

**HYGIENE SANITARY PRACTICES OF MEAT HANDLERS
AND ANTIBIOGRAM OF MICROORGANISMS
ASSOCIATED WITH ABATTOIR FACILITIES IN OWERRI
MUNICIPAL, IMO STATE**

BY

AGUSIEGBE CHIDINMA SYLVIA

REG NO: 20164024134

**DEPARTMENT OF PUBLIC HEALTH
SCHOOL OF HEALTH TECHNOLOGY
FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI**

JULY, 2023

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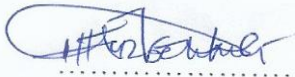
**A THESIS SUBMITTED TO THE
DEPARTMENT OF PUBLIC HEALTH
SCHOOL OF HEALTH TECHNOLOGY
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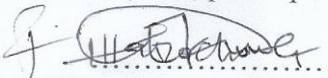
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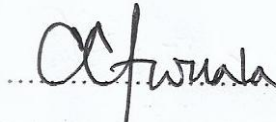
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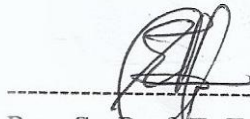
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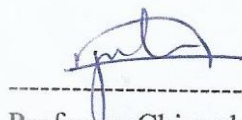
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DEDICATION

This Thesis is fully dedicated to Almighty God, who is my source of wisdom, strength and inspiration. May His name be praised forever, Amen.

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ABSTRACT

This study Assessed the Hygiene Sanitary Practices of Meat Handlers and Antibiogram of Microorganisms Associated with Abattoir Facilities in Owerri, Imo State. Cross-sectional and experimental designs were adopted in this study. Two abattoirs (Somachi and Relief abattoirs) were used in this study. 200 samples of meat handlers were randomly drawn from the 400 population of meat handlers in the 2 abattoirs. For the experimental study, 40 swab samples were obtained from; floor, walls, knives, hooks and workers hands from the two abattoirs. Standard microbiological methods were adopted in the isolation, identification, antibiogram and pathogenicity testing of the isolates. The data obtained from completed questionnaires were collated, analyzed, using statistical package for social sciences, (SPSS version 23) using chi-square analysis. Results of the cross sectional study indicated that there is a statistically significant association between the age of respondents and their perception of safe and hygienic handling of meat ($P = 0.0037$), as well as between the gender of respondents and their perception of safe and hygienic handling of meat ($P = 0.0041$). However, there is no statistically significant association found between educational attainments and safe and hygienic handling of meat. Microbiological examination of the abattoir facilities revealed the presence of; *Escherichia*, *Streptococcus*, *Staphylococcus*, *Salmonella*, *Pseudomonas*, *Bacillus* and *Klebsiella* species. There was a significant relationship between hygiene practices and the presence of certain microorganisms ($P < 0.005$). Specifically, the presence of *Penicillium* species and *Mucor* species appears to have a positive relationship with hygiene practices, while the presence of other microorganisms like *Streptococcus* species, *Salmonella* species, and *Klebsiella* species is associated with lower hygiene practices. Most of the microorganisms from the abattoir facilities were resistant to different antibiotics. Pathogenicity testing with the microbial isolates showed that most of the isolates produced beta and alpha haemolysis. The findings show the need for interventions by providing food safety training to meat handlers to improve hygienic meat handling practices.

Keywords: Hygiene, Microorganisms, Abattoir, Sanitary practices, Antibiogram

CHAPTER ONE

INTRODUCTION

1.2 Background to the Study

Meat handlers play a crucial role in the food chain as they are responsible for the hygienic processing and distribution of carcasses. It is important for meat handlers to practice good hygiene and sanitation practices in order to ensure that pathogenic microorganisms do not contaminate meat products (Njoga et al., 2023). The most important hygiene steps for meat handlers include washing their hands before and after preparing meat, using sterilized knives and cutting boards, wearing protective clothing, and avoiding contact with raw meat juices. Additionally, it is essential that all tools used by butchers are kept clean and stored properly to prevent contamination. By following these guidelines, they can help ensure safe meat products for consumers (Siluma et al., 2023).

An antibiogram is an invaluable tool in the assessment of the hygiene and sanitary practices of meat handlers in abattoirs. It serves as a comprehensive record of bacterial sensitivity to certain antibiotics and reveals any resistance patterns between the different types of bacteria present (Tonjo et al., 2022). This type of analysis can provide important information on microbial pathogens that may be associated with abattoirs, aiding in the assessment of hygiene and sanitation practices, as well as helping to target specific treatments or interventions as needed. As such, it is essential for determining the safety risks associated with these

environments, ensuring that preventive measures are taken to protect both workers and consumers from potential pathogenic microorganisms.

The World Health Organization (WHO 2018) defines foodborne diseases (FBDs) as ailments of infectious or toxic nature caused by or suspected to be caused by the consumption of food and water. Diarrheal diseases due to foodborne pathogens are responsible for 70% of the associated death toll worldwide (Tonjo et al., 2022). Good hygiene practices are essential for meat handlers to uphold in order to ensure safe and quality products. It is necessary for them to understand the risks associated with microbial pathogens so that they can be reduced or eliminated from their processes (Hagos et al., 2021; Siluma B.J. et al., 2023). Abattoirs, where meat is processed, present an environment that has the potential to host a wide range of microbial pathogens that could contaminate food products (Madoroba et al., 2021). To gain a better understanding of the hygiene and sanitary practises of abattoirs, it is important to assess the antibiogram of microbial pathogen strains found in abattoirs and consider how these may be affecting meat handlers' operations. This assessment can help identify areas for improvement, such as improved temperature control, better cleaning techniques, better waste management and steady use of personal protective equipment (PPE), while investigating potential sources of contamination and methods for prevention.

The existence of both man and other biotic organisms is on environment and it therefore serves as a very important and necessary component. An abattoir or slaughter house or meat shop is a place/facility/building where animals are killed

for their meat (Bustillo-Lecompte & Mehrvar, 2015). Abattoir industries are usually sited near water bodies and abandoned farm lands for easy access to water and disposal of generated wastes (Neboh et al., 2013). The meat processing industry produces large volumes of slaughterhouse wastewater (SWW) due to the slaughtering of animals and cleaning of the slaughterhouse facilities and meat processing plants (MPPs) (Padilla-Gasca et al., 2011; Bustillo-Lecompte & Mehrvar, 2015).

The abattoir remains the most common facility available in communities and cities as a space for butchering animals for meat supply for the general populace in Nigeria (Adeyemo et al., 2009). However, when not properly sited, especially in residential areas, it results in pollution from within. Poor management of these facilities in most developing nations have remained of great concern to residents. Low awareness of the threat to health and the environment is problematic. Notwithstanding, residents have been dissatisfied with the siting and management of abattoirs. The compatibility of siting abattoir within residential settings continues to attract attention and debate from many (Adeyemo et al., 2009).

Edible meat from cattle slaughtered at various abattoirs remains the major meat consumed and source of protein for the Nigerian populace (Ademola, 2010). However, the most crucial issue in all meat processing plants is the maintenance of proper hygiene and adequate sanitary conditions (Adeyemo, 2012). Evidence shows that bicycles, motorbikes, tricycles, or car boots are majorly used by 93% of butchers to convey their meat to customers under poor hygiene conditions and with

no regard for safety (Fearon et al., 2013). These practices have a great tendency to affect the kind of meat and the quality of meat available to consumers in the market, with grave health consequences.

In another study, Adzitey et al. (2010) tried to ascertain the quality of “chevon and mutton” sold in meat shops and discovered that meat samples in all the shops surveyed were somehow contaminated with microbes such as *Escherichia coli*, *Staphylococcus* spp., *Salmonella* spp., *Enterococcus* spp., and *Streptococcus* spp). Similarly, *E. coli* infection has also been reported in undercooked beef, presumably contaminated with faeces carrying bacterium in abattoirs (Bello & Oyedemi, 2009). Improper abattoir effluent disposal could result in the transmission of pathogens and a significant outbreak of water-borne diseases such as typhoid fever, diarrhoea, wool sorter diseases, pneumonia, respiratory and respiratory and chest diseases, among others (Mohammed et al., 2012).

A poor drainage system is another major problem with abattoirs. Broken drainages with stagnant water form a breeding ground for flies, rodents, and bacteria. Environmental sanitation is not maintained correctly in many abattoirs, compounded by indiscriminate dumping of refuse, causing pollution to air, surface, and underground waters (Fearon et al., 2013). Food-borne diseases frequently occur in developing countries probably as a result of poor food handling and hygiene, fail regulatory systems, inadequate and insufficient implementation of general food safety laws, lack of resources to procure safety equipment, and lack of training for meat handlers and other food vendors (Goja et al., 2013).

1.2 Statement of Problem

The rising demand for animal products, especially meat, accounts for growing abattoir constructions and a subsequent high volume of waste generation. However, due to poor management or inadequate hygiene and safety practices, there has been a growing concern about the quality of meat from these abattoirs and issues of meat infection and pollution from poor waste management, poor personal hygiene among the meat handlers can also be a problem, including putting on dirty clothing and poor hygiene. Hand-washing facilities are needed at appropriate points to help decontaminate germs before handling meat.

Many abattoirs lack basic amenities, including proper storage facilities for meat, despite the industry's huge potential in recent years. Meat handling is an important stage in meat processing from the abattoir. During these processes, meat can get contaminated by meat handlers. Therefore, considering the importance of meat in the state and the role of meat handlers in the provision of meat with good quality, there is need to ensure regulatory monitoring of hygiene sanitary practices of butchers.

1.3 Aim and Objectives of the Study

1.3.1 Aim of the study

The Aim of this study is to assess hygiene sanitary practices of meat handlers and antibiogram of microorganisms associated with abattoir facilities in Owerri, Imo State

1.3.2 Specific objectives of the study

1. To assess the availability of basic amenities and sanitary facilities in Owerri Municipal abattoirs.
2. To determine the meat hygiene sanitary practices by meat handlers in Owerri Municipal abattoirs.
3. To evaluate the waste management practices used by meat handlers in Owerri Municipal abattoirs.
4. To isolate and identify microbial pathogens associated with the selected abattoir facilities in Owerri Municipal abattoirs.
5. To determine the antibiogram of the microorganisms associated with the study abattoir facilities.

1.4 Research Questions

1. What basic amenities and sanitary facilities are available in Owerri Municipal abattoirs?
2. What are the meat hygiene sanitary practices by meat handlers in Owerri Municipal abattoirs?
3. What are the waste management practices used by meat handlers in Owerri Municipal abattoirs?
4. What are the microbial pathogens associated with abattoir facilities in Owerri Municipal abattoirs?
5. What is the antibiogram of the microorganisms associated with abattoir facilities?

1.5 Research Hypotheses

- 1) There is no significant association between educational qualification of meat handlers and their hygienic sanitary practices.
- 2) There is no significant association between year of practice as a meat handlers and their hygienic sanitary practices.
- 3) There is no relationship between hygienic sanitary practices of meat handlers and presence of microbial pathogens in abattoir facilities.
- 4) There is no relationship between microbial pathogens in abattoir facilities and susceptibility to antimicrobial agents.

1.6 Significance of the Study

It is important to perform such assessments in order to ensure that all personnel involved with the meat production process have been adequately trained and that hygienic protocols are being adhered to. Furthermore, it is vital that any potential risks posed by microbial pathogens are identified and appropriate measures taken for safety purposes.

The result of this study will be valuable in ensuring proper management of the abattoir and its facilities as well as in policy making geared towards preventing the outbreak of diseases associated with poor meat handling in Owerri Municipal.

To the meat handlers, the findings from this study will help to educate them on the importance of hygiene practices with the cutting equipment in order to reduce or avoid the risk of cross contaminations from the abattoir facilities.

To the Environmental Health Officers, the findings from this study will help to encourage them to be more committed in the supervision of abattoir houses in order to ensure strict compliance of meat handlers to the laid down rules guiding abattoir. This will in turn encourage the meat handlers to maintain adequate hygiene practices during slaughtering and butchering of cows as they will know that there is an eye watching over their activities.

To the government, the findings from this study will help them to enact laws that will be strictly monitored by Environmental Health Officers when planning programs for abattoir. It will also generate data on the standard hygiene status of meat handlers in Imo State for record purposes which the health workers and non-governmental organizations (NGOs) can act on.

1.7 Delimitation of Study

The research study will only assess abattoir structural facilities and cattle slaughter practices in Owerri Municipality.

1.8 Operational definition of terms

Antibiogram: This is an overall profile of antimicrobial susceptibility testing results of a specific microorganism to a battery of antimicrobial drugs.

Assessment: According to oxford advanced learners dictionary, an opinion or a judgment about somebody or something that has been thought about very carefully

Abattoir or Slaughterhouse: A building where animals are killed for food

Facility: This includes; buildings, services, and equipment provided for a particular purpose.

Environment: The physical and cultural surroundings of an individual or a community at any point in the life cycle.

Waste Management Is the scientific and hygienic handling of unwanted materials in the human environment so that it does not constitute a hazard or nuisance.

Sanitation: This is the act and practice of ensuring a disease-free and healthy environment. It protects the environment from such things that could constitute a health hazard to the environment and human

Municipality: A town, city, or district with its local government

Owerri: The capital of Imo state

CHAPTER TWO

LITERATURE REVIEW

In other to throw more light on the topic of study, relevant literature to the issue of study will be discussed under the following headings

2.1 Conceptual Framework/Review

2.1.1 Abattoir

Abattoir or slaughter house or meat shop is a place/facility/building where animals are killed for their meat. The abattoir activities are dated back to antiquity. Public abattoirs had been traced to Roman Civilization and in France by 15th and 16th centuries. In Nigeria, nearly every town and neighbourhood is provided with slaughter house or slaughter slab. The advantages of the rural sites according to him outweighed those of the other sites and recommended that a rural location be chosen where possible (Nafarnda et al., 2012).

The butchery of animals for consumption is practically unavoidable in the community globally despite the increasing presence of vegetarians and protests against killing animals for meat. This tradition dates back to the existence of the Roma Empire and France in both the 15th and 16th centuries. Abattoirs are usually facilities or spaces specifically registered and approved by the authority for the aseptic slaughtering, handling, and inspection of animals and the processing of meats for practical preservation and storage for safe human consumption.

Depending on the available facilities, Abattoirs can be classified into slaughter slabs in rural areas and slaughterhouses in most townships. Commonly slaughtered animals for meat and commercial purposes are sheep (lamb and mutton), goats, cattle (beef), pigs (pork), and poultry. Horses have also been reported to be slaughtered mainly in Europe and some parts of Nigeria for meat (Tekki et al., 2012).

Slaughter houses are usually regulated by law to ensure usual standards of hygiene, the prevention of the spread of disease and the maximization of needless animal cruelty (Nafarnda et al., 2012). The slaughter house had to be equipped with a specialized water supply system to effectively clean the operating areas of blood and offal. The main essence of an abattoir is to process meats hygienically using best practices for safe human consumption. The setting allows for proper inspection of the animals until they are processed meat for the consumers.

However, this process is without the generation of waste and waste materials. These materials also need to be handled properly to avoid any potential risk of pollution or meat-borne infection. The safety situation of both the animals and the meat products reported in Nigeria is a highlight of the need to improve the quality of animal products from production, handling, and sales until the final consumption to reduce the grave public health problems that poor management of abattoirs constitutes to the country (Okoli et al., 2006).

2.1.2 Basic Requirements in an Abattoir

A suitable site must be situated for the construction of a conventional abattoir, and this site should also provide the following; a source of portable water and steady electricity, well channelled and constructed sewage. A good road and other means of transport are necessary, so also the proximity of a transport system, labour, and other sources of pollution. The local housing and other structures should be remotely situated to avoid exposing residents to noise and other environmental pollution. It should also be of quality foundations devoid of flooding, with sufficient space for potential expansion if need be (Akpabio & Kalu, 2015).

Other components of an abattoir include making available; a slaughter hall, lairage, gut and tripe room, room for detained meat, offal, condemned meat, or even hide and skin. Also are spaces for cutting, refrigeration, veterinary inspection, personal welfare, a supply of pressured cold and hot water, and a facility for disinfection, chemical treatment, and disposal. All the above-mentioned basic amenities and standards are essential to maintain a standard abattoir infrastructure. Any setback can infringe on the everyday operations for safe and healthy meat and meat products, production for human consumption, and pose a tremendous public health danger (Adeolu et al., 2019).

2.1.3 Environmental Problems in Abattoirs

The majority of the problems faced by the animal production and processing industry can be linked to the poor development of the sector, including livestock

producers, meat processors, and marketers, as well as the quality of the regulating agencies, their staff training capacity, and the consumers to an extent at each segment of the livestock industry. To operate an abattoir, prerequisite programs must be met to provide the best environmental and health conditions necessary for processing animal and meat products. Some prerequisites might include good manufacturing practices, established standard operating procedures, and a lay down plan for good hygiene practices (Declan et al., 2004).

