AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

ASSESSING FOOD SAFETY PRACTICES AND MICROBIAL SAFETY OF FRESH MEAT AND KHEBAB AMONG VENDORS AND CONSUMERS IN THE ASANTE MAMPONG MUNICIPALITY OF GHANA

ABDUL-TAMIM BOLLOW NIARA

2025

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BY

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THESIS SUBMITTED TO DEPARTMENT OF ANIMAL SCIENCE EDUCATION OF THE FACULTY OF AGRICULTURE EDUCATION, AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF PHILOSOPHY DEGREE IN ANIMAL SCIENCE

JUNE, 2025

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my original work and that no part of it has been presented for another degree at this university or elsewhere.

Candidate's Name: ABDUL-TAMIM BOLLOW NIARA

Signature: …… Date: ……

Supervisors' Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development.

Supervisor's Name: DR. W. K. J. KWENIN

Signature: …… Date: …….....

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DEDICATION

This thesis is dedicated to my lovely mother Fati Luri, and my caring wife Jalia Babini.

ABSTRACT

Khebab safety has become a growing public health concern in the Asante Mampong Municipality of Ghana, mainly due to unhygienic practices observed in some retail settings. Despite the popularity of khebab, there is limited data on its microbial safety in the Manpong Municipality, thus raising concerns about potential health risks to consumers. This study examined the level of microbial contamination in khebabs, vendors' compliance with hygiene and safety protocols, and food safety enforcement, and consumers' awareness of foodborne illnesses. A mixed-method study design was used, with 145 retail outlets selected through convenience and purposive sampling techniques. Khebab samples were collected using sterile procedures and analyzed for the presence of *Escherichia coli*, *Salmonella spp.*, *Pseudomonas spp.*, yeast and mould. Structured interviews and questionnaires were administered to khebab vendors, consumers and Sanitation Officers to assess their knowledge, attitudes, and practices regarding khebab hygiene and safety. Results showed widespread non-compliance with good hygiene practices (GHPs) among vendors, including inadequate handwashing, use of contaminated utensils, and poor control of cooking and storage temperatures. These poor practices increased the risk of cross-contamination and bacterial proliferation. Cold store sausage had the highest total aerobic bacterial load at 8.00 log cfu/g, while butcher shop beef recorded the lowest at 2.40 log cfu/g. The highest yeast and mould count was also found in cold store chicken at 6.10 log cfu/g. *Escherichia coli* was not detected in any of the fresh meat samples. However, *Salmonella spp.* was found in both butcher shop beef (2.00 log cfu/g) and cold store sausage (1.00 log cfu/g), which exceeded the acceptable threshold. *Pseudomonas spp.*, which is an indicator of spoilage, recorded the highest load in cold store sausage at 5.00 log cfu/g. A comparison of fresh meat and processed meat showed a significant difference ($P < 0.05$) in microbial load, with fresh meat having higher total aerobic bacteria levels. Consumer's awareness of food safety was generally low, with only 52 % of respondents demonstrating basic knowledge of safe handling and storage practices. Although some consumers were aware of the risks of eating contaminated khebabs, their understanding of prevention methods remained limited. The study found weaknesses in regulatory enforcement, as many vendors operated without licenses and were not subject to regular health inspections. In conclusion, the study highlights food safety challenges related to khebab handling and vending in the Municipality. The presence of pathogenic microorganisms at high levels poses a significant risk to public health. It is recommended that the Municipal authorities enhance regulatory oversight by implementing regular inspections, provide hygiene training programs for vendors, intensifies public education campaigns, ensures strict licensing procedures, and fosters collaboration between health authorities, vendors, and consumers to create a safer and healthier food environment.

Keywords: *Microbial contamination, food safety, khebab vendors, consumer awareness, Asante Mampong Municipality, public health, foodborne pathogens*

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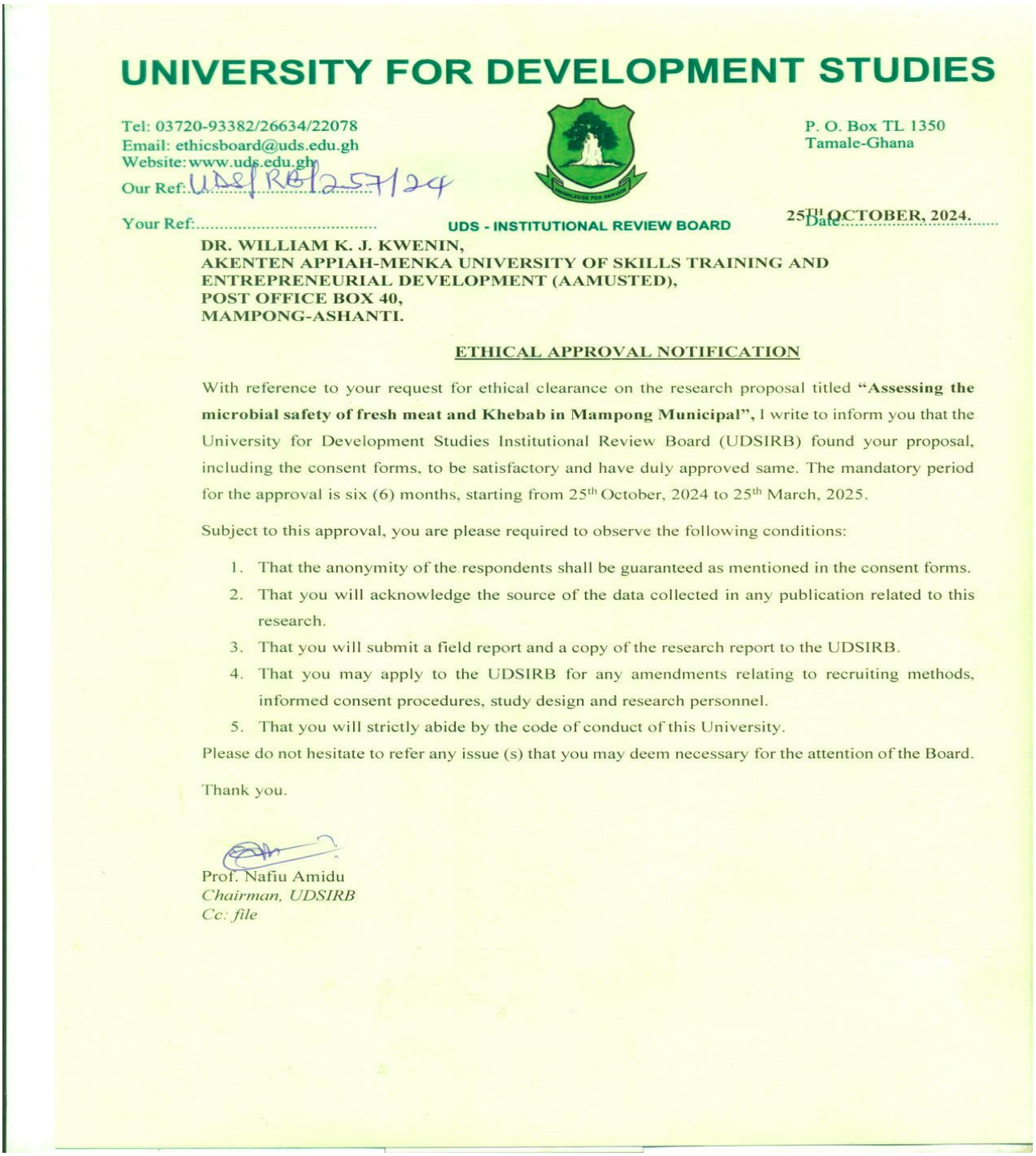
LIST OF ABBREVIATIONS

ACC	Aerobic Colony Count
AMC	Aerobic Mesophilic Count
APC	Aerobic Plate Count
AW	Water Activity
B	Board
CFU/g	Coliform Forming Unit per gram
CFUs	Colony Forming Units
MCM	Mampong Central Mosque
EHS	Environmental Health and Sanitation
FDA	Food and Drugs Authority
GNB	Group Nduom Bank
GSA	Ghana Standards Authority
GSS	Ghana Statistical Service
HSO	Health and Sanitation Officers
HUS	Haemolytic Uremic Syndrome
K	Knife
KNUST	Kwame Nkrumah University of Science and Technology
RTE	Ready-to-eat
SD	Standard Deviation
SDA	Sabouraud Dextrose Agar
SHS	Senior High School
SMEs	Medium Sized Enterprises
SPSS	Statistical Package for Social Sciences
SST	Simple Stores
TVC	Total Viable Count
VIP	Very Important Personnel
WHO	World Health Organization

ETHICAL APPROVAL



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ETHICAL APPROVAL NOTIFICATION

With reference to your request for ethical clearance on the research proposal titled **"Assessing the microbial safety of fresh meat and Khebab in Mampong Municipal"**, I write to inform you that the University for Development Studies Institutional Review Board (UDSIRB) found your proposal, including the consent forms, to be satisfactory and have duly approved same. The mandatory period for the approval is six (6) months, starting from 25th October, 2024 to 25th March, 2025.

Subject to this approval, you are please required to observe the following conditions:

1. That the anonymity of the respondents shall be guaranteed as mentioned in the consent forms.
2. That you will acknowledge the source of the data collected in any publication related to this research.
3. That you will submit a field report and a copy of the research report to the UDSIRB.
4. That you may apply to the UDSIRB for any amendments relating to recruiting methods, informed consent procedures, study design and research personnel.
5. That you will strictly abide by the code of conduct of this University.

Please do not hesitate to refer any issue (s) that you may deem necessary for the attention of the Board.

Thank you.

Prof. Nafiu Amidu
Chairman, UDSIRB
Cc: file

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Meat is an integral part of the world's diets as an essential provider of protein and required nutrients (Smith et al., 2022). In countries like the United States of America, Australia, and Brazil, amongst others, consumers consume high amounts of meat as an expression of the importance it has in not only providing nutrient requirements but also serving as an expression of affluence (Hötzel & Vandresen, 2022). Several studies have documented the benefit of meat like being capable of providing high-quality protein, iron, zinc, and vitamins required for development and health (Ponnampalam et al., 2024).

Yet with these advantages come difficulties, especially in maintaining meat as safe as possible from microbial contamination responsible for foodborne diseases. For instance, studies in the United States have highlighted the importance of rigorous hygiene protocols along the entire meat supply chain as a measure of safeguarding public health (Akpan et al., 2025).

In European countries like Italy and Spain, meat contamination has also been an issue. Different studies have confirmed pathogenic bacteria like Salmonella spp., Listeria monocytogenes, and Escherichia coli as the prime culprits in fresh meat products (Ali & Alsayeqh, 2022). These microorganisms have the capability of triggering grave health complications and in severe instances may lead to fatalities. European authorities have highlighted the significant health and economic impact of foodborne outbreaks and shown the need for proper handling, storing, and processing of meat products.

In Africa, challenges are more pronounced such as limited resources, weak implementation of policies on food safety, and weak infrastructure making it hard to maintain proper standards of hygiene. In Kenya, Nigeria, and South Africa, studies have shown high contamination levels in meat sold in markets (Birgen et al., 2022). In Kenya, for instance, studies showed that more than 60% of sampled meat products had bacteria like E. coli and Salmonella spp., largely ascribed to unhygienic practices (Kimindue, 2024). Similarly, studies done in Nigeria showed that unsound conditions of handling and storage greatly contributed to contaminating meat products (Ncube, 2020).

In Ghana, meat forms a standard dish in nearly all families and products such as khebabs sell considerably in the urban and peri-urban regions. Unfortunately, research has indicated that conventional markets and butcheries scarcely observe proper hygiene standards, thereby revealing higher risk of microbial contamination. In Kumasi, research indicated that fresh meat bought from conventional markets contained pathogenic bacteria such as Salmonella spp., Listeria monocytogenes, and Escherichia coli (Ahiabor et al., 2024). These organisms have severe health implications and more gravely on vulnerable groups of people such as children, the older adults, and those whose immunity has been compromised.

The meat is not only consumed but also processed into sausages, canned meat, and khebabs. These processed foods are favorably accepted for their ease of use, good taste, and variety. Like other foods though, they are equally predisposed to contamination during production at different points such as during slaughter and

processing through to storage and sale. Contamination is normally caused by unsound hygiene measures, cross-contamination as well as unsuitable temperature control and has implications for causing food poisoning. Khebabs being one of the street foods of preference in Ghana. These products tend to be produced and sold in outdoor environments where it is difficult to ensure hygiene. Vendors often have poor storage conditions, clean water, and sanitary waste disposal methods (Dadwal & Singh, 2023). Testing in Accra found the presence of pathogenic bacteria such as Staphylococcus aureus, E. coli, and Salmonella spp. in khebab samples and demanded better food safety standards (Baidya & Rahman, 2021).

1.1 Background to the Study

Although health authorities in Ghana have made efforts to enforce food safety regulations, many challenges remain. Research indicates that both vendors and consumers often lack adequate knowledge about food safety, which contributes to the ongoing problem of foodborne illnesses (Madilo *et al.,* 2023). In the Asante Mampong Municipality, where this study was focused, fresh meat and khebabs are widely consumed. However, poor hygiene conditions in local markets and butcheries can significantly increase the risk of contamination. This study therefore aimed to assess the microbial quality of fresh meat and khebabs in the Asante Mampong Municipality.

1.2 Statement of Problem

Vending street food substantially contributes to economic development in cities of developing nations like Ghana (Addi, 2020). The vendors also realize state economic growth through tax payments (Okoye, 2020; Biney, 2019). Street food delivers a

plethora of reasonably priced, wholesome, and far-reaching varieties of dishes to many users daily (McGrath, 2019; Prayag & Liu, 2024). Even though the vending of street food plays a vital role, the consumption of street food increases the risk of foodborne infections stemming from a microbial source (Chalachew, 2022). Each year, Ghana has, therefore, recorded about 420,000 outpatient cases of foodborne infections, which result in about 65,000 deaths and an estimated total cost of $69 million (Ayamah *et al*., 2021). It is well-known that foodborne illness outbreaks are prevalent in developing nations due to vendors not following standard guidelines when preparing food and because contamination can occur a second time after food preparation (Oladipo-Adekeye & Tabit, 2021). In addition, inadequate training in food safety for vendors who work in unclean conditions is another leading cause (Sharif *et al.*, 2024). Street food is believed to be the most common source of foodborne illness outbreaks (Dominguez-Gonzalez *et al*., 2022).

In developed countries, foodborne disease outbreaks have occurred as well. In some parts of Italy and Europe, the annual death toll can amount to 3,000 and 4,654, respectively (Colarusso *et al.,* 2022). Khebab is a popular kind of ready-to-eat (RTE) food alternatively called "chinchinga" in Ghana. Khebab seems to be among the most widely consumed of all RTE foods (Giwa *et al.*, 2021). With its immense popularity, it is most often sold at street corners, markets, beaches, lorry terminals, beer bars, and restaurants. It is usually prepared using meat sources such as beef, pork, chevon, mutton, or chicken, marinated with a spice called 'suya' (Erhirhie *et al.,* 2020). Its production involves charcoal grilling, whereby vendors frequently handle the beef or turn the pieces over while cooking. This handling process could introduce high levels of microbial contaminnats. Moreover, portions of the meat can get stuck on the

skewer and may not be sufficiently cooked, allowing cross-contamination to endanger pathogen survival (Buckley & Lewis, 2022).

Foodborne disease outbreaks associated with khebab consumption have been reported in England and Wales (Manyi-Loh & Lues, 2025). Numerous studies have also reported khebab samples wherein bacterial loads of fecal coliform count exceeded 10^5 cfu/g (Marzoli *et al.,* 2023; Nagpal, 2023). Within the Bolgatanga Municipality of Ghana in particular, a significant number of people consume ready-to-eat foods such as khebab (Aduah *et al.,* 2021). Thus, the microbial quality of both fresh meat and khebab should be of importance to public health and the prevention of foodborne illnesses. Contaminated meat products could be the cause of serious infections in vulnerable groups such as infants, young children, the elderly, and sick individuals (Lund, 2019). By controlling the microbial contamination of meat products, incidences of foodborne illnesses can be minimized, and the general health and well-being of consumers enhanced. Effective food safety measures open the way for consumer protection and the enhancement of the food industry's image and economic fitness (Kamboj *et al.,* 2020). This study was performed to bridge the research gap in assessing the prevalence of food safety practices and microbial safety of fresh meat and khebab among vendors and consumers in the Asante Mampong Municipality of Ghana.

1.3 Study Objectives

The main objective of the study was to assess food safety practices and microbial safety of fresh meat and khebab among vendors and consumers in the Asante Mampong Municipality of Ghan

1.3.1 Specific objectives

Specifically, the study sought to:

i. Assess meat source used in preparation of khebab, safety and hygienic practices among vendors.
ii. Assess consumers' knowledge and perception of the safety of ready-to-eat khebab in the Mampong Municipality.
iii. Assess meat and khebab safety standards, regulations and enforcement in the Mampong municipal.
iv. Determine the microbial quality and safety of vended khebabs in the Mampong municipality.

1.4 Research Questions

i. What is the level of knowledge among khebab vendors regarding food hygiene, and how does this impact the safety of their products?
ii. What is the level of knowledge among khebab consumers regarding food safety, and how can this be improved to prevent foodborne illnesses?
iii. To what extent is food safety enforcements being implemented for fresh meat and khebab sold in retail outlets in the Asante Mampong Municipality? Are there any gaps or weaknesses in the current enforcement system?
iv. Which specific microorganisms are present in fresh meat and khebab sold in retail outlets in the Asante Mampong municipality, and what are their potential health risks to consumers?

1.5 Significance of the Study

The study sorts to provide insights into the prevalence and levels of bacterial contamination in these products, which can inform public health policies and interventions aimed at reducing the risk of foodborne diseases. The study contributes to our understanding of the microbiological safety of khebab, which is becoming increasingly popular in Ghana and other African countries. Khebab is often sold as ready-to-eat food by street vendors and restaurants, and its consumption has been associated with outbreaks of foodborne diseases in some instances. By assessing the microbial load and quality of khebab sold in retail outlets in Asante Mampong municipality, the study provides valuable information for improving the safety and hygiene of khebab production and consumption practices. Thirdly, the study has practical implications for food safety and public health in Ghana and beyond. The study's findings can be used to develop guidelines and standards for the production, processing, and sale of fresh meat and kebabs in retail outlets, as well as to inform education and training programs for food handlers and vendors. By promoting good hygiene and food safety practices, we can reduce the incidence of foodborne diseases and improve the health and well-being of consumers. Additionally, the study can help to identify potential sources of foodborne illnesses and enable targeted interventions to prevent outbreaks.

1.6 Delimitation of the study

The study focuses on identifying the specific bacterial contaminants present in these products and determining their levels of contamination. The study also investigates factors that may contribute to bacterial contamination, including food handling practices, storage conditions, and hygiene standards. The study's findings have practical implications for improving food safety and hygiene practices at retail outlets,

as well as for developing guidelines and standards for fresh meat and khebab production and sale within Asante Mampong Municipality and beyond, based upon international best practices and standards for food safety and hygiene, as well as Ghanaian food safety and hygiene legislation and guidelines, such as those set out by Ghana Standards Authority (GSA), Food and Drugs Authority (FDA), and World Health Organization (WHO). The study will also contribute to our understanding and knowledge about microbial quality and safety of fresh meat and khebab sold in retail outlets in the Asante Mampong Municipality and Ghana. It also will help to inform education and training programs for food handlers and vendors within the Municipality.

1.7 Organization of the Study

The thesis is structured into five chapters. This chapter has presented the relevant context of the research and included a statement of the problem that led to the research objective, research question, and significance of the study. Chapter two presents an overview of the literature related to the analysis of stakeholder participation and the factors that can influence the participation of key stakeholders in game resource management applied to the gamely sector. Chapter three showcases the study area and the materials and methods. Details of key stakeholder engagement findings and discussions are presented in Chapter 4. This includes findings and discussion of key stakeholder engagement and the role of key stakeholders, as well as a chi-square analysis of the factors influencing the participation of key stakeholders at different levels of game resource management. Chapter five presents a summary of findings conclusions and presents policy implications as well as recommendations for effective participation of key stakeholders in game management.

CHAPTER TWO: RELATED LITERATURE REVIEW

2.1 Overview

As street food (khebab) progresses in acceptance worldwide, with the intention of enhancing reach to larger numbers of people, but the handling of these foods has become a major concern regarding their microbial quality (Savvaidis *et al.,* 2022). Studies by Wiatrowski (2024) have shown unfavourable trends in this regard. Food must be roasted to its minimum cooked internal temperature according to guidelines to ensure safety for the consumer (Romano *et al.,* 2024). Roasting will kill the majority of vegetative microorganisms but does not kill spores or neutralize any toxins that may have been produced (Ogwu & Ogunsola, 2024). Therefore, it is vital to ensure the safe handling of the khebab before and during roasting. This reviewed various aspects related to food safety, including sources and routes of contamination, the role of quality assurance systems, and current methods used to monitor hygiene in food processing establishments.

