly done in butcheries, with few supermarkets participating in the venture. Further analysis confirmed that many meat retailers handled raw meat (77%) and only 2% majored on processed meat. This indicated that majority Nairobi residents preferred raw meat and not processed meat. The major source of meat was the public abattoirs (81%) while the private sources accounted for 15%. Beef was the popular meat sold by the meat retailers, as mentioned by 46% of the responses followed by chicken (18%) and goat meat (17%).

### **5.1.2 Findings on preservation methods**

The study revealed that 56% of meat handlers relied on refrigeration methods for storing meat, while, over 27% of the respondents hanged the meat at room temperatures. Half of the respondents had refrigerated counters, which was very helpful in maintaining the frigid temperatures necessary to make the meat items safe for human consumption. This findings are in agreement with the study by Heinz & Hautzinger, (2007) who also found that many meat handlers relied on refrigeration methods in preserving meat, but differ with those reported by Chepkemoi, (2016) who found 83% and 47% of the operators in Nairobi and Isiolo counties, respectively to store meat by hanging it in open space in the butchery. The current study found that majority of meat handlers owned a refrigerator (87%) and only 6% had the cold room facilities. In addition, half of the respondents had refrigerated counters, which further helped to keep the meat products in cold temperatures and safe for consumption. The results therefore indicate that many meat handlers in the study area relied on refrigeration techniques to prevent meat spoilage, thus allowing them to maximize on

the shelf life. This findings contrasts with the report by Kyayesimira *et al.* (2019)) in Uganda which indicated that 70-80% of butcheries lacked refrigeration facilities.

In Ghana, Asuming-Bediako *et al.* (2018) found that most markets did not have adequate storage facilities for unsold meat except in places where there was a cold storage facility. The best temperature for storage of raw meat is  $-2^{\circ}\text{C}$  to  $0^{\circ}\text{C}$ . It is however recommended that meat businesses display the meat at chilling temperatures of  $2^{\circ}$  to  $4^{\circ}\text{C}$  to delay spoilage and prevent the growth of harmful bacteria (Mbugua & Karuri, 1994). Hanging meat at room temperature as practiced by 27% of meat businesses identified in this study makes meat vulnerable to microbial spoilage due to rapid microbial growth that takes place at temperatures above  $4^{\circ}\text{C}$ , consequently, the flesh does not fulfill the obligatory minimal health and tidiness regulations (Chepkemoi, 2016). The practice of hanging meat at room temperature was explained by retailers to be partly as a result of consumers not preferring refrigerated meat. A previous study found hot chain meat to be preferred by majority of Kenyan meat consumers in all the consumer segments, with 85.7% of low income, 59.8% of middle income and 46.5% of high income consumers preferring hot chain meat (KMT, 2019). The same study identified reasons for consumers not preferring cold chain meat as lack of awareness of the benefit of cold storage of meat and consumer perception that cold chain meat had lost taste (KMT 2019). The county administration should encourage the use of refrigerated meat display facilities and educate meat business operators on the importance of such preservation techniques to preserve meat and cut down on meat spoilage.

The results observed that no supermarkets or butcher shops mentioned the use of modern thermal or non-thermal methods of meat preservation in their preference list. Modern meat preservation techniques such as super-chilling, ultra-rapid freezing,

immersion vacuum cooling, hydrofluidization freezing, and impingement freezing were also not mentioned in any of the replies, indicating a lack of familiarity with these techniques. For this reason, it is important to raise awareness and encourage the use of the cutting-edge technology now in use to keep the high standards of flavor, freshness, and safety in the meat supply that consumers have come to expect. The county health department can take advantage of this opening by implementing such tools in an effort to improve the retail meat supply in urban areas. It has been argued by ur Rahman *et al.*, (2018) that new, cutting-edge techniques can keep meat fresh for longer without compromising its flavor. Furthermore, there was no indication of cutting-edge packaging techniques such active clay nanocomposite films made from linear low-density polyethylene in the study. Therefore, contemporary meat preservation methods would improve meat quality and reduce waste.