Issues of waste disposal have dominated the slaughtering sector. Averagely, 45% of each live beef animal, 34% of each pig, and 53% of each sheep are made up of non-meat substances. Slaughterhouse waste and effluent characteristics vary daily depending on how many animals are involved, what stock type is being processed, and how it is being processed. There has been great concern about the handling of meat in Nigeria, especially when slaughtering is done on a bare floor or unhygienically outside adequate abattoir settings by some butchers (Lawan et al. 2013).

The waste generated by abattoirs can be solid or liquid. These comprise paunch content, horns, and bones and a slurry of suspended solids, faecal components, blood, fat, and soluble materials. When a proper management process is not followed, waste can pollute land, water, and air. However, some waste products, like animal waste, can be of economic importance, mainly used as manure for crop production. However, when they find their way to the water body, they can impair the water quality and endanger aquatic life. Abattoir effluent leaking into streams

increases the nitrogen and phosphorus levels and the biochemical oxygen demand of that water, and it could permeate into groundwater and adversely affect its quality. Some water sources, primarily wells used for meat processing, also serve as drinking water sources for abattoir users where portable water is unavailable. Nevertheless, this water source is prone to pollution by effluent from the abattoir, especially when sited close to the abattoir constituting health risks for both butchers and other users (Robert, 2005).

It is also good to note that some of the wastes could contain organic solids, sediments, trace heavy metals, salts, bacteria, viruses, and other microorganisms. The health of the residents determines the health status of a community. If the environment is polluted, it affects people's health and morbidity drastically, and a wide range of chemical and biological pollutants cause or contribute to diseases. Considerably, many biological and chemical pollutants contribute to pollution, and some may pose a risk to the health of a particular group or the entire population. Noise pollution has been associated with abattoir activities (Oyedemi, 2004).

According to Wing and Wolf (2010), poor health and reduced quality of life are associated with living or residing around intensive livestock operations. They implied that respiratory and mucous membrane-related issues were prevalent in neighbourhoods where swine are intensively operated. Similarly, conditions such as pneumonia, wool sorter diseases, typhoid, asthma, diarrhoea, and respiratory and chest infections have been associated with abattoir activities by medical experts. Additionally, another study reported only *E. coli* infection in undercooked beef

suspected to be contaminated with animal faeces harbouring the bacterium in abattoirs (Bello et al., 2009). These diseases are easily spread via meat products sold at the abattoir to the consumers. Improper animal waste disposal could also pose a risk of zoonotic diseases.

Despite the evidence on infected meat products, there has been a growing demand for meat resulting in more construction and establishment of an abattoir and consequent increase in pollution from their activities in many developed countries. Thus, if considering constructing an abattoir, there environmental problems have increased over the last four decades with improper management practices being largely responsible for the gross pollution of water environment with concomitant increase in water-borne diseases especially typhoid fever, cholera, diarrhea and dysentery (Atuanya et al., 2012).

In many countries, pollution arises from activities in meat production as a result of failure in adhering to Good Manufacturing Practices (GMP) and Good Hygienic Practices) (GHP). Consideration is hardly given to safety practices during animal transport to the abattoir, during slaughter and dressing. For example during dressing, the oesophagus of cattle and sheep should be sealed to prevent leakage of animals' contents. These ineptitudes often lead to contaminations from hides, hooves and content of alimentary canal during evisceration and negatively impact on the environment, including microbes in the soil and surface and groundwater (Hinton et al., 2010).

Effluent discharge from slaughter houses has been reported to have caused the deoxygenation of rivers and also been known to contaminate ground water (Neboh et al., 2013). A specific example of what happens is logging of contaminated water in the soil. In that situation, oxygen becomes less available as an electron acceptor, prompting denitrifying bacteria to reduce available nitrate into gaseous nitrogen which enters into the atmosphere with resultant negative effects. Also, an aerobic archaea (methanogens), may produce excessive methane at a higher rate than aerobic methane oxidizing bacteria (methanotrophs) could cope with, thus contributing to greenhouse gas than carbon(IV) oxide (Osibanjo et al., 2011).

Leaching into ground water is a major part of the concern, especially due to the recalcitrant nature of some contaminants (Akan et al., 2014). The process of adsorption and trapping by fine sandy materials-clay and organic matter can remove pathogenic organisms and some dissolved organic matter during passage of polluted water through the soil, thus reducing the microbial load. However, if there is too high departure of conditions from normalcy, beyond the carrying capacity of the natural process, diversity of autochthonous species could diminish while count of individuals that are able to survive may increase with possibility of grave consequences on groundwater (Neboh et al., 2013).

Another serious problem associated with the liquid waste is effluent salinity. Skin preservation by dry salting is a common procedure at small abattoirs that are remote from tanning operations and often export their hides and skins for tanning. After salting, often in converted cement truck mixers, the hides are hung to dry for

a minimum of 5 days. During this period, the salt draws the moisture out of the hide, together with the protein-filled fluids contained in the attached flesh. The effluent from drying sheds is therefore highly saline and has a very high biochemical oxygen demand (BOD). It contains high levels of fluoride (Osibanjo et al., 2011). This may lead to salinity problems if the effluent is irrigated and also to fluorosis problems with vegetation including tree deaths.

2.1.4 Abattoir Waste

Activities of the abattoir generate both solid and liquid waste, and these include;

- a. **Solid waste:** carcasses, condemned organs, carcass trimmings, hides, bones, undigested feed, hair, aborted foetuses, horns, fat; and
- b. **Liquid waste:** Blood, urine, bile, chemicals dissolved detergents, and water. These have high organic matter, high alkalinity, and high biological nutrients, and constitutes the most significant pollution load and highest chemical oxygen demand of all the liquid effluents' component, after fat (Gerhard, 2014)

2.1.5 Public Health Importance of Abattoir Wastes

Wastes generated by abattoir are potential environmental quality problems with attendant effects on human health and diseases. The wastes can affect water, land and air qualities if proper practices of management are not followed (Environmental Protection Agency, 2015). Animal wastes can be valuable for crops but can cause environmental hazards. It contains organic solids, trace heavy metals,

salts, bacteria, viruses, other micro-organisms and sediments. The waste from animal can also be washed into streams if not protected and reduces oxygen in water, thereby endangering aquatic life. Improper animal waste disposal can lead to animal diseases being transmitted to human through contact with animal faeces (Addy et al., 2015).

Abattoir effluent reaching streams contribute significant level of Nitrogen, phosphorus and biochemical oxygen demand and other nutrients resulting in stream pollution. Excess nitrate problems in groundwater are attributed to concentrated livestock and manure usage (Abdullahi et al., 2017). The health of the city is linked to the health of the dwellers. The health of the dwellers is affected by the environments. In every neighborhood, there is a considerable range of biological and chemical pollutants that cause or contribute to diseases. Some may pose health risk for a particular group while others for the entire neighborhood. Pathogens from cattle wastes could be transmitted to humans via water-based recreations (Nafarnda et al., 2012).

The wells in the meat processing areas sometimes get polluted. Wells in vicinity of abattoirs which serve as sources of water to the abattoir users was traced by Sangodoyin et al. (2012), to be polluted by effluent from the abattoir and constitute health risk for the butchers and users of the wells. Noise pollution was reported by Oyedemi (2010) to be associated with abattoir activities and location. Wing and Wolf (2010) noted decrease in health and quality of life of residents around

intensive livestock operations and hinted that respiratory and mucous membranes effects were common with neighbours of intensive swine operation.

Medical experts have reported associated diseases with abattoir activities which include pneumonia, diarrhoea, typhoid fever, Asthma, wool sorter diseases, respiratory and chest diseases (Agedah et al., 2015). *Escherichia coli* infection sources were reported to be undercooked beef which has been contaminated often in abattoirs, with faeces containing bacterium (Seiyaboh et al., 2017). These diseases can spread from the abattoir to the neighborhood via vectors or animals. Growing population with increase in demand for meat has resulted in increased abattoir related pollution and has attracted intervention in many developed countries. There is high level of awareness on pollution from animal waste whether in the farm or in the city and over the years several measures have been put in place to protect the public health and the environment.

2.1.6 Health and Environmental Challenges of Abattoir

The risks of food contamination or poisoning; the uncontrolled access of scavengers to condemned products and animal carcasses which are dangerous to health but consumption by scavengers or poor persons feeding on dumpsites; the exposure of public areas and close residential settings to offensive odours polluting the air; increase in morbidity and mortality from a condition related to the above-listed risks (Gerhard, 2014).

2.1.7 Occupational Hazards Associated with Abattoir Operation

Abattoir activities are not devoid of risk and consequently associated with environmental and health hazards resulting in occupational diseases which might aggravate existing health conditions. Occupational hazards remain the primary source of morbidity and mortality among employees in most industries, and employees of abattoirs are exposed daily to numerous risks depending on their activities. The most common and vital occupational hazards encountered by abattoir operators are chemical, physical, psychosocial, biological, ergonomics, or musculoskeletal (Auwalu et al. 2016).

Consequently, to ensure adequate control of these occupational health hazards among employees of abattoir workers, there is a need to standardize the abattoir's design and improve the industry's environmental sanitation and hygiene practices. Emphasis on exposure control and developing a plan for risk identification, characterization, assessment, and management, as well as the implementation of workers' education/training and retraining for safe work procedures by the government and all parties in the industry is crucial. Existing laws and new regulations governing the operation of an abattoir in the nation should be made compulsory (Auwalu et al. 2016).

2.1.8 Ways of Managing Abattoir Waste

Waste management remains a severe challenge to the majority of abattoirs. While the traditional methods of services are becoming obsolete due to the increased risk of environmental emissions, contamination, and disease outbreak, the means of

transporting, handling, and processing meat products in abattoirs and disposal of waste need to be regulated to standards. The application or adoption of alternative and innovative techniques is crucial for properly handling and processing meat as waste from the abattoir (Auwalu et al. 2016).

Ideally, any material that has been condemned should and must be disposed of through either of the following means; complete incineration; locating a secured site for denaturing and burial of charged material and this site must be approved by both the local government and the provincial executive officer. This can be done by; waste reduction before it is sprayed with, or immersed in, an obnoxious colourant used and approved for such purpose; and digging and immediate burial of such waste as deep as at least 60 cm must be kept not less than 100 m away from the abattoir surround. It is expected that such material provided may not adversely affect the hygiene of the abattoir; or processing the condemned material at an approved and registered sterilizing plant (Gerhard, 2014).

Additionally, the following should be considered for adequate management of abattoir waste as well as to prevent the easy spread of diseases emanating from poor hygiene practices and improper abattoir waste management; a strict law regulating hygiene and general environmental management by everyone using the abattoir is needed. Mandatory sanitization of all abattoir infrastructures and its surrounding; stringent implementation of all existing environmental health and hygiene regulations, development of technologies that are appropriate, acceptable, environmentally friendly, and cost effective for waste disposal, and public

enlightenment of abattoir operators by State Environment protection agencies and cooperative societies and organization on the impacts of wash-down from abattoirs on the environment, public health, and the ecosystem is vital (Gerhard, 2014).

2.1.9 The Butcher

A butcher is a person who may slaughter animals, dress their flesh, sell their meat, or participate within any combination of these three tasks (Merriam-Websters Dictionary, 2013). They may prepare standard cuts of meat and poultry for sale in retail or wholesale food establishments (Merriam-Websters Dictionary, 2013). A butcher may be employed by supermarkets, grocery stores, butcher shops and fish markets, slaughter houses, or may be self-employed. Standards and practices of butchery differ between countries, regions and ethnic groups. Variation with respect to the types of animals that are butchered as well as the cuts and parts of the animal that are sold depends on the types of foods that are prepared by the butcher's customers (Miner et al., 2020).

2.1.10 Steps in Butchery by Butchers

Butchery is a traditional line of work. In the industrialized world, slaughterhouses use butchers to slaughter the animals, performing one or a few of the steps repeatedly as specialists on a semi automated disassembly line. The steps include stunning (rendering the animal incapacitated), exsanguination (severing the carotid or brachial arteries to facilitate blood removal), skinning (removing the hide or pelt) or scalding and dehairing (pork), evisceration (removing the viscera)

and splitting (dividing the carcass in half longitudinally). After the carcasses are chilled (unless "hot-boned"), primary butchery consists of selecting carcasses, sides, or quarters from which primal cuts can be produced with the minimum of wastage; separating the primal cuts from the carcass; trimming primal cuts and preparing them for secondary butchery or sale; and storing cut meats. Secondary butchery involves boning, trimming and value-adding of primal cuts, in preparation for sale (Miner et al., 2020).

Historically, primary and secondary butchery were performed in the same establishment, but the advent of methods of preservation (vacuum packing) and low cost transportation has largely separated them. In parts of the world, it is common for butchers to perform many or all of the butcher's duties. Where refrigeration is less common, these skills are required to sell the meat of slaughtered animals (Reddy et al., 2019).

2.1.11 Hygiene

Hygiene refers to conditions and practices that help to maintain health and prevent the spread of diseases (World Health Organization, 2020). Hygiene can also be defined as the practice of keeping your living and working areas clean in order to prevent illness and disease. Meat hygiene on the other hand is refers to all conditions and measures necessary to ensure safety and suitability of meat at all stages of the food chain. Meat is one of the basic needs of life as it helps in maintaining life because of its nutritional value but it can also cause food borne diseases. Food borne diseases are important public health issues worldwide.

2.1.12 Meat

Meat is defined as the flesh of animals which are suitable as food. Meat could be gotten from meat flesh, skeletal muscles, connective tissues or fat and others including brain, heart, liver, kidney, pancreas, spleen, thymus tongue and tripe that are used as food. Meat contains high biological value protein and important micronutrients that are needed for good health throughout life (Moshood et al., 2012). It is an edible animal flesh which comprises principally the muscular tissue, and also includes internal organ called viscera such as heart, liver, kidney, intestine and bladder (Yusuf et al., 2013). The bulk of meat is derived from goat, cattle, pig, sheep, and poultry.

Meat as a source of animal protein is consumed heavily in Nigeria and is also recommended by nutritionists as a major source of protein for growing children, the convalescent, the expectant mothers and the aged. Meat contains an abundance of all nutrients required for the growth of bacteria, yeasts and molds and an adequate quantity of these constituents exist in fresh meats in available form. Processed meat is any meat which has been modified in order to either improve its taste or extend its shelf-life (Yusuf et al., 2013). Meat can be gotten from cow, sheep, goat, chicken, turkey, duck etc.

2.1.13 Sources of Contamination of Meat in the Abattoir

Contamination is the presence of a constituent, impurity or some undesirable elements that spoil, corrupts, infects, makes unfit or makes inferior a material,

physical body, natural environment or workplace. The major sources of contamination are the animal itself, tools and equipment used in slaughter, the workmen and the condition of the slaughterhouse environment (Rouger et al., 2017). Microorganisms are the major contaminants of meat and as a result contamination can take place at any point along the food chain, from farm to fork. Concern over contamination is a significant issue in the combat against food-borne illnesses.

Staphylococcus, *Escherichia*, and *Bacillus cereus* are sources of pre-slaughter circumstances like feeding and housing that include spreadable contaminations from skin and feces, contents of digestion system, and contaminated water (Rouger et al., 2017). There are also different types of hazards associated with meat which are chemical, biological or physical but biological hazards are of great concern because the microorganisms or pathogens are found naturally in the environment or even on live animals (Sofos, 2014). Bacterial contamination during slaughtering process is a safety problem and concern for shelf life in meat production (Bakhtiary et al., 2016).

2.1.14 Stages of Meat Contamination

Meat contamination can result from improper handling, processing, and storage practices, meat handlers' insufficient knowledge about meat safety, unhygienic abattoirs, or inherent micro flora in animals' normal tissues, the environment, and the air. Meat contamination can take place at any point, from producers to consumers, i.e., from farm to fork. To determine what the main source of

contamination is, this knowledge is essential. At any stage, the meat can become contaminated extremely fast and readily, so necessary precautions should be taken to stop and manage it (Arun et al., 2019).

The first stage is the pre-slaughter contamination. This involves the animals being raised to be slaughtered in future. The animals can be contaminated by the food that they are been fed as a result of microorganisms, pathogens, heavy metals, pesticides and other harmful chemicals that can contaminate the food either by soil grown upon or the water used for irrigation. Some of the chemicals are already present in food as a result of environmental contamination (Nerin et al., 2016). The contamination in this stage can also occur from all the equipments used for harvesting such as knives, blades, sickles, boxes, chippers etc by workers (Alum et al., 2016) and also the containers used by workers for storing.

The secondly stage is slaughter contamination. Cross-contamination can occur at this slaughter because, during the killing process, bacteria on an animal's hide that originated in its intestines can enter the finished meat product. Use of contaminated equipments such as knife used for slaughtering can cause cross contamination (Sharma et al., 2020). Structural and work surfaces may also be significant hideout for microbes thus, serve as sources of bacterial contamination on meat. Again, because of the absence of motorized or manual hoists, animals are frequently slaughtered and dismembered on the floor also when meat is washed in contaminated water after being slaughtered, further contamination might occur (Nerin et al., 2016).

The third stage is post-slaughter. Meat and meat products are highly perishable commodities and hence, they should be properly stored, processed, and packed and distributed in order to prevent microbial growth (Heetun et al., 2015). The meat is cut into pieces after being slaughtered so that it can be cooked, dried, frozen, smoked, etc. There are numerous places in this process where contamination might occur while moving meat from the point of slaughter to the location of the customer.