2.2 Microbial Quality

The microbial quality of fresh meat and khebab is crucial in ensuring food safety and preventing foodborne illnesses in consumers worldwide (Salamandane *et al*., 2024). Globally, a study by Afsana *et al.* (2022) estimates that approximately 600 million people fall ill from consuming contaminated food annually, resulting in 420,000 deaths. Fresh meat and khebab are among the most commonly implicated food items in foodborne outbreaks, with bacteria such as *Salmonella, Escherichia coli (E. coli), and Listeria monocytogenes (L. Monocytogenes*) being the most frequently identified pathogens (Abalkhail, 2023). Therefore, assessing microbial quality in fresh meat and

khebab is crucial in preventing foodborne illnesses globally by ensuring that food products meet established safety standards (Eshamah *et al.,* 2020).

In Africa and Ghana in particular, the establishment of microbial quality is of utmost importance due to several reasons (Boas *et al.,* 2024). First is climate; Africa is known for its warm weather that favours bacterial growth (Abdulsalam *et al.,* 2023). Second is the inconsistent hygiene practices of many small-scale meat processors, who do not have access to clean water to wash their hands or utensils (Asaki *et al.,* 2024). The absence of refrigeration for many smallholder meat processors in Ghana causes spoilage and the proliferation of bacteria (Afriyie *et al.,* 2023). Thus, establishing microbial quality in the fresh meat and khebab is crucial for ensuring food safety such that no outbreak of foodborne illness takes place in Ghana and Africa, in general.

A study by Ahiabor *et al.* (2024) found that 62 % of fresh meat and khebab samples from local markets in Accra, Ghana, were found to be contaminated with pathogens such as *Salmonella, E. coli, and L. Monocytogenes.* Furthermore, another study also established that poor hygiene practices of washing hands and utensils with contaminated water play a vital role in enhancing the presence of pathogens in meat samples (Kanaan *et al.,* 2023). Therefore, establishing microbial quality in fresh meat and khebab would be important to pinpoint contamination sources and intervention measures to stop the spread of the pathogens (Salamandane, 2024).

Microbiological testing involves culturing bacteria from the meat samples to identify the presence of pathogens (Renzi, 2023). Chemical analysis involves testing for the presence of chemical contaminants such as antibiotics and pesticides (Ripanda *et al*., 2021). Sensory evaluation involves assessing the appearance, colour, texture, and

odour of the meat samples to ensure that they meet established quality standards (Kumari *et al*., 2023). High microbial loads can lead to spoilage, off-flavours, and off-odours in meat products, while low microbial loads can indicate that the meat has been properly handled and stored (Akinsemolu & Onyeaka, 2024). Therefore, understanding microbial load is essential in ensuring consumer safety and food quality. A study by Dela (2021) found that the microbial load of fresh meat and khebab samples from local markets in Accra, Ghana, ranged from 1.2×10^2 to 7.1×10^4 cfu/g. The study also found that the microbial load was higher in khebab samples compared to fresh meat samples. This was because khebab is typically prepared and stored for longer periods of time than fresh meat, leading to higher microbial loads (Bansal *et al.*, 2025).

2.3 Microbial Contamination in Fresh Meat

The presence of microbial contamination on fresh meat is very detrimental to the health of the consumers, as the bacterial-type contaminants are capable of causing foodborne illnesses with mild gastrointestinal symptoms to serious infections occurring mainly among susceptible populations, including young children, pregnant women, and the elderly. Of importance are the sources of bacterial contaminants found in fresh meat and their associated health risks.

2.3.1 Salmonella

Salmonella is a non-spore-forming gram-negative bacterium that usually lives in animal faeces and infiltrates poultry, swine, and cattle (Sykes & McDonough, 2021). Cross-contamination during slaughtering, processing allows *Salmonella* to enter a cheese product or raw fresh meat (Birke & Zawide, 2019). Manifesting in terms of

salmonellosis, it can lead to diarrhoea, fever, and abdominal cramps, lasting from a few days to even several weeks (Wang & Zhang, 2022). Severe cases of *Salmonella* sometimes require hospitalization, especially in very young children, the elderly, and people with weakened immune systems (Bisola Bello *et al.,* 2024). To avoid *Salmonella* contamination in the fresh meat-handling processes, hygiene practices must be carefully adhered to, including proper handwashing techniques by personnel dealing with meat products (Nabwiire, 2023).

2.3.2 *Escherichia coli (E. coli)*

E. coli are gram-negative bacteria causing food-borne illness, especially from undercooked or raw meat. It is found throughout the intestines of healthy cattle, pigs, and poultry. Contamination of fresh meat can occur during slaughtering, processing, or handling (Das *et al.,* 2019). Signs and symptoms of *E. coli* infections can include diarrhoea, abdominal cramps, and fever lasting from days to a week (Negrut *et al.,* 2020). In the worst scenario, *E. coli* causes hemolytic uremic syndrome (HUS), or kidney damage, a possibly fatal condition (Liu *et al.,* 2022). Proper hygiene should be followed during the production of fresh meat; for instance, meat workers should observe correct personal hygiene practices such as handwashing techniques and the use of pasteurization methods during processing, for prevention of *E. coli* contamination (Sanchez Rojas, 2023).

2.3.3 Campylobacter

Campylobacter is a Gram-negative bacterium found in the intestines of poultry, cattle, and sheep. It can contaminate fresh meat during slaughtering, processing, or handling, causing foodborne diseases (Severino *et al.,* 2025). The infection caused by *Campylobacter* results in *campylobacteriosis*, which manifests as diarrhoea, fever,

and abdominal cramps that may persist for a few days to a week (Chukwu *et al.*, 2024). Severe cases may lead to hospitalization, particularly in children, the elderly, and immunocompromised people (Committee on Infectious Diseases 2022). To prevent Campylobacter contamination in fresh meat production processes, strictly adhere to hygiene practices, such as proper handwashing by personnel handling meat products and proper pasteurization techniques during processing (Owiti, 2023).

2.3.4 Listeria monocytogenes

Listeria monocytogenes is a Gram-positive bacterium that is commonly found in soil, water, and animal faeces (Gartley *et al.,* 2022). Fresh meat can become contaminated during slaughtering, processing, or handling and can lead to foodborne diseases (Abebe *et al.,* 2020). In specific populations, such as pregnant women, the elderly, and those with immune-compromising illnesses, listeriosis, caused by *Listeria* may present symptoms such as fever, muscle aches, and gastrointestinal symptoms (Pakdaman, 2023). Hygiene practices must include proper handwashing techniques by those handling meat products and pasteurization techniques during processing to prevent *Listeria* contamination in the production of fresh meat (Spanu & Jordan, 2020).

2.3.5 Staphylococcus aureus

Staphylococcus aureus is a Gram-positive bacterium commonly found on human skin and in the nasal cavity. It contaminates fresh meat during handling, especially during meat processing operations in food plants, where it can be transferred to meat through improper handling of food (by-food handlers) or from contact between equipment and food surfaces (Kinyua, 2024). *Staphylococcal* food poisoning is the effect produced by food contaminated by *Staphylococcus aureus*. Symptoms include nausea, vomiting,

and diarrhoea, occurring within a few hours to a few days after ingestion (Arca *et al.*, 2022). To prevent contamination of fresh meat by *Staphylococcus aureus,* all fresh meat production operations must consistently apply hygiene practices such as appropriate handwashing methods for workers handling meat products and the introduction of pasteurization techniques during processing (Das *et al.*, 2019).

2.4 Sources of Meat Contamination

Microbial growth in meat depends on many factors: types of microbes, temperature, past treatments, pH, availability of nutrients, oxidation-reduction potential, and atmosphere around meat (Aziz *et al.,* 2019). The sources of bacterial contamination can be varied, and some of the sources could be from the skin of the animal, equipment at each stage of processing, clothing of attendants attending to the process, hands of those who handled the meat while at work, and the physical plant itself (Ovuru *et al*., 2024). Because of their larger surface area, bigger cuts of meat, and greater availability of water and nutrients, will have a more pronounced high microbial load, thus making them more prone to spoilage and microbial growth (Devi *et al.,* 2019). The level of contamination in meat products can further vary because of newer technologies in processing and added processing steps for value addition (Anas *et al.,* 2019).

The contamination of raw meat begins at the very time of slaughter. At this point, the carcass is contaminated with microorganisms originating from the external surfaces of the animal, the gastrointestinal tract, the lymph nodes of the animal, and the environment of the plant facility (Manyi-Loh & Lues, 2023). The existing contaminants may also increase their spread through certain stages of processing,

contributing to enhanced contamination. In a meat handling system, measures should be taken to minimize microbial contamination to ensure there is no spoilage and to lessen health hazards relating to meat consumption (Rebezov *et al.,* 2024). Though healthy living animals may lack microorganisms within the musculature, except for what could be found on external surfaces or in the gastrointestinal and respiratory tracts, slaughtered meat animals lose their internal defences that would normally restrict microorganism growth (Hunde *et al.,* 2024).

Preventing microbial contamination and growth must be initiated at exsanguination and incorporated into the subsequent stages of lamb slaughtering (Wilson, 2023). Bacterial levels on workers' hands will pose a significant risk, given the high interactions with carcasses and other body parts throughout the activities. Moreover, in many abattoirs, knife cleaning is not done between operations, according to a hot water bath for knife cleaning (Yimana & Hassen, 2024). Microbial flora from knives, hooks, and hands resulted when direct contact with carcasses, intestines, and organs was in effect (Saleh, 2022). Drop-out from blood, meat/fat particles, broken bones, and gut contents will continuously drop on the floor, obstruct removal, and spread from one point to another due to the continuous movement of personnel in slaughter areas may contribute to higher counts on the floor. Intake of food contaminated with animal origin, like meat, eggs, and milk, can lead to infections in humans (Kundul & Ame, 2022).

The cycle of transmission of *Salmonella* between humans, animals, food, and environmental sources is well known (Ferrari *et al.*, 2019). Non-typhoidal *Salmonella* is usually transmitted in the food chain through first hybridization via animal feed and high faecal shedding levels by infected animals recognized as major entry nodes in

the food chain (Huang & Naushad, 2024). During the primary and further handling of meat, there are chances for contamination with various bacteria responsible for spoilage and public health, including *Clostridium perfringens, Staphylococcus aureus, Salmonella spp.,* pathogenic *Escherichia coli, Campylobacter spp., Yersinia enterocolitica, Listeria monocytogenes,* and *Aeromonas* (Ghosh & Ray, 2025). Healthy persons can experience self-limiting enteric infections from pathogenic bacteria, while immunocompromised persons, older adults, and toddlers may develop severe systemic diseases (Paul, 2024).

Spoilage of meat mainly depends on the initial microbiological quality and subsequent storage conditions. Cleaning and sanitizing high-contaminating areas like floors, walls, evisceration platforms, and wooden logs should be done regularly to prevent cross-contamination of carcasses in areas where slaughtering occurs (Moerman *et al.,* 2023). Cleaning should be done as soon as a round of butchery is completed, to avoid the adhesive property of residues onto surfaces, which could later lead to contamination (Moerman *et al.,* 2023). Regular cleaning, washing, sterilizing, and maintenance of knives and hooks can help control cross-contamination, as tools used come into direct contact with carcasses and may serve as vectors (Koech, 2024). A thorough cleaning procedure not only destroys the existing sources of contamination but also creates a revised environment and promotes worker cleanliness (Ezzatpanah *et al.,* 2022).

2.5. Indicators of Meat Quality

2.5.1 Aerobic mesophilic count

The aerobic mesophilic count (AMC) or aerobic plate count (APC) is a general indicator of the microbiological quality of food and serves as a measure of sanitation during food handling (Odundo, 2021). However, it cannot directly contribute towards a safety assessment of ready-to-eat food (Adetunji *et al*., 2021). The aerobic colony count (ACC), also known as the total viable count (TVC) or standard plate count, is the total number of bacteria that can grow in an aerobic environment at moderate temperatures. Like AMC, ACC is an indicator of quality, not safety, and cannot directly contribute towards a safety assessment of ready-to-eat food. While ACCs can provide useful information about the general quality and remaining shelf life of food, they are not deemed a priority in a risk-based analysis.

AMC can be used as part of a general quality assessment, including that of extended shelf-life foods. If an aerobic mesophilic count (AMC) is above the expected level, then it becomes necessary to isolate the organisms and their levels before considering an extended study (de Souza Fernandes, 2024). A high AMC may indicate quality issues and possibly poor temperature control, which must be investigated in detail (Tian *et al.*, 2023). The high AMC may indicate that a product has been prepared unhygienically or was exposed to inappropriate storage conditions (Chitrakar *et al.*, 2019).

Aerobic plate count (APC) is the number of eight non-fastidious aerobic bacteria, which can grow without special nutritional supplements or conditions applied to agar growth plates (Adrah, 2021). *Staphylococcus* species can live in nutrient-sparse environments and survive in wider temperature ranges compared to many fastidious

bacteria. Foods that may look fresh might have a high APC and are likely to spoil In fresh products, APC indicates the effectiveness of sanitary procedures used during processing and handling before storage of the product (Soladoye *et al.,* 2025). However, APC has some limitations; for example, fermented foods naturally contain a high microbial load, and in consequence, APC cannot be used to evaluate their general microbiological quality. In addition, the plating medium does not support the growth of fastidious microorganisms, thus leading to the underrepresentation of microorganisms in the APC (Wong, 2022).

2.5.2 Total Coliforms

Coliforms counts are used as indicators of water or food quality, and high levels indicate unhygienic conditions (Beyene *et al.,* 2023). They are a group of bacteria that share common biochemical and morphological characteristics that include being Gram-negative, motile, facultative anaerobic, non-spore-forming rods that ferment lactose and produce acid and gas within 24 to 48 hours at temperatures between 32 to 35 °C with a water activity (AW) (use the appropriate symbol) of 0.92 (Chitrakar *et al.,* 2029). These characteristics also apply to *E. coli,* which is the most important coliform as far as sanitary significance is concerned since it is predominantly found in the faeces of warm-blooded animals (Muendo *et al.,* 2022). *Coliforms* are assumed to be present in many raw foods and food ingredients of both animal and plant origin.

Total Coliforms are a heterogeneous group of bacteria that are ubiquitous (Solaiman *et al.,* 2020). Whereas all members belonging to the total *Coliforms* group may be isolated from the faeces of a human being, some of them can equally be obtained from animal manure and soil, sunken wood, and other environmental sources. Hence, the ability of total *Coliforms* to act as a faecal contamination indicator depends upon the

proportion by which the bacterial species are faecal and of human origin (Omondi, 2021). In the case of recreational waters, it is no longer recommended to use total Coliforms as an indicator. In contrast, in the case of drinking water, it still remains the standard test as their presence indicates that there is contamination from some outside source (Singh *et al.,* 2024).

The term "total Coliforms" includes all Coliforms and is used because if any are present, it shows the absence of faecal Coliforms (Mabvouna Biguioh *et al.,* 2020). Total Coliforms have sources from both the intestines of warm-blooded mammals and from the environment (Qayoom *et al.,* 2023). Since Coliforms normally inhabit the intestinal tracts of organisms, their presence in food might show that there has been a contamination by faeces. In some plant-derived foods, their counts may be very high due to soil contamination (Ratajczak *et al.,* 2020). The specificity of Coliforms as an indicator of faecal contamination in raw foods is lost since large numbers of Coliforms in the food can arise from the growth of non-faecal microorganisms (Pizarro *et al.,* 2019). On the other hand, in heat-processed (pasteurized) food products, their presence indicates post-heat-treatment contamination arising from poor sanitation practices (Ray, 2019).

Faecal Coliforms: A specific subgroup of the total Coliforms, which are capable of growth at a higher temperature of 44.5 °C (Masakha, 2019). Total Coliforms are a heterogeneous group of bacteria that are ubiquitous (Solaiman *et al.,* 2020). Whereas all members belonging to the total Coliforms group may be isolated from the faeces of a human being, some of them can equally be obtained from animal manure and soil, sunken wood, and other environmental sources. Hence, the ability of total Coliforms to act as a faecal contamination indicator depends upon the proportion by which the

bacterial species are faecal and of human origin (Omondi, 2021). In the case of recreational waters, it is no longer recommended to use total Coliforms as an indicator. In contrast, in the case of drinking water, it still remains the standard test as their presence indicates that there is contamination from some outside source (Singh *et al.,* 2024).

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2.5.3 Staphylococcus aureus

Staphylococcus aureus is a gram-positive, spherical bacterium that is commonly found in the human body, particularly in the upper respiratory tract and on the skin (Berini *et al.*, 2022; Arunachalam *et al.,* 2023). S. aureus is commonly found on the human body, particularly in the nose, throat, hands, and wounds (Angeline et al., 2024). It is an auspicious member of the Firmicutes and is capable of producing

enterotoxins that can cause acute gastrointestinal illness when ingested (Roussel, 2019). Some strains of *S. aureus* can survive heating at 100 °C for 30-700 minutes due to the heat-stable nature of the enterotoxin it produces (Khan *et al.,* 2023). It can also be found on food contact surfaces and can become a persistent organism in slaughterhouses (Morshdy *et al.,* 2023). *S. aureus* can contaminate food through contact with contaminated hands, materials, and surfaces, as well as through the air (Ballah *et al.,* 2022).

S. aureus is responsible for a variety of diseases, including wound infections, blood poisoning, and toxic shock syndrome (Abdallah & Sulieman, 2024). Other apecies of Staphylocuccus *S. intermedius, S. hyicus, and S. epidermidis. S. aureus* can be distinguished from *S. epidermidis* by the production of coagulase and thermos-nuclease (Prihandani *et al.,* 2024). The presence of *S. aureus* in fresh meat suggests poor hygienic practices, as this organism is a normal flora of the skin and nasal passages (Auta & Diram, 2021). Enterotoxins produced by *Staphylococcus* species at favourable temperatures are a common cause of foodborne illnesses worldwide (Zhang *et al*., 2022). The presence of pathogenic organisms in fresh meat indicates poor hygienic and sanitary practices employed in the slaughtering, processing, and packaging of fresh meats (Ovuru *et al.,* 2024). This may be due to possible contamination of fresh meats or meat products during sales or unhygienic handling of the meats right from slaughtering (Adesola *et al.,* 2024). Improper handling and improper hygiene may lead to contamination, which can adversely affect the health of consumers (Musema, 2022). Therefore, it is recommended that fresh meat processors and sellers should be educated on the adverse effects of contamination (Adesola *et al.*, 2024).

2.5.4 Total Aerobic Spore-Forming Bacteria

Most spore-forming bacteria present in food have acquired great significance due to their ability to form spores and thus withstand different adversities (Sharma *et al.*, 2021) such as heat, freezing, chemicals, and other environmental changes during food processing and preparation. While most of these conditions destroy the vegetative cells of bacteria, their spores require harsher conditions to be killed. Bacteria of the genus *Bacillus* comprise one of the very important groups (Payne *et al.,* 2024). These are airborne to facultative anaerobic rod-shaped microbes. Some species can grow under mesophilic temperatures (up to 35 ºC) or thermophilic temperatures (up to 55 ºC) causing food spoilage or food-borne illnesses (Arficho & Kebede, 2019). The other important genera of spore formers are *Clostridia* which includes anaerobic bacteria that can grow under mesophilic and thermophilic temperatures again depending on the species (Cingano, 2021). *Clostridium* species are of great interest in the field of food industry since these are spoilage and food-borne pathogens, C. botulinumbeing one of the most common examples (Farag *et al.,* 2022). The spores of these bacteria are in soil, water, and the intestinal contents of humans and animals, which get transferred through food sources (Tran *et al.,* 2020).

2.5.5 Salmonella Spp.

According to Huang and Naushad (2024), *Salmonella* comprises a major group in the *Enterobacteriaceae* family associated primarily with closely related "Gram-positive, non-sporulating, facultative anaerobic motile rod-shaped" bacteria, part of a grouping that is naturally occurring motile bacteria mostly Gram-positive, non-sporulating, and facultative anaerobic (Azis *et al.,* 2019). They can produce gas during growth on media containing glucose and ferment dulcitol, but not lactose, use citrate as carbon

sources, produce hydrogen sulfide, and decarboxylate lysine, do not produce indole, and are negative for urea (Aziz *et al.,* 2019). Their temperature for optimum growth is between 35-37 °C, with a pH of 3.7-9.8, and AW of 0.94 (Espagne & Magacho, 2022). To kill *Salmonella,* it is possible by pasteurization temperatures but they can multiply in several foods without changing their acceptance qualities (Sun *et al.,* 2024). Almost all studies and trial programs conducted on food items, particularly meat, seafood, spices, and coconut, are proof of this bacterium (Gómez-López *et al.,* 2022).

