UNIVERSITY OF CAPE COAST

MICROBIAL LOAD IN SOME SELECTED CUT AND VENDED FRUITS AND THEIR IMPLICATIONS FOR FOOD SAFETY IN THE TAMALE METROPOLIS

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BY

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Thesis submitted to the Department of Vocational and Technical Education of the Faculty of Science and Technology Education, College of Education Studies, University of Cape Coast, in partial fulfillment of the requirements for the award of Master of Philosophy Degree in Home Economics

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is as a result of my own original research and that no part of it has been presented for another degree in this University or elsewhere.

Candidature's Signature…… Date…….

Name: Patience Kpekurah

Supervisor's Declaration

I hereby declare that the preparation and presentation of this thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Supervisor's Signature……Date: ……

Name: Miss. Irene Ampong

ABSTRACT

Fruits and vegetables have been the major dietary source of vitamins, minerals, fibre and other natural substances. An improved nutrition full of fruits and vegetables reduce risk of some chronic diseases e.g., hypertension. Outbreak of some food borne diseases have been linked to fresh cut fruits available on streets. The study examines the microbial load in some selected cut and vended fruits and their implications for food safety in the Tamale Metropolis. Descriptive, cross-sectional survey design involving the use of questionnaire and observation checklist were used for the study. The target population involved all street fruits vendors who sell pawpaw and water melon in the Tamale Metropolis with sample size of 113. Total of 30 cut fruit samples of both (15 each watermelon and pawpaw) were taken from ten (10) vendors selected from the 113 participants for laboratory analysis to check the levels of microbial load in them (aerobic mesophiles, E. coli, staphylococcus aureus, salmonella and listeria monocytogen). Convenience sampling was used for both field samples and for the laboratory samples. Data was analyzed using Statistical Package for Social Sciences version 22 while the microbial load was analysed using five different culture conditions. Identification of all bacteria was accomplished with Nordic Committees for Food Analysis (NKML) and International Organization for Standardization (ISO) Standards. The finding shows that less than half of the respondents always washed their hands after coughing or sneezing while more than half of respondents did not wear gloves during cutting of fresh fruits. In the microbial analysis significant variations of bacteria ($p<0.05$) were observed in the pre-cut fruits sampled among the vendors. *Salmonella spp.* was not detected whereas *Listeria monocytogenes* was detected in 70% of the pre-cut fruits sampled. The analyses also revealed that, out of every ten sampled fruits, seven of the fruits had staphylococcus aureus and only one fruit had E. coli. Seven of the ten sampled fruits had Listeria monocyte. Based on the findings, it was concluded that, sampled fruits in the study setting had microbial load hence the consumption could lead to foodborne diseases. The study recommended that; street fruit vendors and handlers should be educated on fruit hygiene practices through engagement by the Health Directorate Unit of the Tamale Metropolis and the Ministry of health.

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I am grateful to my family members for their support during my study and the research period.

I am equally thankful to my friends for their encouragement.

God bless you all

DEDICATION

I dedicate this work to all my friends and family members.

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LIST OF ABBREVIATIONS

FAO	Food and Agriculture Organization
FDA	Food and Drugs Authority
GHS	Ghana Health Service
SPSS	Statistical Package for Social Sciences
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

Background to the Study

There is a global increase in demand for and dependence on street foods including fruits. Street foods are well patronized in many developing countries because they are affordable and accessible (Feglo & Sakyi, 2012). They also serve as an important source of nutrients for the people and also income for the vendors. According to Chukuezi (2010) and Feglo and Sakyi (2012), approximately 2.5 billion people eat street food every day, supporting the livelihood of millions of low-income people and making a significant economic contribution. Street food also offers a convenient diet for many people in developing countries. According to Ababio and Lovatt (2015), Afoakwa (2005), and Feglo and Sakyi (2012), there have been international and local rules and guidelines by the World Health Organisation (WHO) and Food and Drugs Authority (FDA) to ensure food hygiene because of the significant role that street foods play in people's lives.

Since they retain regional eating customs, cultural traditions, and social legacy, foods served on streets are an essential component of a nation's cuisine. They provide the sellers with a source of revenue and other people with jobs. According to studies (Barro, Nikiéma, Ouattara, & Traoré, 2002; Buscemi Barile, Maniaci, Batsis, & Verga, 2011; Kok, 2014), consumers place a high value on street meals due to its flavour, accessibility, affordability, link to cultural and social legacy, and nutritional value. These enormous advantages cannot be ignored on a global scale.

To paraphrase the Food and Agriculture Organisation (FAO), "ready-to-eat foods and beverages sold and prepared by vendors or hawkers on streets or other public places" is the definition of "street food." To the contrary, a street food seller is generally understood to be someone who sells food to the general public from either a temporary static structure or a movable stall-head load/wheel-barrow/truck (Azanza, Gatchalian, & Ortega, 2000). Food safety, according to Sesotec (2020), is "routines in the preparation, handling, and storage of food meant to prevent foodborne illness and injury."

From the farm to the factory to the table, food items may be exposed to a wide range of potential health risks. To mitigate these threats and protect customers from damage, safe food handling practices and procedures must be applied across the whole food production cycle (Sesotec, 2020). For this reason, proper food handling practices and procedures must be adhered to at all stages of the food production chain to ensure that no damage comes to the final consumers. However, these street foods are typically prepared and served in unsanitary conditions. The potential for food poisoning epidemics implies that these diseases may be quite dangerous, say Janie and Marie (2010).

It has been observed that many vendors selling food on the street are not college educated and, as a consequence, may not know why or how important it is to practice good food hygiene. Their behaviour may increase the risk of microbial contamination of food, which has been linked to outbreaks of diarrhoeal illness in economically disadvantaged nations (WHO, 2008). The use of contaminated food is responsible for the illness of a rising number of individuals throughout the world (Kubde, Pattankar, & Kokiwar, 2017).

The Ghana Health Service (GHS) has said that everyone has the right to consume food that is free from harmful substances. A person's whole life is affected by the food they consume, from their growth and productivity to their susceptibility to illness. Hygienic food is essential to human survival because it improves health, boosts productivity, and serves as a solid foundation for economic growth and poverty reduction (Clark, 2005).

For the fact that people cannot survive without food, many people all over the world, especially those with busy schedules, tend to depend on ready-to-serve foods (Hiamey, Amuquandoh, & Boison, 2013). This is confirmed by Baidoe, Ananga and Nyinaku (2020) when they posited that street food is a major source of sustenance for developing countries resulting in tremendous growth in street food vending. This attitude of global dependence on ready-to-serve food has created, and repeatedly increasing the global demand for such food. Street foods, also known as ready-to-serve foods, are ready-to-eat foods and beverages prepared and sold by vendors or hawkers in streets and other public places (FAO, 2013, as cited in Manko, 2018).

According to the Ministry of Food and Agriculture and the World Bank (2006), there are approximately 420,000 cases of foodborne disease or disorders recorded annually in Ghana, with a fatality rate of 65,000. Some believe these estimates significantly understate the true magnitude of the problem, since persons suffering from food poisoning may be less inclined to seek medical attention in areas of high poverty and inadequate healthcare infrastructure. They are more inclined to use traditional herbal medicines, which may be both ineffective and even harmful (Ministry of Food and Agriculture, 2006). According to Elvis & Henry (2016), street food has been a

staple of Ghanaian cuisine for quite some time. Commonly seen in urban areas, street food has become an integral aspect of Ghanaian culture for both locals and visitors. Therefore, poor food handling and unhygienic circumstances are a cause for worry while eating street food (Odonkor et al., 2011).

One major challenge of ready-to-eat street cut and packaged vended fruits is the contamination of these street foods, and that has been a huge public health threat (Igiehon et al., 2020). The sliced fruits and sometimes vegetables are contaminated by unhygienic processing either by dirty utensils or/and washing with contaminated water (Igiehon et al., 2020). The contaminated fresh-cut fruits, salad vegetables and juices have the potential of causing serious food borne diseases. The most common pathogens are Vibrio cholerae, Shigella, Salmonella Typhi and Bacillus cereus which cause several diseases such as food poisoning, diarrhea, typhoid, dysentery etc. (Balali et al., 2020).

In spite of regulations, improvement in food safety systems has not been fully realized, and this is observed in recent reports of food borne illness and or contamination of street foods with enteric bacteria in various parts of the country (Monney, Agyei & Owusu, 2013). A number of outbreaks have recently been reported in Ghana by Osei-Tutu and Anto (2016) which indicate that four persons died in Sheho (Upper East Region of Ghana) after eating contaminated meat. They also reported a cholera outbreak after eating contaminated food in Atebubu (Bono East Region) which claimed nine lives while another such outbreak resulted in the death of one person in Obuasi (Ashanti Region) and the hospitalization of over 50. Thus, the knowledge

levels, practices and attitudes of most of the street foods vendors largely do not meet proper hygienic standards and can therefore lead to consumers of street foods eating unsafe food which in effect can cause morbidity and mortality due to food borne illnesses, and concomitant effects on trade and development (Monney, Agyei & Owusu, 2013).

All prospective consumers are vulnerable to food poisoning due to the proliferation of street food vending, which has increased risk factors such as poor and unclean handling of food (Omemu & Aderoju, 2008). According to some estimates, eating tainted street food is linked to as many as 70% of cases of diarrheal sickness in underdeveloped countries (Von & Makhoane, 2006). Fresh cut fruits have been related to food-borne illness epidemics in both industrialised and developing nations by Kumar, Agarwal, Ghosh, and Ganguli (2006). Similarly, Oyedele et al. (2020) did research in Nigeria and concluded that fresh cut fruits from all six states in Nigeria are contaminated with several enteric bacterial species. The prevalence of unsanitary practises among Ghana's street food vendors has been attributed, in part, to a lack of regulation and enforcement of bylaws governing street food vending by local authorities (Feglo & Sakyi, 2012) and an inefficiency or absence of education and training of food vendors on health and hygiene.

The knowledge levels, practices and attitudes of most of the street foods vendors largely do not meet proper hygienic standards and can therefore lead to consumers of street foods eating unsafe food which in effect can cause morbidity and mortality due to food borne diseases, and concomitant effects on trade and development (Monney, Agyei & Owusu, 2013). It is very necessary that investigations be made to establish facts on street fruit safety to

inform policy and education of citizens who engage in food vending to prevent the future spread of food-borne diseases.

Statement of the Problem

Research indicates that the knowledge levels, practices and attitudes of most of the street foods vendors largely do not meet proper hygienic standards and can therefore lead to consumers of street foods eating unsafe food which in effect can cause morbidity and mortality due to food borne diseases which can have concomitant effects on trade and development (Monney, Agyei & Owusu, 2013). The educational level of fruits vendors is perceived to be low. Some people also perceive that most people with low educational levels may not have much knowledge about possible health implications of some practices which may compromise the safety of street foods.

According to the Ministry of Food and Agriculture and the World Bank (2006), there are approximately 420,000 cases of foodborne disease or disorders recorded annually in Ghana, with a fatality rate of 65,000. Kumar, Agarwal, Ghosh and Ganguli (2006) have linked outbreaks of food borne diseases in both developed and developing countries to fresh cut fruits. Similarly, a study conducted at Nigeria concluded that fresh cut fruits across six States are infected with diverse enteric bacterial species which is a threat to food safety (Oyedele et al.2020.) These are evidence that fresh cut fruits can be a source of food borne diseases.

The evidences in literature indicate that unhygienic handling of fresh cut fruits have the possibility of causing food borne diseases. However, It appears little or no research work has been conducted on this all-important topic when it comes to food venders dealing in fruits in Ghana. Studies that I have come

across on food safety issues were conducted on food vendors selling cooked foods, like yam, rice, 'banku', fufu and spices, among others (Aglidza,(2019); Bakobie, Addae, Cobbina, & Miniyila (2017)). Other studies examined the knowledge and attitude of vendors on hygiene and safe handling of food other than fruits (Addo-Tham, Appaih-Brempong, Vampere, Acquah-Gyan, & Gyimah Akwasi (2020); Akabanda, Hlortsi, & Owusu-Kwarteng (2017))

Individuals differ in many respects and difference geographical areas exhibit difference weather conditions. It is therefore necessary for area-specific studies to be conducted on this topic to add to knowledge on this all-important topic. Empirical investigation on the Microbial load in some selected cut and vended fruits; the implication for food safety has therefore been identified for this study.

Purpose of the Study

The purpose of the study was to find how safe the fruits that are cut and sold on the streets of Tamale metropolis may be and their impact on the health of the consumers, considering the microbial load, knowledge of vendors on food safety and food and personal hygiene practices. To examine and analyze the microbial load in some selected cut fruits in the Tamale Metropolis and find out the knowledge level and practices of street food vendors on hygiene.

Research Questions

1. What is the knowledge level of street fruits vendors on food hygiene in the Tamale metropolis?
2. What are the practices of street fruits vendors during food preparations, selling, processing and storage in the Tamale metropolis?

3. What is the microbial load in freshly cut street fruits in the Tamale metropolis?
4. What health implications are associated with microbial load present in sample cut fruits in the Tamale metropolis?