Meat can become infected during other activities like heating, boiling, baking, and serving as well as while mixing raw food with ingredients and spices. The contamination can occur from the hands of cook (if gloves are not worn), equipments (if not washed or sanitized) used for preparation such as knives, chopping boards, spoons, and other utensils (Alum et al., 2016). The cook should practice good hygiene and sanitation, and they should frequently wash and clean their tools and work areas. Additionally, it is vital to separate raw and cooked food in order to prevent the risks of cross-contamination. The right temperature and amount of time should be used for cooking. Food is kept at the correct temperature by food handlers. Cooking is seen as a significant risk-reduction tactic.

Abattoirs are a significant source of pollution because the atmosphere in the slaughterhouse and the methods used to kill the animals are key factors that influence how wholesome and safe the meat is. And as such, the presence of pathogens in meat, environmental pollution, unhygienic practices in abattoirs and during post-process handling may pose health hazards to customers. Finally,

abattoirs need to adopt the hazard analysis critical control point (HACCP), sanitation standard operating procedure (SSOP), good manufacturing practice (GMP), and good hygienic practice (GHP) for meat safety (Alum et al., 2016).

2.2 Theoretical Framework

2.2.1 The Health Belief Model (HBM)

The Health Belief Model (HBM) was developed in the 1950s by Kurt Lewin. It is a psychological model that explains and predicts health behaviours by focusing on the attitudes and beliefs of individuals. The model covers three major areas: background, perceptions and action. The background covers diverse demographic, socio-psychological and structural variables that affect an individual's perception and thus indirectly influence health related behaviour. Perceptions cover perceived threat and perceived expectations. The perceived threat consists of perceived severity of a health condition. The HBM model is interactive in nature and has four primary dimensions which include: Perceived susceptibility, Perceived severity, Perceived benefits, Perceived barriers.

Perceived Susceptibility: This is a person's subjective perception of the risk of contracting a particular health condition. In health education, a person who feels that a dirty environment can contribute to a health problem will do everything possible to avoid contracting the disease condition. On the other hand a person who for some reasons sees himself as immune to the disease may not feel susceptible to the health condition.

Perceived Severity: This has to do with a person's feeling concern the seriousness of contracting an illness or leaving it untreated when contracted. This includes the difficulties the illness will create. **Perceived Benefits:** This involves the effectiveness of the various available health strategies one has designed to reduce the threat of illness or the benefits one can gain in reducing the perceived threat from the health problem.

Perceived Barriers: This refers to the perceived negative aspect of the recommended course of action which may act as impediment to full appreciation of the indicated health behaviour. Sometimes, actions do not take place even though individuals may believe that the benefits of the action are effective. The relevance of the model to this study lies in its implications for health behaviours. It can form a basis for any research meant to explore a variety of health behaviours in diverse populations. A health educator using this model is expected to investigate the background of the research participants and guide them to appreciate threats (dangers) posed by their activities. The severity of the problem is also expected to be understood by them. This will help them to appreciate the benefits of the health education programme and take necessary actions to overcome such barriers. Their perceived self-efficacy to perform the action required to maintain a clean environment will sustain the positive effects of the health education programme especially among meat vendors. In the application of this model, the vendors need to be made to understand that they are susceptible to health problems emanating from dirty environment. They should also be made to understand the severity of

diseases resulting from unhygienic practices in both abattoirs and meat stalls. They should as well understand the benefits of maintaining clean and safe environment within the abattoir and meat stalls in order to avoid meat contamination. In this same vain they should be taught the necessary steps to overcome the barriers to maintaining healthy environment or personal hygiene.

2.2.2 Theory of Reasoned Action (TRA)

The theory of reasoned action (TRA) was developed by Ajzen and Fishbein (1980). This theory provides a construct that links individual beliefs, attitudes, intentions and behaviours based on the premise that human beings are rational and that the behaviours being explored are under volitional control.

1. Behaviour: A specific behaviour defined by a combination of four components: action, target, context, and time (e.g., implementing health education programme by health educators (action) to help meat vendors (target) in abattoirs and meat stalls to maintain hygienic practices (context) every time (time)).

2. Intention: The intent to perform a behaviour is the best predictor that a desired behaviour will actually occur. In order to measure it accurately and effectively, intent should be defined using the same components used to define behaviour: action, target, context, and time. Both attitude and norms, described below, influence one's intention to perform behaviour.

3. Attitude: A person's positive or negative feelings toward performing the defined behaviour.

4. Behavioral Beliefs: Behavioural beliefs are a combination of a person's beliefs regarding the outcomes of a defined behavior and the person's evaluation of potential outcomes. In the context of this study, behavioural beliefs may refer to the vendors' beliefs regarding environmental health and benefits (concerns) derivable from the environmental health education instructional programme.

5. Norms: A person's perception of other people's opinions regarding the defined behaviour.

6. Normative Beliefs: Normative beliefs are a combination of a person's beliefs regarding other people's views of a behaviour and the person's willingness to conform to those views. The TRA provides a framework for linking each of the above variables together. Essentially, the behavioral and normative beliefs -- referred to as cognitive structures - influence individual attitudes and subjective norms, respectively. In turn, attitudes and norms shape a person's intention to perform behaviour.

Finally, as the proponent of the TRA argue, a person's intention remains the best indicator that the desired behaviour will occur. Overall, the TRA model supports a linear process in which changes in an individual's behavioural and normative beliefs will ultimately affect the individual's actual behaviour. TRA is very relevant to the current study. First, it implies a health educator wishing to improve on the health knowledge and practice of meat vendors, for example, should take action, identify the target group, the context and time for programme. These are very important as their absence may not lead to the desired behaviour.

In the same manner, the above behavioural components should define the intention of both the health educator and the meat vendors. This will guide them to work towards the same goal based on the norms establishing the business or environmental norms with reference to human activities and human health. Social Cognitive Theory This is a theory of human functioning developed by Bandura in 1986. It is based on the idea that person's, behaviour, and environment are all key factors in influencing a person's development and learning. The theory describes human functioning as the triadic interaction between person, behaviour, and environment. Personal factors that affect behaviours include thoughts, beliefs and attitudes. Behavioural factors include the effects of prior performance and quality of the engagement in a task.

Environmental factors involve access to information, external feedback, and help from other participants or from evaluators. Bandura suggested that each of these three factors (personal, behavioural, and environmental) can influence one another and will in turn be influenced by it. Specifically, how one thinks can affect what one does and how one perceives the environment. One's behaviours can change one's environment and influence how one thinks of oneself; and the environment can affect how we think and what one does. This notion of the triadic interaction can be specifically applied to understanding the nature of human functioning. The relevance of the above theory to the current study lies in self-regulation which occurs during the reciprocal interaction of the environment and the person, mediated through the behaviour.

Thus, self-regulation is an ongoing process that occurs during the interaction among the person, the behaviour and the environment and during this interaction, self-regulatory functioning involves several key sub-processes: planning; self-monitoring; self-evaluation and self-reaction. These sub-processes are very important in understanding meat vendors' health knowledge and practices. For instance, when placing for the programme, the vendors should be made to set task-specific goals that are used as criteria to guide their cognition in general.

Again, the researcher should help the vendors to be aware and monitor various aspects of their cognition and progress towards the goals they have set. The researcher should also help the vendors to evaluate the possible discrepancy between their ultimate goal and the progress they have made toward the learning goals based on the information collected from self-monitoring. The vendors should be made to engage in self-reaction through which they generate responses to the outcomes of their performances and the responses in turn guide and motivate their future actions. These self-regulatory actions are highly related to improvement in the vendors' health knowledge and practices.

2.3 Empirical Review

This review is concerned with previous reports of other researchers who have carried out work relating to meat, meat hygiene, meat hygiene practices, abattoir hygiene practices and presence of microorganisms associated with abattoir facilities.

2.3.1 Previous Reports on Abattoir Sanitary Practices and Meat Hygiene Practices among Butchers

Kehinde et al. (2023) reported on Assessment of Knowledge, Attitude, and Practice of Meat Hygiene among 318 Meat Handlers in Lagos State, Nigeria, using a structured questionnaire. Their findings showed that majority had good knowledge (71.1%), attitude (53.1%), and practice (66.6%) of meat hygiene. There was also significant association between knowledge and age; tribe and length of work experience. There was also a statistically significant association between practice of meat hygiene and age ($P < 0.001$), tribe ($P = 0.0174$), level of education ($P = 0.0029$), work experience ($P < 0.001$), and religion ($P = 0.0194$). There was statistically significant association also between knowledge and practice of meat hygiene ($P < 0.001$). Older meat handlers with more years of work experience (>20 years) had better knowledge and practice of meat hygiene compared to their younger colleagues.

Izunobi et al. (2023) reported on Assessment of Meat Hygiene Practices in Abattoirs and markets in Owerri West LGA., Imo State, Nigeria. A descriptive

cross-sectional survey was carried out among 92 meat handlers in Owerri West LGA, Imo State, Nigeria, who were selected using a multistage sampling technique. A structured questionnaire was used to collect the data concerning their practice of meat hygiene, and data analysis was done using SPSS version 21. Chi-square statistics was used to test the association between the variables at the level of significance of 5%. It was found out that there is association between respondents' sex and their knowledge of meat hygiene, we found that $p = 0.191 > 0.05$ level of significance which shows that there is no association between respondents' sex and their knowledge of meat hygiene and also that there is a relationship that exists between respondents' levels of education and knowledge, attitude and hygiene practices with p-values less than 0.05 level of significance.

Eljamay et al. (2022) reported on Assessment of Knowledge, Attitudes, And Perceptions of Safety and Prevention Procedures among Butchers in Derna and Neighboring Areas / Libya. The study was conducted from different through personal interviews with butchers in the city of Derna and its suburbs, (Karssa, Martouba) and collecting questionnaires from them. It is noticeable the percent of knowledge answered for Butcher, which receives vaccination (60%), which using PPE 58%, which check regally (66.7%), which know the discarded methods of wastes, (52.7%), which know the diseases which transmitted by meat (59.3%), which receive education program the control and prevention (44%). The results indicate that the study found no relationship between the extent of awareness of

butchers and their practices in some questions and in some other questions there is no relationship between the level of education and awareness.

Subedi et al. (2022) reported on Meat Handling Practices among Retail Meat Shops in Dharan Sub-Metropolitan City. A cross-sectional survey was conducted among retail meat shops located in Dharan Submetropolitan City. All the meat handlers who were members of either of two local meat organizations (Masu Byabasayi Shang and Masu Prabidhaik Byabasayi Sang) were included in the study. A total of 117 retail meat shops were randomly selected and interviewed using a semistructured questionnaire. 98.3% of respondents were unaware of Slaughterhouse and Meat Inspection Act, 52.1% of the butchers didn't wear an apron, 76.1% of butchers did not have an evisceration facility, antemortem and post mortem practices were rarely practiced and more than 80% did not use detergent-water for cleaning function. On a 21-point rating score for good hygienic practices, 41.88% of meat shop fell into the poorer category getting less than 45% score showing significant association ($p < 0.05$) with the type of meat, sex of the worker and training received. General hygiene practices in most of the meat shop of Dharan have not been observed satisfactory.

Miner et al. (2020) reported on Knowledge and Practices of Meat Hygiene among Meat Handlers and Microbial Profile of Meat in the Jos Abattoir, Plateau State. A cross sectional study conducted among 128 butchers and meat handlers in the Jos abattoir selected by total population sampling technique. Data on knowledge and practice was collected using a semi-structured interviewer-administered

questionnaire. Sampled meat products were analysed for bacterial load using Serial Dilution technique and bacterial pathogens identified by standard procedures. Epi Info statistical software was used for data analysis at a 95% confidence limit. The mean age of respondents was 32.8 ± 10.4 years and all were males. A fair knowledge of meat hygiene was found among 55.5% of respondents while 8.6% were adjudged to have good meat hygiene practices. The mean bacterial load for sampled meat for sale was $2.5 \times 10^3 \pm 3.4$ cfu/ml. Main bacterial isolates identified were *Escherichia coli*, *Pseudomonas* spp and *Enterobacter* spp. This study knowledge of meat hygiene was mostly fair among respondents with a low level of meat hygiene practices and a high level of meat bacterial contamination. The study recommended training for meat handlers for hygiene maintenance, increased inspection of meat sold to the public and provision of standard facilities to ensure the maintenance of a good level of meat hygiene.

Laban et al. (2021) reported on Evaluation of Different Hygienic Practices Applied in Slaughterhouses and its Effect on Beef Quality. A structured questionnaire was prepared to assess the knowledge of 45 workers from three different slaughterhouses (15 per each slaughterhouse) regarding the hygienic and sanitary practices during slaughter and processing of beef. A total of 91 swabs were collected from 3 different slaughterhouses in Cairo-Egypt (30 swabs per each slaughterhouse and one control negative swab). 6 swab samples were obtained from each type of beef contact surfaces and equipment that include; floor, walls, knives, hooks and workers' hands. Beef samples (n=36) each of 100 g (50 g from fore

Shank and 50g from opposite hind Shank) were collected from the 3 slaughterhouses (12 sample per each slaughterhouse) representing 100% of carcasses. Results showed that total bacterial counts of beef samples were 3.1, 4.39, 4.43 log₁₀ CFU/g for slaughterhouses 1, 2, and 3 respectively. Total coliform counts were nil for beef samples of slaughterhouses (1) and (2) and 4.43 log₁₀ for that of the slaughterhouse (3). TBCs of water samples were 1, 1, and 1.3 log₁₀/ml respectively while coliforms were negative for all samples. TBC of wall, floor, Knives, hooks, and workers' hand' s swabs were highest in the slaughterhouse (3) followed by slaughterhouse (2) and lowest counts were found in the slaughterhouse (1).

Pradhan et al. (2018) reported on Comparative Microbial Load Assessment of Meat, Contact Surfaces and Water Samples in Retail Chevon meat Shops and Abattoirs of Kolkata, W.B, India. The study was carried out selecting meat shops both from retail (n=8) and municipality abattoirs (n=2) located in and around Kolkata, West Bengal. A total of 348 (288 from retail and 60 from abattoirs) samples were collected aseptically from the hands of workers, floor, cutting platform (wood), surface of cutting instruments (Knife) along with water and meat samples from retail shops and organized abattoir maintained by Kolkata municipality. The TPC, FCC and TSC were 6.27±0.48, 4.16±0.32 and 3.85±0.42 log cfu/cm² for floor, 3.46±0.11, 1.36±0.17 and 2.34±0.28 log cfu/cm² for hands of the workers and 3.12±0.18, 2.14±0.09 and 2.11±0.36 log cfu/cm² for cutting knife used in the abattoir. On the other hand, the TPC, FCC and TSC values were

7.86±0.53, 5.69 ± 0.21 and 4.76±0.40 log cfu/cm²; 3.85±0.09, 1.98±0.16 and 3.88±0.31 log cfu/cm² ; and 4.31±0.22, 3.04±0.13 and 3.55±0.32 log cfu/cm² for floor, hands of workers and cutting knife, respectively in retail meat shops. The meat samples of retail shop had comparatively higher mean values of TPC (6.22 ±0.48 vs 5.14±0.12), FCC (4.22 ±0.28 vs 3.04±0.05) and TSC (3.33 ±0.11 vs 2.74±0.11) log cfu/cm² than meat samples from abattoir.

Siluma et al. (2023) reported on Evaluation of Meat Safety Practices and Hygiene among Different Butcheries and Supermarkets in Vhembe District, Limpopo Province, South Africa. Samples were collected from different village butcheries (6), commercial butcheries (8), and supermarkets (18) through direct personal observations. The supermarkets and commercial butcheries wore personal protective equipment (PPE) and used proper waste procedures. Moreover, there were pest control devices, a safe water supply, and staff handling money away from meat. At village butcheries, wearing hairnets and aprons, and the display of raw meat being separate from offal were identified as good practices. The irregular washing of hands (67%), less use of gloves (83%), wearing of open sandals (67%) and jewelry (33%), use of the same coat for different activities (100%), lack of paper towels (100%) and pest control devices (67%) and mismanagement of waste (33%) were practices that led to unsafe meat handling. The study identified good meat safety practices at supermarkets. A combination of good and unhygienic meat handling practices were identified at commercial and village butcheries. These findings suggest a need for intervention through training on food safety in order to

improve the hygienic practices of meat handling along the beef supply chain, more especially in commercial and village butchereries.

Ruot et al. (2023) reported on Hygiene Practices and Associated Factors among Meat Handlers at Butcher Houses and Restaurants in Gambela Town, Southwest Ethiopia. A sampling frame of 1,080 workers was obtained from the total number of restaurants, meat selling shops, and restaurants in the town. A sampling interval (K) was calculated. Finally, a participant was selected for every two individuals until the final 422 individuals were sampled. This study showed a low prevalence of good hygiene practices of 40.6% (36.0– 45.6) among meat handlers at butcher houses and restaurants in Gambela, southwest Ethiopia. Low levels of good hygiene practices were significantly related to education (i.e., having a secondary education) (AOR: 95% C.I., 2.51: 1.17– 5.41) and food hygiene training (i.e., receiving training on general safe food hygiene) (AOR: 95% C.I., 5.11: 2.55– 10.23).