Salmonella represents a major pathogen affecting food-producing animals, whose main mode of spreading the disease is through the trading of live animals and animal-feed products that have not undergone heat treatment (Hunde *et al.,* 2023). This bacterium is predominantly responsible for causing a gastrointestinal infection called *Salmonellosis* in humans (Soltani *et al.,* 2023). Even with low levels of contamination in minced meat, *Salmonella* can multiply very positively at conditions that are not even favourable, especially at above +6 °C and this can lead to cross-contamination. Operations in slaughtering plants do usually exacerbate the background level of bacterial contamination associated with living animals (Gutema *et al.,* 2021). *Salmonella* is still a major problem in the export of quality food and is the cause of rejecting batches in which they are detected (Gómez-López *et al*., 2022).

Salmonella primarily spread through contaminated food, drinks, or water, often resulting from contact between infected individuals or chronic carriers through urine or faeces (Riley, 2020). These zoonotic infections are commonly acquired through consuming contaminated animal-derived products, such as fresh meat and eggs, which are the primary reservoirs of the bacteria (Zenu & Bekele, 2024). Food safety criteria dictate that the presence of *Salmonella* in any sample unit of a batch results in its

withdrawal from the market or further processing (Gordon & Schreurs, 2020). *Salmonella* can be found in a wide range of domestic and wild animals and various foodstuffs, including those of both animal and plant origin (Galán-Relaño *et al.*, 2023). The bacteria are typically introduced into the food chain through faecal contamination, and transmission may also occur through direct contact with infected animals and contaminated environments or surfaces (Antunes *et al.*, 2019).

Salmonella causes two diseases in humans, namely *Salmonellosis* and enteric fever (typhoid), which result from bacterial invasion of the bloodstream (Worley, 2023). *Salmonella* is one of the most significant pathogens associated with acute gastroenteritis caused by bacterial invasion of foodborne genera implicated in foodborne bacterial outbreaks and infection/intoxication of diseases (Al-Hamadany, 2021). *Salmonella* is the most commonly reported cause of foodborne illness in Ethiopia (Nkeza *et al*., 2019). The prevalence of *Salmonella* on carcasses has been reported as 0.31 % for beef and 0.63 % for sheep (Tohamy *et al.*, 2022). To have a 90 % probability of detecting *Salmonella* on beef carcasses when the average incidence is 0.31 %, it is necessary to test 1171 samples (Khanal, 2019).

2.6 Factors Contributing to the Prevalence of Microbial Indicators and Pathogens

These microorganisms have the potential to make big losses in the food safety aspect at retail store outlets where meat products are sold or prepared, and could have very serious health effects, such as foodborne illnesses, and gastroenteritis fever, among others (Vinod *et al.*, 2023). Poor hygiene practices during slaughtering, processing, or storage will really increase the chances that the microbial indicators or pathogens will prevail at increased rates (Ovuru *et al.*, 2024; Ogunlade *et al*., 2024). Birgen (2019)

found that *Coliforms* were present in 38 % of beef samples bought from retail outlets, and Alaali & Thani (2020) found that *Coliforms* were present in 44 % of beef samples purchased in Turkey. Korkmaz *et al.* (2020) also found that about 10 % of samples were found to be positive for *Salmonella* in beef samples purchased from retail outlets in Turkey, while Martínez-Laorden *et al.* (2023) discussed that there were about 12 % *Salmonella* bacteria in beef collected from retail outlets in Turkey.

Improper storage and transportation practices can also contribute towards contamination by microbial indicators or pathogens, leading towards increased prevalence rates (Ovuru *et al*., 2024; Oduoye *et al.*, 2024). Kunadu *et al*. (2020) found that *Escherichia coli* bacteria were present on approximately 20 % of chicken samples purchased from retail outlets, while Sahin *et al*. (2022) found that *Escherichia coli* bacteria were present on approximately 16 % of chicken samples purchased from retail outlets in Turkey. These studies indicated that improper storage and transportation practices can significantly contribute towards contamination by microbial indicators or pathogens, leading towards increased prevalence rates (Akinsemolu & Onyeaka, 2024). The use of antibiotics and growth promoters in animal husbandry can also contribute towards contamination by microbial indicators or pathogens, leading towards increased prevalence rates (Ovuru *et al*., 2024; Akinsemolu & Onyeaka, 2024).

2.7 Hygiene Knowledge and Practices

The study done by Aglidza (2019) concerning food safety knowledge and practices surveyed street food vendors on a university campus in Quezon City, Philippines. It covered various areas like health and personal hygiene among vendors, food processing procedures, food contamination and waste management, and food

legislation (Rosales *et al.,* 2023). The results showed that the vendors have good insight into food safety concepts involving health and personal hygiene, food contamination, and good manufacturing procedures (Parikh *et al.,* 2022). It was also noted that the vendors did poorly when it came to knowledge of food legislation and waste management (Odipe *et al.*, 2019). Ali, (2024) further studied food-handling practices of 10 mobile food vendors in Manhattan, New York City, and noted that more than two-thirds (67 %) of them violated norms by serving food with bare hands during the 20 min observation period dedicated to a daily visit to each vendor's stall. Some been sighted as handling food with visibly dirty hands or gloves without washing or changing throughout their shift; four others contaminated served food with raw meat or poultry during the same observation period but none washed their hands nor changed their gloves during this period, despite such violations (Ovuru *et al.,* 2024).

The study by Omidiran *et al.* (2020) investigated the hygienic practices of street vendors regarding food safety in Owerri, Nigeria. The data were collected with the use of structured interviews, semi-structured questionnaires, and observations. The study adopted a descriptive survey design. The results stated that 23.81 % of vendors prepared food in unsanitary environments, 42.86 % do not wear aprons, 47.62 % handle food with bare hands, and 52.38 % serve the customers without hair covering (Omidiran *et al.* 2020). Money handling during food-selling service was done by 61-90 % of the vendors, and 19.05 % wore jewellery while serving food (Gbedze, 2021). A few (9.52 %) open storages among vendors, 23.81 % stored food in wheelbarrows, and serve food, and a large number (42.86 %) of food vendors store leftovers for the next day with poor storage (Gbedze, 2021). In addition, 47.62 % of those interviewed

cited washing their utensils with dirty water that had been recycled and reused. Only 9.52 % complained of a lack of water supply in the stalls (Gbedze, 2021). Kuboka *et al.* (2024) studied hygiene and sanitary practices of street food vendors in Nairobi, Kenya and recommended that health education is necessary to ensure food safety for consumers. A study involved street food vendors from Cheru (2020) estates and data was collected through in-depth interviews and observational checklists. Results showed that most vendors were males (60 %) and aged within 20-25 years (35 %). Most were found with primary education or less (62 %), and most learned cooking principles by observation (61 %). Most found (85 %), of vendors prepared food in unsanitary conditions as trash and foul waste are often found around their stalls. Thus, 92 % of the vendors had no garbage receptacles and disposed of wastes around their stalls while 92 % threw wastewater near their stalls. This leads to a dirty environment surrounding the eaters. The study did not find a significant relationship between education level and the state of the environment around the vendors' stalls. Molina, (2020) carried out a study on hygienic practices by street food vendors selling doubles, Trinidad as well as general public perception regarding vending practice. The study employs a structured questionnaire to assess street vendors and the general public, 120 street vendors and 115 public members, in Trinidad, West Indies. The majority of the vendors were male (61.7 %), were in vending for 5 years (81.7 %), and received primary-level education (72.5 %). Doubles were mostly prepared in the morning by the family of the vendors (84.2 %). Vendors generally wear attired with proper dressing (99.2 %) and served him with forks/spoons (100 %) and tongs (81.7 %). Water supplied to sites of vending was from containers having faucets (85.7 %), and toilets were not nearby (97.5 %). Most respondents (86.1 %) did consume doubles.

Some (30.6 %) however, said felt ill after eating doubles, with only 2.7 % visiting a doctor/health authority.

Macpherson *et al.* (2022) in another study investigated the dietary risk factors with respect to Helicobacter pylori transmission in Lima, Peru. The researchers then collected demographic and dietary data from 104 children between the ages of 0 and 17, who were to undergo endoscopy for evaluation of the gastrointestinal system. Biopsy specimens taken from the gastric antrum were affected to detect if Helicobacter pylori were present. 52 (50 %) of the participants were found to be infected and were significantly older than those not infected. No significant differences were found between infected and uninfected in gender, crowding, source of drinking water, or exposure to domestic animals. However, the quantity of fish, chicken, beef, beans, vegetables, rice, cheese, and milk was significantly higher and consumption of unboiled water was also higher in the infected group compared with the uninfected group. The findings of the research thus supported the hypothesis that transmission might be through food prepared in unhygienic conditions in developing countries.

The present study showed that faecal contamination occurred in 65 % of drinking water samples, 91 % of dishwater samples, and 100 % of ice cube samples. Furthermore, pathogens such as *Salmonella typhi* and non-typhoidal *Salmonella* were detected in faeces from 13 (7 %) street food vendors. From the present study, it was discovered that food vendors in general kept rather poor food hygiene as compared with those in restaurants, thus making recommendations for interventions to mitigate the transmission of foodborne illness, which included regular hand washing with soap, sound food hygiene practices, and frequent turnover of dishwater in street food trucks.

Akinbule *et al*. (2019) studied the food hygiene practices of food vendors in secondary schools in Ilorin, Nigeria. It was found that premedical practices scored high at 141 (76 %), while periodic check-ups were low at 30 (16 %). Some 61 (33 %) prepared food in advance while 72 (39 %) heated food before selling it. Interestingly, the unclean practice one finds among food vendors is poor care of utensils, where a whopping 100 (57 %) of the vendors wash and clean utensils using water that was previously used. Added to that, are 128 (69 %) vendors. Also, 100 (57 %) used unhygienic methods in cleaning their vessels.

A recommendation was made that training and education for food vendors and handlers should include basic principles of safe food handling (Kunadu *et al.,* 2020). Trained food vendors and handlers on elementary principles of safe food handling. Lemomo (2022) found that street food vendors in Nairobi were generally poor with regard to hygiene and sanitation. The majority would have had no formal training in food preparation; water used for washing utensils and personal hygiene were compromised. Stalls are poorly constructed, and vendors do not protect street food from dust and smoke properly. Vendors practised very personal hygiene, with about 81.3 % not wearing aprons and 60 % handling food with hair uncovered. On food serving, vendors handle money to them, with only about 10 % putting jewellery on their hands. Utensils were washed in water in buckets that were washed solely once and then reused dozens of times before being substituted. The water used to wash and rinse these utensils was found dirty. No proper methods of storing leftover food were used in this area, which could have aided in the sale of stale food. 32.1 % of interviewed vendors consumed leftover food, while the rest stored it for sale the next

day. Leftover food was stored by vendors in open places (21 %), refrigerators (21 %), and plastic containers (21 %), while 16 % kept it in polythene bags or cupboards.

A study by Aglidza (2019) in Ghana, assessed the microbiological quality of street foods sold in Accra, as well as the factors attributable to food contamination. The study indicated that out of a total of 177 street vendors, 79 (66.7 %) received education. They demonstrated good hygiene behaviour. The vicinity of the vending sites was generally clean save for 3.4 %, which was classified as very dirty. The study observed cooking food beforehand, exposing food to flies, and preparing food on the ground as probable risk factors for contamination. Out of the 511 menu items analyzed, 356 (69.7 %) were identified as mesophilic, and 28 (33.7 %) were identified as *Enterobacteriaceae*. Most of the food had acceptable levels of microbial quality, while salad, macroni, fufu, rice balls, and red pepper samples were found to have unacceptable contamination levels. Gbedze, (2021) affirmed that street food is a source of pathogens in their study about the role of unwholesome meat in the causation of disease. A study by Katumi (2020) advised that street vendors who sell food should be educated on food hygiene particularly regarding causes of diarrhoea, means of transmission of diarrhoea pathogens, equipment handling, cooked food, hand washing practices, and proper environmental hygiene.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Introduction

This chapter details the research methodology employed. It includes the research design, study area, data collection techniques, and laboratory analysis methods.

3.2 Background to the Study Area

The study was conducted in the Asante Mampong Municipality, located in the Ashanti Region of Ghana, which has a diverse population predominantly composed of the Ashanti people. The Municipality has a population of approximately 161,000, according to the Ghana Statistical Service (GSS) (2021). It includes both urban and rural communities, with Mampong town serving as the administrative and commercial hub. Educational attainment is increasing, supported by several primary, secondary, and tertiary institutions. Religiously, the population is mainly Christian, accounting for about 70 %, with various denominations including Catholic, Pentecostal, Presbyterian, Seventh Day Adventist, Methodist churches etc. Muslims constitute about 20 % of the population, and the remaining 10 % adhere to traditional African religions or other faiths (GSS, 2021).

Agriculture is the main economic activity, employing a significant portion of the population. The area produces staple crops such as maize, yam, and plantain, as well as cash crops like cocoa and cashew nuts. Livestock farming, including poultry, goats, and cattle, also plays a crucial role in the local economy (Naazie *et al.*, 2024). Besides agriculture, the local economy is diversified with various economic activities such as trade, commerce, and small and medium-sized enterprises (SMEs) in food processing, textiles, and crafts. The municipality benefits from remittances from residents working in other parts of Ghana and abroad, which contributes to household incomes

and local development (GSS, 2021). Financial institutions like banks and microfinance organizations facilitate economic transactions and support entrepreneurial activities. A notable aspect of the local economy is the vibrant market for fresh meat and khebab. Numerous khebab sellers operate within the Municipality, providing a popular and accessible source of protein for residents. These vendors play a significant role in the local food industry, contributing to the daily dietary needs of the population. The climate in Asante Mampong Municipality is tropical, characterized by a rainy season from March to November and a dry season from December to February. The area receives substantial rainfall, ranging from 1,200 to 1,500 millimetres annually, with temperatures typically ranging between 22 °C and 30 °C, making it conducive to agricultural activities (Ghana Meteorological Agency, 2022). Fig 1 shows a map of Mampong Municipal area

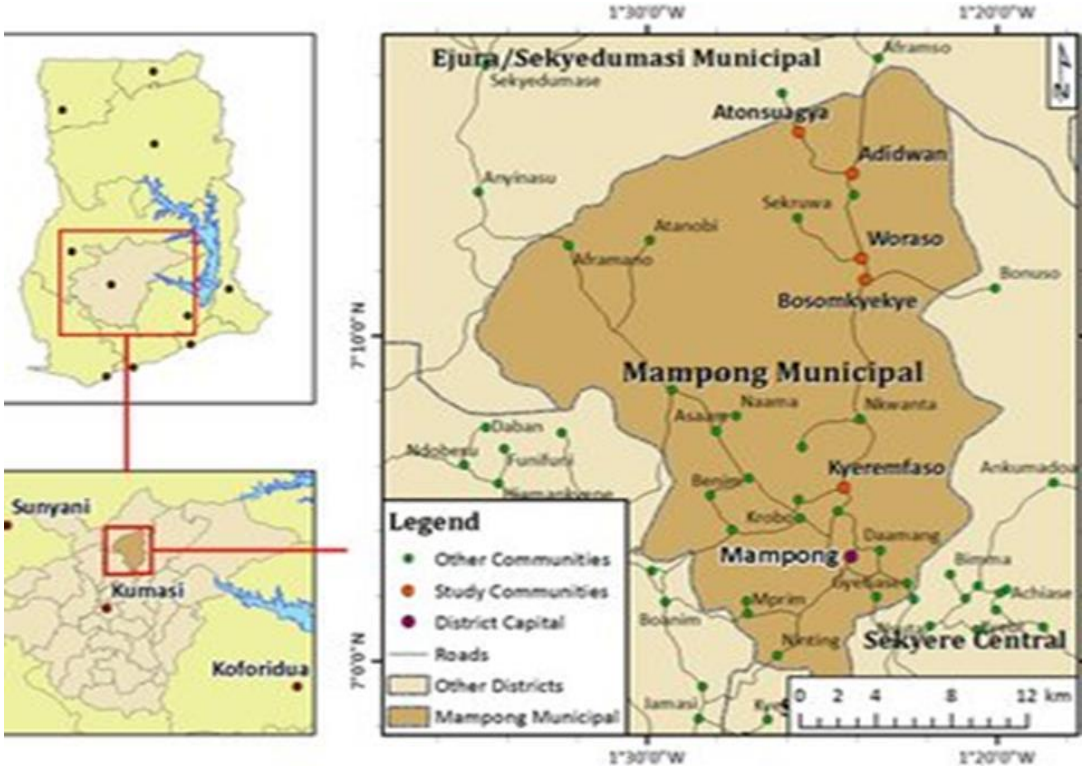

Fig. 3.1: Map of Mampong Municipality (Adams, 2021)

3.3 Research Design

This study employed a mixed-method design to assess the food safety practices and microbial safety of fresh meat and khebabs among vendors and consumers in the Asante Mampong Municipality. This design was used to determine the prevalence of microbial contamination and possible risk factors affecting meat safety in the municipality (Ahiabor *et al.,* 2024). This design allowed an assessment of microbial exposures and contamination levels in meat at various retail outlets, including markets and street vendors (Atlabachew & Mamo, 2021).

3.3 Study Population

The study population consisted of khebab vendors, meat consumers, and Health and Sanitation Officers (HSO) in Asante Mampong Municipality. The khebab vendors were males between the ages of 18 and 60. However, meat consumers in the municipality included males and females ranging from 15 to 65 years.

3.3.1 Sample Size Estimation

A sample size of 145 respondents was estimated based on a 50 % prevalence of meat contamination using Cochran's Formula as $N = \frac{Z^2 \, x \, pq}{e^2}$ previously described (Sarmah et al., 2013)

Where N is the sample size

Z is the chosen critical value of the desired confidence level

p is the estimated proportion of an attribute present in the population

q = 1 – p

and **e** is the desired level of precision or sampling error.

Table 3.1 Summary of Sample Size used

Survey on Knowledge of Meat Safety Survey	Estimated Sample Size
Khebab Vendors	20
Khebab Consumers	115
Health and Sanitation Officers	10
Total	**145**
Sample for Meat Microbial Quality Determination	
Khebab Samples	12
Fresh Meat Samples	6
Frozen Meat Samples	4
Swab samples	8
Total	**30**

3.3.2 Sampling Techniques

Purposive and convenience sampling techniques were used to recruit the respondents to ensure that each category of the population was adequately captured for the study. Both purposive and convenient sampling techniques were used to select khebab vendors and consumers. Meanwhile, convenience technique was employed to select the HSO. For meat, microbial quality survey, khebab, swab, fresh meat, and frozen meat samples were conveniently sampled for the analysis.

3.4 Data Collection Instruments

The data were collected from three key groups: khebab vendors, consumers, and Health and Sanitation Officers (HSO). A structured questionnaire was designed to capture insights from each group, focusing on six key areas. Vendor Background (Section A): This section gathered basic details about khebab vendors, including their age, gender, religion, marital status, level of education, and nationality.

Khebab Preparation Practices (Section B): Vendors were asked about where they source their meat, how they prepare and transport it, how they display their products,

and their cleaning routines. Additionally, the number of chopping boards and slicing knives used was recorded to assess potential hygiene risks.

Hygiene and Food Safety (Section C): This section focused on hygiene practices, including whether vendors had the required permits, how often they renewed their licenses, how frequently health inspections were conducted, and how regularly they underwent medical check-ups.

Consumer Purchasing and Consumption Habits (Section D): Consumers provided insights into their khebab consumption patterns, including how often they ate it, their preferred types, where they purchased it, and the reasons behind their vendor choices whether based on taste, price, or perceived hygiene.

Consumer Knowledge of Food Safety (Section E): For public safety awareness, consumers were asked about their knowledge of foodborne illnesses, risks of cross-contamination, proper cooking and handling practices, personal hygiene, and safe storage methods.

Regulatory Oversight and Enforcement (Section F): EHS officers shared their experiences in monitoring food safety, including how often they conducted inspections, the challenges of enforcing hygiene regulations, the penalties imposed on non-compliant vendors, and any logistical or bureaucratic hurdles they faced.

A total of 20 khebab vendors participated in the study, providing first-hand accounts of their food-handling practices. 115 consumers shared their experiences, discussing their purchasing decisions, food safety concerns, and any health issues they encountered after consuming khebabs. Additionally, 10 EHS officers provided insight

into their roles in ensuring food safety, the difficulties they faced in enforcement, and their observations on vendor compliance.