Significance of the Study

To guarantee proper hygiene practises by food sellers, particularly in the study setting, the research's results would be extremely useful to policymakers in terms of the correct set of rules and educational programme that should be established and executed. Healthcare workers and the Food and Drug Authority could implement measures to improve on food safety, especially cut fruits sold on the street based on this study.

The findings would further provide contextual understanding of the problem and serve as a basis upon which future studies on any topic related to hygienic practices and microbial load of cut fruits for students, and researchers would be done. The research would add to the academic and professional literature on the topic of food hygiene. With this research as a foundation, food vendor associations might better educate their members on how to lessen the microbial load of their cut fruits, which in turn would increase sales.

Delimitations of the Study

A study on street fruits vendors' knowledge, practices of hygiene and microbial load of cut fruits is a complex concept to be assessed comprehensively in one study. As a result, the study was conducted to cover selected fruit vendors in the Tamale metropolis. Samples of only cut water melon and pawpaw sold on the street in the study setting by street fruits vendors were selected for laboratory analysis.

The scope of the Laboratory test for microbial load included Staphylococcus aureus, Salmonella, Aerobic mesophiles and *E. Coli and Listeria monocytogene.*

Additionally, the study carved out two other research questions with dimensions on knowledge and practices of street food vendors on food hygiene therefore street fruit vendors with at least eighteen years of age formed the study population.

Limitations of the Study

The study assessed microbial load of some selected cut fruits, knowledge and practices on hygiene of cut fruits street vendors in the Tamale metropolis. The findings of this study may not be generalized to all cut fruits sold on the street in Ghana. Again, the findings cannot be generalized to vendors of cut fruits in other areas in Ghana.

Samples were collected in the morning, afternoon, and evening because of the weather prevailing at the time of data collection which was hot and dry. Such weather condition was likely to show differences in microbial load. However, temperatures of food were not taken

Respondents' food hygiene practice, may have changed within the data collection time to please the researcher. However, respondents were briefed to be natural in their practice. Since the data was collected with questionnaire, responses could have emanated from study participants simply ticking to provide answers. The use of research assistants helped to translate the items for better understanding. These limitations therefore did not have any serious effect on the findings.

Definitions of Terms

i. **Food**: Food is any substance that provided nourishment to body. Food in this research is considered as the selected cut street fruits which include cut pawpaw and watermelon.

ii. **Knowledge**: A street food vendor having the right information about food hygiene.

iii. **Microbial**: Any infectious agent that was found in cut fruits sampled. The microbes in this study are Staphylococcus aureus, Salmonella, Aerobic mesophiles and *E. Coli and Listeria monocytogene.*

iv. **Practice**: The adherence of street food vendors to hygienic practices that promote food safety.

v. **Street food:** Any person who sold food along the street of Tamale Metropolis.

Organization of the Study

The study was structured into five chapters. Chapter one contains the introduction, the background of the study, the problem statement, purpose of the study, research questions, significance of the study, delimitations, limitations and definitions of terms. Chapter two contains empirical and conceptual framework on the study variables that were assessed. Chapter three presents the research method that was employed for the study. The various subsections include the research design, study population, sample and sampling procedures, data collection instrument, validity and reliability of the research instrument, data collection procedures, data processes and analyses. Chapter four presents the results and discussion of the study. Chapter five contains the summary, conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews literature that outlines the boundaries of the study and gives insight into some concepts relevant to the study. The conceptual basis of the study has also been presented to guide in understanding the relationships between and among the variables under study. The literature presents the theoretical underpinning of the study, conceptual review and empirical review that have been found to have close connection with this study.

Theoretical Review

The Health Belief Model

The study employed the health belief model as the theoretical basis. The health belief model is a flexible framework for promoting actions for disease prevention and good health. In order to comprehend why individuals don't employ disease preventive methods and technologies for early illness identification and prevention, scientists in the United States created the Health Belief Model (Devi, Devi, Pradhan & Lepcha, 2022). The Health Belief Model examines the range of individual beliefs that influence one's desire to adopt a healthy habit. The preconceived notions include perceived vulnerability, perceived seriousness, perceived advantages, and perceived obstacles. While perceived severity relates to views of the condition's potential seriousness, perceived susceptibility refers to the impression of a condition's susceptibility. The term "perceived benefits" refers to the value or benefit that altering one's conduct is seen to have. Any obstructions or hurdles

to the behavioural changes being considered to reduce risk are referred to as perceived barriers.

The theory has been used for the investigation because the practises of the sellers before the customer even gets the fruits for eating have a significant role in the degree of microbial load on cut fruits. Vendors that follow hygiene best practises will be able to reduce the microbial burden. The model works because the seller will be aware of the procedures to follow and will respond accordingly if they believe (perceive) that the fruits supplied at the sales point are microbially contaminated. This is shown by the study's measurement of the sellers' understanding of fruit-borne illnesses and how they spread. Knowledge will have an impact on practise. The model also shows the perceived harshness in a different aspect. The perceived severity is explored in the context of this investigation in relation to vendors' awareness of fruit-borne illness symptoms. Vendors are more likely to follow good hygiene practises when they believe that these fruit-borne illnesses are serious. The perceived advantages and obstacles are the only element that is not the subject of this investigation. This is not a constraint since the research places a strong focus on information that will translate into practise to lower microbial burden.

Despite the fact that the theory has drawn criticism for emphasising healthy conduct. The theory is applicable for this research since it does not concentrate on the social and economic factors that may or may not cause vendors to follow sanitary practises. The concern of the study is microbial load which is capable of leading food-borne disease.

Conceptual Framework

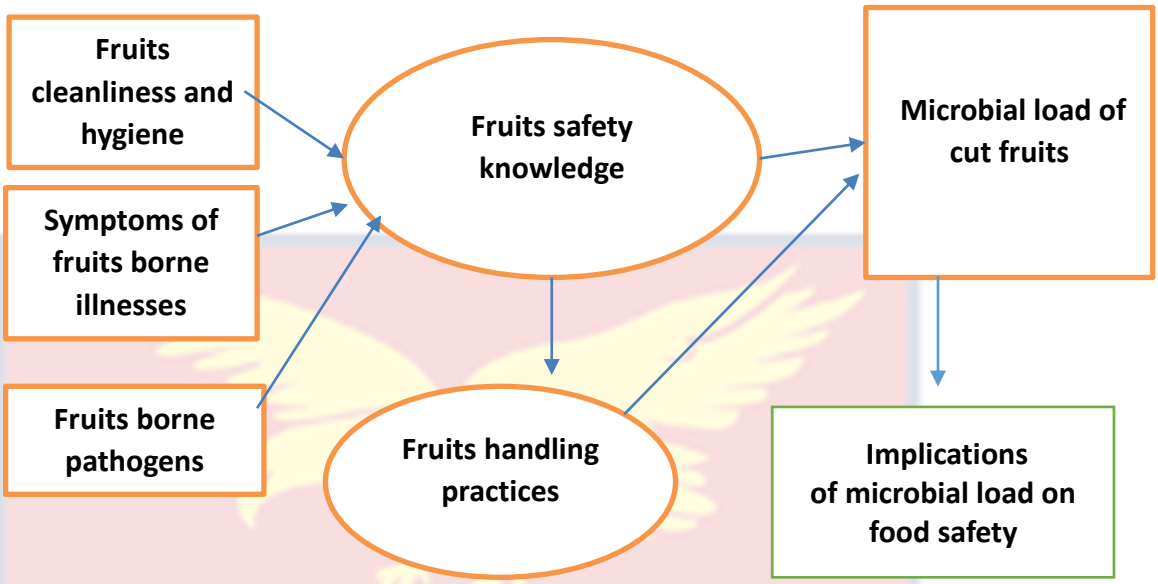

Figure 1: Conceptual Framework on Implications of microbial load of selected cut fruits on food safety
Adapted from Woh, Thong, Behnke and Lewis (2016)

The researcher adapted a conceptual framework developed by Woh, Thong, Behnke and Lewis (2016) as indicated on Figure 1. The framework shows the relationship between the level of knowledge of the streets fruits vendors on food cleanliness and their food handling practices which could lead to microbial load in the sample fruits. The study assessed the level of knowledge of the streets fruits vendors on food cleanliness, symptoms of food borne and their knowledge on food borne pathogens as indicated on the conceptual framework. The study also assessed food handling practices among the respondents as indicated in the framework. The components are explained as follows;

Fruits safety knowledge: According to Thanh (2015), knowledge of street fruits vendors has a very important influence on fruits safety as most of them are unlicensed and are not trained in fruits hygiene and sanitation. The conceptual framework seems to examine knowledge on the street fruits

vendors in three areas namely; fruits cleanliness and hygiene, symptoms of fruits borne illness and knowledge on fruits borne pathogens. As indicated on the framework, the knowledge of the street fruit vendor can inform how he/she is going to handle the fruits hence the microbial load.

Fruits handling practices: the framework examines fruits handling practices among street fruits vendors because unwholesome handling of fruits may increase the risk of contamination of the fruits and hence cause diseases to those who buy and eat (Thanh, 2015). The framework indicates that fruits handling practices also informs the level of microbial load of the fruits.

Microbial load: many studies have reported that cut street fruits are found to be an appropriate medium to transmit antimicrobial-resistant pathogenic bacteria (Thanh, 2015). The framework shows that the microbial load of freshly Cut Street fruits could be informed by the level of knowledge of the street fruits vendors and the manner of handling of the fruits.

The hands, hair, nose, and mouth harbor microorganisms that can be transferred to the food during processing, packaging, preparation, and service by touching, breathing, coughing and sneezing (Nurudeen, Lawal and Ajayi, 2014) uneducated vendors who sell these fruits often display or hawk them on the streets in contaminated containers, utensils, or dirty environments.

Concept of Street Food Vending

Street vended foods are interpreted by Von Holy and Makhoane (2006, p. 89) as "foods and beverages prepared and/or sold by vendors in streets and other public places for immediate consumption or consumption at a later time without further processing or preparation." Vending street food is a common sight in major cities around the world, including Bangkok and Mexico City.

Near metropolitan workplaces, educational institutions, healthcare facilities, transportation hubs, bus and train stations, and taxi stands, you will find a concentration of food vendors selling street fare. Even though it's a major contributor to the country's economy in terms of jobs and food sales, relatively little is known about South African street cuisine or the habits of the people who eat there (Odonkor et al., 2011, p. 1).

The practise of selling meals on the street is ingrained in the culture of many nations. Vendors selling snacks, drinks, and even whole meals from carts set up along the sidewalks are a common and noticeable sight in most major urban centres. Over time, the street food industry has grown into a complex and substantial market that serves millions of people from all walks of life at affordable prices while also providing a source of revenue for the vendors themselves (Oghenekohwo, 2015).

To address the needs of city people, this sector plays a significant role in the economies of many nations (Omemu & Aderoju, 2008). It is no secret that the global street food industry is booming, and Ghana is no exception. It is widely agreed that street foods serve an important socioeconomic role in providing jobs, money for women, and affordable meals to people of all income levels.

The "street-food trade" is "recognised as a phenomenon that has great economic and socio-cultural importance" (Paola & Allan, 2010), according to their research. Despite being a legitimate segment of the hospitality sector, the street food vendor community is sometimes seen as unofficial since so few vendors bother to register their operations. They are often rather modest in

scale and are operated out of people's homes, on sidewalks, or via other ad hoc means.

Location and portion size are often cited as reasons for the prevalence of street food vendors. The phrase "street food vendors" may seem to exclude individuals who sell their wares at marketplaces, bus terminals, by the side of the road, on school campuses, and in other legally sanctioned public areas (Offei-akoto, 2015; Tessema, Gelaye, & Chercos, 2014). The World Health Organisation (WHO) broadly defines street meals as those produced and/or sold by vendors on streets and "other public places" for immediate consumption or consumption at a later time without additional processing or preparation (WHO, 2008).

"Street food" may refer to anything from a full meal to a quick bite (Manko, 2018). Snack foods are often lower in calories and nutritional value since they are supposed to keep you full between meals (Makwande & Moyo, 2013). Snacks derived from fruits, vegetables, and grains may now be eaten raw or cooked (Bernardo et al., 2015). Modern and processed refreshments including ice cream, biscuits, and yoghurt are common offerings from street vendors. Raw or cooked, fruits and vegetables are a nutritious component to any diet (Makwande & Moyo, 2013; Omari, Frempong & Arthur, 2018). Researchers have shown that factors such as local customs, religious practises, and weather patterns influence the ultimate form of street food.

People who don't move very much are more frequent in the street food industry, where lengthy lines of hungry consumers must be patiently endured. However, it is possible that some of the street food is served from trucks as they go down a major thoroughfare (Boateng, 2014). The revenue of some

street food sellers is seasonal (Buted & Ylagan, 2014; Liu, Guangyi & Zhang, 2014), whereas that of others is supplementary to their main source of income. However, one may argue that, whether they work part-time or seasonally, these street food vendors either have a fixed location from which they sell their wares or are movable (Makwande & Moyo, 2013; Buted & Ylagan, 2014).