Gebeyehu et al. (2022) reported on Food Safety Knowledge and Practice of Abattoir and Butcher Shop Workers: A Health Risk Management Perspective. The cross-sectional study design, using structured questionnaire interviews was used to assess the knowledge and practice of abattoir and butcher shop workers. A total of 226 randomly selected workers were participated in this study and bivariate logistic regression was used for data analysis. Of 226 total participants, 46% were abattoir workers and 54% were butcher shop workers. Majority (88.9%) of the participants did not know about meat safety and 74.3% of the participants had insufficient

practices. The cumulative knowledge of both abattoir and butcher shop workers was significantly associated ($p = 0.001$) with their knowledge of the presence of diseases causing agents in meat, the source of meat contamination, and the common critical points of meat contamination along the meat value chain. The cumulative practice of abattoir workers was significantly associated with their practices on daily meat transporting vehicle washing ($p = 0.007$), reducing meat contamination ($p = 0.001$), duration of animal fasting before slaughter ($p = 0.039$), cleaning of the animal body before slaughter ($p = 0.002$), cleaning material used in the abattoir ($p = 0.003$), disposal of abattoir waste ($p = 0.002$), and type of biosecurity measures used ($p = 0.013$). Similarly, the cumulative practice of butcher shop workers was associated ($p = 0.001$) with their practices of attracting customers, storing remaining meat from daily sales, and measures on contaminated food. Employment of the participants was significantly associated with both the cumulative knowledge ($p = 0.007$) and practice ($p = 0.001$) of the participants while the age of the participants was associated ($p = 0.001$) with only their cumulative practices.

Bhandari et al. (2022) reported on Factors Associated with Meat Hygiene Practices among Meat-Handlers in Metropolitan City of Kathmandu, Nepal. A cross-sectional study was designed with a semi-structured questionnaire and observation checklist that collected information about hygiene practices from 320 consenting meat-handlers by interviewer-administered technique. Data was entered in Epi-Data and analyzed using IBM SPSS version 21. Descriptive statistics of frequency distribution were used to report meat hygiene-practices and other independent

variables, with multivariate logistic regression to establish predictors of meat hygiene-practices at 5% level of significance. The study revealed that less than half (44.4%) of the meat handlers had satisfactory meat hygiene practices. The adjusted regression analysis showed, strong evidence ($p < 0.01$) of association of higher education level (AOR = 2.8, 95% CI = 1.7– 4.5), other occupational involvement (AOR = 2.2, 95% CI = 1.9– 2.4), and being officially registered (AOR = 2.8, 95% CI = 1.2– 6.8) with meat hygiene practices. However, there was fair evidence ($p < 0.05$) of association between shorter duration of meat being processed to sale (AOR = 0.57, P = 0.042) and meat hygiene practices. In this study, the satisfactory meat hygiene practices of meat handlers were low. The educational level, registration status of shops, involvement in other jobs, and awareness on meat hygiene were identified as key factors associated with meat hygiene practices.

2.3.2 Previous Reports on Microorganisms Associated with Abattoir Facilities and Meat Contact Surfaces used by Butchers

Odetokun et al. (2021) reported on Bacterial Contamination of Surfaces and Facilities at the Ultra-Modern Abattoir Ilorin, North Central, Nigeria. Sample collection was carried out weekly for a period of 12 months (November 2019 to January 2020). A total of 261 samples were collected randomly from selected slaughter units in the abattoir during active slaughter operations. samples included water (n=16), meat (n=14), and surface swabs (n=231); butchers' knives (n=50), clothes (n=50), palmar surface of hands (n=9), foot wear (n=50), table surfaces (n=5), floor (n=31) and wall (n=36). The surface swabs were collected using sterile

swab sticks. Significant differences and association between samples were determined using Tukey's Multiple Comparison Test and Carl Pearson Correlation Matrix, respectively, on GraphPad Prism with $p < 0.05$ considered as significant. Generally, the SPC and TCC for all samples exceeded the acceptable limits for meat and potable water set by WHO, CDC, and EU regulations. The floor had the highest mean count for SPC ($8.66 \pm 8.24 \log \text{cfu/cm}^2$) and TCC ($6.02 \pm 5.85 \log \text{cfu/cm}^2$). Water sourced from the borehole had no significant count for coliform as opposed to the water from the well ($4.43 \pm 4.32 \log \text{cfu/ml}$). There was a significant association between the contamination levels of butchers' hands and processed meat ($p < 0.05$).

Nuguse et al. (2022) reported on Assessment of Good Hygienic Handling Practices and Microbial Load of Meat and its Contact Surfaces in Bedele Town, Buno Bedele Zone, South West Ethiopia. Samples for laboratory analysis were taken from all 25 butcher shops and 40 butchers were administered with study questionnaires in the area. All microbiological samples were inoculated to general and different differential and selective media for bacterial counting. Data were analyzed using IBMSPSS statistics 20 version using descriptive statistics and one way ANOVA. A total of 125 samples from Meat cutting boards, Hands, Knives and Meat hanging hooks and meat were collected and analyzed for total viable counts and obtained as $6.44 \pm .67 \log_{10}/\text{cm}^2$, $6.12 \pm .66 \log_{10}/\text{cm}^2$, $6.08 \pm .87 \log_{10}/\text{cm}^2$, $6.20 \pm 86 \log_{10}/\text{cm}^2$ and $6.26 \pm .87 \log_{10}/\text{g}$ in that order. A mean counts for Enterobacteriaceae, total *E. coli* and total *Staphylococcus* counts were $5.32 \pm$

.65log₁₀, 5.19 ± .86log₁₀ and 5.05 ± .75log₁₀ respectively. From surveyed 25 butcher shops, none of them had refrigerator and cleaned the butcher shop surfaces using sanitizers and disinfectants. About 67.5% of butchers wore white coat always at work and 52.5% butcher men had no head cover and the rest wore sometimes. None of butcher shops had separate cashier and only 42.5% of butchers had valid health certificate and follow medical checkup at six months interval.

Zailani et al. (2016) reported on Microbial Evaluation of Meat Contact Surfaces in Red Meat Abattoirs of Bauchi State, North-Eastern Nigeria. Two hundred and forty 240 swab samples (SS) from MCS that include cutting equipment, floor, tables and transport media were collected for total aerobic plate count and isolation of *E. coli* O157. Results of the SS indicated a mean value 7.1 ± 0.3 log₁₀ cfu/cm². A minimum value of 6.4 ± 0.6 log₁₀ cfu/cm² was recorded on cutting instrument from Ningi abattoir, while a maximum value of 7.8 ± 0.3 log₁₀ cfu/cm² was obtained from tables at Darazo abattoir. Only 3 (1.2%) of the 240 SS of the MCS were positive for *E. coli* O157 using the latex agglutination kit (Difco, Michigan, USA).

Gurmu and Gebretinase (2013) reported on Assessment of Bacteriological Quality of Meat Contact Surfaces in Selected Butcher Shops of Mekelle city, Ethiopia. They utilized total of 72 swab samples obtained from the butchers' knives, processing tables and workers' hands. The swab samples were inoculated on plate count agar for enumeration of bacterial load and on different selective media to isolate pathogenic bacteria. Out of the 72 swab samples they obtained, 24 each were

collected from tables, workers' hands and knives of butcher shops. Gurm and Gebretinase (2013) generated a structured questionnaire to assess the knowledge of butchers on hygienic processing of meat. The swabs collected at the pre-processing stage were analysed and the mean bacterial count ($\log_{10}\text{cfu}/\text{cm}^2$) was found to be 6.28, 5.67 and 5.30 from tables, hands and knives, respectively. On the other hand, Gurm and Gebretinase (2013) found that the result for post processing was 6.56, 6.15 and 6.89 from tables, hands and knives, respectively as well. Their study showed that *E. coli* was the predominant isolate (32%) followed by *Staphylococcus* species (28%) while the least bacterial isolates were *Streptococcus* species and *Salmonella* species with frequency of isolation 20% each. Gurm and Gebretinase (2013) therefore revealed higher potential of contamination of meat from the working surfaces.

2.4 Summary of Literature Review

The review of related literature covered conceptual framework, theoretical framework, theoretical studies and empirical studies. Under the conceptual framework, such concepts as abattoir, basic requirements in abattoir, environmental problems in abattoir, abattoir waste, public health importance of abattoir waste, health and environmental challenges of abattoir, occupational hazards associated with abattoir operation, ways of managing abattoir waste, butcher, steps in butchery by butchers, hygiene, meat, sources of contamination of meat in abattoir, and stages of meat contamination were defined. Other concepts defined under this sub-heading included health knowledge, health practice and meat vendors.

Under theoretical framework, three theories were discussed. The theories included; Health Belief Model, Theory of Reasoned Action and Social Cognitive Theory. Each of the theories was first reported and their relevance to the current study was also highlighted. The three theories combined to give the study its theoretical base. The theoretical studies comprised the common meats handled by vendors including their contaminations and preventions. Another aspect discussed under this subheading included meat and abattoir waste as well as environment pollution.

Several studies were reviewed under the empirical studies. Some of the studies reviewed were on knowledge, attitude and hygiene practices of meat vendors and abattoir operations. Other aspects of empirical studies covered included studies on presence of microorganisms on meat contact surfaces. Though meat handling and practices were implied in the studies, it is important to note here that none of them indicated the effect of sanitary hygiene practices of butchers on the microbial quality of abattoir facilities. Secondly none of the studies was specifically on butchers in Owerri municipal, Imo State. The above shows that serious research efforts have not been done on the environmental health education programme on health knowledge and practices of meat vendors especially in Owerri municipal, Imo State. An obvious gap in knowledge has therefore been noticed. This study is therefore intended to bridge the above gap in literature.

CHAPTER THREE

MATERIALS AND METHODS

This chapter presents methods and procedures used for the study under the following subheadings.

3.1 Research Design

A cross-sectional descriptive experimental design was used in this study. The attempt is to collect data about one or more variables in a population (Gay, 2005). According to Nworgu (2006), descriptive studies aim to collect data and describe them, stating the characteristic features of the population of the study.

3.2 Study Area

The study was conducted in Owerri Municipal, located in the central capital of Imo State, Nigeria. Owerri municipal lies within the headquarter and covers about 58km² area with an estimated population of 127,213 according to the 2006 census. Owerri town comprises five villages: Umuororonjo, Umuodu, Amawom, Umuonyeche, and Umuoyima (collectively known as Owerri Nchi Ise). There are two major abattoirs within study area: Somachi Abattoir behind ShopRite complex, and Relief Market Abattoir within the state capital Owerri.



Figure 1: Map showing Owerri Municipal

3.3 Population of the Study

The target population for the study consisted of meat handlers in Somachi abattoir and Relief market abattoir in Owerri Municipal. Their total population was 400

3.4 Sample Size and Sampling Method

3.4.1 Sample size

The sample size of the study was estimated from the population using the Taro Yamane method (Yamane 1968) for sample size. This method was formulated by the Statistician Taro Yamane in 1967 to determine the sample size from a given

population. Below is the mathematical illustration of the Taro Yamane's method for the present study:

$$n = \frac{N}{1 + N(e)^2} \quad (\text{Taro Yamane equation})$$

Where:

n signifies the sample size

N signifies the population under study

e signifies the margin error (it could be 0.10, 0.05 or 0.01)

For the present study, to determine sample size From N = 400 meat handlers, using e = 0.05:

$$n = \frac{N}{1 + N(e)^2} \quad \Rightarrow \quad n = \frac{400}{1 + 400(0.05)^2}$$

$$n = \frac{400}{1 + 400(0.0025)} \quad \Rightarrow \quad n = \frac{400}{1 + 0.96}$$

$$n = \frac{400}{1.96} \quad \Rightarrow \quad n = 200$$

Therefore, sample size was 200.

3.4.2 Sample and Sampling Technique

The sample size for the study consisted of 200 meat handlers at the two popular abattoirs in Owerri Municipal. The questionnaires were distributed to meat handlers through a systematic sampling technique where one (1) store interval in each row or column is skipped. This sampling method gives all meat sellers and butchers an equal probability of selection.

- i. In the Relief Abattoir, 100 meat handlers were randomly selected.
- ii. In the Somachi Abattoir, 100 meat handlers were randomly selected.

A total of 200 meat handlers were drawn from the entire population of the study.

3.5 Instruments for Data Collection

3.5.1 Questionnaire

The instrument used to collect data is the personal structured questionnaire. It consisted of 15 questions arranged in four sections as follows: Section A elicited socio-demographic data comprising age, sex, education among others. Section B elicited information on knowledge of meat hygiene, while Section C sought information on hygiene practice of meat handlers.

3.5.2 Bacteriological instruments

Sterile swab sticks moistened with normal saline was used to carefully swab the surfaces of the cutting equipments used by the butchers. The swab sticks were properly labelled and transported to the laboratory for microbiological analysis.

The surfaces were swabbed include; the floors, walls. knives, hooks used by the meat handlers, as well as their hands.

3.6 Validity of Instruments

The study questionnaire was carefully prepared by the researcher and the validity of the questionnaire was reviewed by the researcher's supervisor and two (2) other experts in the department. This was to ensure that the items in the questionnaire can elicit the intended information. Inconsistencies observed were corrected by experts before the final production of the questionnaire. For the bacteriological instrument, adoption of Miner et al. (2020) methods which includes Isolation of microorganisms from the butcher's cutting equipment, Microbial plate count, Colonial Morphology Identification, Purification and preservation of isolates, Gram staining of isolates, biochemical reaction of isolates, In vitro pathogenicity test, standardization of inocula, Antibigram of the isolated bacteria, and Antifungal susceptibility testing of the fungal isolates were adopted.

3.7 Reliability of Instruments

The questionnaire was administered to 200 respondents with similar characteristics to those in the target population. The reliability of the instrument was tested using Chrombach Alpha Coefficient of Reliability test, and a coefficient of ($r=0.70$) was deemed reliable.

3.8 Method of Data Collection

3.8.1 Descriptive Study

The researcher trained two research assistants who assisted in the data collection process. The introductory letter from the Head of Department was given to the Chairman. The questionnaire was administered to the respondent by the researcher and research assistant. The respondents that are literate were allowed to fill the questionnaire, but for those respondents that are non-literate, the questions were asked in local language and their responses were filled by the researcher (or research assistant).

3.8.2 Experimental Study

Collection of Samples

The sampling procedure described by Laban et al. (2020) was adopted in the collection of samples from two hundred (200) abattoir meat handlers. Forty (40) swab samples comprising twenty (20) swab samples from each of the abattoirs were obtained from each type of beef contact surfaces and equipment that include; floor, walls, knives, hooks and workers hands were collected. Sterile cotton-tipped swabs were moistened with sterile normal saline then rubbed against the sampling sites for around 30 seconds and then transferred to an individual screw-capped test tube containing 5 ml of sterile maintenance medium (0.85% NaCl and 0.1% peptone), samples were properly labeled.

Sterilization of materials

All the glasswares used for the experiment was sterilized using the laboratory hot air oven at a temperature of 160⁰C for 1 hour. Wire loop was sterilized over burning flame and allowed till red-hot, while glass spreader was sterilized by dipping into 70 % ethanol and passing over Bunsen flame. The media used in this study include nutrient agar, peptone water, eosin methylene blue agar, triple sugar iron agar, Simmon's citrate agar and Sabouraud Dextrose agar. They were prepared according to the manufacturer's instructions and sterilized using the autoclave at a temperature of 121⁰C at 15 psi for 15minutes and then allowed to cool to a temperature of 45⁰C. About 20 milliliter was poured into sterile petri-dishes. The plates were allowed to cool and set for inoculation (Cheesbrough, 2010).

Isolation of Microorganisms from the Abattoir Sanitary Facilities used by the Meat Handlers

The method described by Miner et al. (2020) was adopted in the isolation of microorganisms from the surfaces of the abattoir facilities (floors, walls, knives, hooks and workers' hands) used by the butchers. Swabs from sampled surfaces were inoculated in 10ml of peptone water by cutting the swabs aseptically into the peptone water, shaking and was allowed to stand for 20 minutes. The spread plate technique as described by Cheesbrough (2010) was used in the inoculation of the plates. 0.1 milliliter aliquot and was dropped onto the different media in the plates. A sterile bent glass rod was used to spread the aliquot evenly on the media (nutrient agar, eosin methylene blue agar and sabouraud dextrose agar). The plates

were labeled accordingly. The inoculated plates were inverted and incubated in the incubator at a temperature of 37 °C for 24 hours except Sabouraud Dextrose agar plates were incubated at room temperature (28°C) for three days.

Microbial Plate Count

After the incubation of the different plates, the different colonies formed on the media were counted using the digital colony counter. The total populations of the colonies were expressed as colony forming unit per swab (cfu/swab).

Colonial Morphology Identification

The method described by Cheesbrough (2010) was adopted in the colonial morphology identification. Presumptive identification of the colonies was done by observing their individual shape, colour, elevation, edge, surface, consistency and appearance on the media used for isolation. Colonies with characteristic metallic sheen on EMB agar and lactose fermenters on MacConkey agar were noted. The colonies were preserved in sterile agar slants in test tubes. Purified colonies were further characterized using Gram stain and biochemical tests.