Beyond these surveys, laboratory tests were conducted on fresh meat and khebab samples collected from various vendors. These tests were designed to check for microbial contamination and overall meat quality.

Laboratory form for sampling of meat and microbial analysis report

Laboratory analysis of microorganisms found in fresh meat and khebab (total aerobic bacteria, total yeast, and mould, *E. coli*, *Salmonella* spp., and *Pseudomonas* spp.). Each questionnaire was tailored to a specific group, ensuring relevant information was obtained. In addition, thirty (30) samples of various meat types, including beef, chicken, chevon, and gizzard, etc. were collected from different butcher shops, cold stores, and khebab stands for laboratory analysis to determine the microbial load.

3.5 Data Collection Procedures

The questionnaires were administered through face-to-face interviews to ensure clarity and accuracy of responses.

3.6 Sample Collection procedure for meat and khebab

Sterile Ziplock bags were purchased to collect meat samples. Hand gloves, a knife, and disinfectant were also prepared during the sample collection. Samples were collected aseptically using an ice chest with ice cubes. Dry swab sticks containing 15 ml of peptone solution were used for swabbing. Samples were collected from various khebab joints within the Mampong Municipality. The collected meat samples were placed in the ice chest containing ice cubes and transported to the AAMUSTED

Biological Laboratory, where they were stored in a freezer at -21 °C. The weighing balance was disinfected before use. Each meat sample was weighed to 25 grams, and 225 ml of the buffer solution was added. The samples were then homogenized using a stomacher (BAM, 2015). After weighing each sample, the weighing balance was disinfected before proceeding to the next sample. The prepared samples were kept in the ice chest with ice cubes and transported to the KNUST Pharmaceutical Microbiology Laboratory for microbial quality analysis.

3.7 Laboratory Materials and Methods

3.8 Preparation of Media for Microbial Analysis

The preparation of various agar media was essential for the accurate enumeration and identification of different microbial groups. Nutrient Agar was used to enumerate the total count of aerobic bacteria. To prepare Nutrient Agar, beef extract (3.0 g), peptone (5.0 g), and agar (15.0 g) were dissolved in 1 litre of distilled water. The solution was heated to boiling to ensure all components were dissolved entirely, and the pH was adjusted to 7.0 using hydrochloric acid or sodium hydroxide. The medium was then sterilized by autoclaving at 121 °C for 15 minutes. After sterilization, the solution was cooled to about 45-50 °C before being poured into sterile Petri dishes.

Sabouraud Dextrose Agar was used to enumerate the total count of yeast and mould. The preparation involved dissolving dextrose (40.0 g), peptone (10.0 g), and agar (15.0 g) in 1 litre of distilled water. The mixture was heated to boiling to dissolve the components thoroughly. The pH was adjusted to 5.6, and the medium was sterilized by autoclaving at 121 °C for 15 minutes. Once sterilized, the medium was cooled to 45-50 °C before being poured into sterile Petri dishes.

MacConkey Agar was used for detecting *Escherichia coli (E. coli).* The preparation process included dissolving peptone (17.0 g), lactose (10.0 g), bile salts (1.5 g), sodium chloride (5.0 g), neutral red (0.03 g), crystal violet (0.001 g), and agar (13.5 g) in 1 litre of distilled water. The solution was heated to boiling to ensure complete dissolution of the components. The pH was adjusted to 7.1, and the medium was sterilized by autoclaving at 121 °C for 15 minutes. After cooling to 45-50 °C, the medium was poured into sterile Petri dishes.

Cetrimide Agar was used for isolating *Pseudomonas spp.* The medium was prepared by dissolving peptone (20.0 g), magnesium chloride (1.4 g), potassium sulfate (10.0 g), cetrimide (0.3 g), and agar (15.0 g) in 1 litre of distilled water. The solution was heated to boiling to ensure all components were dissolved. The pH was adjusted to 7.2, and the medium was sterilized by autoclaving at 121 °C for 15 minutes. After sterilization, the medium was cooled to 45-50 °C and poured into sterile Petri dishes.

Bismuth Sulphite Agar was used for detecting *Salmonella spp*. The preparation involved dissolving peptone (5.0 g), dextrose (5.0 g), disodium phosphate (4.0 g), ferrous sulfate (0.3 g), bismuth sulfite indicator (8.0 g), brilliant green dye (0.025 g), and agar (20.0 g) in 1 litre of distilled water. The mixture was heated to boiling to ensure thorough dissolution of all components. The pH was adjusted to 7.7, and the medium was sterilized by autoclaving at 121 °C for 15 minutes. Once cooled to 45-50 °C, the medium was poured into sterile Petri dishes.

3.9 Enumeration and Identification of Bacteria

Enumeration and identification of bacterial groups were conducted following the methodology described by Adzitey (2020). Swabs were placed in 10 mL sterile

peptone water and thoroughly shaken to obtain the neat (diluted sample to be analyzed). One millilitre of the neat was transferred into 9 mL sterile peptone water until a dilution of 10^{-6} was obtained. Serial dilutions (10^{-1} to 10^{-6}) were spread plated onto blood and nutrient agar plates. Plates were incubated at 37 °C for 24 hours under aerobic conditions, and the colony-forming units (cfus) were counted to obtain the microbial load. The cfu was calculated using the formula:

$$N = \frac{\Sigma C}{(1 \; x \; n_1) + (0.1 \; x \; n_2) \; x \; d} \quad \text{.....equation 1}$$

N = Number of colonies per cm²

ΣC = Sum of all colonies on all plates counted

n_1 = Number of plates in the first dilution counted

n_2 = Number of plates in the second dilution counted

d = *Dilution from which the first counts were obtained (Adzitey, 2020)*

$$\textit{Microbial Load (cfu/g)} = \frac{Number\ of\ Colonies}{Dilution\ Factor \times Volume\ of\ Sample\ (ml)} \text{..... equation 2}$$

3.9.1 Total Aerobic Bacteria

Total aerobic bacteria were enumerated by spreading 1 mL of the serial dilutions onto nutrient agar plates. The plates were incubated at 37 °C for 24 hours, and the colonies were counted. The results were expressed as cfu per gram of meat.

3.9.2 Total Yeast and Mould

To enumerate yeast and mould, 1 mL of each dilution was spread-plated onto Sabouraud dextrose agar (SDA) plates. The plates were incubated at 25 °C for 5 days. Colonies were counted and reported as cfu per gram of meat.

3.9.3 Enumeration of Escherichia coli (E. coli)

E. coli was enumerated using MacConkey agar. 1 mL of each dilution was spread-plated, and the plates were incubated at 37 °C for 24 hours. Characteristic colonies were identified and counted.

3.9.4 Enumeration of Salmonella spp.

Salmonella spp. was isolated using Xylose Lysine Deoxycholate (XLD) agar. 1 mL of the serial dilutions was spread-plated, and the plates were incubated at 37 °C for 24 hours. Typical colonies were counted and confirmed through biochemical tests.

3.9.5 Enumeration of Pseudomonas spp.

Pseudomonas spp. was enumerated using *Pseudomonas* agar (PA) plates. 1 mL of each dilution was spread-plated, and the plates were incubated at 30 °C for 48 hours. Colonies were counted and identified based on their characteristic pigmentation.

3.9.6 Quality Checks/Controls

Quality control measures were implemented throughout the survey questionnaires and laboratory analysis to ensure the reliability and accuracy of the results. Sterility checks were performed on media and diluents, and positive and negative controls were included in each batch of samples tested. Quality control measures put in place to ensure quality laboratory results included making sure meat samples were placed into a sterile polythene bag immediately after it was purchased, using water, media, and plates that were sterilized, and doing inoculation in an air-conditioned room.

Alcohol was used to swab the field before dilution; sterilized Petri dishes were kept in a sterile oven at 160 °C for two hours. The Petri dish was placed in a lamina hood solidified agar and was then sent to an incubator for 24 hours and colony counter was used to count colonies and averages were found.

3.10 Data Analysis Method

Data collected from the Vendors, consumers, and EHS were entered into SPSS version 16.0 software, edited separately, and analyzed using descriptives. The student t-test was used to compare continuous variables and the Pearson Chi-square test for discrete variables. P-values of less than 0.05 were taken as statistically significant. Also, point estimates were compared and presented as means and percentages. Nominal 2-sided p-values were reported with statistical significance defined at p-value < 0.05 at 95 % confidence interval. Percentage or proportion was calculated for discrete variables while the mean with its standard deviation (SD) was computed for the continuous variable. The microbial data were analyzed to determine the levels of contamination in the meat samples.

3.11 Ethical Consideration

Ethical clearance was sought from the ethics committee of UDS, the review board of the University for Development Studies (UDS)-Tamale. Clearance was also sought from the Mampong Municipal Environmental Health and Sanitation directorate. Questionnaires and observational guides had no space for the names of respondents, Also, informed verbal consent was obtained from the Khebab Vendors, consumers, and HSO before the interview. Above all, participation in this study was voluntary.

CHAPTER FOUR: RESEARCH FINDINGS AND DISCUSSIONS

4.0 Introduction

This chapter presents the results, findings and discussions. The data collected were analyzed and discussed to determine the extent of microbial contamination and its implications for public health. The chapter is structured as follows: data presentation, profile of respondents, descriptive and inferential analysis, discussion of findings, and a summary.

4.1 Research Findings? Where is Data presentation?

4.1.1 Profile of Respondents

Socio-Demographic Characteristics of Khebab Vendors

The Socio-Demographic Characteristics of Khebab Vendors are presented in Table 4.1. The age distribution indicated that the highest proportion of vendors (25.0 %) were between 26 and 30 years old (tricenarians), while the lowest proportion (5.0 %) were teenagers between 15 and 20 years old. Vendors were males from different nationalities, with the majority being Ghanaians (55.0 %), followed by Nigeriens (15.0 %), Togolese (15.0 %), Burkinabes (10.0 %), and Ivorians (5.0 %). Vendors had different educational backgrounds, a significant proportion (55.0 %) of vendors were illiterate, while a few proportion (5.0 %) had Senior High School (SHS). The vendors engaged in other occupations since they operate at night, with most vendors being masons (40.0 %), followed by farmers (30.0 %), carpenters (20.0 %), and the least teachers (10.0 %).

Table 4.1: Socio-Demographic Characteristics of Khebab Vendors

Variables	Frequency(N=20)	Percent (100 %)
Age (years)		
15-20	1	5.0
21-25	3	15
26-30	5	25
31-35	3	15
36-40	2	10
41-45	2	10
≥51 years	4	20
Nationality		
Ghanaian	11	55
Togolese	3	15
Nigerien	3	15
Ivorian	1	5
Burkinabe	2	10
Gender	20	100
Level of Education		
Tertiary	2	10
SHS	1	5
JSS	2	10
Primary	4	20
Illiterate	11	55
Marital Status		
Single	9	45
Married	7	35
Divorced	3	15
Widowed	1	5
Religion		
Christianity	12	60
Islam	6	30
Traditionalist	2	10
Other Jobs		
Farming	6	30
Teaching	2	10
Masonry	8	40
Carpentry	4	20

Most vendors were single (45.0 %), married (35.0 %), and divorced (15.0 %), with the least being widowed (5.0 %). For religious affiliation, the highest percentage (60.0 %) of vendors were Christians, and Muslims (30.0 %), while the lowest (10.0 %) were Traditionalists.

Socio-Demographic Characteristics of Consumers

Table 4.2 shows the Socio-Demographic Characteristics of Khebab Consumers.

Table 4.2 Socio-Demographic Characteristics of Consumers

Variables	Frequency (N=115)	Percent (100 %)
Age		
15-20	10	8.7
21-25	23	20.0
26-30	26	22.6
31-35	25	21.7
36-40	8	7.0
41 and above	23	20.0
Sex		
Male	60	52.2
Female	55	47.8
Marital Status		
Single	53	46.1
Married	44	38.3
Divorced	8	7.0
Widowed	10	8.7
Nationality		
Ghanaian	98	85.2
Nigerien	9	7.8
Burkinabe	8	7.0
Level of Education		
Illiterate	20	17.4
SSS/SHS	40	34.8
JSS/JHS	12	10.4
Tertiary	43	37.4
Religion		
Christianity	89	77.4
Islam	22	19.1
Traditionalists	4	3.5

The tricenarians were the majority among consumers aged 26–30 years (22.6 %), closely followed by the adults aged 31–35 years (21.7 %), and the least were those middle aged 36–40 years (7.0 %). Males made up 52.2 % of the respondents, while females accounted for 47.8 %. The most significant demographic segment among consumers was single individuals, accounting for 46.1 %, while married individuals represented 38.3 %. The least represented group was divorced individuals, who comprised 7.0 %. Consumers from Ghana constituted the majority at 85.2 %, with

those from Niger accounting for 7.8 %, and Burkinabe consumers making up the smallest segment at 7.0 %. Regarding educational levels, the highest proportion of participants had attained tertiary education (37.4 %), followed by those who completed Senior High School (SHS) (34.8 %). The group with the least educational attainment was Junior High School (JHS) graduates, representing 10.4 %. Christianity was the most prevalent among consumers (77.4 %), followed by Islam 19.1 % and the least by Traditionalists (3.5 %).

Socio-Demographic Characteristics of Health and Sanitation Officers

Table 4.3 presents the socio-demographic characteristics of Health and Sanitation Officers (HSO).

Table 4.3: Socio-Demographic Characteristics of Health and Sanitation Officers

Variables	Frequency (N=10)	Percent (100 %)
Age (Year)		
25-30	2	20.0
31-35	3	30.0
36-40	2	20.0
41-45	1	10.0
46-50	1	10.0
≥51	1	10.0
Sex		
Male	7	70.0
Female	3	30.0
Marital Status		
Single	3	30.0
Married	6	60.0
Divorced	1	10.0
Nationality		
Ghanaian	10	100.0
Level of Education		
Secondary	4	40.0
Tertiary	6	60.0

From the survey, it was indicated that the highest age group among health and sanitation officers were adults of 31–35 years (30.0 %), while the least was middle-aged, 41–45, 46–50, and 51 years, with each accounting for 10.0 %. Males formed the majority (70.0 %) of the officers, whereas the rest were females representing 30.0 %. Married officers represented the largest group at 60.0 %, followed by single officers at 30.0 %. Divorced officers were the least represented by 10.0 %. All officers were Ghanaians. A significant 60.0 % had tertiary education, while 40.0 % had completed secondary education.

4.2 Sources of Meat and khebab Preparation

4.2.1 Sources of Meat and Khebab Preoaration

Table 4.4 outlines the various meat sources and khebab preparation methods utilized by different vendors. The majority of meat was sourced from slaughterhouses (60.0 %), while butcher shops had the least contribution (5.0 %). Motorcycles were the primary transportation method (40.0 %), and vehicles were the least used (15.0 %). For preparation, parboiling and roasting with spices were preferred (40.0 %), while other methods like roasting raw meat with oil, parboiling and roasting with oil, and roasting raw meat with spices were less common (20.0 % each). In terms of display, open tables were the most used (50.0 %), whereas glass sieves and grills were the least preferred (10.0 %). The number of knives and chopping boards per vendor were 2. Knives were mostly used for slicing khebab (50.0 %) and the least used for cutting fresh meat (20.0 %).

Table 4.4 Sources of Meat and Khebab Preparation

Variables	Frequency (N=20)	Percent (100 %)
Source of Meat		
Slaughterhouse	12	60
Cold store	5	25
Self-slaughtered	2	10
Butcher shop	1	5
Transportation Method		
Motorcycles	8	40
Tricycles	4	20
Vehicle	3	15
On head	5	25
Preparation Method		
Parboiled and heated with spices	8	40
Roasted raw meat with oil added	4	20
Parboiled, heated with oil added	4	20
Roasted raw meat and spices	4	20
Display Method		
On open table	10	50
Table with wire mesh	4	20
Glass sieve	3	15
On grill	3	15
Knives		
Number of knives	3	50
For cutting onions	3	15
For slicing khebab	10	50
For cutting fresh meat	4	20
Number of Chopping Boards	2	50
Chopping Board Operations		
For slicing khebab	8	40
For cutting onions	6	30
For chopping fresh meat	6	30
Cleaning Method		
Broom	5	25
Duster	2	10
Water and detergents	12	60
Disinfectant	1	5

Similarly, chopping boards were mostly used for slicing khebab (40.0 %) and less commonly used for cutting onions and chopping fresh meat (30.0 %) each. The dominant cleaning method was water and detergent (60.0 %), whereas disinfectants (handsanitizer) were the least used (5.0 %).

4.2.2 Kind of Meat Used for Khebab

The type of meat utilized by khebab vendors, is shown in Figure 4.1.

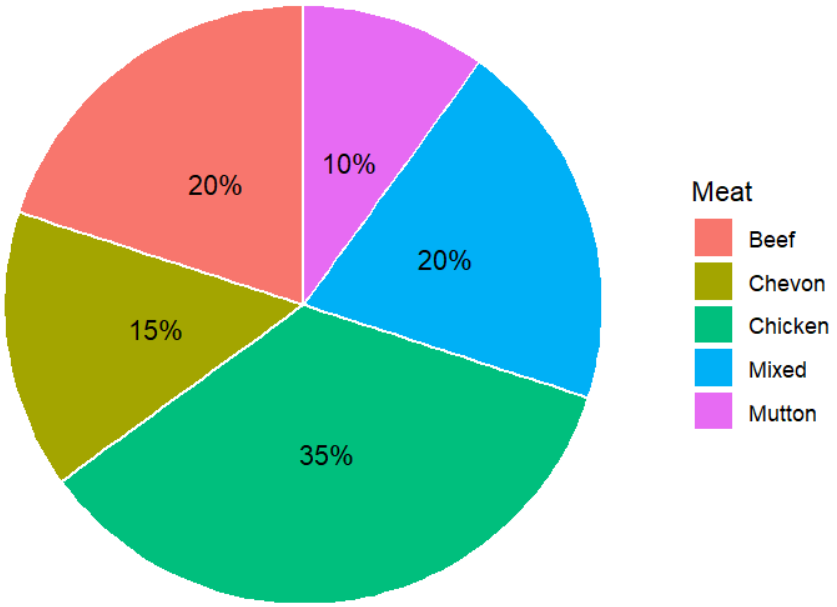

Fig. 4.1 Kind of Meat Used for Khebab

From study it indicates that chicken is the most commonly used meat, accounting for 35.0 % of the total meat used by these vendors. Beef accounts for 20.0 %, chevon for 15.0 %, and mutton accounting for 10.0 %. In addition, 20.0 % of the respondents used a combination of different meats for khebabs.

4.2.3 Khebab Hygiene and Safety

Table 4.5 shows the Khebab Hygiene and safety practices among vendors. The most common hygiene practice was wearing aprons (35.0 %), while only 10.0 % of vendors regularly sanitized their hands. Gloves usage was low (15.0 %), and only (20.0 %) used separate chopping boards and knives for different tasks. The majority of vendors obtained their permits from the Mampong Municipal Assembly (45.0 %), while

(20.0 %) had no permit. License renewal was mostly annual (45.0 %), followed by quarterly renewals (35.0 %).

Table 4.5: Khebab Hygiene and Safety Parameters

Variables	Frequency (N=20)	Percent (100%)
Hygienic Practices		
Wearing apron	7	35
Using hand gloves	3	15
Using different chopping boards	4	20
Using different chopping knives	4	20
Sanitizing hands	2	10
Permit Source		
Health Department	4	20
Assembly	9	45
Local assembly	3	15
No permit	4	20
License Renewal Frequency		
Once a month	1	5
Quarterly	7	35
Bi-annually	3	15
Yearly	9	45
Inspection Frequency		
Monthly	5	25
Quarterly	5	25
Bi-annually	3	15
Yearly	7	35
Medical Check-up Instruction		
Yes	17	85
No	3	15
Medical Check-up Frequency		
Annually	10	50
Once every three months	7	35
Every six months	3	15
Last Medical Check-up		
Last 3 months	6	30
Last 6 months	8	40
Last year	5	25
Never	1	5

The most common inspection frequency was annually, accounting for 35.0 %, while 25.0 % of inspections were conducted on a monthly and quarterly basis. Medical check-up instruction was mandatory for 85.0 % of vendors, while the least 15.0 %

were not being checked. Half of the vendors participate in an annual medical check-up. The most recent check-up for 40.0 % of vendors was within the last six months, while 5.0 % had never undergone a medical check-up.

4.2.4 Sanctions/Penalties Applied to khebab Vendors

The sanctions/penalties on vendors who failed to comply with instructions given by HSO are shown in Figure 4.2.