Total Quality in Food Service

The concept of standard practice adopted from the total quality in the hospitality industry dates back to the late 1980s. In the 1980, the motivation for total quality was considered as a key strategic policy which was implemented by the hospitality industry to achieve excellence in their service delivery. The notion was to use all the needed resources of the hospitality industry to provide quality services to customers (Ababio & Lovatt, 2015).

Over time, additional writers argued for broadening the notion's application to industry standards, and the comprehensive quality concept took root in the hotel sector. It was in the West that efforts to protect client privacy, safeguard their safety, and guarantee their happiness in the hotel industry got their start (Alfers, 2012). Customers were likewise happy with the services they received from Japan's hotel industry, which adopted the practise. Since then, Ghana joined the rest of the globe in adopting what would become global norms for the hotel business. This time around, however, the components are unique to the hospitality industry in each nation, albeit fundamental concerns like security, discretion, comfort, and tidiness are universal (Azanza et al., 2000).

Standardisation in the hotel business is increasingly desired by consumers throughout the globe (Buted & Ylagan, 2014). Given that the hospitality sector is now one of the tourist industry's most important components (Danikuu et al., 2015), this is now a must. For the hospitality business, "standard practises" are "those measures put in place by management to ensure that customers and non-customers are protected and enjoy the needed benefits associated with seeking any service in the hospitality sector" (Alfers, 2012).

The hotel industry in sub-Saharan Africa makes sure that clients are starting to worry about high quality practises in the industry they seek services from (Danikuu et al., 2015). According to Kubde et al. (2017), some examples of expected standard practises for hotel personnel include contentment, comfort, cleanliness, and hygiene. Similar to this, Buted and Ylagan (2014) highlighted security and safety as standard practises of hotels that are expected to guarantee that these components are satisfied to give the required requirements to their clients. As a result, one of the essential elements that hotels continue to strive to achieve as a regular practise is client happiness. The sustainability and prosperity of the hotel sector cannot be ensured without any consumer satisfaction with the services they want from the hotels (Hiamey et al., 2013).

Customers have been more sensitive and aware of standard practises, including the price and quality of services they would get when they pay for services, due to the rising demand of visitors from all over the globe to visit locations (Danikuu et al., 2015). According to studies, consumers are more likely to have pleasant and happy experiences when the services provided are

perceived favourably. They would also have a favourable opinion of the facility and maybe recommend it to others (Janie & Marie, 2010). On the other hand, when a service provider provides subpar services to clients, such clients will have negative opinions of the provider and may not recommend the location to others (Altekruse & Swerdlow, 1996). As a result, the hotel industry makes sure that best practises are followed in order to provide essential services to clients who consistently use their services (Alfers, 2012) in order to keep them and draw in new ones.

Empirical Review

Food Safety/Hygiene

The study of food safety incorporates numerous disciplines, such as chemistry, microbiology, and engineering. A synthesis of these competing philosophies is required wherever food is obtained, made, processed, stored, or marketed to ensure consumer safety. According to Käferstein and Abdussalam (1999), "food safety" refers to "a system of cleanliness and accountability that touches all aspects of the global food business." Food safety, which includes both the preparation and storage of food, aims to reduce the likelihood of illness and injury caused by eating contaminated or otherwise unsafe food. Several potential health dangers are incurred by food products while they travel from the farm to the factory to the table, and these risks must be reduced as much as possible (Käferstein & Abdussalam, 1999).

The estimated 600 million annual instances of foodborne diseases highlight the global impact of unsafe food on human health and the economy. For this reason, maintaining food safety is a priority for public health and an absolute need for attaining food security. Access to local, regional, and

worldwide markets is crucial to encouraging economic development and improving lives (Borchers et al., 2010), making food safety and quality control systems even more important for safeguarding people's health and welfare.

Food safety is an essential part of food security that is often overlooked. Nonetheless, some 40,000 people in the United States die and another 600 million become ill annually as a result of consuming tainted food elsewhere in the globe. Many health problems may be traced back to eating too much fresh food. For instance, food poisoning from tainted meat, fruit, or vegetables is not uncommon in Kenya. Meat has been tainted on occasion owing to lack of sanitation, excessive physical handling, insufficient worker training, inadequate facilities, and unsafe water. Water used to clean the kale has been connected to the contamination with faecal germs. Additionally contributing to food contamination include a lack of buildings for food display, growing foods in polluted water, and dirty food processing facilities (World Health Organisation, 1999).

Safe food handling, preparation, and storage practises are essential for reducing the risk of food-borne illness and harm. Products' exposure to several possible dangers to customers' health along their route from farm to factory to table is significant. Reduced hazards to consumers are achieved by the use of safe food handling practises across the whole food supply chain. This has been shown elsewhere (Käferstein & Abdussalam, 1999).

Food safety is critical from both a monetary and moral standpoint. Serious problems might arise from disregarding food safety regulations. When businesses don't take proper precautions to guarantee their food is safe at every stage of production, it costs them dearly in terms of money and lives.

They may have to recall goods, change their procedures, and deal with a public relations problem. The significance of having access to healthy food in the modern society is difficult to overstate (Schmidt & Rodrick, 2003). Inadequate food safety measures are the major cause of over 200 avoidable illnesses throughout the world.

About 10% of the population becomes ill or is injured each year as a result of eating something they shouldn't have. More than a quarter of the 420,000 fatalities per year traced down to tainted food include children younger than five, according to statistics. Inadequate food safety has a multiplier effect that slows economies, particularly in undeveloped places, and has a direct impact on people's lives. According to the World Health Organisation, there is an inseparable relationship between food security, nutrition, and safety. When there is not enough nutritious food to go around, it puts a pressure on public health systems and causes disruptions in society (Schmidt & Rodrick, 2003).

Personal Hygiene

People who work in the food service business should take extra care to practise good hygiene because of the prevalence of communicable diseases in the profession. Individual contact, faecal handling, and handling of contaminated food and surfaces are all potential vectors for the spread of illness among food sellers (Dingwall, 2010). Those whose professions include preparing fresh meals like salads and fruits are particularly vulnerable to this issue. Worryingly, germs may be easily transmitted during food preparation, with just a small window of opportunity for remediation before the meal is ingested.

Maintaining clean skin and hair is a must for everyone who wants to feel confident in their appearance. This is crucial for both mental and physical well-being. A lack of personal hygiene increases a person's susceptibility to illness because it allows germs to proliferate in an unsanitary setting. Isolation and loneliness might set in if others avoid you due to poor personal hygiene. It's been estimated that there are over a million sweat glands each human. Body smell is produced when bacteria digest sweat. A good shower can wash away bacteria that cause body odour and protect your skin from irritation (Mattson et al., 2016). Dust and dirt would stick to the skin and combine with perspiration as the day continued since so few people bothered to leave the vending area for a shower.

Hair that is washed on a regular basis helps eliminate oil, giving the wearer a more youthful appearance. Frequent hand washing is suggested for the prevention of the transmission of infectious diseases. Bacteria may be spread in part because dirt and germs may accumulate under fingernails. Keeping your nails short may help lower the risk of infection since dirt and bacteria have less of a chance to build beneath them. Dirt may become trapped beneath nails if they aren't cut regularly using clean equipment. Sarkar (2013) found that some participants in his research used a nail brush as part of their usual hand hygiene practise to clean beneath their nails. Replacement of sanitary items such as tampons, pads, and the like is necessary due to their frequent usage. Be careful to scrub up both before and after. Soap should not be used to clean the vaginal area since the vagina cleans itself. Infections are a real risk. Once a day, using gentle soap and water, you should clean the vulva (the outside of the vagina) to prevent infection (Mattson et al., 2016).

Both poverty and a lack of access to clean water may have a detrimental influence on personal hygiene. A person's mental health may have an effect on how well they take care of themselves. If a person has a mental illness, clinical depression, or an addiction issue, they may find it very challenging to keep up with their usual routines of personal hygiene (Dingwall, 2010). Hygiene is a sensitive topic, thus it may be difficult to bring up with someone. Poor personal hygiene has been linked to increased loneliness (Mattson et al., 2016).

Split ends and skin damage may be caused by the harsh soaps and shampoos people use in the shower (Smith, 2008). This process speeds up or slows down depending on the individual's oily/dry skin type and the weather conditions where they live. Feeling your skin pull tight after a shower is not a sign of cleanliness. Instead, it's a symptom of skin that's too dry. Even while showering has been shown to improve one's physical, mental, and emotional health, it's unlikely that most individuals need to take one every day as many Americans have come to expect (Smith, 2008).

Knowledge Level on Food Hygiene of Street Food

According to research, most vendors selling food on the street are uninformed about proper food hygiene procedures (Paola & Allan, 2010; Mensah et al., 2002), making this a major subject for public health advocates to address. Oghenekohwo (2015) and Kubde, Pattankar, and Kokiwar (2017) estimate that roughly 2.5 billion individuals throughout the globe eat street food on a regular basis without enough training in food hygiene.

The low prices and easy availability of street food are two of the main reasons for its popularity, particularly in economically depressed places

(Ababio & Lovatt, 2015). In addition, the firm may be run with less resources and provides both food and nutrition for customers and jobs for city dwellers (Alfers, 2012). Knowledge of street food sellers has been evaluated in several empirical research, with mixed results. According to the results of a research done by Osei-boateng (2012) to evaluate food selling on the streets of Ghana, roughly 78% of participants had a solid understanding of food hygiene. Because of their limited education, most street food sellers have little expertise in ensuring the quality and safety of the food they sell.

In other contexts, when experts are supposed to share what they know, they often settle for mediocrity since customers don't insist on it. The food safety awareness of street food sellers was shown to be related to socio-demographic variables such as age, sex, and socioeconomic level (=2.76; p=0.05), according to research by Obi-Nwosu et al. Janie and Marie (2010) conducted a survey on this topic and found that although food vendors on the street tend to have less formal education than those in the food service industry as a whole, there is no correlation between their level of education and their food hygiene expertise at the time of the research (OR=2.83; p=0.15).

Studies conducted all throughout the world have shown that street food sellers have always been an easy target for criminals. Therefore, it is essential that those who operate in the street food industry be well-versed in the best practises that guarantee the safety of their customers at all times (Danikuu et al., 2015). The authors found that the clients are vulnerable to all sorts of food safety issues due to the lack of understanding of street food sellers on basic practises. Due to their availability throughout the clock, street vendors play an

important role in ensuring the public's access to a wide variety of safe foods (Barro et al., 2006).

In addition, understanding industry norms is important for street food vendors because of the increased scrutiny that comes with operating in a high-traffic area frequented by a diverse range of customers (from locals to tourists) (Amoah et al., 2009). In addition, it is increasingly difficult for street sellers to tell their real from counterfeit goods or identify consumers who may pose a security risk to them (Azanza et al., 2000).

Buted and Ylagan (2014) found that street sellers in the African environment typically don't comply with food safety problems since they don't know enough about them. The results demonstrated that the designs and configurations of street food sellers are not focused on food safety, making it exceedingly challenging to guarantee optimum food safety security operations.

An empirical study found that vendors on the street do not have the knowledge to meet regulatory requirements. The results showed that most people do not know how to ensure cleanliness and value for money in the best way. Researchers Danikuu et al. (2015) observed that vendors of street food were often uninformed about fundamental food safety practises.

Similar findings were reported by Barro et al. (2006), who discovered that most vendors of street food lacked the knowledge to follow proper food safety procedures. Research participants were not well-versed in the importance that customers put on cleanliness. In addition, the data showed that most survey respondents didn't have a solid grasp on why it's so important to keep food clean. From the advent of taverns till the present day, vendors of street food have taken the rap for customers becoming sick due to poor

hygiene. When asked whether they had ever heard anything about food hygiene from the media or government, the great majority of Ghanaian street food vendors replied they had, according to research by Osei-boateng (2012). The majority of vendors surveyed wore aprons when making and serving customers food, although some also covered their faces with scarves and washed their hands completely after using the restroom.

In Vietnam, too, Samapundo et al. (2016) discovered that street sellers were well-versed in food hygiene practises. The vast majority of participants in the research were careful to avoid any potential dangers. Similarly, Osei-boateng (2012) found that media outlets were cited by street food sellers as key informants on food safety practises. According to the results, the vast majority of respondents understand what makes food safe to eat.

However, Ababio and Lovatt's (2015) evaluation of research on food safety and food hygiene in Ghana found that, overall, more than 80% of street food operators had little awareness of food hygiene practises. According to the results of the survey, most of the workers were not washing the utensils with soap. Three-quarters of respondents were not giving their clean bowls a last rinsing in warm water, and almost a quarter (23.8%) never dried their dishes with a clean towel. The research also showed that almost half of the employees included in the study never took a proper shower before working with the public. Because so many of them have made the market their bed, this has happened. It was also found that the vast majority of the volunteers never had a medical examination before being given access to the meals. However, the research found that none of the subjects had any visible skin lesions when they were unclothed.