Purification and Preservation of Isolates

After the various colony counts, bacterial isolates were picked with a wire loop based on their cultural and morphological characteristics. The picked colonies were sub-

cultured onto freshly prepared nutrient agar plates to obtain pure cultures. They were further incubated for 24hrs at 37⁰C. After incubation pure cultures were stored in McCartney Bottle in a refrigerator. Fungal isolates were sub cultured onto freshly prepared Sabouraud dextrose medium using needle tease method (Cheesbrough, 2010).

Gram Staining of Isolates

The Gram staining techniques described by Cheesbrough (2010) was adopted. The procedure was as following: A smear of the colony from pure culture was made on a clean grease-free glass slides to be stained. The smears were allowed to air dry and later heat fixed. Crystal violet was added to the slide and allowed for 1 minute. The slide was rinsed with a gentle stream of water for a maximum of 5 seconds. Gram's iodine was added for 1 minute, then the slide was rinsed again with water. The slide was rinsed with acid alcohol for 3 seconds and with water. The secondary stain, safranin, was added to the slide and allowed for 1 minute. The slide was rinsed with gentle stream of water for a maximum of 5 seconds. The stained slides were allowed to air dry and were viewed under a microscope using x40 and x100 objective lenses. Gram positive bacteria retained the primary stain (crystal violet) and appeared purple under the microscope. Gram negative, lost the primary stain and took the secondary stain, causing it to appear pink when viewed under a microscope.

Biochemical Reactions of the Isolates

❖ **Catalase Test**

Three milliliter (3ml) of hydrogen peroxide was poured in a test tube. A colony of test organism was taken with sterile wooden or glass rod and immersed into hydrogen peroxide solution. Generation of bubbles indicated oxygen production. Presence of bubbles indicated catalase positive while none indicated catalase negative.

❖ **Oxidase Test**

A piece of filter paper was placed in Petri-dish and 3 drops of freshly prepared oxidase reagent were added. Using a sterile glass rod, a colony of test organisms was removed from a culture plate and smeared on the filter paper. Oxidase positive organisms gave blue color within 5-10 seconds, and in oxidase negative organisms, color did not change.

❖ **Citrate Test**

A bacterial colony was inoculated in Simmon's citrate agar and incubated at 35°C to 37°C for 18 to 24 h. Thereafter, development of blue color was observed. Citrate positive showed that growth was visible on the slant surface and the medium became an intense blue while Citrate negative showed trace or no growth was visible and no color change occurred.

❖ **Indole Test**

Test bacterial colony were inoculated in peptone water and incubated at 37°C for 24-28 h. Thereafter, 0.5 ml of Kovac's reagent was added. Positive test showed pink colored ring was observed after addition of reagent. Negative test showed no color change after reagent addition.

❖ **Motility Test**

The semi-solid agar of nutrient agar was used for this study. The media were prepared in slants and the organisms were inoculated by stabbing technique. Zig-zag growth along the line of stabs indicates a positive result while none indicates a negative result.

❖ **Coagulase Test**

A drop of distilled water was placed on each end of a slide for each of the test organisms. Thereafter a colony of each of the test organism was emulsified in each of the drops to make two thick suspensions. A loopful of plasma was then-added to one of the suspension and mixed gently for each of the test organism. Clumping within 10 seconds was an indication of positive test while none was an indication of a negative test (Cheesbrough, 2010).

❖ **Sugar Fermentation Test**

Each colony of the different test organisms were inoculated onto sterile agar slopes of triple sugar iron agar using stab inoculation. After this, the inoculated, agar

slopes were incubated at 37°C for 24 hours. The different colors of the slopes and butts in addition to the presence of gas production and hydrogen sulphide (H₂S) blackening was an indication of the type of bacteria present (Cheesbrough, 2010).

***In vitro* pathogenicity test**

In vitro pathogenicity test of different bacteria was done by streaking pure culture of isolated bacteria on blood agar plate. The plates were incubated in B.O.D. at 30±2°C for 24 h. The pathogenicity of bacteria was confirmed by determining α - β zone of growing bacteria on the plates (Ryan & Ray, 2004).

3.9 Standardization of Inocula

The standardization of the inocula was carried out as described by Ede et al. (2017). The test organisms were inoculated by transferring representative organisms from fresh culture plate into sterile saline bottle. The mixture was shaken to achieve homogenous suspension. The homogenous suspension was adjusted to 0.5 McFarland's standard.

3.10 Antibiogram of the Isolated Bacteria

Antibiotic susceptibility profiles of the bacterial isolates were evaluated using disc diffusion assay. The antibiotic discs containing the following antibiotics will be used: tarivid (10mcg), riflacine (10mcg), ciproflox (10mcg), augmentin (30mcg), gentamycin (10mcg), streptomycin (30mcg), ceporex (10mcg), nalidixic acid (30mcg), septrin (30mcg) and ampicin (30mcg). The discs were aseptically placed

on the surface of Mueller-Hinton agar (MHA) plates that has already been seeded with 0.5 McFarland standard of the test isolates and was incubated at 37°C for 18-24hrs. After incubation, diameters of zone of inhibitions were observed and measured in millimeters accordingly. The interpretation of the measurement as sensitive and resistant was made according to the manufacturer's standard zone size interpretative table (CLSI, 2010).

3.11 Antifungal Susceptibility Testing of the Fungal Isolates

Antifungal susceptibility profiles of the fungal isolates were evaluated using agar well diffusion assay. Antifungal drugs such as; Ketoconazole® (200 mg), Fluconazole® (200 mg), Griseofulvin® (200 mg) and Nystatin® (500, 000 IU) were used in testing the antifungal effect against the fungal isolates. Each of 200mg of Ketoconazole®, Fluconazole®, Griseofulvin® and 500,000IU of Nystatin were dissolved homogenously in 200 ml of dimethylsulphoxide (DMSO) to obtain 1 mg/ml for Ketoconazole®, Fluconazole®, Griseofulvin® and 2,500 IU for Nystatin. The turbidity of the suspended cells was adjusted to match the turbidity standard of 0.5 McFarland's standard which was prepared by mixing 0.6ml of 1% barium chloride dehydrate ($\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$) and 99.4ml of 1% concentrated tetraoxosulphate (VI) acid (Conc. H_2SO_4). The turbidity was standardized using spectrophotometer at 660 nm which was equivalent to approximately 10^8 cells per millilitre. Each of the fungal isolates was carefully streaked onto the surface of Mueller-Hinton agar (MHA) plates supplemented with glucose that has already being seeded with 0.5 McFarland standard of the test isolates. Thereafter, 6 mm

cork borer was used to make a 6 mm agar well in the streaked petri-dishes containing the test fungal isolates. 0.1 ml each of the antifungal drug suspensions was pipetted and dropped into each of the wells made. The plates were labeled accurately and incubated at 30 ± 2 °C for 5 days. After incubation, diameters of zone of inhibitions were observed and measured in millimeters accordingly. The interpretation of the measurement as sensitive and resistant was made according to the manufacturer's standard zone size interpretative table (Chidi-Onuorah et al., 2017).

3.12 Method of Data Analysis

The data obtained from completed questionnaires were collated, analyzed, using statistical package for social sciences, (SPSS 2021) using chi-square analysis to determine the hygiene practices of butchers and presence of microorganisms from the cutting equipment.

3.13 Ethical Considerations and Informed Consent

The structured questionnaire included a consent note. The anonymity and confidentiality of the respondents was assured throughout the study.

CHAPTER FOUR

RESULTS

Chapter Four describes the results from the questionnaire generated data and experimental generated data from a mix of meat handlers and abattoir facilities selected randomly from two abattoirs in Owerri Municipal council. The data was gathered, collated, and then entered into an Excel spreadsheet before importing it to SPSS version 20 for descriptive and inferential analysis. Data from the findings were presented in tables and charts.

4.1 Socio-Demographic Characteristic of Respondents

Table 4.1 below shows that of the 200 participants in this study, the majority (32.5%) of respondents were within the age group 31-44 years, followed by those aged either less than 30 years or between 45 and 59 years (29%). There were fewer participants (9.5%) aged 60 years and above.

Most participants were male (89%), about 38.5% were single, 44.5% married, and the remaining were divorced, separated, or widowed. Only a few (18.5%) have attained tertiary education, whereas most have completed at least a secondary education. More than 90% of the respondents believe the abattoir is a public establishment.

Table 4.1: Socio-demographic Characteristics of Respondents

	Frequency	Percentage
Age group		
Less than 30 Years	58	29.0
31 - 44 Years	65	32.5
45 - 59 Years	58	29.0
60 Years and above	19	9.5
Gender		
Male	178	89.0
Female	22	11.0
Marital Status		
Single	77	38.5
Married	89	44.5
Divorced or separated	15	7.5
Widow	4	2.0
Widower	15	7.5
Educational attainment		
No formal Education	39	19.5
Primary (FSLC)	27	13.5
Secondary (SSCE)	97	48.5
Tertiary	37	18.5
Abattoir type		
Public	199	99.5
Private	1	0.5
Name of Abattoir		
Relief Abattoir	100	50.0
Somachi Abattoir	100	50.0

4.1.1 Nature of the Abattoir Somachi

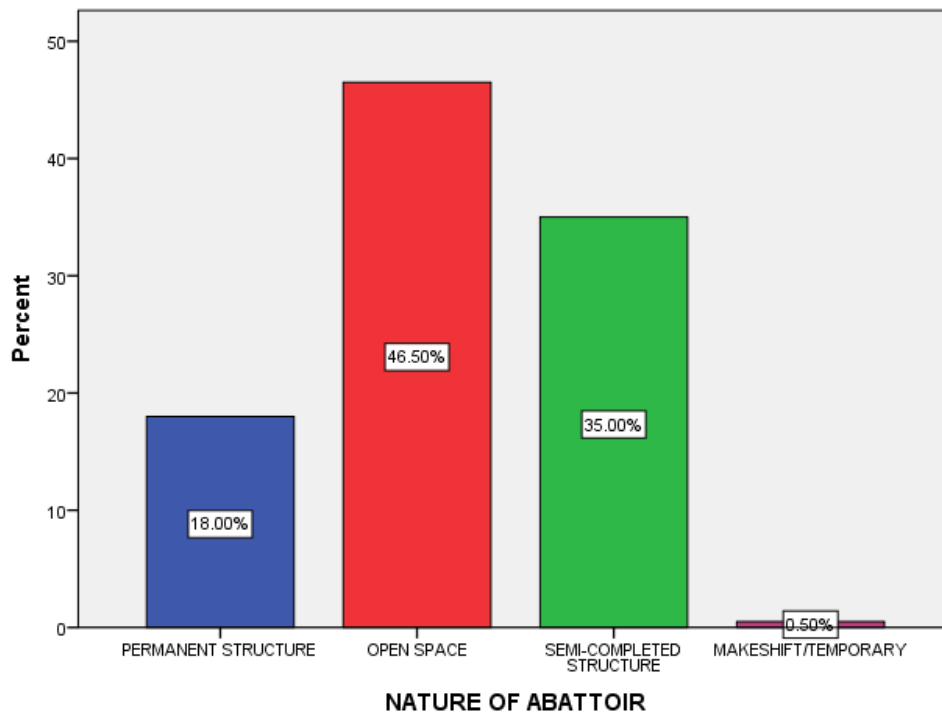


Figure 4.1: Nature of Abattoir

Similarly, the descriptive nature of the abattoirs was broken into makeshift (0.5%), Semi-completed structure (35%), open space (46.5%), and 18% as permanent structure.

4.2 Availability of Basic amenities and sanitary facilities

85.5% of respondents responded “ No” to the existence of tiles on floors where meat or animals are being butchered. However, according to environmental health regulations for hygienic practices, tiles are necessary to ensure the meat doesn’ t have contact with sandy surfaces and allow a free water flow during meat preparation. There were 99% responses that there was an available source of water. However, there were no proper mud-free drainage (88%) or sloppy floor (77%) for ease drainage of water or blood from the slaughter slab (see Table 4.2 below).

89.5% of responses were that there is an available toilet facility, while 77% of the responses were that there was availability of electricity for the abattoirs' operation. All the abattoirs have some resting places (lairage) for goats, sheep, or cattle before they are sold or slaughtered for meat.

Table 4.2: Basic amenities and sanitary facilities

	No (%)	Yes (%)
Availability of Tiles on floors	85.5	14.5
Availability of potable water	1	99
Proper and mud-free drainage	88.0	11.5
Sloopy floor for drainage	77.0	23.0
Availability of toilet facility	10.5	89.5
Availability of electricity	23.0	77.0
Availability of lairage	0.0	100

4.3 Method of Waste Disposal and Management

The table 4.3 below presents the responses to questions related to waste disposal methods used in abattoir premises. The responses are categorized into different levels of frequency, ranging from "Never" to "Always." Each row represents a specific waste disposal method, and the columns represent the frequencies of responses for each frequency level.

The most frequent response category for the incineration of waste is "Rarely" (56 responses), followed by "Never" (36 responses). This suggests that the use of incineration as a waste disposal method is not common among the surveyed participants. However, there is still a notable number of participants who reported occasional (33 responses), frequent (32 responses), or even consistent (43 responses) use of incineration.

For liquid waste, the responses are more evenly distributed across the different frequency levels. The most common response categories are "Rarely" and "Always," with 43 responses each. This suggests that there is some variation in the practice of appropriately dumping liquid waste, with a notable number of participants indicating both regular and infrequent practices.

The responses for landfill of waste show a relatively even distribution among the different frequency levels. The response category with the highest frequency is "Always" (42 responses), followed closely by "Never" (48 responses). This suggests that while a considerable number of participants reported regular open

dumping, a significant proportion also indicated that they never engage in this practice.

Responses for dumping wastes into water bodies are somewhat varied. The most frequent response category is "Occasionally" (47 responses), while the least common is "Always" (34 responses). There is a significant number of participants who indicated both occasional and frequent engagement in this practice.

The responses for waste segregation and proper disposal show a distribution that leans towards less frequent engagement. The most common response category is "Never" (50 responses), and the next common categories are "Frequently" (43 responses) and "Always" (39 responses).

The responses for burying wastes in the sand after disposal are widely distributed across the frequency levels. The response categories with the highest frequencies are "Frequently" (51 responses) and "Rarely" (46 responses). This suggests that burying wastes in the sand is a practice with varying degrees of frequency among the participants.

Table 4.3: Waste Disposal Methods

	Never	Rarely	Occasionally	Frequently	Always
Incineration of waste	36	56	33	32	43
Appropriate dumping of liquid waste	39	43	36	39	43
Open landfill	48	38	37	35	42
Dumping of wastes into the water body	41	37	47	41	34
Waste segregation and proper disposal	50	32	36	43	39
Waste burial	38	46	29	51	36

4.3.1 Source of water

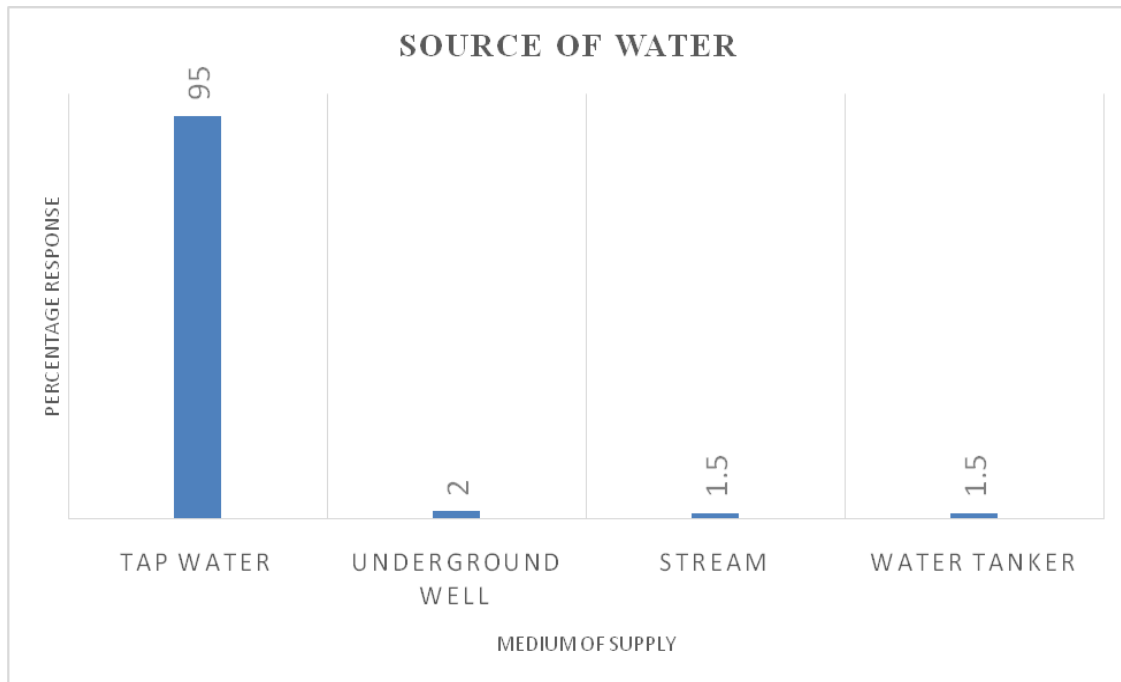


Figure 4.3.1: Sources of Water Supply

Figure 4.3.1 above presents different sources of water supply for the abattoir premises. The sources are categorized as “Tap water,” “Underground well,” “Stream,” and “Water tanker,” and the corresponding numbers represent the percentage distribution of each source.