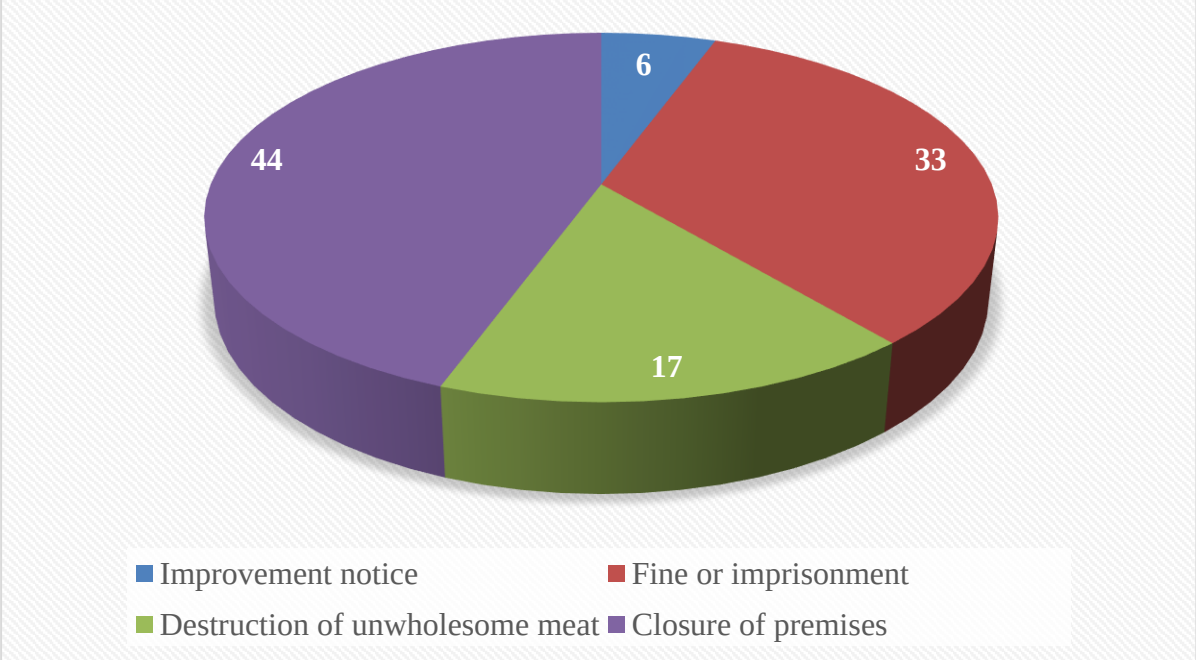

Fig. 4.2 Sanctions/Penalties on khebab vendors

The closure of premises was identified as the most common and severe sanction, impacting 44.0 % of vendors. Following this, imprisonment was enforced on 33.0 % of vendors. Additionally, 17.0 % faced the destruction of their unwholesome meat. The least frequently applied measure was the issuance of improvement notices, which affected only 6.0 % of vendors.

4.3 Consumers' knowledge and perception of the safety of khebab

4.3.1 Khebab Consumption Patterns

Table 4.6 illustrates the khebab consumption habits of individuals in the Mampong Municipal area.

Table 4.6 Khebab Consumption Patterns Among Consumers

Variables	**Frequency(N=115)**	**Percent (100 %)**
Consumption of Khebab	115	100.0
Consumption Frequency		
Daily	30	26.1
Twice a week	32	27.8
Once a week	38	33.0
Monthly	15	13.0
Types of Khebab		
Beef	48	41.7
Chicken/Guinea fowl	55	47.8
Sausage	15	13.0
Gizzard	11	9.6
Purchase Location Preference		
Roadside	60	52.2
Market	30	26.1
Drinking spot	18	15.7
Other	7	6.1
Reasons for Preference		
Cheaper	52	45.2
Hygienic environment	30	26.1
Neatness of vendor	20	17.4
Nearness to residence	13	11.3
Display		
Open table	70	60.9
Table with wire mesh	26	22.6
Glass sieve	16	13.9
Other	3	2.6

The most common consumption frequency was once a week, accounting for 33.0 % of responses, followed by twice a week at 27.8 %, and daily consumption at 26.1 %. The least frequent consumption was monthly, which represented 13.0 %. In terms of preferred khebab types, chicken / guinea fowl was the most favoured at 47.8 %,

followed by beef at 41.7 %. Sausage and gizzard were the least popular options, with preferences at 13.0 % and 9.6 %, respectively.

The majority of khebab consumers (52.2 %) purchased their khebabs from roadside vendors, while 26.1 % bought them from market hawkers, and 15.7 % obtained them from drinking establishments. The least common purchase locations accounted for 6.1 %. The primary reason for choosing vendor locations was price (45.2 %), followed by the cleanliness of the environment (26.1 %), and then the neatness of the vendor (17.4 %). The least influential factor was how close the vendor was to their home (11.3 %). Open tables were the most frequently used method at 60.9 %, followed by wire mesh-covered tables at 22.6 %, glass sieves at 13.9 %, and other unspecified methods, which accounted for 2.6 % of usage.

4.3.2 Assessment of Consumer Knowledge and Perceptions of Khebab Safety

The information in Table 4.7 shows the evaluation of consumer understanding and views on Khebab safety.

Table 4.7 Assessment of Consumer Knowledge and Perceptions of Khebab Safety

Awareness and Knowledge	Response	Frequency (N=115)	Percent (100%)
Awareness of Foodborne Diseases	Yes	85	73.9
	No	30	26.1
Knowledge of Proper Cooking Temperatures	Yes	55	47.8
	No	60	52.2
Understanding of Cross-Contamination	Yes	70	60.9
	No	45	39.1
Safe Handling Practices	Yes	50	43.5
	No	65	56.5
Personal Hygiene Awareness	Yes	60	52.2
	No	55	47.8
Safe Storage Practices	Yes	45	39.1
	No	70	60.9

The findings indicated that the greatest awareness was concerning foodborne illnesses, with a percentage of 73.9 %. This was followed by awareness of cross-contamination at 60.9 %, and personal hygiene knowledge at 52.2 %. Nevertheless, there were notable gaps in knowledge, particularly regarding safe handling practices, which stood at a low of 43.5 %, and awareness of proper cooking temperatures at 47.8 %. The lowest level of awareness was found in safe storage practices, where only 39.1 % were informed, indicating that an alarming 60.9 % of respondents lacked knowledge about appropriate storage methods.

4.3.3 Perceptions and Concerns of khebab Consumers

The data in Table 4.8 reveals the perceptions and concerns of khebab consumers.

Table 4.8: Perceptions and Concerns of khebab consumers

Aspect	Response	Frequency (N=115)	Percent (100 %)
Perception of Vendor Hygiene	Good	50	43.5
	Poor	65	56.5
Concerns About Khebab Safety	Yes	70	60.9
	No	45	39.1

It indicates that a majority of khebab consumers, specifically 56.5 %, consider the hygiene practices of vendors to be insufficient, while 43.5 % believe these practices are acceptable. In addition, 60.9 % of respondents expressed concerns about khebab safety, whereas 39.1 % had no concerns.

4.3.4 Enforcement and Operational Practices of Health and Sanitation Officers

The findings from Table 4.9 represents regulations enforcement and operational practices by Health and Sanitation Officers on vendors. It indicated that khebab safety inspections are most frequently conducted on a weekly or monthly basis, with each schedule representing 40.0 % of the total inspection frequencies. Meanwhile, only 10.0 % of inspectors reported performing these checks either every day or once per year.

Table 4.9 Enforcement and Operational Practices of health and Sanitation officers

Aspect	Category	Frequency (N=10)	Percent (100 %)
Inspection Frequency	Daily	1	10
	Weekly	4	40
	Monthly	4	40
	Yearly	1	10
Sanctions Applied	Yes	5	50
	No	5	50
Transport Support	Yes	3	30
	No	7	70
Inspection Capability	Yes	6	60
	No	4	40
Legal Action Challenges	Plea by Opinion Leaders	6	60
	No Means of Transport	2	20
	Delay in Court Cases	2	20
Departmental Interference	Veterinary	2	20
	Food and Drugs Board	5	50
	Assembly	3	30

Regarding sanctions, half (50.0 %) of the officers applied penalties for health violations, while the rest did not. A majority (70.0 %) of officers reported a lack of transport support, with only 30.0 % receiving assistance.

In addition, 60.0 % of officers indicated they had sufficient capacity to conduct inspections, whereas 40.0 % lacked the necessary resources. Legal action challenges were evident, with 60.0 % of officers citing pressure from opinion leaders, 20.0 % pointing to court delays, and 20.0 % facing transport constraints. Departmental interference also played a role, with 50.0 % attributing challenges to the Food and Drugs Board, 30.0 % to the assembly, and 20.0 % to veterinary authorities.

4.4. Relationship Between Vendors' Education Level and Wearing an Apron

Table 4.10 illustrates the correlation between the educational backgrounds of vendors and their adherence to wearing aprons. The results showed that vendors who had higher levels of education were more inclined to wear aprons.

Table 4.10: Relationship Between Vendors' Education Level and Wearing an Apron

Education Level	Wearing Apron	Not Wearing Apron	Total	Chi-square value	p-value
Illiterate	0	2	2		
Primary	0	1	1		
JSS	1	1	2		
SHS	2	2	4		
Tertiary	6	5	11	2.78	0.01
Total	9	11	20		

The results showed a significant relationship between the education level of vendors and the wearing of aprons ($p < 0.05$).

Specifically, among those with tertiary education, (6 out of 11) chose to wear aprons, which represented the highest level of compliance. In contrast, vendors with no formal education or only primary education did not wear aprons at all, making them the least compliant. The chi-square test result ($\chi^2 = 2.78$, $P = 0.01$) confirms a statistically significant association ($p < 0.05$) between education level and apron use.

4.5 Relationship Between Consumers' Knowledge of Foodborne Diseases and Perception of Vendor Hygiene

Table 4.11 demonstrates the connection between consumers' understanding of foodborne illnesses and their views on vendor cleanliness.

Table 4.11: Relationship Between Consumers' Knowledge of Foodborne Diseases and Perception of Vendor Hygiene

Knowledge of Foodborne Diseases	Perception of Vendor Hygiene (Good)	Perception of Vendor Hygiene (Poor)	Total	Chi-square value	p-value
Yes	40	45	85		
No	10	20	30	5.23	0.022
Total	50	65	115		

The analysis indicated a significant association between consumers' knowledge of foodborne diseases and their perception of vendor hygiene ($p < 0.05$).

The results showed that individuals who were knowledgeable about foodborne diseases generally held more discerning opinions regarding the hygiene practices of vendors. Among those who were knowledgeable about foodborne diseases (85 respondents), the highest proportion (45 out of 85) rated vendor hygiene as poor, while 40 rated it as good. In contrast, among those who lacked knowledge of

foodborne diseases (30 respondents), the least proportion (10 out of 30) rated vendor hygiene as good, with the majority (20 out of 30) perceiving it as poor. The chi-square test result ($\chi^2 = 5.23$, $P = 0.022$) confirms a statistically significant association ($P < 0.05$) between consumers' knowledge of foodborne diseases and their perception of vendor hygiene.

4.6 Correlation Between Inspection Frequency and Perception of Vendor Hygiene

Table 4.12 presents the correlation between the frequency of inspections and the perception of vendor hygiene based on a mean perception score.

Table 4.12: Correlation Between Inspection Frequency and Perception of Vendor Hygiene

Inspection Frequency	Perception of Vendor Hygiene (Mean Score)	Pearson correlation coefficient (r)	p-value
Daily	4.5		
Weekly	4.2		
Monthly	3.8	0.45	0.041
Yearly	3.5		

A moderate positive correlation was found between inspection frequency and perception of vendor hygiene, which is statistically significant ($p < 0.05$).

The findings suggested that a decrease in inspection frequency is associated with a decline in the perceived hygiene of vendors. Vendors who were inspected daily received the highest mean perception score (4.5), followed by those inspected weekly (4.2) and monthly (3.8). The lowest perception score (3.5) was observed for vendors who were only inspected yearly. A Pearson correlation coefficient of 0.45 ($r = 0.45$, $p = 0.041$) indicated a moderate positive correlation between inspection frequency and perception of vendor hygiene, which is statistically significant ($p < 0.05$).

4.7 Correlation Between Vendors' Use of Hygienic Practices and Consumer Concerns

The data in Table 4.13 shows a relationship between the hygienic practices employed by vendors and the level of consumer worries about the safety of khebab.

Table 4.13: Correlation Between Vendors' Use of Hygienic Practices and Consumer Concerns

Hygienic Practices	Consumer Concerns (Mean)	Pearson correlation coefficient (r)	p-value
Low	4.0		
Medium	3.5		
High	3.0	-0.32	0.038

The analysis showed a significant negative correlation between vendors' use of hygienic practices and consumer concerns ($p < 0.05$).

The findings revealed that an increase in the adoption of improved hygienic practices by vendors led to a reduction in consumer apprehensions regarding khebab safety. Vendors who exhibited low hygienic practices received the highest consumer concern score (4.0), while those with high hygienic practices received the lowest consumer concern score (3.0). A Pearson correlation coefficient of -0.32 ($r = -0.32$, $p = 0.038$) suggests a moderate negative correlation between vendors' hygienic practices and consumer concerns, which is statistically significant ($p < 0.05$).

4.8 Relationship Between Health Officers' Inspection Frequency and Vendors' Compliance

Table 4.14 indicates a notable correlation between how often health officers conduct inspections and the compliance rates of vendors, with a significance level of $p < 0.05$. Out of the total vendors surveyed ($n = 10$), those inspected daily ($n = 1$) and yearly ($n = 1$) exhibited full compliance (100 %). Weekly inspections resulted in three vendors showing high compliance, while one demonstrated low compliance.

Table 4.14: Relationship Between Health Officers' Inspection Frequency and Vendors' Compliance

Inspection Frequency	High Compliance	Low Compliance	Total	Chi-square value	p-value
Daily	1	0	1		
Weekly	3	1	4		
Monthly	3	1	4	3.12	0.022
Yearly	1	0	1		
Total	8	2	10		

There was a significant relationship between the frequency of health officers' inspections and vendors' compliance ($p < 0.05$).

Similarly, among vendors inspected monthly, three exhibited high compliance, whereas one showed low compliance. The chi-square test yielded a value of 3.12 with a p-value of 0.022, indicating a statistically significant relationship.

4.9 Relationship Between Consumers' Marital Status and Concerns About Khebab Safety

The relationship between consumers' marital status and their concerns about khebab safety is presented in Table 4.15.

Table 4.15: Relationship Between Consumers' Marital Status and Concerns About Khebab Safety

Marital Status	Concerns About Khebab Safety (Yes)	Concerns About Khebab Safety (No)	Total	Chi-square value	p-value
Single	30	23	53		
Married	30	14	44		
Divorced	5	3	8	2.14	0.01
Widowed	5	5	10		
Total	70	45	115		

The results indicated a significant relationship between consumers' marital status and their concerns about khebab safety ($p < 0.05$).

A considerable number of both married and single consumers expressed concerns about khebab safety, with 30 respondents in each category reporting concerns. Among

divorced consumers, 5 individuals expressed concerns, while 3 did not. Widowed consumers were evenly split, with 5 expressing concerns and 5 having no concerns. With a p-value of 0.01, the results indicated a statistically significant relationship between consumers' marital status and their concerns about khebab safety.

4.10 Relationship Between Consumers' Level of Education and Awareness of Foodborne Diseases

Table 4.16 illustrates the correlation between consumers' educational attainment and their knowledge of foodborne illnesses.

Table 4.16: Relationship Between Consumers' Level of Education and Awareness of Foodborne Diseases

Level of Education	Aware	Not Aware	Total	Chi-square value	p-value
Illiterate	10	10	20		
SSS/SHS	35	5	40		
JSS/JHS	7	5	12	18.56	0.001
Tertiary	33	10	43		
Total	85	30	115		

There was a significant relationship between consumers' level of education and their awareness of foodborne diseases ($p < 0.01$).

The findings revealed a positive systematic relationship, where higher educational attainment is associated with greater awareness of foodborne diseases. Specifically, 87.5 % of consumers with SSS/SHS education reported awareness, compared to 76.7 % of those with tertiary education. Among illiterate consumers, only half (10 out of 20) were aware of foodborne diseases. The p-value of 0.001 confirms that the relationship between consumers' level of education and their awareness of foodborne diseases is statistically significant ($p < 0.05$).

4.11 Microbial quality and safety of vended khebabs in the Mampong Municipal.

4.11.1 Microbial Quality of Fresh Meat

The microbial quality of fresh meat from different sources presented in Table 4.17 revealed varying contamination levels.

Table 4.17: Microbial Quality of Fresh Meat (cfu/g)

Sample (Source)	Type	Total Aerobic Bacteria (Mean ± SD)	Total Yeast and Mould (Mean ± SD)	E. Coli (Mean ± SD)	Salmonella spp. (Mean ± SD)	Pseudomonas spp. (Mean ± SD)
Butcher Shop	Beef	3.30	2.00	ND	2.00	2.50
Butcher Shop	Beef	2.40	ND	ND	3.40	2.00
Cold Store	Gizzard	6.22	3.20	ND	ND	3.20
Cold Store	Chicken	3.88	1.60	ND	3.20	ND
Cold Store	Chicken	7.40	6.10	ND	ND	1.52
Cold Store	Sausage	8.00	ND	ND	ND	4.60
Cold Store	Sausage	3.60	4.61	ND	1.00	5.00

Mean values ± standard deviation (what are differences between the repeated types of meat?

Total aerobic bacteria count ranged from 2.40 log cfu/g (Butcher Shop Beef) to 8.00 log cfu/g (Cold Store Sausage), with Cold Store Chicken (7.40 log cfu/g) also having a significantly high bacterial load. Total yeast and mould counts were highest in Cold Store Chicken (6.10 log cfu/g), suggesting potential spoilage. *Escherichia coli* was not detected in fresh meat samples, indicating good sanitary handling. *Salmonella spp*. was detected in Butcher Shop Beef (2.00 log cfu/g) and Cold Store Sausage (1.00 log cfu/g), exceeding the required endpoint. *Pseudomonas spp*. was significant in Cold Store Sausage (5.00 log cfu/g), highlighting spoilage potential.

4.11.2 Microbial Quality of Gizzard Khebab

Table 4.18 outlines the microbial contamination levels in gizzard samples sourced from various vending locations, indicating differences in hygiene and safety across these sites.

Table 4. 18: Microbial Quality of Gizzard Khebab

Sample	Total Aerobic Bacteria (Mean ± SD)	Total Yeast and Mould (Mean ± SD)	E. Coli (Mean ± SD)	Salmonella spp. (Mean ± SD)	Pseudomonas spp. (Mean ± SD)
SST Gizzard	4.93	4.79	ND	ND	ND
GNB Gizzard	4.70	3.64	ND	ND	3.49
VIP Gizzard	4.67	2.78	5.93	ND	3.57
SST Gizzard	4.79	3.51	ND	ND	4.51

Mean values ± standard deviation; ND=Not Detected SST=Simple Stores; GNB= Group Nduom Bank; VIP=Bus Terminal.

The total aerobic bacterial counts expressed in logarithmic value ranged from 4.67 log cfu/g (VIP Gizzard) to 4.93 log cfu/g (SST Gizzard). The total counts of yeast and mould had the maximum in SST Gizzard 4.79 log cfu/g, and VIP Gizzard had the lowest count at 2.78 log cfu/g. *E. coli* was found exclusively in VIP Gizzard, with a concentration of 5.93 log cfu/g, which exceeded the acceptable limit. *Salmonella* spp. was not detected in any of the samples. *Pseudomonas* spp. appeared in three out of four samples, with the highest concentration noted in VIP Gizzard at 4.57 log cfu/g and the lowest in GNB Gizzard at 3.49 log cfu/g.

4.11.3 Microbial Quality of Beef Khebab

The microbial quality of beef samples obtained from various vending sites is detailed in Table 4.19.