From the standpoint of persons utilising appropriate service supply to consumers and using zero tolerance to surpass customers' expectations, merchants on the street know what elements influence their motivation to execute the standard practises, write Janie and Marie (2010). In order to increase and improve customer satisfaction, workers at street food sellers need the skills to distinguish between customers' expectations and the service they really get (Chukwuezi, 2010).

Customers' familiarity with a location's street food sellers has also been shown to be an important factor in the decision-making process. The desire to be shielded from harm is often their primary concern (Hiamey et al., 2013). However, owing in large part to individuals and personnel having poor awareness about the ideas of food safety (Barro et al., 2006), the street food sellers sector is very susceptible in terms of safety. Researchers have shown that dirty utensils are a common source of danger in the home (Chukwuezi, 2010). However, this has placed the burden on the street food sellers to maintain high quality standards and provide efficient procedures to prevent or lessen the negative effects on individuals, businesses, and society at large (Azanza et al., 2000).

Safeguarding national health, boosting tourism and international trade, and the production, distribution, and consumption of safe food are all ways in which street food vendors' knowledge of food safety can contribute to economic and health development of nations (Von & Makhoane, 2006; Odonkor et al., 2011 There is an increasing number of street food sellers in developing nations, despite the significance of food safety, there seem to be

little quality control mechanisms in place to safeguard customers from food-related diseases (Shu-ai, Yi-Mei & Kuo-Wei, 2012; Odonkor et al., 2011).

Street Food Industry

Providing a broad range of cuisines at cheap rates and in accessible places, the street food business is essential to meeting the daily nutritional demands of the millions of people who reside in urban areas of developing nations. Many persons with less education or experience might find work in the street food sector (Abano & Amoah, 2011). Significant nutritional implications (nutritionally balanced diets, sufficient in quantity, and presenting options for variety and choice) result from the nutritional quality of foods available on the street, especially for consumers in the middle and low-income sectors of the population who rely heavily on street foods (Abbott, 2012).

Mahfuza et al. (2016) report that the majority of street food sellers in Nairobi earn more than double the national minimum wage, suggesting that this is a viable source of income for them. Although the precise proportion of street food to the nutrition of the urban poor is unknown, it is a considerable element of it (Slavin & Lloyd, 2012). The rapid growth of street food, according to studies performed in Africa (Boeing et al., 2012), has had a detrimental effect on municipal infrastructure including water and sewage systems and city planning in the form of congestion and trash.

According to the FAO (Christison et al., 2008), there is reason for concern over the improper use of additives, the prevalence of adulterants and environmental pollutants, and the defective food handling procedures among street food sellers. Many vendors selling food on the street are not only unlicensed but also untrained in food safety and sanitation and maintain

unsanitary establishments. The number of Kenyans who sell food from carts on the street is growing quickly. This is plainly evident in the fact that vendors on the streets of Nairobi sell both raw and cooked meals. It's a result of the need to diversify income streams in the face of salary stagnation or decline (Losio et al., 2015) and the increasing cost of living.

The tremendous diversity of street food is due in large part to the impact of both location and individual vendors. Authentic street cuisine from a different culture will most likely include foods you've never heard of. Simply said, there are too many varieties of street food consumed throughout the globe for there to be a menu listing them all. In addition to a broad selection of rice-based meals, fried snacks, traditional pastries, soups and porridges, beverages, and fruit were all reported to be accessible in the EPOC investigations (Tango et al., 2018).

There was a wide variety of ingredients used in the preparation of these meals, including meat, poultry, fish, seafood, eggs, grain, soy, fruit, and vegetables. Either they were eaten fresh out of the oven (or uncooked) or they were made ahead of time and consumed later. There are many ways to classify the wide range of street foods available, including by meal (meals, meal components, snacks, and drinks), by number of ingredients (simple single-ingredient foods and complex multi-ingredient foods), by degree of processing (minimally processed foods, such as fruit that may only have been peeled or sliced), and by central production. While the bulk of what is sold consists of traditional meals, a considerable market exists for processed foods created by big manufacturers in various countries (Razzaq et al., 2014).

The kind of meals available from street sellers vary greatly from one location to the next. According to studies conducted in Jamaica and Pune, India by EPOC researchers and others (Huang et al., 2011), many street vendors specialise in selling just one kind of cuisine, such as rice or noodle-based meals, rather than a wide selection of both. Some Senegalese vendors, both male and female, focus on selling just one kind of product, although this is the exception rather than the norm. In Indonesia, men tended to specialise in wheat-based noodle dishes, while women cooked mostly using rice. This difference was not as evident in other countries. EPOC study, as well as studies conducted in Jamaica and India (Buchholz et al., 2011), indicated that women were more often engaged in the preparation and sale of traditional foods.

Cost and Availability the common belief is that since street food is not prepared in a kitchen, it must be unhealthy and costly. Despite a dearth of quantitative data on these features of street food, the EPOC and other studies have come to the opposite conclusion. Street food is sometimes cheaper than equivalent meals at restaurants or fast food companies. Street food may be cheaper than the same dish cooked at home because to economies of scale, even if the cost of fuel and supplies might be greater in urban environments (FAO, 2016).

The EPOC study in Nigeria found that during times of economic distress, people ate more street food than usual because of the shortage and high cost of procuring goods used in home cooking (Razzaq et al., 2014). Similarly, another Nigerian study found that after structural adjustment policies were enacted, including currency devaluation, there was an increase in

the consumption of street foods. The latter caused patrons to eat less at eateries where costs had increased. While vendor competition can help keep prices down, the Food and Agriculture Organization (FAO) has warned that it can also lead to the purchase of subpar raw materials, which could compromise food safety (FAO, 2016). Depending on the business model, some retailers provide discounts to frequent buyers or other merchants. It's been brought to people's attention by EPOC that many traditional foods require extensive preparation, and that buying street food can allow women to spend that time earning an income instead of preparing food. This makes street food an attractive option because of its potential cost-effectiveness (Ngnitcho et al., 2017).

Most major cities across the globe have street food vendors. The vendors carefully choose their locations, clustering in a variety of high-traffic areas that are not necessarily business districts. It has been hypothesised that the number of street food sellers grows in parallel with the size of cities (Allen et al., 2004), and EPOC's findings support this theory (with the exception of Minia in Egypt). There were over 18,000 vendors per square mile in the city of Bogor, which had a population of approximately 250,000. That worked out to 14 salespeople for every vendor. Minia's density of 255 people per vendor was much higher than the global average of 34 to 69. The peculiar nature of the street food offered there has been cited as a possible explanation for the latter figure (Abisso et al., 2018).

Offei-Akoto's (2015) research in this area also found that most street food sellers set up shop along to roads. More than 88% of individuals were also not using hair restraints, and just roughly 56% of participants were using

aprons to protect against food contamination. The vast majority of people wore hand and arm jewellery, which might have been a source of pollutants. However, FAO mandates that all food service workers remove jewellery (including watches, bracelets, and rings) and wash their hands and forearms well before handling food (1997).

As well, Chukuezi (2010) found that, among street food sellers in Owerri, Nigeria, the vast majority did not use hair nets, and some even painted their fingernails. One additional problem was that the street food sellers' outfits were unclean, they chewed gum while working, and they had untreated lesions on their hands. It was discovered that over 40% of the street food vendors did not have employees wear uniforms. People weren't washing their hands after using the loo or covering their food with a lid, and there weren't any bathrooms for them to use if they needed one.

In the Central State of Northern Nigeria, sampled street food vendors were found to not be wearing an apron while serving customers, and in the Niger Delta University, food vendors were found to be wearing jewellery at the time of the study, as reported by Nurudeen et al. (2014) and Oghenekohwo (2015), respectively. Although 34% of vendors washed their hands after some major activities, 45% of them did not use soap to wash their hands, and 71% of the vendors had not undergone medical screening despite a high knowledge level of its importance, according to research by Dwumfour-Asare and Agyapong (2014) on food safety knowledge and practise of street food vendors in rural Northern Ghana. According to other research (Liu, Guangyi, & Zhang, 2014), a brief suspension of vending for the exclusion of ill-food handlers should be followed at all times.

For instance, 67 percent of respondents in a study by Nurudeen, Lawal, and Ajayi (2014) in Central State of Northern Nigeria about the hygiene and sanitary practises of street foods said that food operators should temporarily stop their business if they have a cough, cold, diarrhoea, stomach cramps, typhoid, hepatitis, food poisoning, or communicable disease. In addition, Sarkodie et al. (2014) observed that street food sellers in Sunyani Township did not have any visible skin lesions.

Similarly, Opoku-Boateng (2016) found that customers' food safety knowledge and attitudes are affected by factors such as their age, sex, income, and level of education at street food vendors. The probabilities of having strong knowledge were greater in educated street food operators than in those without education (OR=1.56; p=0.04), according to the research. Also discovered: the older the vendor, the more they know about keeping their food safe. People above the age of 45 had a lower odds of knowing about food hygiene than those under that age (OR=0.83; p=0.05). Statistical analysis also revealed a correlation between the income level of street food sellers and their level of expertise (OR=1.15; p=0.05). There was a significant income gap between individuals who knew about food hygiene and those who did not.

People who sell meals on the streets in Nigeria often re-heat previously sold items. Bad personal hygiene was detected during the inspection. There was a lack of health education on street food and a lack of pre-employment medical examinations (Omemu & Aderoju, 2008; Olang'o, Olima & Leah, 2012), and few people possessed medical examination certificates.

Researchers in Zimbabwe found that vendors with formal training in food hygiene had a deeper understanding of how to keep their customers safe

from illness by avoiding poor handling, cooking, and storage practises. About a quarter of the people surveyed in the research also said that they had experienced everyday problems with their health after eating street food due to dust. It was also found that the circumstances under which food was sold were unsatisfactory and needed to be improved (Makwande & Moyo, 2013).

In order to prevent the spread of food-borne diseases, it is crucial that those who work in the street food industry have an in-depth understanding of modern methods of food cultivation, harvesting, and storage. Controlling the processing, storage, cooking, and packing of food requires an intimate familiarity of the machinery used to do so. Safeguards against food poisoning may be established using knowledge of the susceptibility of food items to contamination (Buted & Ylagan, 2014; Boateng, 2014).

Alternatively, chicken, meat, milk, eggs, and fish are common sources of Salmonella, one of the most dangerous food-borne illnesses. They are responsible for the softening and loss of taste in food because the enzymes they generate break down carbs, lipids, and proteins (Paola & Allan, 2010). Toxic metabolites called mycotoxins are produced by moulds under favourable conditions during harvesting, processing, and storage of food commodities; these mycotoxins are heat stable and can cause acute or chronic diseases if consumed along with food (Omari, Frempong, & Arthur, 2018).

The liver, kidneys, neurological system, endocrine system, and immunological system are only some of the organs that might be harmed by these. However, Manko (2018) found that among Ghanaian vendors of fast food, 28% and 21% respectively knew that Salmonella E. coli might cause food poisoning. It was also suggested that the applicable authorities translate

the general hygienic requirement and practises to be followed by the vendors into codes of practise, as this was recognised as cost-effective tools for the control of street foods, by fully taking into account local conditions, including specific risk factors that are relevant to each operation. Street food sellers, on the other hand, are frequently impoverished and illiterate, so they may not understand the importance of properly sanitising their products before selling them. As a result, many worry much about the effects of eating at street vendors (Paola & Allan, 2010). The best way for a community to get the benefits of street-vended foods while minimising its exposure to food-borne disease is for the government to step in and ensure that the level of safety for such items is as high as it can be given the specific circumstances and laws of that area (Shu-ai, Yi-Mei & Kuo-Wei, 2012).

According to research done by Azanza et al. (2000) in Italy, the vast majority of food consumers and street food vendors who had attended training workshops on food hygiene showed high understanding of foodborne illnesses management and prevention measures. Kubde et al. (2017) came to a similar conclusion, arguing that up-to-date knowledge about food preparation and storage is crucial for preventing foodborne diseases. Understanding the machinery used for food processing, storage, preparation, and packaging is essential for maintaining quality control.

We can better protect ourselves against food poisoning if we have an idea of how quickly certain foods might get contaminated. Experts have attributed the rapid growth in popularity of street meals to its cheap price, ubiquitous availability, and ease of preparation. Janie and Marie (2010) showed that many of the snacks consumed by children in rural India were

nutritionally inadequate. The iron content of various traditional Indian snacks made from grains and legumes was found to be low but the phytate level to be potentially high, which might hinder iron absorption (Jiao & Zheng, 2017).

EPOC researchers found that many frequent street foods had a high nutritious density at a reasonable cost using local food composition tables. Meals featuring meat were found to have the highest calorie and protein content among the most commonly consumed meals in the Philippines (average 193 Kcal and 16 g protein per meal). Even though the typical serving of vegetables included 2.9 mg of iron, 434 IU of vitamin A, and 12 mg of vitamin C, its bioavailability was questioned (Manko, 2018). Similar research in Indonesia (Makwande & Moyo, 2013) found that a "typically modest" Rp 300 dinner in the country provided more than half of the daily needs for iron, vitamin A, and vitamin C (again, assuming those of an adult).