The overwhelmingly dominant source of water supply for the abattoir premises is tap water, accounting for 95% of the responses. This high percentage indicates that tap water is the primary and most commonly used source of water for various activities within the abattoir. A small proportion of respondents (2%) indicated the use of underground wells as a source of water supply. This suggests that a very limited number of abattoirs draw water from underground wells. A minor percentage (1.5%) of respondents mentioned utilizing streams as a source of water supply. This indicates that a small number of abattoirs may be drawing water from

nearby streams. A similar percentage (1.5%) of respondents reported using water tankers as a source of water supply.

4.4 Meat Handling and Storage

The table 4.4 below presents responses (No or Yes) related to meat handling and storage practices in abattoirs. Each row represents a specific aspect of meat handling and storage, and the columns represent the percentages of responses for each agreement level. For the aspect of safe and hygienic handling of meat, the majority of responses (88%) were ‘ Yes’ . This is a significant percentage, suggesting that a considerable portion of participants believe that meat handling practices in the abattoirs are safe and hygienic. It’s worth noting that a smaller percentage of responses (12%) were in disagreement with this; indicating that there is room for improvement in addressing concerns related to safe and hygienic meat handling practices.

For the aspect of availability of storage and preservation facilities, the results paint a less positive picture. 90% of responses were “ No” , representing disagreement with the availability of these facilities. On the positive side, a small percentage of respondents 10% agreed with the availability of these facilities. However, these percentages are notably lower than the levels of disagreement, indicating the need for improvements in this area.

Table 4.4: Meat Handling and Storage

	No	Yes
Safe and hygienic handling of meat	12.0	88.0
Availability of storage and preservation facility	90.0	10

4.4.1 Availability of Sterilization Facility and Adequate Transportation of Meat and Meat Products

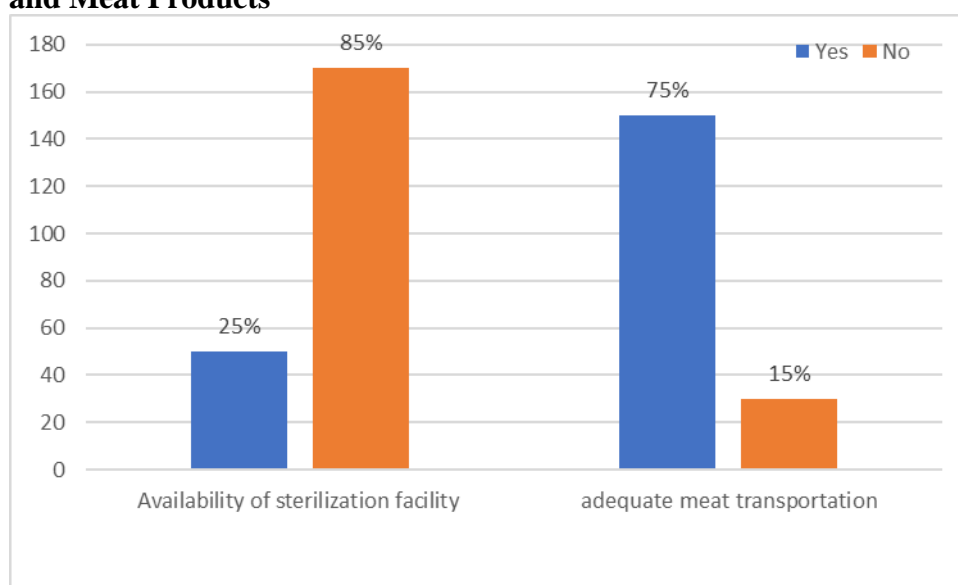


Figure 4.4.1: Availability of Sterilization Facility and Adequate Transportation of Meat and Meat Products

There was a lack of appropriate sterilization facilities. There was the availability of different transportation of meat and meat products (see figure 4.3), mainly a combination of cars or pickup vehicles, wheelbarrows, minibuses, or tricycles (see figure 4.4.2 below).

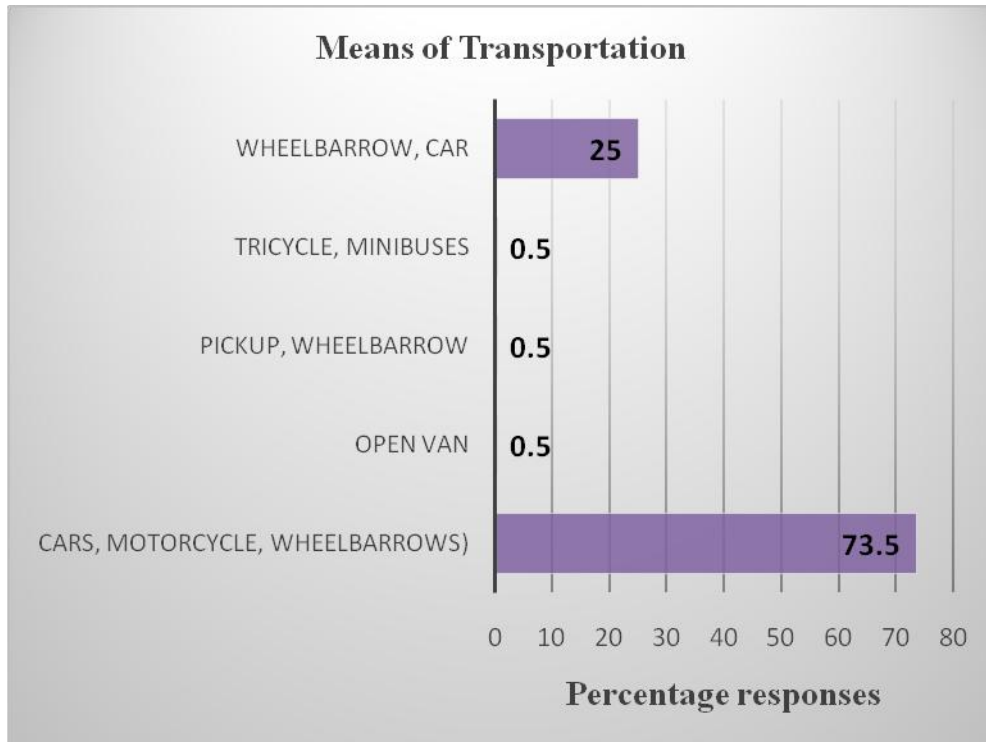


Figure 4.4.2: Means of Transportation

4.5 Abattoir Regulation and its Implementation

The result from Table 4.5 shows that majority of the respondents agreed that there were inspections pre and post-mortem by Environmental Health Officers. On whether “ Officers do not collect fine” for the inspection process, the distribution of responses were almost evenly spread with “ No” (60.5%) than “ Yes” (39.5). Also, majority of responses were “ No” (62.5%) to both statements that “ Butchers have copies of rules and regulations” and there were “ Daily monitoring by Officers” (64.5%). However, response on bribing by Butchers to the Monitoring Officers generate almost as much “ No” (52.5%) as “ Yes” (47.5%).

Table 4.5: Abattoir Regulation and Implementation

	No	Yes
Regular inspection before slaughter by Officers	4.0	96.0
Regular inspection after slaughter by Officers	4.5	52.0
Officer don't collect fine	60.5	39.5.0
Butchers have copies of rules and regulations	37.5	62.5
Daily monitoring by Officers	35.5	64.5
Butchers bribe Monitoring Officers	15.5	37.5

4.5.1: Possession of Valid Medical Examination Certificate

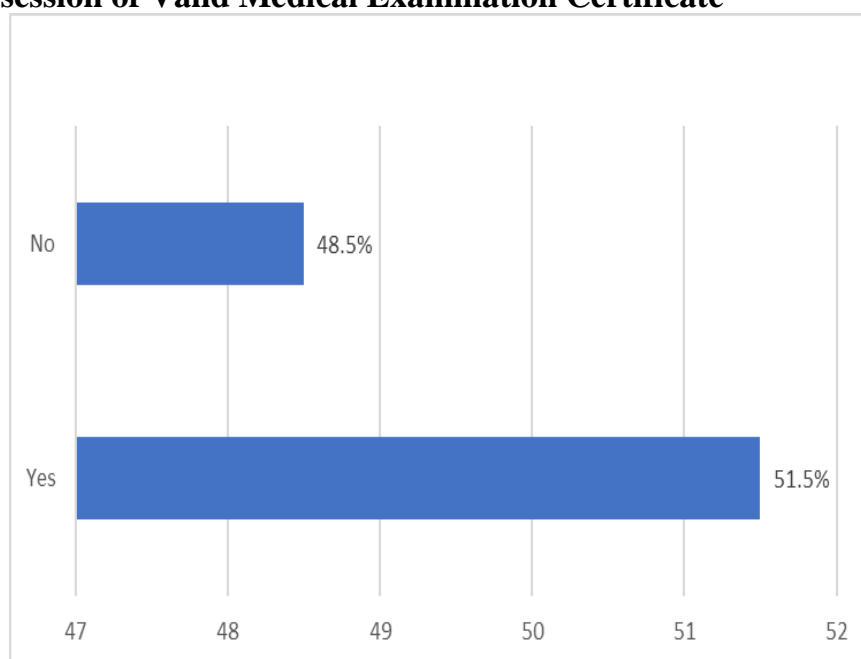


Figure 4.5: Valid Medical Examination Certificate

Figure 4.5 shows while 51.5% have a valid medical examination certificate, the rest do not.

4.6 Protection and Personal Hygiene Practice

From Table 4.6 below, majority of the respondents undergo medical examination only when sick (37%) while 24% did so more than twice a year (24%). Protective gears were utilized mostly only once a year (42%) or when respondents were sick (21%). While practicing personal hygiene like cutting fingernails before handling meats is not as often as possible, washing meat handling clothes or an apron is more common than even washing hands after using the toilets (See table 4.6 and figure 4.6).

Table 4.6: Protection and Personal Hygiene Practice

	Never	Only When Sick	Once a Year	Twice a Year	More than Twice a Year
Undergoes medical examination	14.0	37.0	11.5	13.5	24.0
Use of protective gears	9.5	21.0	42.0	12.0	15.5
Cutting of fingernails before meat handling	.05	17.0	37.5	27.0	18.0
Washing of meat-handling aprons	0.0	0.5	2.0	10.5	87.0
Handwashing after toilet use	0.5	6.5	27.5	31.5	34.0

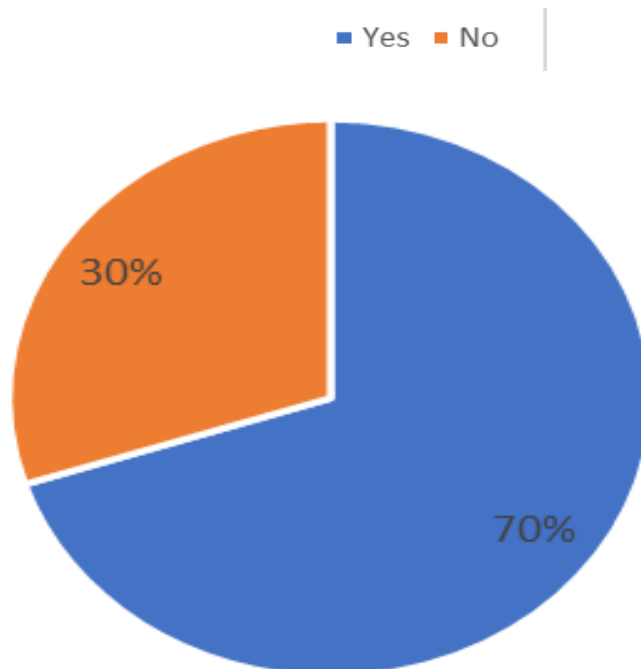


Figure 4.6: Possession of Aprons or Clothing for Meat Handling

The figure 4.6 above presents the responses regarding the possession of aprons or specialized clothing for meat handling in abattoirs. The responses are categorized as "Yes" and "No," and the corresponding percentages indicate the distribution of each response.

The result reveals that a significant majority of respondents (70%) indicated that they possess aprons or specialized clothing for meat handling in the abattoirs. This high percentage suggests that a large proportion of participants recognize the importance of using protective clothing while handling meat, and they have taken steps to possess such clothing. On the other hand, the remaining 30% of respondents indicated that they do not possess aprons or specialized clothing for meat handling.

4.7 Hypothesis test one

H₀: There are no association between Safe and hygienic handling of meat and Socio-Demographic characteristic of respondents

H₁: There are association between Safe and hygienic handling of meat and Socio-Demographic characteristic of respondents.

Decision Rule: Reject the null hypothesis if p-value is less than 0.05 level of significant, otherwise do not reject.

The table 4.7 below represents the analysis of the association between safe and hygienic handling of meat and socio-demographic characteristics of the respondents. The chi-square statistic and corresponding p-values are presented for each socio-demographic characteristic.

Table 4.7: Safe and hygienic handling of meat vs Socio-Demographic characteristic of respondents.

Safe and hygienic handling of meat			Chi-Square
	No	Yes	P-value
Educational attainments			11.792 (0.225)
No Formal Education	4	35	
Primary (FSLC)	3	24	
Secondary (SSCE)	16	81	
Tertiary	1	36	
Age of Respondents			17.861(0.037)
Less Than 30 Years	1	57	
31 - 44 Years	8	57	

45 - 59 Years	9	49	
≥60 Years	6	13	
Gender			8.276(0.041)
Female	24	154	
Male	0	22	

The chi-square test for test of association between Safe and hygienic handling of meat and educational attainment yielded a chi-square statistic of 11.792 and a p-value of 0.225. Since the p-value (0.225) is greater than the significance level of 0.05, we do not have enough evidence to reject the null hypothesis. This suggests that there is no statistically significant association between educational attainments and safe and hygienic handling of meat among the respondents.

The chi-square test for association between Safe and hygienic handling of meat and age of respondents yields a chi-square statistic of 17.861 and a p-value of 0.037. The p-value (0.037) is less than the significance level of 0.05. Therefore, we have enough evidence to reject the null hypothesis. This indicates that there is a statistically significant association between the age of respondents and their perception of safe and hygienic handling of meat.

The chi-square test of association between Safe and hygienic handling of meat and gender yields a chi-square statistic of 8.276 and a p-value of 0.041. The p-value (0.041) is less than 0.05, allowing us to reject the null hypothesis. This implies that there is a statistically significant association between the gender of the respondents and their perception of safe and hygienic handling of meat.

4.7.2 Conclusion of Hypothesis Tests 4.7.1

Based on the chi-square tests conducted, the results indicate that there is a statistically significant association between the age of respondents and their perception of safe and hygienic handling of meat, as well as between the gender of respondents and their perception of safe and hygienic handling of meat. However, there is no statistically significant association found between educational attainments and safe and hygienic handling of meat. The p-values for educational attainments are greater than 0.05, suggesting that any observed differences in safe and hygienic meat handling perception among different educational levels could have occurred due to chance.

4.8 Biochemical Characterization of Bacteria Associated with the Abattoir Facilities

4.8.1 Mean microbial plate count of the abattoir facilities (log cfu/g)

Table 4.8 shows the mean microbial plate count of the abattoir facilities used in this study. Total plate count recorded ranged from 1.40 ± 0.22 log cfu/g to 7.86 ± 0.28 log cfu/g, faecal coliform count ranged from 0.10 ± 0.42 log cfu/g to 1.40 ± 0.28 log cfu/g. Total fungal count ranged from 0.10 ± 0.22 log cfu/g to 2.86 ± 0.28 log cfu/g. Abattoir facilities from Egbu abattoir had highest microbial plate count compared to the abattoir facilities from Relief abattoir.

Table 4.8: Mean microbial plate count of the abattoir facilities (log cfu/g)

Samples	Total plate count	Faecal coliform count	Total fungal count
Egbu abattoir			
Floors	7.86±0.28	1.40±0.32	2.86±0.28
Walls	6.45±0.18	1.20±0.22	1.80±0.22
Knives	5.40±0.52	ND	0.80±0.32
Hooks	2.40±0.22	0.10±0.42	0.40±0.42
Hands	4.10±0.52	1.00±0.20	0.30±0.40
Relief abattoir			
Floors	4.16±0.28	0.80±0.20	1.86±0.28
Walls	3.24±0.18	0.60±0.22	1.10±0.22
Knives	1.40±0.52	ND	0.40±0.32
Hooks	1.62±0.22	ND	0.10±0.42
Hands	2.10±0.52	ND	0.20±0.40

Key: ND = Not detected

On the other hand, Table 4.9 below shows the biochemical characterization of the microorganisms associated with the abattoir facilities. The microorganisms were identified using cultural morphology, Gram' s staining and biochemical tests such as; catalase, oxidase, indole, citrate utilization, sugar fermentation, motility, and coagulase tests.