Table 4. 19: Microbial Quality of Beef Khebab

Sample	Total Aerobic Bacteria (Mean ± SD)	Total Yeast and Mould (Mean ± SD)	E. Coli (Mean ± SD)	Salmonella spp. (Mean ± SD)	Pseudomonas spp. (Mean ± SD)
SST A Beef	5.73	3.46	ND	ND	3.74
GNB A Beef	3.90	3.41	ND	3.56	2.90
MCM Beef	4.56	3.85	3.76	ND	3.83
GNB B Beef	3.52	3.30	ND	2.30	3.40
SST B Beef	4.38	ND	ND	3.53	2.30

Mean values ± standard deviation ND=Not Detected SST=Simple Stores; GNB= Group Nduom Bank; VIP=Bus Terminal MCM=Mampong Central Mosque

The total count of aerobic bacteria, represented in logarithmic values, varied from 3.52 log cfu/g in GNB A Beef to 5.73 log cfu/g in SST Beef khebab, with the latter surpassing the acceptable threshold of 4.00 log cfu/g. Yeast and mould counts were relatively low across all samples, with MCM Beef showing the highest level at 3.85 log cfu/g and GNB Fresh Beef the least at 3.30 log cfu/g, both remaining within the permissible limit of 4.00 log cfu/g. *Escherichia coli* was identified exclusively in MCM Beef at a count of 3.76 log cfu/g, exceeding the allowable limit of 0 cfu/g as per GSA (2013). *Salmonella* spp. was detected in only three out of five, with the maximum count in GNB A Beef (3.56 log cfu/g) and the minimum in GNB B Beef (2.30 log cfu/g), all breaching the required safety standard of 0.0 log cfu/g for food products (GSA, 2013). *Pseudomonas* spp., on the other hand, exhibited variability

among samples, with MCM Beef recording a significant count of 3.83 log cfu/g and SST B Beef showing the minimum count at 2.30 log cfu/g.

4.11.4 Microbial Quality of Chicken Khebab

Table 4.20 highlighted the microbial quality of chicken samples, showing significant differences in contamination levels among various sampling sites.

Table 4.20: Microbial Quality of Chicken Khebab

Sample	Total Aerobic Bacteria (Mean ± SD)	Total Yeast and Mould (Mean ± SD)	E. Coli (Mean ± SD)	Salmonella spp. (Mean ± SD)	Pseudomonas spp. (Mean ± SD)
SST Chicken	7.60	4.00	3.20	ND	6.60
GNB Chicken	9.10	6.00	1.80	1.00	5.70
MCM Chicken	9.60	8.60	ND	ND	8.30
VIP Chicken	4.90	9.40	3.60	8.00	2.40

Mean values ± standard deviation, ND= Not Detected SST-simple stores, GNB-Group Ndum bank MCM- Mampong central Mosque, VIP- Bus Terminal

The total aerobic bacterial counts ranged between 4.90 log cfu/g in VIP Chicken to 9.60 log cfu/g in MCM Chicken, with all surpassing the acceptable limit of 4.00 log cfu/g. Yeast and mould levels varied across samples, reaching a maximum of 9.40 log cfu/g in VIP Chicken and a minimum of 4.00 log cfu/g in SST Chicken. *Escherichia coli* was identified in VIP Chicken (3.60 log cfu/g), SST Chicken (3.20 log cfu/g), and GNB Chicken (1.80 log cfu/g), all exceeding the permissible limit of 0 cfu/g. *Salmonella* spp. was detected at levels of 8.00 log cfu/g in VIP Chicken and 1.00 log cfu/g in GNB Chicken, both above the acceptable threshold of 0 cfu/g. *Pseudomonas* spp., present in all samples, showed the highest concentration in MCM Chicken (8.30 log cfu/g) and the lowest concentration in VIP Chicken (2.40 log cfu/g).

4.11.5 Microbial Quality of Chevon Khebab

The chevon samples' microbial quality in Table 4.21 showed variations in contamination levels.

Table 4.21: Microbial Quality of Chevon Khebab

Sample	Type	Total Aerobic Bacteria (Mean ± SD)	Total Yeast and Mould (Mean ± SD)	E. Coli (Mean ± SD)	Salmonella spp. (Mean ± SD)
GNB A Chevon	Chevon	8.00 cfu/mL	ND	ND	ND
GNB B Chevon	Chevon	7.70 cfu/mL	4.62 cfu/mL	ND	ND

Mean values ± standard deviation ND=Not Detected GNB= Group Nduom Bank;

The highest counts of total aerobic bacteria were found in GNB A Chevon at 8.00 log cfu/mL, followed by GNB B Chevon at 7.70 log cfu/mL, both of which exceeded the acceptable limit of 4.00 log cfu/mL. Total yeast and mould were only present in GNB Chevon, recorded at 4.62 log cfu/mL, which is above the acceptable threshold of 1.00 log cfu/mL. Neither *Escherichia coli* nor *Salmonella* spp. were detected in either sample, indicating that there was no faecal contamination.

4.11.6 Microbial Quality of Sausage Khebab

The microbial quality of sausage, as shown in Table 4.22, indicated variations in contamination levels across different samples.

Table 4.22: Microbial Quality of Sausage Khebab

Sample	Total Aerobic Bacteria (Mean ± SD)	Total Yeast and Mould (Mean ± SD)	E. Coli (Mean ± SD)	Salmonella spp. (Mean ± SD)	Pseudomonas spp. (Mean ± SD)
SST Sausage	5.50	7.00	ND	ND	ND
MCM A Sausage	9.50	5.00	2.20	ND	9.00
GNB Sausage	7.72	6.50	5.00	ND	ND
MCM B Sausage	3.60	4.61	ND	1.00	5.00

Mean values ± standard deviation, ND=Not Detected SST=Simple Stores; GNB= Group Nduom Bank; VIP=Bus Terminal MCM=Mampong Central Mosque

The total count of aerobic bacteria was recorded at 3.60 log cfu/g in MCM B Sausage, followed by significantly higher levels of 9.50 log cfu/g in MCM Sausage and 7.72 log cfu/g in GNB Sausage, both exceeding the permissible limit of 4.00 log cfu/g for safe consumption. Similarly, total yeast and mould counts were highly concentrated in SST Sausage at 7.00 log cfu/g and less in MCM B Sausage at 4.61 log cfu/g, surpassing the acceptable threshold of 1.00 log cfu/g. *Escherichia coli* was detected in MCM Sausage (2.20 log cfu/g) and GNB Sausage (5.00 log cfu/g), transcending the acceptable level of 0 cfu/g. *Salmonella* spp. were found only in MCM B Sausage (1.00 log cfu/g), indicating contamination. *Pseudomonas* spp. was detected in MCM Sausage (9.00 log cfu/g) and MCM B Sausage (5.00 log cfu/g), suggesting potential spoilage risks.

4.11.7 Microbial Quality of Chopping Knives and Boards Swabs

Swab samples collected from chopping knives and boards at various khebab joints revealed microbial loads that exceeded acceptable limits across several parameters (Table 4.23).

Table 4.23: Microbial Quality of Chopping Knives and Boards Swabs

Sample	Total Aerobic Bacteria (Mean ± SD)	Total Yeast and Mould (Mean ± SD)	E. Coli (Mean ± SD)	Salmonella spp. (Mean ± SD)	Pseudomonas spp. (Mean ± SD)
SST B	5.22	2.60	6.10	1.40	ND
GNB B	2.90	8.80	ND	ND	5.00
VIP B	7.62	5.84	ND	ND	3.20
SST K	7.10	5.30	ND	ND	ND
GNB K	8.60	ND	ND	ND	ND
VIP K	5.00	ND	ND	ND	ND
MCM K	2.20	4.00	ND	ND	1.90

Mean values ± standard deviation, ND=Not Detected SST B=Simple Stores Board; GNB B= Group Nduom Bank Board; VIP B=Bus Terminal Board MCM K=Mampong Central Mosque Knive, VIP K= Bus terminal Knive, SST K= Simple Stores knive

Total aerobic bacteria ranged from 2.20 log cfu/g (MCM K) to 8.60 log cfu/g (GNB K), with all samples exceeding the acceptable limit of 1.0 log cfu/g (USDA, FSIS), indicating poor surface hygiene. Total yeast and mould counts were highest at 8.80 log cfu/g (GNB B) and lowest at 2.60 log cfu/g (SST B), both above the FDA's acceptable limit of <1.0 log cfu/g, suggesting spoilage risks. *Escherichia coli* was detected only in SST B (6.10 log cfu/g), far above the acceptable level of 0 cfu/g (GSA, 2013), indicating faecal contamination. *Salmonella* spp. was also present only in SST B (1.40 log cfu/g), violating the required absence and posing a serious health risk. Pseudomonas spp. ranged from 1.90 log cfu/g (MCM K) to 5.00 log cfu/g (GNB B), with all detected levels exceeding the recommended limit of < 1.0 log cfu/g (FDA, 2020), indicating potential spoilage.

Table 4.24: Microbial Quality Reference Guide

MQ = MICROBIAL QUALITY			
Microorganism	**Acceptable Level**	**Unacceptable Level**	**Source**
***Escherichia coli (E. coli*)**	Must be absent (0 cfu/g)	Presence > 0 cfu/g	GSA, 2013
Salmonella typhi	Must be absent (0 cfu/g)	Presence > 0 cfu/g	GSA, 2013
Staphylococcus aureus	< 1.0 log cfu/g	≥ 1.0 log cfu/g or greater	GSA, 2013
Total Aerobic Bacteria	< 1.0 log cfu/g	> 1.0 log cfu/g	USDA, FSIS
Total Yeast and Mould	< 1.0 log cfu/g	> 1.0 log cfu/g	FDA, 2020
***Pseudomonas* spp.**	< 1.0 log cfu/g	> 1.0 log cfu/g	FDA, 2020, ICMSF, 2018

GSA: Ghana Standards Authority

USDA: United States Department of AgricultureFDA: Food and Drugs AuthorityICMSF: International Commission of Microbiological Specifications for Food

4.11.9 Microorganisms across Different Vendor Joints and Products

Table 4.25 indicates significant variations in microbial contamination across different meat types.

Table 4.25: Microorganisms Across Different Vendor Joints and Products

Microorganism / Comparison	F/t Statistic	p-Value
Total Aerobic Bacteria	5.67	0.0012
Total Yeast and Mould	2.78	0.0381
E. coli	4.13	0.0089
Salmonella spp.	-	-
Pseudomonas spp.	3.56	0.0185
Fresh vs Processed Meat (Total Aerobic Bacteria)	2.45	0.0142

The results indicated significant microbial variation across meat types and between fresh and processed meat. Total aerobic bacteria showed the highest variation ($F = 5.67$, $p = 0.0012$), influenced by handling, storage, and processing conditions. Yeast and mould ($F = 2.78$, $p = 0.0381$) and *E. coli* ($F = 4.13$, $p = 0.0089$) also varied, pointing to cross-contamination and moisture exposure. *Pseudomonas spp.* ($F = 3.56$, $p = 0.0185$) suggests potential spoilage, while *Salmonella spp.* was absent, possibly due to effective cooking or low prevalence. Fresh meat exhibited higher microbial loads than processed meat ($t = 2.45$, $p = 0.0142$), likely due to direct environmental exposure, while processing techniques such as cooking or freezing reduced contamination (Kebede & Getu, 2023; Mandigo & Osburn, 2019).

4.12 DISCUSSIONS OF FINDINGS

4.12.1 Socio-Demographic Characteristics of Khebab Vendors

The predominance of tricenarians may also reflect a shift towards informal employment as a viable means of income generation in urban areas where traditional job opportunities may be limited. This may be due to the flexibility and economic opportunities the trade offers (Quarcoo, 2022). The author also indicated that many elderly individuals possess valuable cooking skills developed over the years of experience.

Most of the vendors were Ghanaians, predominantly from Northern Ghana, with few Togolese, Ivorians and Burkinabes. The diversity in nationality among vendors reflects the transnational nature of khebab vending. In Ghana, khebab vending is greatly shaped by the culinary traditions of Middle Eastern and North African communities, which have introduced styles like shish khebabs and kofta (Okech &

Timothy, 2023). These variations enhance the local food scene and foster cross-cultural exchanges.

The dominance of males in khebab vending in the Mampong Municipality aligns with Cardoso *et al.* (2024), who noted that informal sector jobs requiring physical effort and exposure to public spaces are often occupied by men. Education levels among vendors are generally low, with over half having no formal education. These uneducated vendors could overlook basic hygiene principles, including personal hygiene, personal protective clothing, and cross-contamination.

Marital status may also influence food safety adherence, as married vendors might face competing responsibilities that affect their focus on hygiene (Elsahoryi *et al.*, 2024). Religious beliefs play a role in shaping the slaughter methods of animals that are accepted by the general public (Sinclair *et al.*, 2023).

The majority of khebab vendors were Christians because Mampong Municipality is a Christian-dominated area. Khebab vending is done mostly at night; as such, the vendors engage in other works such as farming, teaching, and masonry to supplement their vending business.

4.12.2 Socio-Demographic Characteristics of Consumers

The study revealed that khebab consumers in Mampong Municipality are primarily young adults (21–30 years old). Young adults often have limited disposable income compared to older generations. Khebab is generally inexpensive, making it an attractive option for this age group. This suggests that khebab consumption in Ghana is socially driven, appealing to younger individuals seeking convenience and variety,

contrasting with South Africa, where older individuals (40–50 years) dominate street khebab consumption (Quarcoo, 2022).

Although gender representation was nearly equal among consumers, khebab was widely available at various street vending points, making it accessible to all demographics. It was noticed at the vending sites that some male consumers bought the khebab for other female consumers. The convenience of purchasing khebab on the go appeals equally to both genders, especially young adults who may have busy lifestyles, compared to Kenya, where men predominantly consumed street-vended khebab (Anaafo *et al*., 2024). Cultural variations may explain this, as some societies traditionally expect women to prepare meals at home for consumption.

Most consumers were single (46.1 %), differing from Nigeria, where married individuals purchased more street-vended khebab due to time constraints (Ezeh & Nkamnebe, 2023). Ghana's trend reflects a socially active demographic engaging in fast-food consumption (Gersten, 2023). Consumer diversity was notable, with Nigerien and Burkinabe patronage contributing to demand (Yendaw *et al.* 2021). Ghana's position as a regional migration hub likely fosters this multicultural trend.

A significant proportion (37.4 %) of consumers had tertiary education because the flavour profile of khebabs is appealing to many consumers. The combination of spices, sauces, in grilled meats creates a satisfying taste experience that attracts repeat customers compared to Uganda, where most street food consumers have only primary education (Tumuhe *et al.,* 2020; Lemomo, 2022). These does not explain why a higher proportion of khebab consumers were tertiary educated!

Religious dietary requirements, particularly for halal food, influenced consumption patterns in Mampong Municipality. Halal certification often involves rigorous standards for food safety and quality control. Many consumers, including Christians, may perceive halal-certified products as being subject to stricter regulations compared to non-certified options. Unlike Senegal, where halal adherence among vendors is less strict, Ghanaian comsumers prioritize meat obtained from animals slaughtered by the halal method (Badu, 2021; Dione *et al.,* 2021).

4.12.3 Socio-Demographic Characteristics of Environmental Health and Sanitation Officers

The Environmental Health and Sanitation Officers' demographics highlighted their role in public health enforcement. A mix of young officers aged 31–35 years and older officers ensured a balance of experience and fresh perspectives, crucial for sanitation management (Venugopal *et al.,* 2023).

Gender distribution was skewed toward males as the majority, with fewer females reflecting broader trends in sanitation roles. While men dominate, gender diversity enhances decision-making (Toldy & Garraio, 2021), because women’s involvement is essential for addressing gender-specific health concerns (Ramesh *et al.,* 2023).

Marital status also plays a role (in what?), with most officers being married, suggesting strong community commitment. In contrast, Bastos *et al.* (2021) found a more mobile, single workforce in Nigeria, lacking long-term community attachment. Cultural familiarity enhances enforcement success, aligning with Ayeo-eo (2025), though Sillah (2022) highlighted challenges when officers are not local.

Education levels were high among the environmental health workers, with dominance in tertiary education and few secondary-level qualifications. This aids in enforcing advanced sanitation practices, unlike in some regions where lower education levels limit effectiveness (Snyder *et al.*, 2025).

4.12.4 Khebab Preparation

The use of meat obtained from slaughterhouses by most vendors reflects a positive trend toward safer meat sources, thus potentially reducing contamination risks (Koech *et al.*, 2024). Regular inspections of meat by Sanitation officers ensures compliance with health standards, ensuring the possibility of identifying potential hazards before they could reach consumers, thus, sourcing meat from informal outlets exposes it to higher contamination risks (Ahiabor *et al.*, 2024).

With transportation methods, the majority of vendors used motorcycles and others with head-carriage, further increasing contamination potential, unlike enclosed transport, which offers better protection (Liffen, 2025). Preparation practices also varied, with most of the vendors relying solely on roasting, which may not consistently eliminate pathogens (Mahunu *et al.* 2024), while the rest of the vendors parboiled meat before roasting is considered a more effective microbial reduction method (Owusu *et al*., 2023).

Display methods are of concern during khebab preparation and vending., With half of the vendors using open tables, there is the likelihood of exposing the meat to dust and insects. In contrast, using wire mesh and glass displays offers better protection of khebab (Aduah, 2020). Cross-contamination risks persist due to the use of the same

knives and chopping boards for processing fresh meat and khebab. Improper use of tools were leading causes of foodborne illnesses, and dedicated utensils for raw and cooked meat were recommended (Isnaeni *et al.,* 2024). There were gaps in sanitation practices, and only few respondents used disinfectants, which accoding to Chirgwin *et al.* (2021) are more effective in reducing microbial contamination (Chirgwin *et al.,* 2021). While most vendors cleaned with water and detergent, the rest relied on brooms and dusters, indicating inadequate hygiene measures.

4.12.5. Kind of Meat Used

From the study, the kinds of meats used for khebab preparation included: chicken, beef, chevon, and gizzard. Chicken was the most preferred due to its affordability and availability. The chicken used was obtained from cold stores, and this made it highly susceptible to contamination with *Salmonella* and *Campylobacter*, and would require proper handling and thorough cooking (Ray *et al*., 2020). Beef was widely used by a good number of vendors, but improper storage and handling can increase the risk of *E. coli* contamination, particularly when sourced from informal markets (Bukachi *et al.,* 2021; Ahiabor *et al*., 2024). Chevon and mutton were less commonly used in khebab preparation (why?). While chevon and mutton are not frequently linked to foodborne outbreaks, they equally require careful handling and adequate cooking to eliminate any potential contaminants (Asati *et al.*, 2024).

The use of different kinds of meat by a vendor presented additional safety challenges. Different meats have varying cooking requirements, and increased risks of cross-contamination especially if vendors fail to maintain proper separation of raw and cooked products (Faiz *et al.,* 2024; Owusu-Apenten & Vieira, 2022). To ensure

khebab safety, vendors must adhere to strict hygiene measures, source meat from regulated suppliers, and implement proper cooking and storage practices. Strengthening khebab safety education among vendors could reduce cross-contamination risks and improve the overall quality of khebabs sold in Mampong, Ghana.

4.12.6 Khebab Hygiene and Safety

The hygiene and safety practices of khebab vendors revealed both commendable efforts and critical gaps. Many vendors wore aprons and others used hand gloves, indicating some degree of awareness of protective measures. Only few respondents used separate chopping boards and knives for different tasks. This presents a major risk of cross-contamination, which Rohith (2021) identified as a key factor in the spread of bacteria in khebabs. Particularly, the findings indicated that only a small number of vendors regularly sanitize their hands, despite hand hygiene being one of the most effective ways to prevent foodborne illnesses. Similar hygiene lapses among khebab vendors in Ghana have been linked to outbreaks of foodborne diseases (Ahiabor *et al.,* 2024), while studies in Kenya (Kinyua, 2024) show that poor hand hygiene significantly increases contamination risks. To address these issues, comprehensive khebab safety training is essential. Ahiabor *et al*. (2024) in Ghana advocated for continuous training and stricter enforcement of hygiene regulations to improve safety standards. This is supported by Kuboka *et al.* (2024) in Kenya, who also found that vendors with proper training adhered better to food safety protocols, ultimately reducing health risks for consumers.

4.12.7 Sanctions/Penalties Applied to Khebab Vendors

The enforcement of khebab safety regulations among khebab vendors varied in severity, reflecting both corrective and punitive approaches. Improvement notices were issued to a fraction of vendors; others were given education and guidance or allowed to rectify hygiene violations before facing harsher consequences. This approach aligns with Salamandane *et al*. (2024), who found that improvement notices effectively raised awareness among vendors, particularly those unfamiliar with food safety protocols.

More severe penalties, such as fines or imprisonment, affected a notable portion of vendors, highlighting the strict legal consequences of non-compliance. Aglidza (2019) noted similar enforcement trends in Ghana, where such measures played a crucial role in ensuring adherence to food safety standards. Adegbeye *et al*. (2024) emphasized the necessity of these penalties, particularly in the khebab sector, where poor hygiene can pose significant health risks.