Many diseases, including cholera epidemics, may be spread by eating tainted street food, and this has been shown time and time again (Kubde et al., 2017). The risk of contamination in street food varies greatly among meal types and preparation styles. Dry cereals and baked items are more resistant to bacterial growth than their wet counterparts, as well as suitably sugared, salted, acidulated, and fermented foodstuffs. Cooked meals that are allowed to sit out at room temperature for a lengthy amount of time provide a greater health risk than their ready-to-eat counterparts (Ning, 2017). There are a few instances of potentially dangerous meals, including raw food and dishes made with ice (Liu et al., 2014). The proliferation of dangerous bacteria in the food supply is exacerbated by inadequate sanitation and waste management systems (Janie & Marie, 2010).

Street meals may not be any more hazardous to your health than those from other areas, but (Kubde et al., 2017). Two studies conducted in India (Pune and Calcutta) by Liu et al. (2014) found that the microbiological quality of street meals was comparable to or greater than that of foods bought from hotels and restaurants. Female street food sellers have been shown to have greater levels of sanitation than their male counterparts (Manko, 2018). Studies conducted by the Environmental Protection Agency (EPA) have found that the microbial quality of street foods is generally equivalent to or better than that of foods prepared by customers at home, making the EPA's practical point that the hygienic quality of foods prepared on the street is unlikely to be any worse than that of foods prepared at home especially in poorer households.

Concerns concerning the safety of street meals need the inclusion of efforts to improve their microbiological quality in any campaign to expand access to these foods. Education and training programmes for vendors, upgrades to vendors' equipment for preparation and storage, provision of adequate sanitation and refuse disposal facilities, and the establishment of dedicated food centres are just some of the interventions that have been proposed to increase the safety of street food (Chukwuezi, 2010). Most dishes sold on the street will not be edible without access to potable water. Safe food handling practises also need legislation and enforcement mechanisms. The World Health Organisation and the Pan American Health Organisation both endorse the use of a hazard analysis critical control point (HACCP) approach as the most practical and cost-effective solution to ensuring the safety of street foods prepared under a wide variety of circumstances (Dwumfour-Asare &

Agyapong, 2014), but there are competing technical approaches to achieving this goal.

The HACCP methodology can be implemented at any stage of the food chain to pinpoint high-risk areas and prioritise preventative measures. Priorities may be established, interventions designed, and the training and education requirements of suppliers and consumers can be determined with the help of this data. Pilot projects employing the HACCP approach are planned by WHO, and it is likely that such a strategy might be paired with interventions to improve the nutritional quality of street foods. Food safety issues and solutions have been outlined in standards and rules created by other organisations (Danikuu et al., 2015). Food fortification is a common practise for increasing a person's intake of beneficial micronutrients. Fortified foods can be chosen to provide the desired nutrient(s) to a specific population in an economical, standardised, safe, and sustainable manner.

Practices of Street Food Vendors during Food Processing, Selling and Storage

Studies have shown that the risk of becoming sick from eating from a street vendor is higher due to issues with food handling, insufficient storage, and poor hygiene. Success in the food industry is feasible if workers acquire the right hygiene mindset (Singh et al., 2017; Janie & Marie, 2010), which in turn reduces the likelihood of foodborne disease. Food poisoning is often brought on by carelessness with food preparation. According to some estimates, 97% of all cases of foodborne disease linked to catering establishments may be traced back to carelessness with the food (Kubde, Pattankar, & Kokiwar, 2017; Omari, Frempong, & Arthur, 2018).

Cooking areas near roads and other public spaces are a potential source of contamination for food sold by street vendors, according to empirical studies (Elvis & Henry, 2016; Chukuezi, 2010). However, proper food preparation can significantly reduce this risk. In light of this, the kitchen crew has a crucial part to play in ensuring the safety of the food being served. Employees' unwashed hands may be a source of infection in the food service industry, according to research (Omemu & Aderoju, 2008; Feglo & Sakyi, 2012).

According to polls conducted by Azanza, Gatchalian, and Ortega (2000) and Odonkor et al. (2011), over half of respondents did not use a head covering, and about 8% of people did not hide visible skin lesions. About half of the street sellers surveyed (54.9%) were found to have exposed food to flies, and nearly half (47.5%) had opened polystyrene bags with their mouths before placing food inside. Almost all of the fried yam, plantain, and bean cake sellers I saw used mouth-blown polythene bags, which are easily permeable and might potentially harbour harmful bacteria. Among the vendors surveyed, almost two-thirds did not wear an apron. Slightly more than one-fifth (17%) of those who took part in the study maintained tidy fingernails.

According to Kubde et al., 2007, "some local authorities took the initiative to improve street food vending in their municipal areas." The Ethekwini Metropolitan Council (formerly known as Durban Unicity) in the KwaZulu-Natal Province was one of these cities. According to the author's study, "after some investigation into the impact of street food vending within Durban City, the Metro decided to integrate the informal economy into its long-term plan to promote its economic development." Some advantages of

the informal sector were identified, such as the fact that it plays a significant role in creating jobs, that it offers convenient service to its customers, and that, thanks to its diversity, it is able to meet the religious and cultural needs of the people in the Metro.

According to Kubde et al. (2007), "the Durban Informal Economy Policy, which was developed as a result, provides a strategy that the Metro has aimed to follow in achieving its economic development goals." Ethekwini Metro has solved the issue of public annoyance in Durban by limiting street food sellers to certain locations. The Metro makes sure that street food sellers have the training they need to comply with minimal sanitary rules before they are issued an acceptance certificate. According to research by Jiao and Zheng (2017), medical screenings of street food sellers are required in certain countries to check for the presence of communicable illnesses including typhoid, TB, cholera, and others that may be spread via the air.

Metropolitan, municipal, and district environmental health officials and inspectors demand periodic screenings as well. The suppliers must undergo extensive medical screenings and get health certifications from approved medical facilities. Vendors are responsible for keeping this document on file, presenting it upon request, and renewing it yearly. The authors state that "the safety of street foods was better than expected in these two urban areas studied" (Makwande & Moyo, 2013) after microbiological analysis of foods sold on the streets of Bloemfontein and Johannesburg, South Africa.

Researchers in Johannesburg found that street sellers regularly visited supermarkets to stock up on fresh ingredients, cooked up enough food for the

day, and either donated or discarded any leftovers. This practise affected the potentially harmful microbiological composition of the tested street items, according to Nurudeen et al. (2014), but it may have had other effects on the individuals who ate the leftovers. Even five-star restaurants can't compete with the taste of food cooked by street sellers, provided they use proper sanitation.

Danikuu, Baguo, and Azipala (2015) conducted a survey and found no correlation ($p>0.05$) between sellers' education levels and the cleanliness of their booths. This indicates that participants' commitment to excellent cleanliness was unrelated to the level of education of the vending site sellers. This indicates that vendor hygiene may not be affected by vendor education. The findings showed that only roughly 45 percent of the vendors had any kind of official training in food preparation, while the vast majority lacked even the most fundamental understanding of cleanliness. Other street food sellers learned through their parents or from other vendors, and 23% learned on their own via trial and error (Tessema, Gelaye, & Chercos, 2014).

Less than a quarter of vendors used waste bins to keep their waste, while the rest used gutters along the streets (Elvis & Henry, 2016). This is an appalling way to dispose of trash. A statistical association was obtained (p-values of 0.867, 0.054, 0.412, and 0.151) between personal hygiene practises, food handling practises, surroundings of vending sites, waste disposal methods, and locations of vendors; these values indicated that there was no evidence of a relationship ($p=0.05$) between these factors and demographics.

Studies also revealed that, street food vendors were observed to be serving food with bare hands which could promote contamination and

introduction of pathogenic microbes on foods if their hands were not properly washed (Azanza, Gatchalian & Ortega, 2000). Vendors that were chewing and talking while serving foods stood the risk of introducing harmful microorganisms that can trigger food-borne infections especially if the vendor is already a carrier of such organisms like tuberculosis bacteria (Jiao & Zheng, 2017).

The quantity and kind of microbiological or chemical contamination are two of the features pinpointed. “Street food studies conducted in Africa have revealed that their unrestrained and regulated growth has placed a strain on resources in cities,” the authors write. Water, sewage systems, and disruptions to the city’s layout due to traffic and trash may all have a negative impact on residents’ quality of life. From a medical perspective, the availability of street food is extremely debatable. When it comes to public health, poor hygiene practises pose a significant risk to consumers and are thus of high importance (Lucca et al., 2006:312). It has been argued that street food vendors provide a variety of meals that are essential for the health of certain demographic subsets (Samapundo et al., 2015).

The variety of meals available on the streets varies widely from one country to the next. However, most dishes are variations on the basic fare. Fried pork, fish and maize meal based ready-to-eat items are also cooked and served as part of the meals. Hygiene is defined by Sarkodie et al. (2014) as “the preservation of health,” and it includes all practises undertaken to guarantee the integrity of the food supply. Such precautions include, as outlined by Sarkodie et al., “correct storage of both raw and cooked foods as well as correct preparation and cooking methods.” When food is not prepared

properly, germs and other diseases have enough chance to spread and thrive or survive. According to a 2014 study by Sarkodie et al., the biggest threat to food quality comes from poor hygiene and sanitation practises.

According to research by Shu-ai et al. (2012), most nations' street food booths are makeshift shacks without plumbing, sanitary facilities, or even sinks. Bowls and pots of water are often used for cleaning hands, utensils, and dishes. Disinfection is seldom done, and pests may be drawn to vending locations if sewage is not properly disposed of, as shown in the results of Shu-ai et al. (2012). Inadequate refrigeration and disregard for basic hygiene practises also make the meals cooked there dangerous to eat. Staff members involved in food production and storage have a crucial role in ensuring that food is safe for consumption at all times, according to research by Singh et al. (2017). There is a risk of food poisoning due to poor vendor hygiene, which might let germs to contaminate the food supply. Food poisoning may result from unsanitary conditions and broken appliances.

Salmonella, staphylococcus aureus, clostridium perfringens, bacillus cereus, Escherichia coli (E. coli), and clostridium botulinum have been identified by Daniyan and Ajibo (2011) as the most prevalent bacteria that cause food poisoning. Food-borne microorganisms may be introduced during food processing either by diseased persons who handle the food or by cross contamination from another raw agricultural product and/or the in-plant environment, as determined by Abdalla et al. (2009).

Microorganisms from faeces, the face, the skin, or other locations are most often transferred to sellers via the hands, as found by Singh et al. (2017). E. coli, Salmonella, Shigella, Campylobacter, and Staphylococcus aureus are

only few of the bacteria that may cause food poisoning in humans. In 1994, for example, researchers Arambulo et al. examined the street food vendors of Santa Fe de Bogota, Colombia, and found that many of them carried Staphylococcus aureus, Salmonella typhi, Shigella, and Salmonella enteritidis on their bodies.

To paraphrase Balali et al. (2020), "street foods are frequently associated with diarrheal diseases due to their improper handling and serving practise and microbial contamination of ready-to-eat foods sold by street vendors and hawkers has become a major health problem." Aruambulo et al. conducted a study in the Dominican Republic that showed that there were a wide variety of bacteria in street foods, "including Bacillus cereus, Clostridium perfringens, Escherichia coli, and Staphylococcus aureus," and that the bacterial count of street foods tended to rise steadily throughout the storage and vending processes. Staphylococcus sp., which might have been transmitted from the vendors' hands during food preparation, touching of dish cloths, and the water during dish cleaning and hand washing, is often found on the serving utensils used at many vending locations. Cross-contamination between food-preparation locations, surfaces, dishwater, and the food itself is a serious public health concern.

A study by Beuchat (1996) indicated that while street-vendors in Mexico City sell ready-to-eat food to a significant number of clients, "their microbiological status, general hygienic and trading practises were not well known." According to Buck et al.'s (2013) research, they interviewed 48 different market merchants across five different tianguis in the year 2000. Fourty-three percent of the 103 taco dressings tested positive for E. coli, and

five percent tested positive for Salmonella spp. Three different samples were found to have either E. coli or Salmonella. Eighty percent of Salmonella-positive stalls (four out of five) had three or more food-vendors, and eighty percent of the vendors were male. This is in contrast to 37.3 percent (16 out of 43) and 46.4 percent (20 out of 43) of Salmonella-negative stalls.

Vendors reused water from the morning, there were no restrooms, and taco dressings were made the day before but left out in the open at the tianguis for an average of eight hours. Estrada drew the conclusion that eating from street vendors constituted a health risk to both locals and visitors based on these numbers. Very few individuals in South Africa are aware of the rules relating to the handling, transport, and storage of food for public consumption (Beuchat, 1998). As a result, there is a huge need for practical, applied understanding of hygiene in South Africa. “Thousands of people in South Africa suffer from food borne illnesses each year,” - Ababio & Lovatt (2015). These infections are caused by ingesting contaminated food or water.