The bacterial isolates were; *Escherichia*, *Streptococcus*, *Staphylococcus*, *Salmonella*, *Pseudomonas*, *Bacillus* and *Klebsiella* species.

Table 4.9: Cultural Morphology and Biochemical Characteristics of the Bacterial Isolates from the Abattoir Facilities

Morphological Characteristics	Gram reaction	Oxidase test	Indole test	Spore test	Catalase test	Citrate test	Coaguase test	Motility test		S FT		Possible bacteria		
								S	B	G	H ₂ S			
Milkish, flat, rhizoid-like dry-surface colonies	Gram positive rods in short chains	-	-	+	+	-	-	-	Y	Y	+	-	<i>Bacillus</i> species	
Pinkish, raised, mucoid Colonies with green-metallic sheen	Gram negative rods in diploids	-	+	-	-	+	-	+	R	Y	+	-	<i>Escherichia</i> species	
Yellowish, raised, non-mucoid colonies	Gram positive cocci in clusters	-	-	-	+	-	+	-	No Reaction		-	-	<i>Staphylococcus</i> species	
Bluish-green, flat, non-mucoid colonies	Gram negative rods in diploids	+	-	-	+	-	-	+	R	R	-	-	<i>Pseudomonas</i> species	
Black, raised, non-mucoid colonies of about 3mm	Gram negative rods in short chains	-	-	-	-	+	-	-		R	Y	+	+	<i>Salmonella</i> species
Milkish, raised, non-mucoid colonies, with clear zones	Gram positive cocci in long straight chains	-	-	-	-	-	-	-	No Reaction		-	-	<i>Streptococcus</i> species	
Pinkish, raised, mucoid enlarged colonies	Gram negative rods in short chains	-	-	-	+	+	-	-	R	Y	-	-	<i>Klebsiella</i> species	

KEY: - = Negative + = Positive S = color of slope B = color of butt G = Gas production H₂S = Hydrogen sulphide production (blackening) R = Reddish coloration (alkaline production) Y= Yellow coloration (Acidic production) SFT= Sugar fermentation test

4.8.2: Cultural morphology and Microscopic Characterization of the Fungal Isolates from the Abattoir Facilities

Table 4.10 shows the cultural morphology and microscopic characterization of the fungal isolates from the abattoir facilities. The fungal isolates were identified based on cultural morphology, microscopic examination and comparison with fungal atlas. The isolated fungi were; *Rhizopus*, *Aspergillus*, *Penicillium*, *Mucor* and *Candida* species.

Table 4.10: Cultural Morphology and Microscopic Characterization of the Fungal Isolates from the Abattoir Facilities

Cultural morphology	Microscopy	Possible fungi
Whitish, raised, fluffy, cotton like colonies that covered the plate after three days.	Non-septate hyphae	<i>Rhizopus species</i>
Whitish, circular, colonies with light yellow reverse	Septate hyphae	<i>Aspergillus species</i>
Whitish, circular, colonies with light green powdery centre.	Septate hyphae with tiny mycelium joining	<i>Penicillium species</i>
Whitish, circular, colonies with grey centre.	Non-septate with spores at both ends	<i>Mucor species</i>
White, creamy, circular colonies of about 3mm	Budded yeast cells in diploid	<i>Candida species</i>

4.8.3: Occurrence of Bacteria and Fungi in the Abattoir Facilities from Egbu

Table 4.11 shows the occurrence of bacteria and from the abattoir facilities from Egbu. Samples from the floor had more microorganisms followed by samples from the wall while samples from the hook had lesser microorganisms. *Bacillus* species 20(100%) was isolated from all the floor samples while *Salmonella* and *Klebsiella* species was isolated only from floor and wall surfaces. *Staphylococcus*, *Pseudomonas* and *Bacillus* species occurred in all the abattoir facilities with higher occurrence recorded with floor surfaces followed by wall surfaces.

Rhizopus species was isolated from floor 20(100%) and wall surfaces 15(75%) of the abattoir facilities. *Candida* species was isolated from floor 10(50%), knife 5(25%) and hands of the butchers 5(25%). *Aspergillus* species was isolated from only floor surfaces 10(50%) while *Penicillium* species was isolated from floor 5(20%) and wall surfaces 10(50%). *Mucor* species was isolated from floor 15(75%), knife 10(50%) and wall surfaces 10(50%).

Table 4.8.3: Occurrence of Bacteria and Fungi in the Abattoir Facilities from Egbu

Isolated microorganisms	Abattoir Facilities/Occurrence of Microorganisms				
	Floors	Walls	Knives	Hooks	Hands
<i>Escherichia</i> species	15(75%)	5(25%)	0	10(50%)	10(50%)
<i>Streptococcus</i> species	10(50%)	0	0	5(25%)	5(25%)
<i>Staphylococcus</i> species	18(90%)	10(50%)	10(50%)	5(25%)	15(75%)
<i>Salmonella</i> species	18(90%)	10(50%)	0	0	0
<i>Pseudomonas</i> species	10(50%)	15(75%)	5(25%)	5(25%)	5(25%)
<i>Bacillus</i> species	20(100%)	15(75%)	10(50%)	5(25%)	5(25%)
<i>Klebsiella</i> species	10(50%)	10(50%)	0	0	0
<i>Rhizopus</i> species	20(100%)	15(75%)	0	0	0
<i>Candida</i> species	10(50%)	0	5(25%)	0	5(25%)
<i>Aspergillus</i> species	10(50%)	0	0	0	0
<i>Penicillium</i> species	5(20%)	10(40%)	0	0	0
<i>Mucor</i> species	15(75%)	10(50%)	10(50%)	0	0

4.8.4: Occurrence of Bacteria and Fungi in the Abattoir Facilities from Relief Market

Table 4.12 shows the occurrence of bacteria and fungi from the abattoir facilities from Relief market. A total of seven bacteria were isolated from the abattoir facilities. These include; *Escherichia*, *Streptococcus*, *Staphylococcus*, *Salmonella*, *Pseudomonas*, *Bacillus* and *Klebsiella* species. Floor surfaces had more microorganisms followed by samples from the wall surfaces while samples from the hook had lesser microorganisms. *Bacillus* species 15(75%) was isolated from fifteen (15) out of the twenty (20) floor samples, none with knives and hooks. *Escherichia* species was isolated from floor surface 5(25%) and hands of butchers 5(25%).

For the fungal isolates, *Mucor* species was isolated from floor 10(50%), and wall surfaces 5(25%). *Rhizopus* species was isolated from floor 10(50%) and wall surfaces 5(25%) of the abattoir facilities. *Candida* species was isolated from floor surfaces 10(50%). *Aspergillus* species was isolated from floor surfaces 10(50%) and wall surfaces 10(50%) while *Penicillium* species was isolated from floor 10(50%) and wall surfaces 10(50%).

Table 4.12: Occurrence of Bacteria in the abattoir facilities from Relief market

Isolated microorganisms	Abattoir facilities/Occurrence of microorganisms				
	Floors	Walls	Knives	Hooks	Hands
<i>Escherichia</i> species	5(25%)	0	0	0	5(25%)
<i>Streptococcus</i> species	10(50%)	0	0	5(25%)	0
<i>Staphylococcus</i> species	15(75%)	5(25%)	5(25%)	0	10(50%)
<i>Salmonella</i> species	10(50%)	5(25%)	0	0	0
<i>Pseudomonas</i> species	10(50%)	10(50%)	0	0	5(25%)
<i>Bacillus</i> species	15(75%)	15(75%)	0	0	5(25%)
<i>Klebsiella</i> species	10(50%)	10(50%)	0	0	0
<i>Rhizopus</i> species	10(50%)	5(25%)	0	0	0
<i>Candida</i> species	10(50%)	0	0	0	0
<i>Aspergillus</i> species	15(75%)	10(50%)	0	0	0
<i>Penicillium</i> species	10(50%)	10(50%)	0	0	0
<i>Mucor</i> species	10(50%)	5(25%)	0	0	0

4.8.5: Antibigram of the Microorganisms from the Abattoir Facilities

Table 4.13 shows the antibiogram of the microbial isolates from the abattoir facilities. For the bacterial isolates, zones of inhibition recorded ranged from 16mm to 30mm. *Staphylococcus* species was the most resistant bacteria. Most of the microorganisms from abattoir facilities were resistant to different antibiotics. *Staphylococcus* species was resistant to ciprofloxacin, streptomycin and rifampicin antibiotics. *Bacillus* species was resistant to ciprofloxacin, rifampicin and augmentin. *Enterobacter* species was resistant to ciprofloxacin, gentamycin and augmentin.

For the fungal isolates, zones of inhibition recorded ranged from 16mm to 26mm with ketoconazole showing higher antifungal activities. All the fungal isolates showed susceptibility to the antifungal drugs.

Table 4.13: Antibiogram of the Microorganisms from the Abattoir Facilities

Microbial isolates	Antimicrobial agents/Zones of inhibition (mm)							
	CPX	CN	S	RD	LEV	AU	FLU	KETO
Bacteria								
<i>Klebsiella</i> species	20	16	24	28	30	16	-	-
<i>Escherichia</i> species	28	24	-	30	26	16	-	-
<i>Pseudomonas</i> species	16	-	18	30	26	18	-	-
<i>Staphylococcus</i> species	-	22	-	-	30	18	-	-
<i>Bacillus</i> species	-	24	28	-	28	-	-	-
<i>Streptococcus</i> species	-	-	30	28	20	-	-	-
<i>Salmonella</i> species	30	16	12	28	20	-	-	-
Fungi								
<i>Aspergillus</i> species	-	-	-	-	-	-	26	18
<i>Rhizopus</i> species	-	-	-	-	-	-	18	22
<i>Candida</i> species	-	-	-	-	-	-	16	22
<i>Mucor</i> species	-	-	-	-	-	-	24	26
<i>Penicillium</i> species	-	-	-	-	-	-	22	24

Key: - = No zone of inhibition mm = Millimeter CPX = Ciporfloxacin
 CN = Gentamycin S = Streptomycin RD = Rifampicin
 LEV = Levofloxacin AU = Augmentin FLU = Fluconazole
 KETO = Ketoconazole CLSI guidelines R = Resistant (0 – 12 mm)
 S = Susceptible (16mm and above)

4.8.6 Hypothesis Test results two

H₀: There are no significant relationship between hygiene practice and microorganisms identified

H₁: There are significant relationship between hygiene practice and microorganisms identified

Decision Rule: Reject the null hypothesis, if p-value is less than 0.05 level of significant, otherwise do not reject.

The provided analysis below involves an ANOVA (Analysis of Variance) to examine the relationship between hygiene practices and the presence of different microorganisms. The analysis includes both the ANOVA summary and the coefficients of the predictors. The null hypothesis (H₀) suggests that there is no significant relationship between hygiene practices and the identified microorganisms, while the alternative hypothesis (H₁) proposes a significant relationship.

The ANOVA Table 4.14 provides information about the model's fit, the amount of variance explained, and the statistical significance of the model's overall effect. The p-value associated with the "F" statistic is provided as an indicator of the overall significance of the model. In this case, the p-value associated with the "F" statistic is 0.000 (denoted as "b"), which is less than 0.05. This indicates that the overall model is statistically significant. Therefore, we have enough evidence to reject the

null hypothesis, suggesting that there is no a significant relationship between hygiene practices and the identified microorganisms.

The coefficients Table 4.15 displays the unstandardized coefficients, standardized coefficients (if applicable), t-values, and p-values for each predictor variable in the model. Each predictor variable represents a different identified microorganism.

The "Constant" coefficient is 22.962, indicating the average hygiene practice score when all predictor variables are zero. Positive coefficients (e.g., *Penicillium* species and *Mucor* species) suggest a positive relationship between the presence of these microorganisms and hygiene practices. Negative coefficients (e.g., *Streptococcus* species, *Salmonella* species, *Klebsiella* species) suggest a negative relationship between the presence of these microorganisms and hygiene practices.

Notably, the p-values associated with the coefficients indicate the statistical significance of each predictor. In this result, both *Penicillium* species and *Mucor* species have very low p-values (both less than 0.05), indicating that they are statistically significant predictors of hygiene practices.

Table 4.14: ANOVA test of relationship between hygiene practices and the presence of different microorganisms

Model		Sum of Squares	df	Mean Square	F	p-value
1	Regression	1230.324	11	111.848	14.738	.000 ^b
	Residual	1426.696	188	7.589		
	Total	2657.020	199			

a. Dependent Variable: Hygiene Practice

b. Predictors: (Constant), *Mucor* species, *Streptococcus* species, *Rhizopus* species, *Pseudomonas* species, *Klebsiella* species, *Penicillium* species, *Salmonella* species, *Escherichia* species, *Bacillus* species, *Aspergillus* species, *Candida* species

Table 4.15: Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	p-value
		B	Std. Error	Beta		
1	(Constant)	22.962	2.761		8.317	.000
	<i>Escherichia</i> species	.133	.145	.050	.915	.361
	<i>Streptococcus</i> species	-.143	.142	-.054	-1.008	.315
	<i>Salmonella</i> species	-.133	.120	-.063	-1.109	.269
	<i>Pseudomonas</i> species	.069	.113	.033	.613	.541
	<i>Bacillus</i> species	.023	.114	.011	.201	.841
	<i>Klebsiella</i> species	-.082	.119	-.037	-.686	.494
	<i>Rhizopus</i> species	-.035	.118	-.016	-.301	.764
	<i>Candida</i> species	.124	.121	.057	1.022	.308
	<i>Aspergillus</i> species	.046	.115	.023	.404	.687
	<i>Penicillium</i> species	.930	.121	.417	7.710	.000
	<i>Mucor</i> species	.974	.120	.454	8.090	.000

a. Dependent Variable: Hygiene Practice

Conclusion of Hypothesis two

Based on the ANOVA summary and the coefficients analysis, the results provide evidence to reject the null hypothesis. This suggests that there is a significant relationship between hygiene practices and the presence of certain microorganisms. Specifically, the presence of *Penicillium* species and *Mucor* species appears to have a positive relationship with hygiene practices, while the presence of other microorganisms like *Streptococcus* species, *Salmonella* species, and *Klebsiella* species is associated with lower hygiene practices.

Table 4.9: Potential pathogenicity test of the isolated microorganisms

Table 4.9 shows the potential pathogenicity test of the isolated microorganisms.

Streptococcus species produced beta haemolysis, *Staphylococcus*, *Bacillus*, *Aspergillus*, *Candida*, *Penicillium* species produced alpha and beta haemolysis. *Pseudomonas*, *Salmonella*, *Rhizopus* and *Mucor* species produced gamma haemolysis.

From the results, *Pseudomonas*, *Salmonella*, *Rhizopus* and *Mucor* species were not pathogenic while *Streptococcus* species produced beta haemolysis, *Staphylococcus*, *Bacillus*, *Aspergillus*, *Candida*, *Penicillium* species are pathogenic.

Table 4.16: Potential pathogenicity test of the isolated microorganisms

Fungal isolates	Pathogenicity		
	Alpha zones	Beta zones	Gamma zones
<i>Klebsiella</i> species	+	+	-
<i>Pseudomonas</i> species	-	-	+
<i>Staphylococcus</i> species	+	+	-
<i>Bacillus</i> species	+	+	-
<i>Streptococcus</i> species	-	+	-
<i>Salmonella</i> species	-	-	+
<i>Aspergillus</i> species	+	+	-
<i>Rhizopus</i> species	-	-	+
<i>Candida</i> species	+	+	-
<i>Mucor</i> species	-	-	+
<i>Penicillium</i> species	+	+	-

Key: + = Presence/Positive - = Absence/Negative

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

5.1.1 Hygiene Sanitary Practices of Butchers

The increase in human population has accounted for a tremendous increase in the need for food (Fukase and Martin, 2020), meat inclusive. Also, food-borne diseases account for significant morbidity and mortality globally (Abdul-Mutalib et al., 2012), and the burden is higher in developing countries (Odeyemi, 2016). Meat hygiene and safety in most developing countries are uncontrolled and usually based on approved visual inspection, not microbiological testing (Cook et al., 2017). Thus, proper/hygienic meat handling should play a substantial role in making sure that meats are of good quality and safe (Rani et al., 2017). Although the present study shows no significant association between a typical hygienic process of ‘hand-washing after toilet use’ at the abattoir and respondents’ educational attainment, age, and gender statuses ($P>0.05$), understanding hygienic meat handling practices at abattoirs has been found to be essential to articulate preventive measures to mitigate possible food contamination or food-borne condition (Havelaar et al., 2018).

The availability of basic amenities at the abattoir is essential for proper running and adherence to Environmental health guidelines. Although the present study showed

positive responses to availability of basic amenities and sanitary facilities like availability of portable water, toilet facility, electricity and lairage, it also showed that the design for efficient drainage was poor. Such included availability of Tiles on the floors, mud-free drainage and availability of sloppy floors for drainage. Having a clean slab and drainage is essential for hygienic meat handling and could help in promoting slaughter practises (Thanappan 2022).