The destruction of unwholesome meat, impacting a significant portion of vendors, serves as a critical safeguard for public health. Ensuring that only safe, uncontaminated meat is sold helps reduce foodborne illness risks. Agyarko, (2021) in Ghana reported similar interventions, reinforcing the need for proactive inspection and enforcement. Also, the closure of premises, affecting a considerable number of vendors, represents the strictest regulatory action, typically reserved for repeat offenders or those posing immediate health hazards. Walsh and Leva (2019) observed that such closures are often used as a last resort in cases of serious food safety violations.

Despite these enforcement efforts, there were regulatory oversights. Whereas some vendors operated without permits a notable number received monthly inspections, but there is a need for more consistent monitoring. Jiang (2020) highlighted the importance of frequent inspections to ensure compliance.

4.12.8 Khebab Consumption Patterns

The findings indicated that khebab was widely consumed, underscoring its cultural significance and public health implications. The highest consumption frequency was observed among respondents who consumed khebab once a week, followedby those that consumed it at least twice a week, highlighting the need for stringent food safety measures. Gbedze (2021) emphasized the importance of hygiene in frequently consumed street foods (Khebab), given the increased risk of contamination. Among the types of khebab, chicken khebab had the highest preference, followed by beef, likely due to affordability and availability. Conversely, sausage and gizzard had the lowest consumption rates, suggesting quality concerns, inavailability or limited consumer preference.

This aligns with Parikh *et al.* (2022), who noted that street food choices were influenced by different factors, including perceptions of freshness and nutritional value. The most common purchase locations were roadside stalls and markets, raising concerns about hygiene and food safety risks in such open environments. Vendors in such settings needed to adopt stricter hygiene measures to minimize contamination, as supported by Rohith (2021). The lowest percentage of consumers purchased khebab from drinking spots, indicating its role as a complementary snack and a potential

strategic sales point (Ayim *et al.,* 2024). It was noticed that the prices of khebab at drinking spots were higher as compared to other vending sites. Affordability was the highest-ranking factor influencing vendor choice, followed by vendor hygiene and neatness. Bandara *et al.* (2025) emphasized that khebab vendors maintaining high hygiene standards attracted more loyal customers.

4.12.9 Assessment of Consumer Knowledge and Perceptions of Khebab Safety

The findings revealed significant variations in consumer knowledge and perception regarding khebab safety. The highest awareness was observed in khebab-related disease risks, aligning with Klutse and Sampson (2025), who reported similar awareness levels among urban Ghanaian consumers. This suggests a broad recognition of khebab safety concerns, which is crucial for public health initiatives (Farrukh *et al,* 2025). However, the lowest awareness was recorded for safe khebab storage practices, mirroring Botha *et al.* (2023) findings on inadequate consumer knowledge of proper khebab storage, which could increase contamination risks. Knowledge of khebab cross-contamination was higher than that reported by Hammond *et al.* (2023) report of 50.0 % among khebab consumers in Kumasi, indicating greater awareness, possibly due to targeted khebab safety campaigns.

However, awareness of proper khebab cooking temperatures was relatively low, consistent with Dzudzor and Gerber (2023), who noted similar knowledge gaps among Accra khebab consumers. Understanding safe khebab handling was lower than Klutse and Sampson (2025) findings (60 %) among Takoradi vendors, suggesting gaps in consumer education on khebab hygiene. Awareness of personal hygiene in

khebab preparation (52.2 %) aligned with Kortei *et al*. (2021), who reported 50.0 % awareness among Accra consumers. This consistency underscores the persistent challenges in promoting hygiene within the khebab sector (Yakubu, 2024).

4.12.10 Perceptions and Concerns of Khebab Consumers

The findings indicated that the majority of respondents perceived vendor hygiene as poor, highlighting a critical issue that could impact consumer trust and vendor patronage. This aligns with Wu *et al.* (2024), who emphasized that hygiene is a key determinant of consumer choice in street food consumption. The negative perception suggests that many vendors may not adhere to proper hygiene practices, increasing the risk of contamination and khebab-related illnesses. Addressing this concern requires targeted vendor training and strict enforcement of hygiene regulations.

In addition, a significant number of respondents expressed concerns about khebab safety, likely influenced by observed poor hygiene practices, heightened awareness of foodborne illnesses, and past experiences with contamination. Asiedu *et al.* (2024) found similar trends in Ghana, where consumer perceptions of food safety were closely linked to hygiene standards. Singh & Puniya (2024) emphasized that improving vendor training, increasing health inspections, and educating consumers on safe handling practices are essential for mitigating risks. The link between vendor hygiene perceptions and concerns about khebab safety underscores broader challenges in street food safety management. Ibrahim and Adeola (2024) highlighted that vendor training and public health interventions significantly improve street food safety, while Elizondo, (2021) found that consumer awareness leads to better-informed choices and reduced foodborne illness outbreaks. Strengthening vendor knowledge, enforcing

regulations, and promoting consumer education campaigns are essential steps toward improving khebab quality and safety (Saeed, 2023).

4.12.11 Enforcement and Operational Practices of Health and Sanitation Officers

The results showed inconsistencies in inspection frequencies, with a majority of officers conducting checks either weekly or monthly, while the fewest performed daily inspections. This irregularity creates gaps in vigilance, increasing the risk of khebab-related illnesses. Enhancing inspection frequency through increased staffing and resource allocation could improve oversight, as suggested by Moroney (2019). However, Turfe (2024) argued that frequent inspections alone do not ensure compliance, emphasizing the need for follow-up actions and corrective measures. According to van der Merwe *et al.* (2019), the inconsistent application of sanctions further undermines regulatory credibility, leading to reduced vendor compliance. Kersten *et al.* (2022) highlighted that unclear enforcement policies can create confusion, necessitating standardized guidelines to ensure uniform application of penalties. In addition, most of the officers reported transport challenges, limiting their ability to conduct thorough inspections, particularly in high-risk areas. Simbil *et al.* (2024) emphasized that logistical support, including reliable transportation, is critical for effective oversight.

While a significant proportion of officers felt capable of performing inspections effectively, a few indicated a need for further training and resources. Strengthening inspection capabilities requires technical training, digital reporting systems, and proper equipment (Okpala *et al.*, 2021). Continuous professional development, as

noted by Butt *et al.* (2024), would enhance enforcement efficiency. Legal enforcement challenges, including influence from opinion leaders scored the highest, while both delays in court cases and unavailability of transport had the least, and thus hindering regulatory effectiveness. van der Merwe *et al*. (2019) noted that external pressures often lead to selective enforcement, thereby, reducing compliance among vendors. In addition, interference from regulatory agencies such as the Food and Drugs Aothority was the most significant, followed by local assemblies, and the Veterinary department created fragmented enforcement efforts. The World Health Organization (2020) emphasized that improved inter-agency coordination is necessary for strengthening khebab safety regulations. Addressing these operational inefficiencies through legal reforms, logistical support, and cross-agency collaboration could enhance regulatory enforcement and public health outcomes (Khan & Moazzam, 2022).

4.12.12 Relationship Between Vendors' Education Level and Wearing an Apron

The significant relationship (P=0.01) between vendors' education levels and apron usage indicated that education played a crucial role in adherence to hygienic practices. The highest proportion of vendors with tertiary education consistently wore aprons, demonstrating a greater awareness of hygiene and cross-contamination prevention (Ankomah-Appiah *et al.*, 2023). This finding aligned with Taha *et al*. (2024), who reported that individuals with higher education were more likely to follow khebab safety standards. Conversely, the lowest compliance was observed among vendors with primary or no formal education, who often lacked awareness of proper hygiene protocols (Wallace *et al.*, 2022; Rosales *et al*., 2023).

Similarly, Rachmatika and Bashori (2024) found that vendors with limited formal education had the lowest compliance with khebab safety practices, highlighting significant knowledge gaps. Nordhagen (2022) further noted that educated vendors in Nigeria exhibited the highest adherence to safe khebab handling compared to their less-educated counterparts. However, Uddin (2024) argued that despite higher education levels, some vendors still neglected hygiene due to cultural beliefs or insufficient practical training.

4.12.13 Relationship between Consumers' Knowledge of Foodborne Diseases and Perception of Vendor Hygiene

A significant association (P=0.022) was found between consumer knowledge of khebab-borne diseases and their perception of vendor hygiene. Consumers with higher awareness were more critical of hygiene standards, consistent with findings by Mabkhot and Piaralal (2024). In contrast, those with limited knowledge were less discerning, likely due to a lack of understanding of hygiene-related risks (de Freitas *et al.*, 2019).

4.12.14 Correlation between Inspection Frequency and Perception of Vendor Hygiene

The correlation between inspection frequency and perceptions of vendor hygiene is similarly significant (P=0.041). The positive Pearson correlation coefficient (r=0.45) indicates that increased inspection frequency is associated with better hygiene perceptions among consumers. Vendors subjected to daily (4.5) or weekly (4.2) inspections received higher hygiene scores, emphasizing the importance of regular monitoring in ensuring compliance (Soon, 2019; Amedewonu, 2020)

Conversely, vendors inspected monthly (3.8) or yearly (3.5) had lower hygiene perception scores, suggesting that infrequent inspections may lead to lapses in hygiene standards (Rosales *et al.,* 2025). These findings align with previous research highlighting the strong link between consumer knowledge and hygiene expectations (Nordhagen *et al.,* 2022; Lee *et al.,* 2022). However, Nordhagen *et al.,* 2022) observed that despite awareness, cultural beliefs and vendor reputation sometimes outweighed hygiene concerns. In addition, Stones (2019) emphasized that inconsistent inspections in the informal sector remain a challenge, necessitating stricter enforcement to improve khebab safety standards.

4.12.15 Correlation Between Vendors' Use of Hygienic Practices and Consumer Concerns

A statistically significant inverse correlation (P=0.038, R=-0.32) was observed between vendors' hygienic practices and consumer concerns about khebab safety at a 0.05 significance level. As vendors improved hygiene standards, consumer concerns decreased, aligning with literature emphasizing the role of hygiene in enhancing consumer trust (Anwar *et al.,* 2025). Vendors with lower hygiene standards had higher consumer concern scores (4.0), indicating greater perceived risk, whereas those adhering to better hygiene practices had lower concern scores (3.0). This underscores the need for hygiene training programs to improve consumer confidence and food safety perceptions (Ogunlade, 2024; Haider *et al.,* 2024).

Prior studies support these findings, showing that proper hygiene enhances consumer confidence and purchasing behaviour (Dzudzor & Gerber, 2023; Velasco *et al.,* 2024).

Conversely, inadequate hygiene has been linked to heightened consumer anxiety (Hinson *et al.,* 2024). However, even vendors with strong hygiene practices may still face residual concerns due to past negative experiences or general scepticism about street food safety (Nordhagen *et al*., 2022). The results reinforce the need for stringent hygiene measures to ensure consumer trust and vendor sustainability in the khebab business.

4.12.16 Relationship between Health Officers' Inspection Frequency and Vendors' Compliance

A significant chi-square test (P=0.022) confirmed a strong relationship between the frequency of health officers' inspections and vendors' compliance with hygiene standards. Regular inspections, particularly weekly and monthly, were associated with the highest compliance levels, reinforcing the role of consistent oversight in fostering accountability (Smith *et al.,* 2020; Dzudzor & Gerber, 2023). Interestingly, both daily and yearly inspections also resulted in high compliance, suggesting that extreme frequencies may still promote adherence.

Daily inspections create a constant sense of scrutiny, while yearly inspections may encourage strategic compliance just before assessments (Van Loo, 2019). These findings align with research highlighting that frequent inspections enhance vendor hygiene practices (Wu *et al.,* 2024). However, contrasting studies argue that infrequent inspections can lead to compliance lapses (Van Loo, 2019). In addition, vendors may exhibit "inspection-oriented behaviour," adjusting hygiene practices temporarily to meet regulatory expectations (Ledo *et al.,* 2019). This underscores the

importance of balanced and effective enforcement strategies to ensure sustainable compliance in the khebab industry.

4.12.17 Relationship between Consumers' Marital Status and Concerns about Khebab Safety

A chi-square test (P=0.01) confirmed a significant relationship between consumers' marital status and concerns about khebab safety. This finding suggested that marital status influences food safety perceptions, aligning with research by Sorensen *et al*. (2021) and Dzudzor (2024). Both single and married consumers exhibited high levels of concern, with 30 respondents from each group expressing apprehensions. Single consumers may be cautious due to independent food choices, whereas married consumers likely feel a heightened responsibility for family health, leading to greater scrutiny of khebab safety. Notably, fewer married consumers (14) expressed no concerns compared to single consumers (23), reinforcing the idea that household responsibilities shape food safety perceptions. Divorced and widowed consumers also reported concerns, possibly due to increased awareness of food safety risks (Dzudzor & Gerber, 2023). Supporting this, Rifat *et al.* (2022) and Eng *et al.* (2022) found that married individuals, often involved in meal preparation and caregiving, tend to be more conscious of food safety risks. However, Thomas & Feng (2022) noted that single consumers may prioritize convenience over safety, leading to less concern about food choices. In addition, some research suggests that age and education may play a more significant role in food safety perceptions than marital status alone, as younger consumers, regardless of marital status, tend to show lower concern levels (Thomas & Feng, 2022).

4.12.18 Relationship between Consumers' Level of Education and Awareness of Foodborne Diseases

A chi-square test (P=0.001) confirmed a strong, statistically significant relationship between education level and awareness of foodborne diseases, emphasizing the critical role of education in food safety awareness. This aligns with Sultana *et al.* (2025), who found that individuals with higher education levels exhibit greater knowledge of foodborne illnesses and hygiene practices. Consumers with Senior High School (SHS) and tertiary education reported the highest awareness levels (87.5 % and 76.7 %, respectively), likely due to formal education exposure and better access to public health information (Magwe, 2025).

In contrast, illiterate consumers displayed significantly lower awareness, reflecting a knowledge gap that increases their vulnerability to foodborne diseases (Sorensen *et al.*, 2021). This study supports Insfran-Rivarola *et al.* (2020), who observed that individuals with lower education levels struggle to adhere to food safety standards due to limited understanding. To address this gap, targeted public health initiatives such as community-based education programs and localized campaigns could improve awareness across educational backgrounds (Eruaga, 2024). In addition, practical training may be just as crucial as formal education in improving food safety awareness. Dzudzor & Gerber (2023) highlighted that more educated consumers tend to scrutinize vendor hygiene practices more critically, reinforcing the need for comprehensive education and awareness strategies to enhance food safety across all consumer groups.

4.13 Microorganisms found in fresh meat and khebab

4.13.1 Fresh Meat

The total aerobic bacterial counts observed in Cold Store Chicken (7.4 log cfu/g) and Cold Store Sausage (8.0 log cfu/g) exceeded the acceptable starting point of 5.0 log cfu/g (ICMSF, 2018). This suggested possible temperature abuse, improper handling, or cross-contamination during storage (GSA, 2013). The total yeast and mould count in Cold Store Chicken (6.1 log cfu/g) is of concern, as moulds can contribute to spoilage and foodborne illnesses (Sadiya, 2023). The presence of these microorganisms indicated extended storage time or inadequate freezing. The absence of *E. coli* in all samples suggested that proper hygiene measures were taken during processing.

However, the detection of *Salmonella* spp. in Butcher Shop Beef (2.0 log cfu/g) and Cold Store Sausage (1.0 log cfu/g) raises serious food safety concerns, as *Salmonella* is a major cause of foodborne infections (FDA, 2020). These findings suggested the need for stricter monitoring of meat processing and storage conditions. The detection of *Pseudomonas* spp. in Cold Store Sausage (4.6 log cfu/g) is significant, as this bacterium is known for spoilage in meat products due to its ability to grow at refrigeration temperatures (ICMSF, 2018). This suggests inadequate temperature control or extended storage.

4.13.2 Microorganisms found in the Gizzard Khebab

The microbial quality of gizzard samples revealed varied contamination levels across different vending locations. The total aerobic bacterial counts transcended the permissible threshold of 4.0 log cfu/g in all samples (USDA, FSIS, yaer?), with the

highest count recorded in SST Gizzard khebab (4.93 log cfu/g) and the lowest in VIP Gizzard khebab (4.67 log cfu/g). These values indicated significant microbial contamination, which could be attributed to poor hygiene, cross-contamination, or improper storage (GSA, 2013).

Yeast and mould contamination were also evident, with all samples surpassing the suitable limit of 1.00 log cfu/g (FDA, 2020). The highest count was observed in SST Gizzard khebab (4.79 log cfu/g), while VIP Gizzard khebab had the lowest (2.78 log cfu/g). The presence of yeast and mould suggests exposure to moisture, unsanitary handling, or prolonged storage in improper conditions. *Escherichia coli* contamination was detected only in VIP Gizzard khebab (5.93 log cfu/g), transcending the satisfactory boundary of 0 cfu/g (GSA, 2013). This indicated faecal contamination, which posed a significant public health risk. The presence of this pathogen may be linked to poor handling practices, inadequate washing, or cross-contamination during processin

In contrast, *Salmonella* spp. was absent in all samples, suggesting that contamination from this particular pathogen was not an issue in the analyzed samples (GSA, 2013). *Pseudomonas spp*. was present in three out of four gizzard samples, indicating a potential spoilage. The highest count was in VIP Gizzard khebab (4.57 log cfu/g), while the lowest was in GNB Gizzard khebab (3.49 log cfu/g). The presence of *Pseudomonas spp*. suggested inadequate freezing or improper handling, both of which could accelerate spoilage and reduce the shelf life of khebabs (FDA, 2020).

4.13.3 Microorganisms found in Beef Khebab

The analysis of beef samples indicated differing levels of microbial contamination depending on the vending locations**.** The total aerobic bacterial counts were higher that the agreeable limit of 4.00 log cfu/g in some samples (USDA, FSIS, Year?), with SST Beef khebab (5.73 log cfu/g) recording the highest contamination, oexceeding the 4.00 log cfu/g starting point, which suggests potential health risks from improper handling and storage (GSA, 2013). Conversely, GNB Fresh Beef (3.52 log cfu/g) had the lowest count, indicating relatively better microbial quality. Yeast and mould contamination was observed in all samples, with levels surpassing the 1.0 log cfu/g threshold (FDA, 2020). The highest count was recorded in MCM Beef khebab (3.85 log cfu/g), while the lowest was in GNB Fresh Beef (3.30 log cfu/g). All exceeded the reasonable threshold, with their presence suggesting potential fungal contamination due to moisture retention and unsanitary conditions.

Escherichia coli was detected only in MCM Beef (3.76 log cfu/g), exceeding the tolerable limit of 0 cfu/g (GSA, 2013). This pathogen indicated faecal contamination, possibly due to improper handling, inadequate hygiene, or cross-contamination during processing. In addition, *Salmonella* spp. contamination was detected in GNB Beef khebab (3.56 log cfu/g) and SST Fresh Beef (3.53 log cfu/g), both transcending the 0 cfu/g limit (GSA, 2013). This raises concerns regarding the safety of these samples, as *Salmonella* spp. is a known cause of foodborne illnesses. *Pseudomonas* spp., a spoilage microorganism, was detected in all beef samples except SST Fresh Beef. The highest count was recorded in CM Beef (3.83 log cfu/g), while the lowest was in SST Fresh Beef (2.30 log cfu/g). The presence of *Pseudomonas* spp. suggests poor

refrigeration or prolonged storage, accelerates spoilage and reduces shelf life (FDA, 2020).

4.13.4 Microorganisms found in Chicken Khebab

The total aerobic bacterial counts varied significantly across the chicken samples, with MCM Chicken khebab (9.60 log cfu/g) exceeded the acceptable limit of 4.00 log cfu/g (USDA, FSIS). This indicates poor handling or storage conditions, which could facilitate bacterial growth. Yeast and mould count also surpassed safe levels, with VIP Chicken khebab (9.40 log cfu/g) exceeded outstripping the 4.00 log cfu/g boundary (FDA, 2020), suggesting fungal contamination that could affect food quality and safety.

The detection of *E. coli* in three samples highlights potential faecal contamination, likely due to improper hygiene practices or cross-contamination during processing. Given that *E. coli* should be absent from food products (GSA, 2013), its presence at levels as high as 3.60 log cfu/g in VIP Chicken khebab presents significant health risks. Similarly, the presence of *Salmonella* spp. in VIP Chicken khebab (8.00 log cfu/g) and GNB Chicken khebab (1.00 log cfu/g) indicated possible exposure to contaminated water or surfaces, increasing the risk of foodborne illnesses. The high levels of *Pseudomonas* spp, particularly in MCM Chicken khebab (8.30 log cfu/g), suggested an elevated risk of spoilage, as *Pseudomonas* spp. is commonly associated with khebab deterioration (FDA, 2020).