### **5.1.3 Findings on knowledge**

The study found out that majority of the participants had the basic training on meat safety and hygiene (56, 60%), indicating that 40% of meat handlers were yet to undertake such training. However, this findings showed an improvement on training in contrast to an earlier study by Chepkemoi, (2016), which found 69% of operators in Nairobi County to have no formal training on safe meat handling. Elsewhere, a study by Haileselassie *et al.*, (2013) in Mekelle city, Ethiopia revealed a food safety knowledge gap among abattoir and butchery workers. In addition, this study found that respondents were aware of the risk of consuming contaminated meat as 80% of the participants were able to associate disease with consumption of meat. Sixty percent of respondents associated consumption of meat with outbreaks of food borne diseases while 20% associated meat consumption with worm infestation. In addition, these findings showed that 76% of the respondents separated the meat types during

storage to avoid cross-contamination of meat species. Further, half of the respondents associated a bad smell of meat with meat spoilage, and 34% attributed color change to meat spoilage, indicating that they knew the effects of meat spoilage. This therefore proved that, a good number of meat handlers in the study area had the necessary knowledge to aid them make decisions regarding safety and storage of meat products, and to maintain clean meat storage and retail environment. However, a study by Tegegne & Phyto, (2017) in Ethiopia found that the level of knowledge among meat handlers in abattoirs and retail meat stores in Jijjiga town to be below acceptable standards. The authors reported that, majority were illiterate and had not received any food safety training. In contrast, a study by Adesokan & Raji, (2014) found that the knowledge levels among the meat handlers in the public meat processing factories in Nigeria was 17 times higher than those from the private factories. It is essential therefore for the county government of Nairobi to provide meat workers with adequate food safety education and practical training in order to foster a culture of safety via improved knowledge and attitude. In addition, they are likely to promote meat safety practices that prevent cross contamination and outbreak of food borne illnesses (Abdul-Mutalib *et al.*, 2012). Jianu & Goleţ, (2014) showed that a significant positive correlation exists between the levels of knowledge and sustainable practices among meat handlers. Similarly, Anim-Jnr *et al.*, (2022), concluded that the apparent lack of knowledge on meat safety among meat handlers posed serious concern to consumer health in an era where animal protein consumption is promoted particularly, among children. Good meat safety training can assist meat handlers in understanding the importance of implementing appropriate meat handling practices.

#### **5.1.4 Findings on attitude**

The study assessed the meat handler's attitude on various issues including safe meat handling, cutting equipment and protective clothing. The results indicated that majority (82%) of meat handlers agreed or strongly agreed that safe meat handling was an important responsibility that should be adhered to at all times as required by the public health authorities. The study further revealed that 48% of respondents believed that using common cutting materials such as knives on different meat types was not a good practice as it could lead to cross-contamination and food poisoning. Most respondents also noted that pets and pests were major risk factors for production of unsafe meat and that their presence within the business premise increased chances of contamination. Seventy one percent (71%) of meat handlers also believed that improper storage of meat was a recipe for spoilage and hence they had to follow the proper meat storage and handling guidelines. In addition, respondents agreed or strongly agreed that proper clothing including the use of white overcoats, head cover or hairnets and hand gloves reduced the risk of meat contamination. Further, most of them agreed that butchery operators with hand wounds should not be allowed to handle meat. A sliced finger is no place for a butcher's knife, so they added.