Hygiene problem during slaughter is not the only concern in abattoir practice but also cross-contamination of meat and meat products during transportation. This study showed the availability of different mediums for transporting meat, and the state of the vehicles and transport means has been of great concern. These practices can also influence the food safety of abattoir workers. In the present study, hygienic practises such as cleaning, hand washing, etc as well as waste disposal practice were well practised. These have been associated good abattoir practices by abattoir workers (Cook et al., 2017; Fasikaw et al., 2019). Also, this study showed that younger male adults respondents were more likely to disagree with the safe and hygienic meat handling at abattoirs ($P < 0.05$). There is therefore need to focus on this population in terms of education and re-emphasis on safe and hygienic meat handling at the abattoirs.

The present study also showed that landfill (63.5%) of waste was still practiced even with the regular inspection by Environmental Health Officers. However, the study also found that more than 1/3rd respondents agreed that there were incidences of bribery. This practise is poor and unhygienic and calls for

Improvement in the inspections and implementation of the regulations on waste management. Poor disposal of solid wastes has the potential to create environmental (water, air, and soil pollution) as well as health issues including waterborne diseases and respiratory ailments from the open dumping/burning of wastes (Mozhiarasi and Natarajan 2022).

Periodic medical check-ups are significant in reducing pathogens transmission (if any) from carriers or potentially ill persons to healthy individuals (Gopinath et al., 2012). In this study, 51.5% have a valid medical certificate to handle meat. Also, 37% only go for a medical check only when sick, with only a few (24%) undergoing examinations more than twice a year. In a similar study, more than 78% of the abattoir workers indicated not attending regular medical check-ups (Gadisa et al., 2019). There is need to enforce this aspect of regulation as without regular medical checkup for workers, it could become difficult to ensure food safety of the animal products.

This study depicted lack of sterilization facilities (99%) in both abattoirs surveyed. This poses great concern for equipment used for handling meat and meat products. The study further showed, just like a similar study shows, that the abattoir workers use only water (without disinfection) to clean their equipment to prevent food-borne diseases (Gebeyehu, and Tsegaye, 2022). This could possibly be because they have an insufficient understanding of how ineffective water alone is for cleaning.

At the abattoir, protective gears such as coats, aprons, and hair covering are essential, as much as hand washing hygiene to protect meat handlers and meat from exposure to pathogens (Nel et al., 2004). Although the abattoir workers seemed to understand the regulation guiding their practices, such as head-cover, masks, protective, and gloves, only a few (15.5%) use protective devices as often as possible. It is possible that they perceive that it is only used for personal safety and not prevention of meat contamination (Gebeyehu, and Tsegaye, 2022). This unhygienic practice could have the consequence of high contamination of the equipment with pathogenic microbes (Bersisa, Tulu, & Negera, 2019). However, no significant association was seen in this study between the use of protective gears and respondents' educational attainment, age, and gender ($P>0.05$).

This study shows that only 50% have aprons or special clothing for meat handling. However, females were more likely to wash their aprons more often ($P<0.05$) than their counterparts before using them for handling meat. It therefore seems like the female workers have a better attitude towards hygiene.

As questionnaires were used for data collection, it could mean that our results were reliant on the response of participants. This might not be totally in tandem with the actual situation. Response to regulatory and some practices questions might be skewed by the perception of the respondents on the actual intent of this study. Also, the sample size might not be enough to generalize for all abattoirs in the state.

5.1.2 Microorganisms Associated with the Abattoir Facilities

The study revealed the presence of seven (7) different bacterial genera associated with the abattoir facilities used in this study. From Table 4.8.1, the bacterial isolates were; *Escherichia*, *Streptococcus*, *Staphylococcus*, *Salmonella*, *Pseudomonas*, *Bacillus* and *Klebsiella* species. From Table 4.8.2, the isolated fungi were; *Rhizopus*, *Aspergillus*, *Penicillium*, *Mucor* and *Candida* species. Gurmu and Gebretinase (2013) reported the isolation of *E. coli*, *Staphylococcus* species, *Streptococcus* species and *Salmonella* species from meat contact surfaces in selected butcher shops of Mekelle city, Ethiopia. Similarly, Nuguse et al. (2022) reported the isolation of Enterobacteriaceae, *E. coli* and *Staphylococcus* species from meat and its contact surfaces in Bedele Town, Buno Bedele Zone, South West Ethiopia.

The presence of these microorganisms is a reflection of the sanitary practices employed by the butchers in the abattoir. Gebeyehu, and Tsegaye (2022) in their study reported that the abattoir workers use only water (without disinfection) to clean their equipment to prevent food-borne diseases. However, in most cases, some of the water used in cleaning these abattoir facilities is not clean thereby transferring water microorganisms to the facilities. Also, water is not sufficient to remove some of the microorganisms that are associated with these abattoir facilities. Bersisa et al. (2019) reported that unhygienic practice could have consequence of high contamination of abattoir equipment with pathogenic

microbes. This therefore calls for improvement in the cleaning practices of these abattoir facilities.

From Table 4.8.3 and Table 4.8.4, samples from the floor had more microorganisms followed by samples from the wall while samples from the hook had lesser microorganisms with *Bacillus* species having highest occurrence. This study agrees with the report of Odetokun et al. (2021) who reported that the floor in ultra-modern abattoir Ilorin, North Central, Nigeria had the highest microbial contaminants compared to other surfaces.

The high occurrence of microorganisms on the floor surfaces could be attributed to the numerous activities that go on in the abattoir floors. It could be noted that during slaughtering, the animals are kept on the floor and the butchers likely wear their boots, shoes or other footwears which may transfer microorganisms to the floor surfaces. Sand from the animals, shoes of butchers and other slaughtering equipment could harbour microorganisms which are deposited in the floor of the abattoir.

From Table 4.8.5, most of the microorganisms from the abattoir facilities were resistant to different antibiotics. *Staphylococcus* species was resistant to ciprofloxacin, streptomycin and rifampicin antibiotics. Ketoconazole showing higher antifungal activities. All the fungal isolates showed susceptibility to the antifungal drugs. Drug resistant microorganisms are known to constitute high cost of treatment in the medical care.

5.2 Conclusion

While the understanding of the abattoir workers about the pathogens and the risk of meat contamination is commendable, their practice on ground was quite the opposite. The study showed practices of unhygienic meat handling in abattoirs in Owerri and this poses a potentially serious public health hazardous cross-contamination.

Microbiological examination of the abattoir facilities revealed the presence of seven (7) bacteria and five (5) fungi. Most of these microorganisms are known as organisms of medical importance which have been associated with food-borne diseases in humans. The findings show the need for interventions by providing food safety training to meat handlers to improve hygienic meat handling practices. Similarly, there is need to improve the basic infrastructural design of the abattoir as this will help strengthen food quality and people' s confidence in meat products.

5.3 RECOMMENDATIONS

The following recommendations could be vital to standardizing abattoir operation in Owerri and beyond.

1. The State Government and Regulatory bodies should provide a standard abattoir operational guideline for operators and users.
2. There should be strict enforcement of antemortem examination by sanitary officers before slaughter.
3. The Environmental Health Officers should enforce all existing health and hygiene regulations to minimize slaughtering diseased animals is critical.
4. There should be stringent compliance with proper sanitation within the abattoir premises, and environmental health officers should be held responsible for implementing the guidelines.
5. There is need for government to develop and implement public health education programs on ethical abattoir practices for the abattoir personnel annually.

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APPENDIX I



Figure 6.1: The Lairage



Figure 6.2: Cattles awaiting slaughtering



Figure 6.3: Meat sellers



Figure 6.4: Abattoir slab



Figure 6.5: Abattoir slab 2



Figure 6.6: Abattoir slab 3



Figure 6.4: Abattoir slab 4



Figure 6.7: The abattoir

APPENDIX II

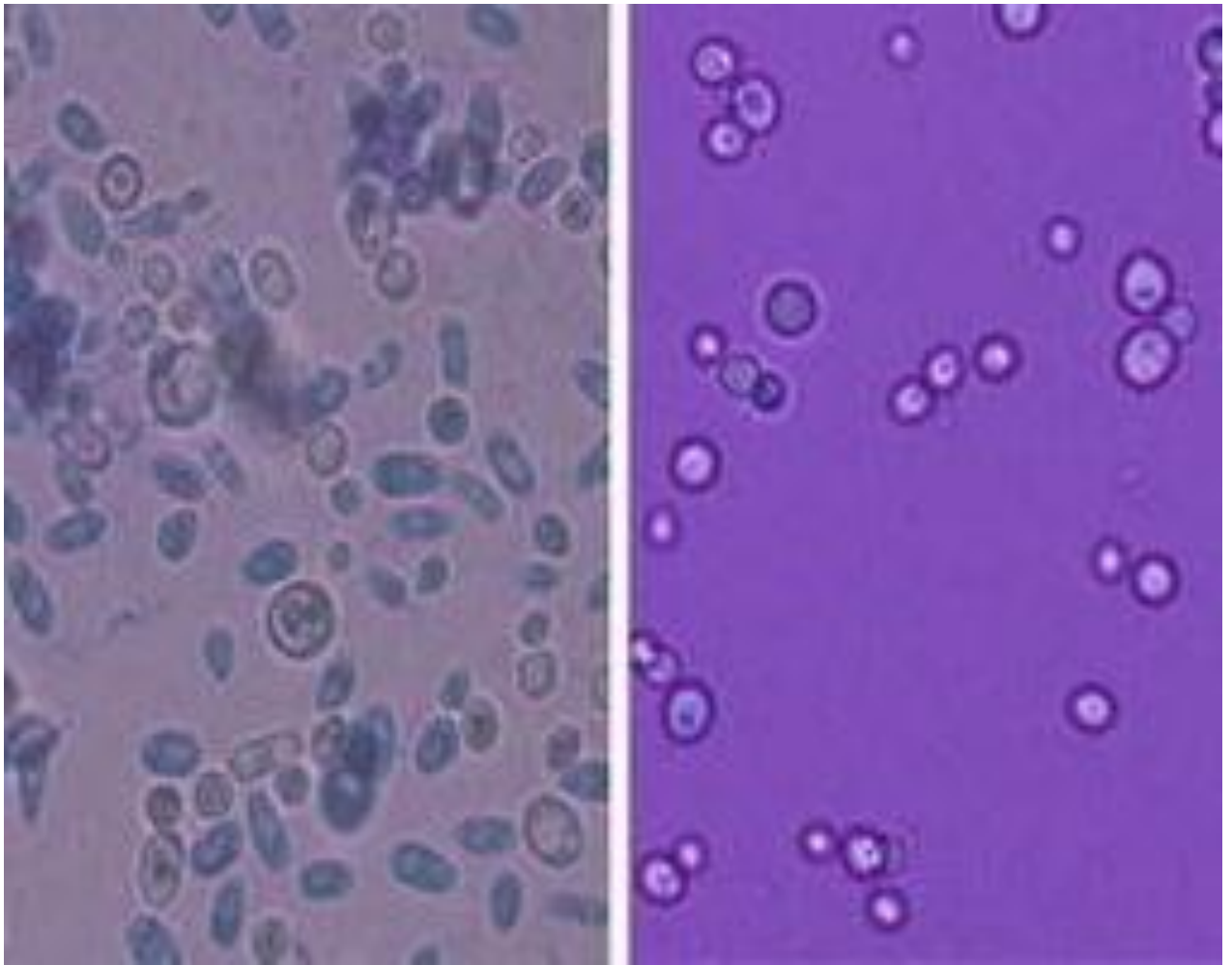


Plate 1: Microscopic view of *Candida* species

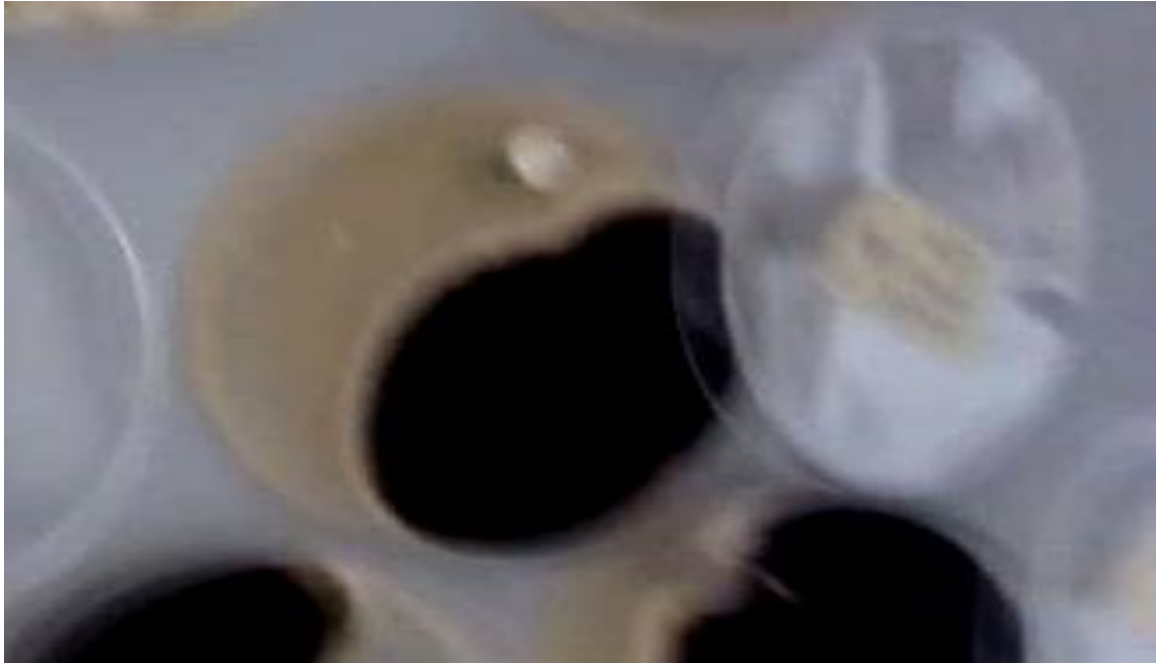


Plate 2: Growth of *Aspergillus* species on Sabouraud Dextrose agar

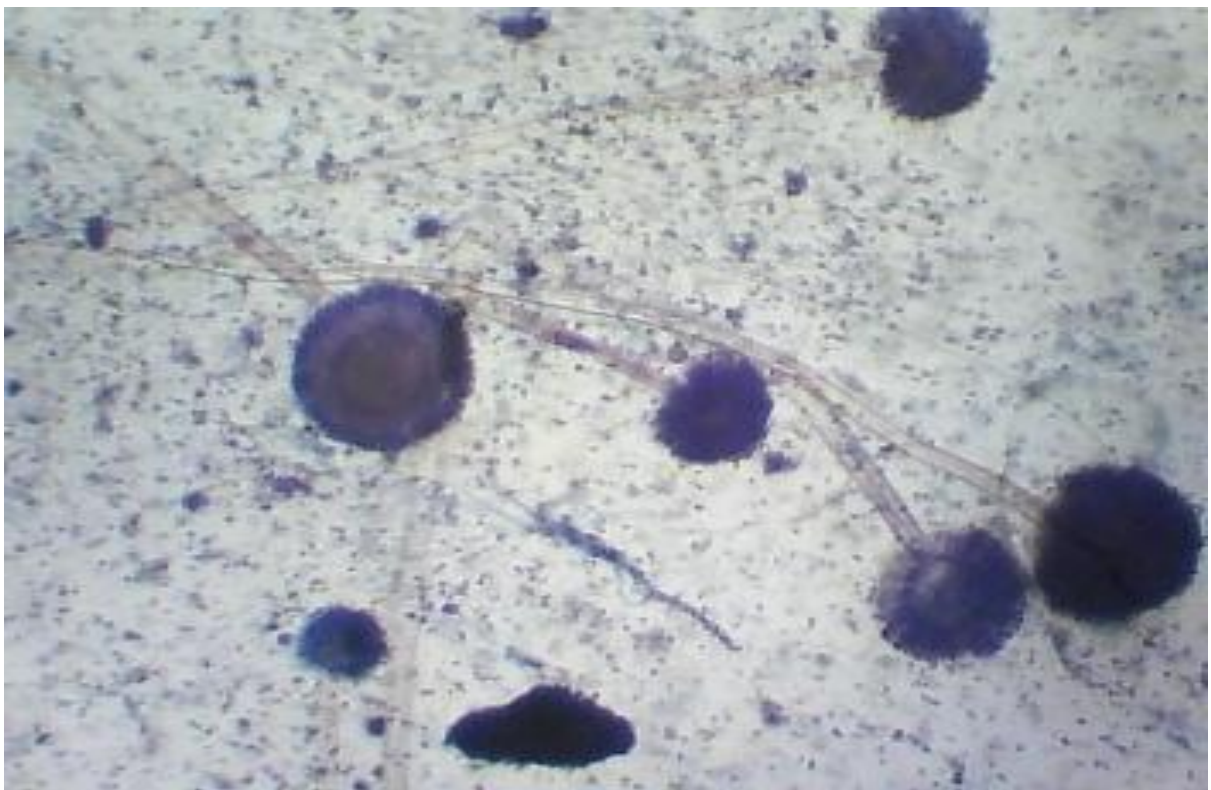


Plate 3: Microscopic view of *Aspergillus* species