African street meals seem to be a public health threat due to their preparation and service in unsanitary settings, as stated by Beuchat (2002). Few street food sellers are aware of food safety hazards, according to research by Beuchat (2002). Typical street food stands lack basic amenities like running water, flush toilets, cold storage, ice, sinks for washing hands after handling food, and trash cans. According to research, most raw materials are of low quality and have been held at harmful temperatures for too long. There is a widespread lack of knowledge among those who prepare and serve street food.

Consequently, street foods are commonly exposed to dangerous abuses, often at all stages of handling. “Products (from the raw material to the finished stage) are often exposed to sources of contamination like soil, dust and sand (Alamo-Tonelada et al., 2018). Street food vending is in profusion within the greater Durban area and plays a major role in meeting the food demand of the city dwellers. A study found that “of all the changes to Durban’s social and economic space, the increasing prevalence of traders in the city streets is perhaps the most visible.” Traders do not obey spatial resolutions, and they seem to show up anywhere in the city, which makes management of their numbers uncontrollable. In Durban, the activities of street vendors disregard the social and moral order, and are thus considered to be tarnishing the city. This kind of equation is of cause nothing new. “Images of urban cleanliness and order have long been associated with the activities of its residents, and the sanitation of urban space equated with the ‘moral hygiene’ of its citizens” (Amoah et al., 2009).

Similarly, money exchanges a lot of hands and as such may be carriers of harmful organism. The vendors were observed handling money while serving food and this may introduce contaminants through hand contact with the food (Makwande & Moyo, 2013). The presence of undressed skin lesion possessed by some food vendors especially those with discharges are important risk factors in food contamination and occurrence of food poisoning (Samapundo et al., 2015). This is because discharge from this lesion can easily come in contact with the food or utensil that is used to serve foods. The surrounding flies can transfer pathogens from the infected lesion unto food utensils also (Boateng, 2014).

Also, the WHO has reported that one of the most critical challenges in street food vending is the supply of water of acceptable quality and sufficient quantity for drinking, washing of raw food materials, cleaning of utensils and surrounding sites (WHO, 2012). Studies carried out by Paola, and Allan (2010) revealed that, street food vending in various parts of the world particularly in developing countries where epileptic water supply is usually observed reported wash water reuse. The oily appearance of water used for washing the utensils confirms the wash water reuse practice amongst the street food vendors surveyed.

Workers of street food vending sites who fail to follow sanitary practices contaminate food that they touch, with spoilage and pathogenic microorganisms that they come in contact with through work and other parts of the environment. The hands, hair, nose, and mouth harbor microorganisms that can be transferred to the food during processing, packaging, preparation, and service by touching, breathing, coughing and sneezing (Nurudeen, Lawal and Ajayi, 2014).

Similarly, studies revealed that, food safety rating revealed that both informal and formal categories of restaurants are employing effective food safety practices. However, other researchers revealed that, visual assessments are not entirely reliable, laboratory results showed pathogenic contamination of a number of food handlers' hands; kitchen equipment and utensils such as cutting boards and plates as well as cooked or raw food like salads. This demonstrates that both registered and unregistered street foods need to improve on their workers' personal hygiene and sanitation of kitchens and eating areas (Liu, Guangyi & Zhang, 2014).

In Cameroon, a study found that, an assessment of hygienic practices and health status of street food vendors in Yaounde was basically showing that personal hygiene of street food vendors was low. In Ghana, studies revealed that, the hygienic practices among food vendors in the educational institutions in Ghana was found to be good as 78% served food properly, 89% had good hygiene while 90% had personal protective clothing (Obi-Nwosu et al., 2013; Offei-akoto, 2015).

In a study carried out in in Shijiazhuang city, China by Liu et al. (2014), findings from the study revealed that street food vendors served consumers using a spoon. It was showed that the relevant authorities ensured that all the necessary food practices were held in high standard. In Nigeria, Obi-Nwosu et al. (2013) revealed that sampled street food vendors indicated they washed food stuff before cooking to ensure that they were neat for consumption. Also, in Tainan City, Shu-ai et al. (2012) found that street food vendors were wearing scarf before serving food to consumers. More so, Singh et al. (2017) revealed that in Mohali street food vendors were not allowed to talk while serving food to consumers.

However, a study found that, in Zimbabwe, majority of the street food vendors in the urban towns had clean workplace, 45% had vendors handled money and food indiscriminately, about 67% had dustbins while 78% of the vendors seldom had their hair covered with scarfs (Makwande & Moyo, 2013). Also, every cutting surface used in the preparation of food should be free from cracks and crevices, with only reasonable wear and tear, and should be cleaned at least on the following occasions: Before and after daily operations; and especially after having put unclean material or food on it if the

surface is subsequently to be used to cut street foods or foods to be consumed raw. Cooked and uncooked food should be handled with separate utensils (Alamo-Tonelada, Silaran & Bildan, 2018).

Every restaurant should ensure that all defective, damaged, cracked, rusted, chipped and unsuitable appliances and crockery are removed from use and discarded (Mensah et al., 2002). The general advice is that, all utensils should be regularly cleaned thoroughly washing them in warm water containing adequate amount of soap or other suitable detergents and then either immersing them for half a minute in boiling clean water and draining them or, for two minutes in potable water at a temperature of not less than 77°C and draining them (Tessema, Gelaye & Chercos, 2014).

The food should at all times be kept clean and free from contamination, and be adequately protected from pests, environmental contaminants and stored at proper temperatures where appropriate. Readily perishable food should be placed or stacked so that it is not likely to be contaminated by contact with raw food, toxic materials or any other materials which may cause contamination (Von & Makhoane, 2006). The bulk of readily perishable foods should be stored in clean containers placed in a clean ice box or refrigerator in which the food should not exceed a temperature of 10°C (Omemu & Aderoju, 2008).

Across the world, the street food vending industry provides standard practices to their customers in varied ways (Kubde et al., 2017). The objective is to provide an objective to accommodate guests for a fee must uphold its status in ensuring standard practices without unnecessary interference (Danikuu et al., 2015). The street food vendors ensure that all customers that

seek their services would achieve a specific goal. The street food vendors ensure that customers together with all their employees are protected to enhance and promote the reputation of the hospitality industry (Hiamey et al., 2013).

In a related development, Donkor et al. (2009) revealed that the importance of street food vendors delivering standard practices would ensure that the service they provide consistently would give a competitive advantage to service organizations. It would provide the street food vendors a consideration of customers' expectations a (Hiamey et al., 2013). Also, Janie and Marie (2010) revealed that the street food vending industry implements the standard practices by not often complaining about the customer behaviour. Empirical studies have also revealed that the desire and motive for customers to implement standard practices are key in today's world of competition. This is because, Telfer (2000) indicated that, the relation between street food vendors providing standard practices to customers are fundamental. Also, the need to implement basic price control and produce a financial return to the street food vendors would provide the economic reality of the hospitality industry business is key to its success.

The importance of street food vendors implementing information would depend on the activities of the service street food vendors provide to the people in Ghana. The pursuit of standard practices would depend largely on the growth and success of the customers. And also, much depends on the performance of the street food vendors which provide the satisfaction of the services customers enjoy to the services they are offered (Elvis & Henry, 2016).

The existence of street food vendors is to provide the needed services to customers in the manner that is appealing to them. The street food vendors ensure that they implement standard practices by providing services that meet the needs of customers in the way that they want and expect them to be met by providing the best services to them which in a way may exceed the expectations of customers. Therefore, the provision of good food should be standard in the eyes of the customers (Addo-Tham et al., 2020).

Similarly, Buscemi et al., (2011) in a survey of how people assess street food vendors indicated that all street food vendors try to ensure that they provide enough price limits to their customers to ensure that they are satisfied. One key factor was the competing firms expanded all their operations in the manner that would influence customers to come and operate with them. Customers on the other hand, tend to become familiar with the services provided to be able to make a firm resolution which street food vendors becomes the key differentiator in terms of the food safety (Chukwuezi, 2010). Every individual in life either at the workplace or outside the workplace has the intrinsic need to be safe and responsible for every decision they make with regards to securing their safety. Street food vendors will continue to be in existence as long as people need to travel long distances where they require food to eat (Amoah et al., 2009).

Also, all non-perishable food should be stored in clean, protected and closed container/cupboard to prevent cross contamination by pests. Once cleaned, the bulk of perishable raw food including wet cereals or pulses should be stored in clean separate containers preferably placed in a clean ice box, a refrigerator or a freezer to prevent spoilage (Rane, 2011). Empirical studies

also showed that, every food handler, during the conduct of the business, shall observe the following; wear an identification tag if issued and required by the relevant authority (Kubde, Pattankar & Kokiwar, 2017). Dress in clean and proper attire. Wash hands thoroughly with soap and clean water before and after handling food, after visiting the toilet, after handling unsanitary articles, touching animals, touching raw food, after handling toxic and dangerous materials as and when necessary (Odonkor et al., 2011).

Also, Elvis and Henry (2016) revealed that majority of sampled street food vendors (987%) were females and these had a predominantly poor level of food safety knowledge. The practice of stirring and reheating left-over food was very low and was practiced by few (21.1%) of the respondents. Frequent hand washing was poor. Inspection of food handlers showed a low level of personal hygiene. Only (42.3%) had pre-employment medical examination and 45,7% had received any form of health education.

In Dunkwa-On-Offin, Upper Denkyira, Boateng (2014) found that street food vendors were using dirty water to wash their bowls. Majority of the street food vendors were not frequently changing the water used for washing bowls. In the Tamale metropolis, Dwumfour-Asare and Agyapong (2014) found that street food vendors were handling money while serving food to consumers.

Globally, customers who patronize the services of hospitality industry are becoming much more discerning about high standards for excellent services making the need for management and employees to ensure that standard practices are upheld in the sector. Hospitality sectors in their normal activities strive to ensure that they provide enough comfort and privacy to the

customers based on the need at the time (Addo-Tham et al., 2020). Empirical studies revealed that authorities monitor the operators in the sector to ensure that employees conform to the standards of food and personal hygiene. Kubde et al. (2017) revealed that the factors that influence customers' satisfaction include the ability of vendors to implement cleanliness, which would influence the way tourists and customers perceive satisfaction. These parameters would be met fully if authorities continue to monitor the activities of the vendors to ensure that they are operating within the standard frame of work.

Microbial Load in Freshly Cut Street Fruits

Despite its health benefits, fresh fruit and vegetables can harbour a wide variety of microorganisms. Mahfuza et al. (2016) and Ogofure et al. (2017) used routine plate counts to determine the microbial densities in fruit samples (SPC). Vendor A had a mean microbiological load of 1.33 x 106 - 1.82 x 107 cfu/ml, Vendor B had a mean microbial load of 9.9 x 106 - 3.0 x 107 cfu/ml, and Vendor C had a mean microbial load of 9 x 105 - 3.0 x 107 cfu/ml. The researchers isolated nine germs from eight different families. Staphylococcus aureus (292 percent), Staphylococcus spp (12.5%), Klebsiella spp (12.5%), and Salmonella spp (12.5%) all followed in isolation frequency. It was found that the least common types of bacteria identified were actinomycetes (4.2%) and Escherichia coli (4.2%).

Five different vegetables had their microbial load measured, and the results were compared to those obtained before and after being exposed to varying concentrations of acetic acid (vinegar; 0.5–2.5%) for 0–10 minutes. Varying the vinegar dosage from 0.5 to 2.5% resulted in a 15-82% decrease in microbial burdens. Vegetables exposed to a 2.5% vinegar solution for 10

minutes had the fewest microorganisms. The results of the study indicated that there is a need to reawaken consumers' consciousness of the risks of eating pathogen-contaminated foods and the importance of insisting on properly processed/stored sliced vegetables (Mahfuza, et a. 2016; Ogofure et al., 2017).

As a result of its low price per serving, high availability, low preparation time, and several health benefits, sliced and ready-to-eat fruits have seen a significant increase in popularity in Ghana over the past few years (Aboloma, 2008). Rising rates of food poisoning have been linked to the widespread consumption of pre-cut fruits. Accraans love their sliced pawpaw, pineapple, watermelon, apple, and mango. Sliced and peeled fresh fruits are often offered by street vendors in small plastic bags for instant eating without further preparation or washing. The majority of street vendors are unregistered and lack proper training in food safety and sanitation (Abbott, 2012).

The health benefits of eating fruits every day are outweighed by the possibility of contracting an illness from eating them because of microbial contamination. The isolation of harmful bacterial species from a variety of produce further supports the hypothesis that contamination is a widespread problem in the produce industry (Mahale et al., 2008). A 2002 and 2006 Salmonella outbreak in the United States were traced back to watermelons, according to the Centres for Disease Control and Prevention (2006). Similarly, 63 confirmed incidents of food illness were linked to Brazilian watermelon that was imported to Europe in 2011. Watermelon slices sold by street sellers in Nigeria had an aerobic count of 0.1-2.3 105 CFU g1 on average, according to a study conducted to assess the fruit's microbiological quality. Carrot, runner bean, cucumber, fresh cut pineapple, green pepper, cabbage, spring

onions, lettuce, watermelon, and apple were all found to have between 9.0 105 and 3.0 107 CFU/ml of Staphylococcus aureus, Klebsiella sp., Salmonella sp., and Escherichia coli isolated from them in a separate study conducted in Nigeria. To wit: (Ugwu & Edeh, 2019).