#### **5.1.5 Findings on practices**

The findings of this study indicated that two thirds (67%) of the butcheries observed public health hygiene protocols. It was observed that nearly all meat handlers washed their hands, with cold water and soap, before handling meat. In addition, respondents in many cases cleaned the knives with hot water and soap, and a majority of them cleaned their butcheries at least once daily to maintain moderate levels of cleanliness. In contrast, an earlier study by Chepkemoi, (2016) asserted that the management of meat by smaller and medium-sized enterprises' (SME) butchers in Nairobi and Isiolo

counties failed to meet the established guidelines for a requisite degree of healthfulness and cleanliness. Moreover, in Nairobi and Isiolo, respectively, 60% and 82% of those in the industry neglected to scrub their fingers prior to handling meat and other nourishments. A study in Ghana by Asuming-Bediako *et al.*, (2018) determined that meat purveyors preserved a certain degree of cleanliness to guarantee the wholesomeness of the product by sanitizing work surfaces and implements prior to and following daily operations.

The current study found that 94% of meat retail operators wore white protective overcoats, 37% wore white head covers, 17% wore hand gloves and all of them kept their fingernails short. In addition, the study found that the respondents had two to five coats (74%) with 13% having more than five coats. They also practiced good levels of personal hygiene as all of them indicated that they washed their hands after using the bathrooms and kept the fingernails short, while 78% trimmed their beards and 90% did not handle meat when sick. This study also showed that meat handlers in Nairobi practiced moderate levels of hygiene of equipment and premises. Thirty eight percent (38%) of butchery operators indicated that they used hot water to clean meat handling equipment, 53% use cold water and soap, while 9% used a disinfected water to ensure proper hygiene. In contrast, a study by Chepkemoi, (2016) ascertained that seven out of ten and eight out of ten butchers who work at retail in Nairobi and Isiolo counties, respectively, were not donning defensive apparel. In comparison, Lamunu *et al.*, (2022) reported that 41.8% Of butchers in Uganda wore protective clothing always (22%), or sometimes (22%), and used gloves when handling retail meat. In Ethiopia, about 91% of butchers used protective clothes (Haileselassie *et al.*, 2013).

With regard to registration of business and related health licenses, the findings of this study revealed that all the meat retail business had a valid business license, but only 39% admitted to having the Public Health Certificate. However, 71% of the respondents had the medical certificates, with 60% of them undertaking medical checkups every 6 months. These findings show that even though the butchereries had business permits, they lacked the clearance from the public health offices. In contrast, an earlier study by Chepkemoi, (2016) observed that the vast majority of operators in Nairobi (94%) and Isiolo (88%) Counties lacked medical documents. Moreover, the proportion of operators in Isiolo (60%) and Nairobi (34%) Counties practicing the reuse of cloth for wiping utensils was considerable. The data gleaned from the investigation serves to affirm a heightened level of adherence to public health guidelines realised by Chepkemoi, (2016). However, the findings of this study compare well with the findings by Asuming-Bediako *et al.*, (2018) who found that about 80% of the meat retailers in Ghana go through annual medical check-ups, while in Uganda, a study by Lamunu *et al.*, (2022) in Wakiso District of Uganda found that 65.7% of butchers did not comply with meat hygiene practices, where 41.8% of them wore protective gear, 71.6% of them washed hands and equipment using cold water and soap, 55% had medical certificates and 56.7% had undergone training on meat hygiene practices. In Ethiopia, approximately 84.6% of the abattoir workers were found to have health certificates (Haileselassie *et al.*, 2013). This findings agree with those of Asuming-Bediako *et al.*, (2018) who reported that meat retailers in Ghana maintained high level of hygiene by always cleaning their premises after the day's work. Earlier reports by FAO indicated the level of adherence to meat hygiene practices in East Africa to be 51%. A report by Yenealem *et al.*, (2020), indicated

that negligent management of comestibles yield over six hundred million cases of alimentary ailments yearly, resulting in four hundred and twenty thousand deaths.