4.13.5 Microorganisms found in Chevon Khebab

The elevated total aerobic bacterial counts in GNB Chevon (8.00 log cfu/mL) and GNB Chevon khebab (7.70 log cfu/mL) indicated potential hygiene or storage issues, as these values transcended the 4.0 log cfu/mL satisfactory limit (USDA, FSIS, ??). Such high bacterial loads suggested prolonged exposure to ambient conditions or inadequate handling practices (FDA, 2020). The presence of total yeast and mould in GNB Chevon khebab (4.62 log cfu/mL), was beyond the 1.00 log cfu/mL threshold (GSA, 2013), indicating a risk of spoilage. This contamination could be attributed to improper storage conditions, prolonged exposure to moisture, or contamination from processing environments. The absence of *E. coli* and *Salmonella spp*. in both Chevon samples is a positive finding, suggesting that handling and processing may have been conducted under sanitary conditions. The non-detection of these pathogens aligns with food safety standards, as *E. coli* and *Salmonella spp.* should be absent from food products (GSA, 2013; USDA, FSIS).

4.13.6 Microorganisms found in Sausage Khebab

The total aerobic bacterial counts showed considerable variation among sausage samples, with MCM Sausage khebab (9.50 log cfu/g) and GNB Sausage khebab (7.72 log cfu/g) surpassing the adequate starting point of 4.00 log cfu/g (USDA, FSIS). This suggests potential lapses in hygiene and storage conditions, which could facilitate bacterial growth. Total yeast and mould levels were highest in SST Sausage khebab (7.00 log cfu/g) and GNB Sausage khebab (6.50 log cfu/g), overstepping the 1.00 log cfu/g boundary (FDA, 2020). The high fungal counts indicated possible spoilage, which impacts food safety and shelf life. The detection of *E. coli* in MCM Sausage khebab (2.20 log cfu/g) and GNB Sausage khebab (5.00 log cfu/g) suggests faecal

contamination, likely due to improper handling or cross-contamination during processing. Given that *E. coli* should be absent from food (GSA, 2013), its presence at these levels poses a significant health risk. The presence of *Salmonella* spp. in MCM Fresh Sausage (1.00 log cfu/g) highlights a contamination risk, as *Salmonella* spp. should be completely absent from meat products (GSA, 2013). This suggests potential contamination from raw ingredients or handling practices. High levels of *Pseudomonas* spp., particularly in MCM Sausage khebab (9.00 log cfu/g) and MCM Fresh Sausage (5.0 log cfu/g), indicated an increased risk of spoilage. *Pseudomonas* spp. is commonly associated with food deterioration (FDA, 2020), and its presence at these levels suggests improper storage conditions. The absence of *Pseudomonas* spp. in GNB Fresh Sausage suggests that it has been handled or stored under better conditions.

4.13.7 Microbial Quality of Chopping Knives

The total aerobic bacteria count in GNB Khebab K (8.6 log cfu/g) significantly outstripped the permissible limit of 4.0 log cfu/g (ICMSF, 2018), indicating possible cross-contamination, poor hygiene practices, or prolonged exposure to ambient conditions. The count of aerobic bacteria in SST khebab K (7.10 log cfu/g) exceeded the threshold of 4.00 log cfu/g suggesting inadequate hygiene practices, cross-contamination or exposure to prolonged environmental conditions. Elevated levels of total yeast and mould in SST Khebab K (5.30 log cfu/g) suggested a high risk of spoilage, possibly due to improper storage or unhygienic processing conditions (GSA, 2013). The total aerobic bacterial counts, especially in VIP Khebab K (5.00 log cfu/g), significantly outdo safety thresholds (ICMSF, 2018), suggesting poor hygiene practices, prolonged exposure to environmental contaminants.

The total aerobic bacterial counts for MCM Khebab K (2.20 log cfu/g), exceeded the safety thresholds (ICMSF, 2018), suggesting poor hygiene practices, prolonged exposure to environmental contaminants, or inadequate cooking temperatures. Total yeast and mould in MCM khebab K (4.00 log cfu/g) surpassed the acceptable limits of 3.00 log cfu/g indicating risk of spoilage, due to improper storage or unhygienic conditions (GSA, 2013). The presence of *Pseudomonas* spp. in MCM Khebab K (1.90 log cfu/g) suggests spoilage potential, as this bacterium thrives in moist environments and is associated with food deterioration (ICMSF, 2018). The findings indicated the need for improved food safety measures, such as proper cooking temperatures, enhanced hygiene practices, and regular microbial testing to ensure the safety of khebab products for consumers (FDA, 2020; GSA, 2013).

4.13.8 Microbial Quality of Chopping Boards

The total aerobic bacterial counts, especially in GNB Khebab B (2.90 log cfu/g), is significantly within safety thresholds (ICMSF, 2018), suggesting good hygiene practices, less exposure to environmental contaminants, or adequate cooking temperatures (GSA, 2013). The presence of high yeast and mould counts in GNB Khebab B (8.80 log cfu/g) and VIP Khebab B (5.84 log cfu/g) suggested possible fungal contamination due to prolonged storage, cross-contamination, or exposure to humid conditions (FAO, 2019). These findings raised concerns about potential mycotoxin production, which can pose serious health risks.

The detection of *E. coli* (6.10 log cfu/g) in SST B Khebab is alarming, indicating faecal contamination and improper handling practices. When consumed, *E. coli* can cause serious gastrointestinal infections (FDA, 2020). The presence of *Salmonella* spp.

(1.40 log cfu/g) in SST B Khebab is of concern, as *Salmonella* is a leading cause of foodborne illness, often linked to undercooked meat or cross-contamination (WHO, 2021). The detection of *Pseudomonas* spp. in VIP Khebab B (3.20 log cfu/g) and GNB Khebab B (5.00 log cfu/g) indicated spoilage potential, as *Pseudomonas* is known for reducing shelf life and degrading meat quality at refrigeration temperatures (ICMSF, 2018).

4.13.9 Microbial Load of Fresh Meat and Processed Meat

The significant difference in total aerobic bacterial counts between fresh and processed meat underscores the impact of processing on microbial quality. The higher counts in fresh meat likely result from increased exposure to contamination during slaughter, handling, and storage, especially under suboptimal hygienic conditions.

In contrast, processing methods such as boiling, smoking, and salting appear effective in reducing microbial loads through thermal inactivation and moisture reduction. This finding aligns with previous research (Bhandari *et al.,* 2021; WHO, 2020) and reinforces the importance of proper meat handling and processing in ensuring food safety and protecting public health.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the research findings on the microbial load and safety practices associated with fresh meat and khebabs in the Asante Mampong Municipality. It outlines actionable recommendations and policy implications to enhance food safety practices, addresses public health risks, and suggests directions for future research.

5.1 Summary of Findings

Many difficulties in food safety were identified during the study in the Mampong Municipal area. The vast majority of khebab vendors were male, and more than half had no education between them, which correlated strongly with their knowledge of hygiene and actual practice on the street. The majority of vendors violated hygiene policies, such as wearing aprons (45 %) and frequently washing hands (15 %). Of great concern, the survey revealed that 20 % of the vendors were unauthorized for these kinds of businesses since they had no appropriate licenses or permits as required by the law.

Overall, consumers showed a fair level of knowledge about foodborne diseases, where 73.90 % confirmed the risks associated with them. This last belief was more or less accurate, as only 50.50 % of the students knew of cross-contamination concerns, and 43.5% knew the correct way to handle foods. The total microbial count was significantly higher in fresh meat, khebabs and chicken. The different types of bacteria isolated were *Escherichia coli, Salmonella* spp., and *Pseudomonas* spp., which have a high risk of posing a threat to public health. These findings require

strategies for immediate implementation to better the hygiene standards of vendors, increase awareness among customers and strengthen the laws regarding food safety.

5.2 Conclusion

The study indicated that there was significant variation among khebab vendors' food hygiene knowledge and the consequent safety of their products. More educated vendors exercised better hygiene practices.

Consumer awareness of khebab safety remained poor, meaning there was a greater need for more public education on this issue. There had, however, been no uniform compliance with food safety regulations; some areas exhibited strict application while others remained virtually unchecked.

The results of the microbiological analysis showed almost all kinds of microorganisms, including total aerobic bacteria, yeast and mould, and *E. Coli*, present in different amounts in different samples. For instance, VIP K possessed the lowest count of bacteria, which could partly be due to better hygiene practices and storage conditions. GNB Gizzard, among other samples, showed increasing contamination levels. The negative finding for *E. Coli* in many samples also implies that the stringent hygiene protocol adhered to had probably guarded against such contamination.

5.3 Recommendations

To reduce the health risks linked to meat vending, the following actions are suggested:

1. Train the Vendors

Vendors should be taught how to handle meat safely, cook it at the right temperatures, store it properly, and maintain personal hygiene. Simple practices like frequent handwashing and wearing clean aprons can go a long way in preventing contamination.

2. Educate the Public

Communities need to be aware of foodborne risks and the importance of buying meat from vendors who follow safe hygiene practices. Public campaigns can encourage better choices and safer food habits.

3. Enforce Rules and Inspections

Local authorities should ensure all vendors are licensed and inspected regularly. Vendors who fail to meet hygiene standards should face clear penalties to keep food safety a priority.

4. Improve Facilities

Vendors need access to clean water, proper waste disposal, and covered areas to display and store meat. Improving slaughterhouses and providing cold storage and transport will also help keep meat safer for longer.

5. Keep Monitoring and Set Clear Standards

Regular checks should track hygiene practices, microbial levels, and foodborne illness trends. Standardized food safety rules, aligned with international practices, will ensure consistent enforcement.

5.4 Future Research Directions

Future studies can build on these findings by:

1. **Trying New Preservation Methods** – Explore ways like vacuum sealing, natural preservatives, or modified packaging to keep meat fresh and safe.
2. **Understanding Vendor and Consumer Behavior** – Learn why some vendors or customers ignore hygiene to create culturally relevant interventions.
3. **Comparing Different Areas** – Study urban and rural vending practices to tailor solutions to each environment.
4. **Finding Practical Hygiene Solutions** – Develop simple, affordable facilities like handwashing stations for vendors.
5. **Predicting Microbial Risks** – Create models to identify which meat types or handling methods pose the highest contamination risk.

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APPENDICES
APPENDIX A

AKENTEN APPIAH MENKA UNIVERSITY OF SKILLS TRAINING
AND ENTREPRENEURIAL DEVELOPMENT (AAMUSTED-M)
COLLEGE OF AGRICULTURE EDUCATION
FACULTY OF AGRICULTURE EDUCATION

INTERVIEW OF KHEBAB VENDORS ON THEIR KNOWLEDGE IN FOOD HYGIENE AND KHEBAB SAFETY

INTERVIEWER: INTRODUCTION AND CONSENT. May I begin the interview now?

PLEASE TICK (√) AND WRITE WHERE APPLICABLE. WHERE NECESSARY YOU MAY TICK MORE THAN ONE OPTION.

NO	QUESTIONS AND FILTERS	CODING CATEGORIES	
	SOCIO-DEMOGRAPHIC CHARACTERISTICS I would like to start by asking you a few questions about yourself.		
Q1.	Age in years	≤14……1 15-20…….....2 21-25…….3 26-30…….4 31-35…….5 36-40…….6 41-45…….7 ≥51……8	
Q2.	Sex	Male……..1 Female……..2	
Q3.	Nationality	Ghanaian……...1 Burkinabe…….....2 Nigerien…….…….....3 Ivorian ……..4 Togolese ……...5	
Q4.	Level of education	Illiterate.....1 Primary…….….2 JSS……..…...3 SHS……..….3 Tertiary……..……4	
Q5.	Marital status	Single ……1 Married …….2 Divorced……3 Widowed……4	
Q6.	Religion	Christianity……1 Islam……..2 Traditionalist……..3	

Q7.	Which other job do you do?	Farming……..1 Teaching…….2 Masonry…….3 Carpentry……..….4	
	SECTION B:		
KHEBAB PREPARATION			
Q8.	Kind of meat used for the khebab.	Chicken…….1 Beef……...2 Chevon……..3 Mutton……...4	
Q9.	How many vendor joints do you have?	|__|__| shops	
Q10.	Where do you obtain meat for the khebab?	Slaughterhouse…….1 Cold store…….…2 Self-slaughtered……...3	
Q11.	How do you transport the meat to the khebab stall?	Motorcycles…….1 Tricycles……. 2 Vehicle…….3 On head……...4	
Q12.	How do you prepare your khebab?	Parboiled and heated with spices……1 Roasted raw meat with oil added.……...2 Parboiled, heated with oil added…….3 Roasted raw meat and spices 4	
Q13.	How do you display your khebab for sale?	On open table……..1 Table with wire mesh……..2 Glass sieve……..3	
Q14.	How many knives do you have?	|__|__| knives	
Q15.	What operations do you use the knives for?	For cutting onions……...1 For slicing khebab……...2 For cutting fresh meat…….3	
Q16.	How many chopping boards or work surfaces do you have?	|__|__| Boards / surfaces	
Q17.	What operations do you use the chopping boards for?	For slicing khebab……1 For cutting onions……2 For chopping fresh meat……..3	
Q18.	What do you use to clean your khebab stall / premises?	Broom……..1 Duster……..2 Water and detergents…….....3	
SECTION C			
KHEBAB HYGIENE AND SAFETY			
Q19.	Which of the following hygienic practice(s) do you implement during operations?	Wearing apron……..1 Using hand gloves……2 Using different chopping boards……..3 Using different chopping knives.....4 Sanitizing hands ……..5	
Q20.	How often are you required to renew the license or permit?	Once a month……...1 Once in 3 months…….2	

		Every 6 months……3 Yearly ……..4	
Q21.	Where did you seek permit before operating as a khebab vendor?	Food and Drugs Board……1 Assembly …….2 At my own will ……...3	
Q22.	How often do health and sanitation inspectors come to inspect your khebab premises?	Daily……1 Weekly…….……2 Monthly……...3 Yearly…….….4	
Q23.	Have you been instructed by the assembly to do any medical check-up?	Yes……..….....1 No……..……..2	
Q24.	How often are you required to do this medical check-up?	Once monthly……..……1 Twice monthly…….…2 Once yearly…….…….3 Twice Yearly……...…….4	
Q25.	When was the last time you went for medical check-up?	Last 3 month……...…….1 Last 6 month……...…….2 A year ago……...…….3	
Q26.	What are some of the sanctions or penalties you will face when you fail to apply the regulations?	Improvement notice……1 Fine or imprisonment…….…….....2 Destruction of unwholesome meat……..3 Closure of premises…….4	

APPENDIX B

AKENTEN APPIAH MENKA UNIVERSITY OF SKILLS TRAINING
AND ENTREPRENEURIAL DEVELOPMENT (AAMUSTED-M)
COLLEGE OF AGRICULTURE EDUCATION
FACULTY OF AGRICULTURE EDUCATION

INTERVIEW OF KHEBAB CONSUMERS ON THEIR KNOWLEDGE IN FOOD HYGIENE AND KHEBAB SAFETY

INTERVIEWER: INTRODUCTION AND CONSENT. May I begin the interview now?

PLEASE TICK (√) AND WRITE WHERE APPLICABLE. WHERE NECESSARY YOU MAY TICK MORE THAN ONE OPTION.

SOCIO-DEMOGRAPHIC CHARACTERISTICS OF KHEBAB CONSUMERS I would like to start by asking you a few questions about yourself.			
NO	QUESTIONS AND FILTERS	CODING CATEGORIES	
Q1.	Age in years	15-20 years……..…1 21-25 years…….2 26-30 years…….……3 31-35 years…….4 36-40 years…….5 41 and above……..…6	
Q2.	Sex	Male ……..…1 Female……..….2	
Q3.	Marital status	Single……1 Married……..2 Divorced……3 Widowed……...4	
Q4.	Nationality	Ghanaian ……..….1 Burkinabe …….…….2 Nigerien……3	
Q5.	Level of education	Illiterate ……1 JSS/JHS……..2 SSS / SHS……..…3 Tertiary……..…4	
Q6.	Religion	Christianity……1 Islam ……..2 Traditionalists…….3	
Q7.	Have you ever consumed khebab?	Yes……..1 No……...2	
Q8.	How often do you buy and eat khebab?	Daily ……..1 Once a week……...2	

		Twice a week……..3 Monthly…….……4	
Q9.	What type of khebab do you buy?	Gizzard……...1 Beef…….....2 Chicken/Guinea fowl…….3 Sausage……..4 Intestines……5	
Q10.	Where do you normally buy your khebab?	Market ……...1 Roadside…….2 Drinking spot……..3	
Q11.	What are your reasons for khebab joint preference?	Cheaper……..1 Nearness to residence……2 Hygienic environment……...3 Neatness of vendor…….....4	
Q12.	How is the khebab you buy usually displayed?	On open table…….....1 Table with wire mesh…….....2 Glass sieve…….....3	
Q13.	Do you usually wash your hands before consuming khebab?	Yes……..…..1 No…….……2	
Q14.	Are you concerned about how the khebab you eat from these joints are prepared?	Yes……...…….1 No……...……..2	
Q15.	Have you ever complained about their mode of operation?	Yes……1 No…….2	
Q16.	Do the khebab vendors comply or listen to your concerns?	Yes……1 No…….2	
Q17.	How do you expect vendors to dress during khebab processing?		
Q18.	Does your knowledge on zoonotic diseases caused a change in your khebab consumption habit?	Yes……1 No…….2	
Q19.	What health concerns do you have about the way vendors sell their khebab?	Diarrhoea……..……1 Typhoid…….……..……..2 Cholera ……..…..……..3 Vomiting……...……4 Abdominal pains.…..…….5	

APPENDIX C

AKENTEN APPIAH MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT (AAMUSTED-M)
COLLEGE OF AGRICULTURE EDUCATION
FACULTY OF AGRICULTURE EDUCATION

INTERVIEW OF ASSEMBLY MANAGEMENT (HEALTH AND SANITATION INSPECTORS) ON THEIR ROLE IN THE PRODUCTION OF SAFE AND QUALITY KHEBAB

INTERVIEWER: INTRODUCTION AND CONSENT**.** May I begin the interview now?

PLEASE TICK (√) AND WRITE WHERE APPLICABLE. WHERE NECESSARY YOU MAY TICK MORE THAN ONE OPTION.

	SOCIO-DEMOGRAPHIC CHARACTERISTICS OF HEALTH AND SANITATION OFFICERS I would like to start by asking you a few questions about yourself.		
NO	QUESTIONS AND FILTERS	CODING CATEGORIES	
Q1.	Age in years	25-30 years……1 31-35 years…….....2 36-40 years…….…3 41-45 years…….……4 46-50 years…….……5 51 and above…….…….6	
Q2.	Sex	Male …….……1 Female …….……2	
Q3.	Marital status	Single…….……1 Married……..……2 Divorced……..……..3 Widowed……..……4	
Q4.	Nationality	Ghanaian…..……...…...1 Burkinabe.……..2 Nigerien.……...…....3	
Q5.	Level of education	Certificate.…….....1 Diploma…….2 Degree. …….……3	
Q6.	How long have you worked with this department?		
Q7.	Which items do you commonly used for inspection?		
Q8.	Which items are lacking?		

Q9.	How do you go about your inspection in terms of transportation?	On foot……1 On motorbike……...2 Hired cars……3 On head……4	
Q10.	Do you receive transport refund or fuel allowance?	Yes……1 No……2	
Q11.	Are you able to visit and inspect eating joints, butchers and livestock owners who slaughter their own animals?	Yes……..……..1 No……..……2	
Q12.	How frequent do you go for inspection?	Daily ……..……1 Weekly ……..……2 Monthly ……3 Yearly ……..……..4	
Q13.	Do you sanction anybody or organization who slaughter for the public without your consent?	Yes……...……..1 No……..……2	
Q14.	How many of such cases are recorded / year?		
Q15.	How many times have unwholesome meat been seized and destroyed?		
Q16.	Are you able to visit and inspect animals slaughtered during the following festivities?	Easter ……..…..1 Christmas ……...……2 Eidul-Adha……...……..3 New year ……...……4	
Q17.	How often do you organize training for butchers and food vendors?	Once a week ……..……1 Once a month……..……...2 Once a year ……..…….3	
Q18.	What are some of the measures taken by your office to improve sanitary conditions at the slaughter house?	Washing animals……..……..1 Keeping lairage clean……..……...2 Using clean trucks……..…...….3	
Q19.	What are some of the hindrances you go through when legal action is taken against offenders?	Plea by opinion leaders…..……1 No means of transport…..……..2 Delay in handling court cases...….3	
Q20.	Which of the following departments interfere or conflict with your duties?	Veterinary ……..……1 Food and Drugs Board……..…….2 Others…. ……..…….3	