Additionally, Escherichia coli (36%), Staphylococcus aureus (33%), Klebsiella sp. (17%), and Bacillus sp. (15%) were found to be prevalent in the raw-mixed vegetable salads studied by Halablab et al. (2010). Despite widespread knowledge of the risks associated with consuming contaminated produce, few data exist in Ghana about the microbiological safety of fruits and vegetables sold in polyethylene bags from street vendors.

As an additional note, human virus outbreaks linked to the eating of fresh or minimally processed fruits and vegetables have increased in recent years despite the fruits' nutritional and health benefits (Ugwu & Edeh, 2019; Halablab et al., 2010). During food-related pandemics, enteric pathogens like Escherichia coli and Salmonella are major causes for alarm. Vegetables produced in or treated with contaminated soil or sewage have been linked to several incidences of typhoid fever epidemic (Ugwu & Edeh, 2019). Since most individuals spend most of their time outside of the house, it's possible that the rise in infections traceable to eating tainted fruits and vegetables while away from home contributed to the problem. For example, in Nigeria, street vendors of pre-sliced fruits and vegetables have just become widespread, and the business is booming (Orji et al., 2016).

Pradnya and Patel (2008) also discovered bacteria on newly cut fruits, with watermelon and pawpaw having mean total aerobic plate counts of 2.6 105-8.1 105 CFU g-1 and 3.7 104-7.1 104 CFU g-1, respectively. Mean

coliform counts per grammes of pawpaw and watermelon were 1.2 x 103 and 8.1 x 103, respectively, while those of watermelon were 1.6 x 104 and 3.1 x 104. There was no statistically significant difference between suppliers and their competitors in terms of either aerobic bacteria or coliforms at a few distinct locations. However, Enterobacter species (33.3%), Citrobacter sp. (20.0%), and Klebsiella sp. (15.9%) were the most commonly isolated bacteria.

Research by Orji et al. (2016) aimed at comparing the efficacy of four different low-cost disinfectants (sterile water, salt water, blanched, and vinegar) in decontaminating 12 different types of fruit and 10 different types of vegetables in terms of total viable bacteria (TVBC), total coliform (TCC), faecal coliform (TFC), pathogenic Pseudomonas spp., and Staphylococcus aureus. TVBC in fruit samples ranged from the lowest (3.18 0.27 log CFU/g) in Indian gooseberry to the highest (6.47 0.68 log CFU/g) in guava. All fruit samples included bacteria, with the range being from 2.04 0.53 to 5.10 0.02 log CFU/g for Staphylococci, 1.88 0.03 to 3.38 0.08 log CFU/g for Pseudomonas, and 2.60 0.18 to 7.50 0.15 log CFU/g for total fungus; however, no Salmonella was observed. When compared to other treatments, vinegar was the most effective at reducing the microbial load of specific fruits and vegetables. Fruits showed a 1.61-log decrease in TVBC and a 2.54-log decrease in TF after being treated with vinegar, whereas vegetables showed a 2.31-log decrease in TVBC and a 2.41-log decrease in TF. Overall, the bacterial load of the fruit and vegetable samples was reduced by all disinfectant treatments compared to the control by a statistically significant amount (p 0.01).

People have been sickened after eating tainted fresh veggies (Pesewu et al., 2014). Exposure to fecally infected manure fertilisers, irrigation with fecally contaminated water, and/or ice washing during handling and shipping contaminate FFV, leading to outbreaks of foodborne illness (Yildiz & Adom, 2011). Researchers have found that many cases of food poisoning are caused by faecal coliform bacteria such Escherichia coli, Shigella spp., Pseudomonas spp., Salmonella spp., Listeria monocytogenes, and Clostridium botulinum. In recent years, pathogenic E. coli outbreaks have been traced back to people eating raw carrots, radish sprouts, lettuce, alfalfa sprouts, spinach, grapes, and berries (Olaimat & Holley, 2012).

Another study indicated that eating sprouts and Chinese cabbage increased one's risk of contracting E. coli O157:H7 in Japan and the Shiga toxin-related hemolytic uremic syndrome in Germany (Al-Kharousi et al., 2016). The average American eats 741 pounds of fresh fruits and vegetables each year, and this number has climbed by at least 25% over the past two decades. Salad vegetable consumption in Europe is growing by 10% annually on average. In addition, the intake of raw fruit and vegetables has been related to an increase in various global epidemics caused by food-borne diseases (Pradnya & Patel, 2008).

In Bangladesh, food-borne related epidemics are most commonly caused by enteropathogenic E. coli, enterotoxigenic E. coli, and Vibrio cholerae, all of which are commonly found in tainted fresh produce. More than a third of Bangladeshi children younger than five suffer from food-borne illnesses each year. Consequently, over the past two decades, there has been a rise in the number of cases of food poisoning in Bangladesh that are traced

back to eating fresh fruits. Frequent washing during post-harvest processing is effective in removing soil and debris, but not harmful bacteria, which can lead to contamination of other foods, cookware, utensils, etc (Adebayo-Tayo et al., 2012).

When it comes to assessing the rising risk that worries both monitoring authorities and food consumers, microbiological investigation is a crucial tool. Washing fresh fruits and vegetables with a disinfectant is crucial for lowering their germ burdens (Yeleliere et al., 2017). There are several methods for cleaning freshly cut produce that have been investigated. These methods include both physical and chemical treatments. The chlorinated solution is used to clean produce before it is eaten. As a liquid, chlorine is most common because of its inexpensive price and portability (Orji et al., 2016). Water with added organic acids, most likely acetic acid, citric acid, and sorbic acid, has also been demonstrated to decrease the microbial load on produce.

However, fresh-cut vegetables and fruits in Bangladesh seldom have microbial contamination reported (Chukwu et al., 2009). To the best of our knowledge, very little study has been done to evaluate the microbiological quality of fresh fruit and vegetables in Dhaka City, and even less has looked into the efficacy of low-cost disinfectants. The current study set out to do just that by quantifying the total viable bacterial load on fresh fruit and vegetables from Dhaka City, Bangladesh, and evaluating the efficacy of low-cost disinfectants in the decontamination of such foods (Prokopowich & Blank, 1991). Salmonella was discovered in watermelons in the United States by Adebolu and Ifesan (2001). Similarly, 63 confirmed cases of Salmonella food illness were linked to watermelon imported from Brazil and consumed in

Europe. Slicked watermelons from Nigerian street vendors have been found to have aerobic counts of between 0.1 and 2.3 105 CFU g1 on average, according to a study conducted to assess their microbiological quality (Beuchat, 1996).

Staphylococcus aureus, Klebsiella sp., Salmonella sp., and Escherichia coli were recovered from carrot, runner bean, cucumber, fresh cut pineapple, green pepper, cabbage, spring onions, lettuce, watermelon, and apple in ranges between 9.0 105 and 3.0 107 CFU/ml in another Nigerian investigation (Beuchat, 2002). In addition, researchers in the Accra Metropolitan Area found a significant prevalence of Escherichia coli (36%), Staphylococcus aureus (33%), Klebsiella sp. (17%), and Bacillus sp. (15%) in raw-mixed vegetable salads. Despite widespread knowledge of the risks associated with consuming contaminated produce, few data exist in Ghana about the microbiological safety of fruits and vegetables sold in polyethylene bags from street vendors. The purpose of this research was to analyse the microbiological quality of sliced pawpaw and watermelon supplied by street vendors in Accra that use polyethylene packaging.

In addition to being essential to human health, fruits are an exceptional nutritional source of minerals, micronutrients, vitamins, and fibre. Vitamin C and A deficiency, as well as the development of numerous diseases, may be avoided through the consumption of a well-balanced, fruit-rich diet (Barro et al., 2006). Contact with soil, dust, and water, as well as improper harvesting and post-harvest handling, are major sources of microbial contamination for fruits. As a result, they provide a home for a wide variety of microorganisms, including diseases (Barro et al., 2006). Fruits sold by hawkers or vendors at farmers' markets and other outdoor venues are often pre-sliced or peeled and

packaged for easy consumption straight from the vendor's wares (Buck et al., 2013).

Small polyethene bags are the standard retail packaging for them. Vended fruit consumption in Nigeria has increased dramatically in recent years. This is due to the fact that they are less expensive than whole fruits while still being convenient and readily available. Other causes include the hectic pace of modern life, the rise of industry, the recession, materialism, and a general lack of time to make a healthy, home-cooked dinner (Pradnya & Patel, 2008). The rising consumption rates and the potential health problems they may cause are a major cause for alarm.

Most of the time, it is hard to verify the cleanliness of the processing facilities or the processors. This is aggravated by the fact that vended fruits are done without suitable storage conditions, hence, exposing the fruits to flies, dust and other infections (Barro et al., 2006). Unlicensed vendors or local hawkers with little to no training in food hygiene sell fruits such watermelon, pineapple, carrots, cucumber, and tiger nuts (also called aki hausa) (Daniyan & Ajibo, 2011). This raises the danger of food poisoning from a variety of microorganisms, including Salmonella, Staphylococcus aureus, and Enterobacteriaceae (Prokopowich & Blank, 1991). Furthermore, these diseases may infiltrate the fruit when it is being processed, packaged, handled, or marketed (Barro et al., 2006).

Including fruit in your daily diet has been suggested due to the many health benefits they provide. However, proper sanitation measures are often overlooked during the fresh fruit harvesting and processing phases, which result in ready-to-eat or vending machine-ready versions of the fruit.

Pathogens have an easy time invading them as a result. Also, street vendors who lack proper training often place the fruits they sell on display or hawk them while using dirty or unclean equipment. Consumers are at serious danger from this. Consequently, some microbial assessments have been conducted to ascertain the safety of these vended fruits, making it necessary to capitalise on the results of some of these microbial assessments on vended fruits to educate consumers on the impact of their consumption and reduce risk by increasing the quality of these fruits. This will help reduce some health problems, illness outbreaks, and deaths (Amoah et al., 2019).

Vitamins, minerals, and other nutrients found in the earth are abundant in the foods we eat every day. There may be health benefits for the population as a whole when people eat fresh fruit and drink fruit juices (Abadias et al., 2008). A perfect diet rich in fruits and vegetables can lower the chance of developing certain chronic diseases. Well-balanced diet rich in fruits and vegetable should be taken to prevent vitamin deficiencies, establishing blood lipid profile and detoxification of human body (Adebolu & Ifesan, 2001). Eating sufficient number of vegetables, fruits and fruit juices also control blood pressure, lower the risk of heart illnesses, reduces blood cholesterol levels and avoid some kinds of cancer (Altekruse & Swerdlow, 1996).

Fruits and fruit juices sold by street sellers or hawkers are examples of "ready to eat" foods that customers can purchase and consume without first having to prepare the ingredients at home by cutting, peeling, or rinsing (FAO, 2004). Street food is the primary source of nutrition for the poor and middle class in developing countries. As entire fruits have increased in price, availability, and difficulty to transport, the use of fresh chopped fruits has

increased. Fresh cut fruits and vegetables, such as hog plum, cucumber, carrot, green mango, and pineapple, are commonly sold on the streets of Dhaka, the capital city of Bangladesh. Bacterial infections can enter these foods through punctures, wounds, and splits that occur while they are growing or being harvested (Abadias et al., 2008).

Total Viable Bacterial Count was evaluated using nutrient agar (DifcoTM, USA, PH 7.0-7.4) (TVBC). Preparation of the media followed the guidelines provided by the manufacturer. To recap, we autoclaved all of our medium at 121 degrees Celsius for 15 minutes to kill anything other than Salmonella and Shigella. Preparation of the Salmonella-Shigella agar required 15 minutes of boiling. Each sample was diluted appropriately, and then 100 l of the homogenate was pipetted into the appropriate culture medium and spread with a sterile glass spreader. The plates were inoculated, and then incubated in an incubator at 370C for 24 to 28 hours. Once the plates had been incubated, the number of colonies present on them could be recorded. TBC was calculated by multiplying the mean colony count by the dilution factor for a given concentration. Counts of microorganisms in fresh-cut produce and fruit juices were reported as cfu/g and cfu/ml, respectively (Amoah et al., 2009).

Same procedure was used to tally the number of total coliforms (TCC) in a sample cultured on MacConkey agar (Acumedia, USA) media. The TSS was determined by incubating Salmonella-shigella agar (Scharlau, Spain) at 370C for 24 to 28 hours. The cfu/g and cfu/ml values were calculated as the mean of at least three separate trials. The total coliform count (TCC) ranged from 1.0 x 103 to 4.9 x 102 cfu/g on average in fruit samples. The number of

TCC in pineapple was lowest (1.0x101 cfu/g), whereas the number in guava was highest (4.9x102 cfu/g). Contrary to what is recommended by the European Union Commission Regulation, TCC was found to be excessively high in this investigation (2005). The total coliform count (TCC) in pineapple was reported to be 2.0 x 105 cfu/g by Oranusi and Olorunfemi (2011).