Meat chopping board is an essential equipment in meat retail business, but can also be a source of meat contamination. This study revealed that all the respondents had a wooden (77%), metallic (7%) or plastic (4%) meat-chopping board, which they regularly cleaned with cold water and soap. Wooden chopping boards are porous and mostly wet due to continuous use and are difficult to clean and sanitize. They can be a source of meat contamination as bacteria can hide in the cracks where they multiply and accumulate. Metallic and plastic boards on the other hand are not porous and are easy to clean and sanitize. However, plastic cutting boards have been found to be the source of polythene microplastic contamination in cut meat commercially available at butcheries and a supermarkets hence should not be overused (Habib *et al.*, 2022) . This study showed that meat dealers in Dagoretti were likely to spread disease pathogens through the use of contaminated wooden meat chopping boards. According to a previous research by Anim-Jnr *et al.*, (2022), over 75% of meat sellers did not clean their cutting instruments while selling, and only 6% of those who did clean their tools did so with detergent or disinfected water between uses and after each day's sales. The results of this study are consistent with those of previous investigations on the hygienic standards of Accra's butchery shops, which identified cutting equipment as a possible source of cross-contamination of meat (Sulleyman *et al.*, 2018). In order to avoid cross-contamination, meat retailers should regularly clean and sanitize cutting boards and all other meat contact surfaces and cutting equipment. Those using wooden and plastic cutting boards should be encouraged clean them regularly using disinfected water, or to acquire heavy duty stainless steel cutting boards as they are easy to clean and sanitize.



### **5.1.6 Findings on financial losses associated meat retail**

Meat losses in a butchery business has been attributed to moisture loss, drip, inaccurate weighing and spoilage. In this study, 59% of respondents revealed that they lost between 1kg and 3kgs of meat every week. These meat losses were attributed to moisture loss (49%) and microbial spoilage (22%). Meat spoilage as a common problem in retail meat business in Nairobi was admitted by 74% of the respondents, which they attributed to poor storage (70%) and poor handling (30%). The results of this study confirm the findings by Waldman *et al.*, (2020) , which indicated that many traders in Nairobi faced challenges of keeping their meat products safe, and revealed that the personal factors and inadequate hygiene and sanitation was partly responsibility for the meat losses incurred. The spoiled meat was mostly disposed through selling it to dog farmers for a price of between Ksh100 and Ksh200. A study in Ghana by Asuming-Bediako *et al.*, (2018) also revealed that waste meat and bones from butcheries was collected by private individuals to feed to their pets. A report by Kyayesimira *et al.*, (2019) indicated that the main causes of meat losses at the butchery in Uganda included, wastage (22.4%), drip loss (19.7%) and spoilage (18.4%). These authors found quantity losses to range between 2.39 -3.2 kg per butchery including Mbale (3.19±2.60 kg) and lower for Mbarara (2.39±1.25 kg) and Kampala (2.39±1.61 kg) on a daily basis with economic losses equivalent to 787.50 USD dollars.

According to the Food Waste Index report from the United Nations Environment Programme, 17 percent (amounts to 931 million tonnes) of all food produced for human use in 2019 is lost or wasted (Sharp *et al.*, 2021). As a result, the issue of food waste is rising in significance due to the fact that it wastes precious resources like land, water, and energy that might be utilized to feed the world's expanding

population. The global ecology, temperature, water, and land resources are all negatively affected by food waste (Canali *et al.*, 2016). Consequently, every effort should be made to prevent meat spoilage through adequate preservation and hygiene and sanitation.

### **5.1.7 Challenges faced by retailers**

With regard to the challenges faced by the meat retailers, 43% of butchery operators indicated low demand for the products as the major challenge they faced. About 70% of the operators also indicated they were affected with the problem of flies, while 12% mentioned unreliable power supply, which affected their efficiency of meat refrigeration. These findings regarded flies as a major problem to meat handlers, which most operator stated they managed using anti-flies coil, and keeping the premises clean. A lack of refrigeration facilities and inappropriate packaging materials was another problem faced by many meat sellers, according to Luong *et al.*, (2020), because they reduce the shelf life of the meat and attract microbial contamination. In addition, some stores' incurred severe financial losses as a result of poor demand and competition, which forces them to discount their items merely to break even.

## **5.2 Conclusions**

1. Meat retail outlets including butcheries and supermarkets in Dagoretti Sub County Nairobi sell mainly raw meat of various animal species, including beef, chevron, mutton, pork, poultry and fish.
2. Two thirds (67%) of the butcheries in Dagoretti sub-county observed and implemented public health hygiene protocols on meat handling including regular hand washing and cleaning of equipment, premise hygiene and use of protective gear

3. The butcheries and supermarket display meat by hanging the carcasses in open air (49%), use refrigerated counters (49%) or both hang and use refrigerated counters (2%).
4. Seventy three percent of butchery businesses stored unsold meat in cold rooms or refrigerators while 27% of the butcheries hanged unsold meat at room
5. Seventy one percent of butchery operators in the study area had medical certificates, with 60% of them undertaking medical checkups every 6 months.
6. Sixty percent of butchery operators had basic training on food safety and hygiene and displayed adequate food safety knowledge.
7. Majority (82%) of meat handlers agreed that safe meat handling was an important responsibility that should be adhered to by all operators.
8. Most (77%) meat retailers use wooden meat-chopping boards while the rest use either metallic or plastic meat cutting boards.
9. Butcheries incur meat losses estimated at USD 5.0 (1-11.0) per week which arise mainly from moisture loss (78%) and microbial spoilage (22%).
10. The main challenges faced by meat retailers include, Fly menace (78%), low demand for the meat and high cost of electricity.

### **5.3 Recommendations**

1. Regular training of personnel handling meat at the meat retail shops in Dagoretti sub-county and in Nairobi in order to influence handler's meat safety knowledge, attitudes and practices,
2. County Public health authorities enhance their supervisory role to enforce the existing food handling regulations.
3. Retail meat shops should enhance their level of cleanliness and timely disposal of meat waste to reduce smell and associated fly menace. They should be

encouraged to install UV light fly killer machine to help them control fly menace.

4. Retailers should be incentivized to install backup uninterrupted power supplies to maintain a consistent power supply to their refrigeration facilities, thus reducing the amount of spoiled meat resulting from frequent power failures.
5. Public health department should develop standard food safety manual to be used by butchery business to orient new or casual employees to further ensure continuity of safe practices. An easy-to-follow pictorial manual should be considered for easy of used by all meat handlers.
6. All meat retailers should be encouraged to acquire and use refrigerated counters to display meat and store the meat under refrigeration to avoid spoilage. As such, tax incentive policies should be applied for refrigerators meant for meat preservation services in order to lower the cost of acquiring them.
7. The county government of Nairobi should provide the necessary amenities (toilet and hand washing facilities) to markets to support hygienic vending practices.

#### **5.4 Areas for further research**

The meat handling process is a special interest in the quality and safety of meat and meat products and their implications to the consumer. The concept of the present study covered meat handlers KAP and losses associated with poor storage practices. As such, the study did not cover the entire production and consumption chain of meat handling. A wider study covering other variables related to transportation and household factors therefore suffice. The study context covered Dagoretti Sub-County County in Nairobi. As such, the results cannot be generalized to capture the exact

context of Nairobi region or nationally. A future study thereof would focus on a wider scope to highlight the variances across sub counties and highlight the specific findings of the sub regions.

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## APPENDICES

### Appendix A: Questionnaire

#### Questionnaires to determine the knowledge, attitudes and practices of Meat Handlers/Retailers towards Meat Hygiene and Safety 2021

#### Dear Meat handlers/Retailers

The purpose of this questionnaire is to assess meat handler's knowledge, attitudes and practices towards Meat Hygiene and Safety. The information that you provide will be used only for academic research purpose and is highly confidential. Thus, are kindly requested to give genuine responses. Please be kind to write the required background information.

<b>PART (A)</b>		
1	Gender	Male ( ) Female ( )
2	Age (years)	Less than 15 ( ) 15-20 ( ) More than 20 ( )
3	Working duration (hours)	5 hrs ( ) 10hrs ( ) More than 10hrs ( )
4	Educational level	Primary ( ) Secondary ( ) University ( )
5	Status in the business	Owner ( ) partner ( ) employee ( )
6	Do you have a business	City county public health ( )



7	Do you have medical certificate?
8	How often do you go for medical checkup?
9	When was the last time you went for medical checkup?

<b>Part (B)</b>	
10	Type of retail business? supermarket ( ) butchery ( )
11	Type of business sale? raw meat processed meat raw and
12	Source of meat? public slaughterhouse ( ) private slaughterhouse ( )
13	Type of meat sold? Beef ( ) Pork ( ) chicken) goat ( ) fish ( ) others specify

<b>Part (C) Storage</b>	
14	How do you store the meat?
15	Do you have refrigerator facilities? 1)Yes 2) No If yes what type? (1) Cold room (2) refrigerator (3) room temperature (4) other specify.....
16	What type of display you have? (1) Refrigerated counter (2) hanging in room temperature (3) Other specify.....
17	How long does the meat stay?

<b>Part (D) Challenges faced</b>	
18	What challenges do you face in your retail business? 1)cold facilities / meat spoilage Unreliable power supply [ ] Flies [ ] lack of demand [ ] Lack of water [ ] unreliable water supply [ ] Other specify .....
19	Do you have flies problem? yes [ ] No[ ]
20	How do you keep the flies away?

<b>PART (E) knowledge:-</b>		Yes	No	Don't
21	Do you have basic meat hygiene and safety training			
22	Is There any relationship between meat and disease			
23	If yes what are the most common diseases associated with consumption of meat due to your own knowledge?			
	Cholera _____			
	Typhoid _____			
	Food poisoning _____			
	Worm _____			
	Dysentery _____			
	Others _____			
24	Do you know how meat becomes contaminated			
25	Is it necessary to separate the meat types in storage			
26	Do you know the dry, chill and frozen storage temperatures			
	If yes specify temperature			
	Chill ( ) _____			
	Freezer( ) _____			
27	What are the signs of meat spoilages			
	Smell _____			
	Color _____			
	Slime _____			
	Molds _____			

<b>PART (F) ATTITUDES</b>		Strongly	Agree	Disagree	Neutral
28	Safe meat handling is an important part of your job responsibilities				
29	Using common knives and cutting boards to cut different raw foodstuff may lead to food poisoning cases				
30	Pest and pets play strong role on meat spoilage				
31	Training and learning about meat safety is important to me				
32	Using hairnet, masks , protective gloves and adequate clothing reduce the risk of meat contamination (spoilage)				
33	Improper storage of meat may lead to spoilage and hazardous to health				
34	Meat handler with abrasion or cuts finger or hand should not touch un wrapped meat				

	<b>PART (G) PRACTICES</b>
35	Is there washing facilities? 1) Yes[ ] 2) No [ ]
36	Do you wash your hands before handling meat? 1) Yes[ ] 2) No [ ]
37	How do you clean your hands? 1) with cold water only [ ] 2) with cold water and soap [ ] 3) with warm water only [ ] 4) with warm water and soap[ ] 5)wiping with piece of cloth[ ]
38	If you get injury in your hand what do you do? a) See doctor [ ] b) Dressing and continue my work [ ] (c) Ignore and continue my work [ ]
39	How often do you clean your butchery/ supermarket? 1) Continuously [ ] 2) Once a day [ ] 3) twice a day [ ] 4) other specify .....
40	Do you have a meat working table? 1) Yes [ ] 2) No[ ]
41	What type of meat working table do you use? 1) Wooden [ ] 2) metallic [ ] 3) plastic [ ] 4) other (specify).....
42	How often do you clean meat working table? 1)immediately after use[ ] 2)daily [ ] 3)twice a day[ ] 4)weekly [ ] 5)hourly[ ]
43	How do you clean your knives before cutting meat? 1) With cold water only [ ] 2) With cold water and soap [ ] 3) with hot water only [ ] 4) with hot water and soap [ ] 5) wiping with piece of cloth [ ]

<b>PART H: PRACTICES</b>	
44	Do you have a meat chopping board? 1) Yes [ ] 2) No [ ]
45	Do you clean meat chopping board? 1) Yes [ ] 2) No [ ]
46	How do you clean your equipment's (knives, containers, chopping board, logs)? 1) Hot water [ ] 2) Disinfectant [ ] 3) Others [ ]
47	What type of weighing scale do you use? 1) Mechanical scale [ ] 2) Digital scale [ ]
48	Do you clean your meat weighing scale in the evening before leaving the butchery? 1) Yes [ ] 2) No [ ]
49	Do you always wear gloves when handling meat? 1) Yes [ ] 2) No [ ]
50	Do you always wear head cover while selling meat? 1) Yes [ ] 2) No [ ]
51	Do you always wear a white protective coat while selling meat? 1) Yes [ ] 2) No [ ]
52	Do you always wash your protective coat? 1) Yes [ ] 2) No [ ]
53	How many coats do you have?
54	How often do you wash your protective coat? 1) daily [ ] 2) twice a day [ ] 3) hourly [ ] 4) weekly [ ]
55	Do you wash your hands after using the bathrooms? 1) Yes [ ] 2) No [ ]
56	Do you handle meat when you have any following disease signs: - diarrhea, cough, vomiting? 1) Yes [ ] 2) No [ ]
57	Is it important to keep your finger nails short? 1) Yes [ ] 2) No [ ] If No why?
58	Do you keep beards? 1) Yes [ ] 2) No [ ]

	<b>PART I: LOSSES</b>
59	Do you experience any putrefaction of meat foods? 1) Yes <input type="checkbox"/> 2) No <input type="checkbox"/>
60	What do you think is the cause of meat spoilage? 1) Poor handling <input type="checkbox"/> 2) Poor storage <input type="checkbox"/> 3) Other (specify).....
	How many kilograms of meat do you normally lose per week? 1) <1kg <input type="checkbox"/> 2) 2kg <input type="checkbox"/> 3) >3kg <input type="checkbox"/> other specify .....
62	What do you do with spoiled meat? 1) Dispose <input type="checkbox"/> Sell at cheaper price <input type="checkbox"/> Others .....
63	If you dispose how you do dispose the spoiled meat? 1) Burry <input type="checkbox"/> 2) Animal feeding <input type="checkbox"/> 3) other specify .....
64	If you sell the spoilt meat to dog farmers at cheaper price, how much per kg? .....
65	What are the principal origins of spoilage in your meat vending enterprise? 1) Chopping/splitting <input type="checkbox"/> 2) microbial spoilage <input type="checkbox"/> 3) moisture loss <input type="checkbox"/> 4) other (specify).....

### Appendix B: Checklist

65	What is the classification of the butchery architecture? 1)concrete building <input type="checkbox"/> 2)open shelter <input type="checkbox"/> 3) kiosk <input type="checkbox"/>
66	Does the purveyor of meat don appropriate apparel suitable for the job? 1)Yes <input type="checkbox"/> 2) No <input type="checkbox"/>
67	Do you have access to a place for cleansing your hands? 1) Yes <input type="checkbox"/> 2) No <input type="checkbox"/>
68	Are lavatories accessible? 1) Yes <input type="checkbox"/> 2) No <input type="checkbox"/>
69	Are there any convenient means of disposing of rubbish? 1)Yes <input type="checkbox"/> 2) No <input type="checkbox"/>
70	Does the purveyor of meat appropriately sanitize their hands prior to addressing meat products? 1) Yes <input type="checkbox"/> 2) No <input type="checkbox"/>

Appendix C: NACOSTI permit


  
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**Appendix D: Veterinary medicine ethics approval**