TCC levels in salad greens ranged from 2.60102 to 6.60102 cfu/g. The number of TCCs was lowest in tomatoes (3.9 x 103 cfu/g) and highest in carrots (4.3 x 103 cfu/g). Salad veggies, such as tomato and cucumber, were found to be infected with total coliforms by Alam et al. (2013) when purchased from vegetable markets. All the juice samples had total coliform counts (TCCs) between 2.3 x 102 and 3.7 x 103 cfu/ml. Sugarcane juice had the lowest TCC (6.3x104 cfu/ml), while olot kombol juice had the highest TCC (1.4x105 cfu/ml). One of the major sources for presence of coliforms in street meals is the washing and processing water contaminated with faecal coliform. Adebolu and Ifesan (2001) found that sugarcane, lime, and carrot juice, as well as apple, orange, pineapple, pomegranate, sweet lemon, and mixed fruit juice, are consumed often in Mumbai, India.

Chapter Summary

The chapter had been able to review literature that outlines the boundaries of the study and gives insight into some concepts relevant to the study. The conceptual framework adopted by Woh thong Behnke and Lewis (2016) to show the relationship between the level of knowledge of street fruits vendors on food cleanliness and their fruit handling practices which could inform microbial load and its implications. Descriptive cross sectional study design, convenience sampling was also used (a sample size of 113, 30 cut fruit

samples of fifteen each of pawpaw and watermelon from ten (10) vendors from the 113 fruit vendors was also used for the laboratory analysis.). The concept of street food vending, total quality in food service, food safety hygiene, personal hygiene and microbial load in freshly cut street fruits were all looked at.

CHAPTER THREE

METHODOLOGY

Chapter Overview

This chapter seeks to examine and analyses microbial load in some selected cut street fruits and also presents the methods employed in conducting the study. The chapter captures the research approach, research design, study area, study population, sample and sampling techniques, data collection instruments, data collection procedure, ethical considerations and data processing and analysis.

Research Approach

This study employed the quantitative research approach to enable the researcher gather relevant numerical data to test, verify and examine the microbial load in some selected cut and vended fruits and the knowledge and practices of vendors on hygiene in the Tamale Metropolis. It is worth noting that the quantitative methodology emanates from the positivist philosophy or paradigm. According to Sekaran and Bougie (2016) the positivist paradigm anchors scientific investigation on the assumption that the world around us is real and that we can learn about it. The positivist researchers further hold the belief that research is used to uncover a reality that already exists.

Research Design

The study employed a descriptive cross sectional study design to examine microbial load of street cut fruits and also to assess the knowledge and practice of vendors of cut fruits on personal and food hygiene in the study setting. The study used this design because the data was gathered from the study participants on the study concept within a specific period of time. The

study considered the use of descriptive cross sectional study design because the design was practical to implement and it was relatively low cost compared to other designs (Creswell, 20s14) This is because the population had similar characteristics and data was collected at one point in time to inform the happening in that population. The design is useful in informing the researcher about the practices of respondents which could determine the microbial load in the cut fruits.

Study Area

The study was conducted in the Tamale Metropolis. The Tamale Metropolis is the capital of the Northern region of Ghana. The metropolis has a total estimated land size of 646.90180 square kilometres. Geographically, the metropolis lies between latitude 9º16 and 9º 34 North and longitudes 0º 36 and 0º 57 West (GSS, 2010). Tamale is strategically located in the Northern Region and by this strategic location, the metropolis has a market potential for local goods from the agricultural and commerce sectors from the other districts in the region (Ghana Statistical Service, 2010).

The businesses setting work strategic because of the people who travel to the location daily, a number of businesses, including street foods vending spring up every day. The occupation of persons in the metropolis includes service and sales work (33% of population), craft and trade related (21.5% of population), 17.5% of the population in agriculture and 8.1% of the population in professional engagement (Ghana Statistical Service, 2010). The study considered this study area because larger populations trope into the capital and observably, larger number of persons engage in the sale of freshly cut fruits. The fruits sold along the streets may have implications for public health in

terms of food safety. There are also a lot of fruits that are sold along the streets and the patronage is high though no one knows the safety of what is being patronized. The map below shows the area of the study area in the map of Ghana.

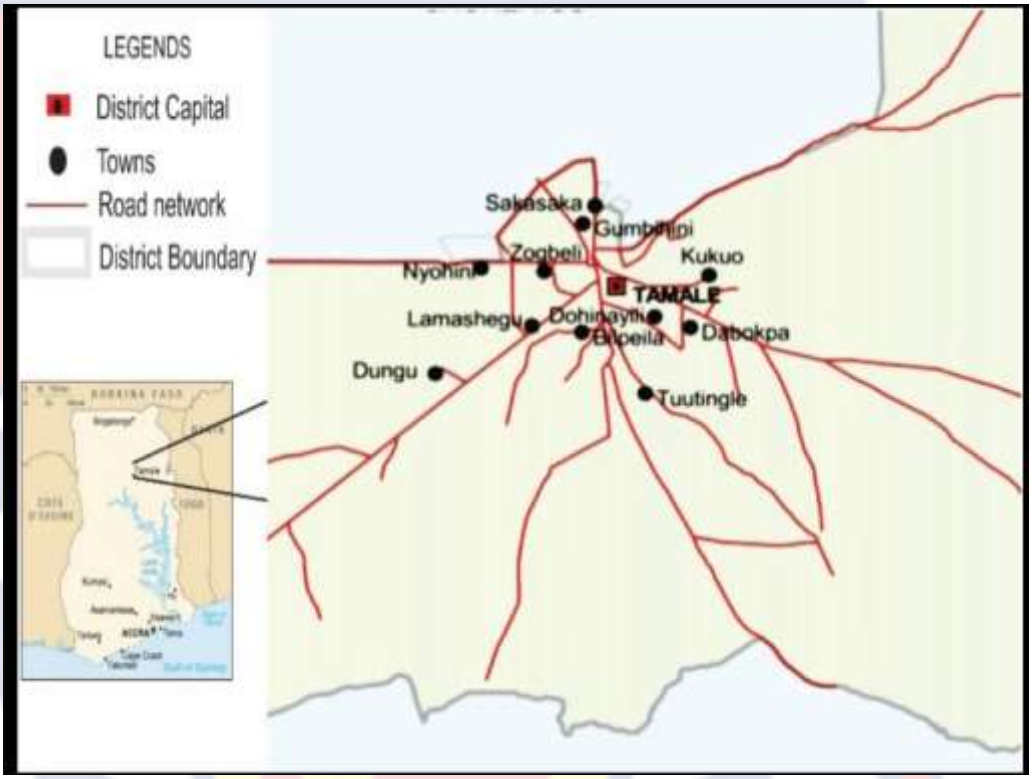

Figure 2: Map of Tamale metropolis
Source: Ghana Statistical Service, 2010

Population

The population consist of cut and vended pawpaw and water melon as well as street fruits vendors in Tamale Metropolis. The target population for the study was 158 fruit vendors in the Tamale township. The population captures vendors who sell water melons, oranges, pawpaw, pineapples, mangoes and apples. Information gathered from the Health Directorate of the Metropolis for fruit vendors is estimated to be 158. This number did not cover new vendors who would have started operations within the period.

Sample and Sampling Procedure

The sample involved one hundred and thirteen participants (113) sampled in the study setting using Yamane formula in determining sample size out of the estimated street fruits vendors population at the time of the study at 158. (Metro health Directorate)

$According\ to\ Yamane\ (1967)\ the\ sample\ size\ (n)$

$n = \frac{N}{1 + N(e)^2}.$

$where$,

N is the size of the population from which the sample was drawn

e is the level of precision. A 95% confidence level and P=0.5 was assumed for the equation.

The Sample size (n) was therefore

$n = \frac{158}{1 + 158(0.05)^2}$ = 113. Sample size needed for the data on personal and food hygiene knowledge therefore was 113. A non-probability method, convenience sampling, was used to select the 113 out of the estimated 158 fruits vendors. Out of this number 10 were again sampled using convenience sampling because I needed 10 vendors who sell cut pawpaw and water melon specifically as they were popular with consumers among the fruits that are cut and sold, according to accounts of the vendors in the Metropolis. Convenience sampling was used because the vendor needed to be available and willing to offer fruits samples for the laboratory analysis before being included. This was done until the number was obtained. In all 30 samples of fruits were taken within the period to ensure reliability.

Data Collection Instrument

Two instruments were used in the study for the data collection. The study employed the use of questionnaire and backed it with observation checklist for the data collection. The questionnaire was used to measure knowledge of street fruits vendors on food hygiene as well as their personal account of food hygiene practices. It was organized into three (3) sections (A, B, and C) according to the objectives of the study. Section A contained the background information of the respondents. Section B contained items on the knowledge of street fruits vendors on food hygiene and finally section C of the questionnaire was composed of questions on practices of food hygiene. The items in the questionnaire were structured in a way that enabled the respondents to tick alternative answers of their choice of responses or write where appropriate. For those who could not read and write, trained assistants read and interpreted the items for them to respond accordingly. The questionnaire had close-ended questions which were developed using a 'Yes' and 'No' response, and a four-point Likert-type scale ranging from 1=Strongly Disagree (SD), 2=Disagree (D), 3=Agree (A) and 4= Strongly Agree (SA). On this scale, the highest mean possible was 2.50 and the lowest mean possible was 1.00. The study employed the use of questionnaire to provide a means for collecting data whose analysis was to help answer the research questions one and two. It was also to help with information that would provide basis for discussing the laboratory test analysis to answer research question three. However, the use of the questionnaire made it very difficult for study participants to go outside the study variables. The study employed the

observation checklist to triangulate what information the vendors provided on their food hygiene practices.

The other data obtained was through the use of laboratory instruments, with the help of reagents. The specialized instruments did analysis that provided insight into the microbial load of the cut fruits. The instruments include stomacher (Lab Blender, Model 4001) water-bath, incubators and safety cabernet.

Reliability and validity of the questionnaire

The initial draft of instrument was subjected to face validation by experts, the supervisor, and peers. Consultations with the supervisor, other lecturers, and peers helped identify errors and offered the opportunity to modify and improve the instrument. To ensure that the items in the questionnaire fully represented the research questions, extensive literature review was done. The essence of validating the instrument was to ensure that it would elicit the information it was designed for. The relevance of the items to the purpose of the study was checked, clearly stated and confirmed to be capable of eliciting the right response from the respondents.

The pretesting was done to get firsthand information on the trends in the difficulty of questions expressed by respondents. The questions were then restructured and the necessary corrections made before the actual field work was carried out. To avoid false information during the actual field study participants used for the pre-test were different from those used for the actual study. Lessons learnt from the test study were used to make the necessary amendments to improve the reliability and validity of the study in general. The reliability of the instruments was determined using Cronbach's alpha

coefficients. According to Taber, (2018) Cronbach's a;pha coefficient of 0.71 – 0.91 is considered good.

Data Collection Procedure

Copies of the questionnaire were delivered to the respondents by the researcher or the research assistants. Periods of 20 minutes was given to each respondent to complete the questionnaire and where the respondent needed clarification, the researcher come in to assist. The researcher made time for translating each item in the local language and helped fill the questionnaire with the information the respondents that could not read and/or write provided. In total 113 questionnaires were administered. The observation checklist used to check actual practice of 113 vendors was filled by the researcher as she observed the practices of the fruit vendors during data collection. With the consent of street fruits vendors, 30 samples of freshly cut fruits were conveniently purchased from fruits vendors within the Tamale Metropolis over the days.

Collection of Samples

A total of thirty (30) samples of freshly cut fruits were conveniently purchased from fruits vendors within the Tamale Metropolis. The samples of fruits were wrapped in sterile ziplock polythene bags and labelled for identification according to the fruit, area and the vendor. They were immediately frozen, and finally transported to Food and Research Institute in ice chest for laboratory analysis after the total sample was collected. This is because, it is a standard laboratory that will give reliable results.

Sample preparation

For all samples, (pawpaw and water melon) 10 g were homogenized in 90 ml sterile diluent (0.1% peptone, 0.8% NaCl, pH 7.2) in a stomacher (Lab Blender, Model 4001, Seward Medical, London, England) for 30s at normal speed. From appropriate ten-fold dilutions, *Aerobic mesophiles* were enumerated by pour plate on Plate Count Agar (Oxoid CM438 Oxoid Ltd., Basingstoke, Hampshire, UK), incubated at 30^0C for 72 h according to NMKL No. 86 (2011).

E. coli were enumerated by pour plate on Tryptone Soy Agar (Oxoid CM126), pH 7.3 overlaid with Violet Red Bile Agar (Oxoid CM118), pH 7.4 and incubated at 44^0C for 24 h. suspected *E. coli* colonies were sub-cultured on EC Broth (Oxoid CM853), pH 6.9, followed by Tryptone Water (Oxoid CM89), pH 7.5, all incubated at 44^0C for 24 h according to NMKL. No. 125 (2005).

Staphylococcus aureus was determined by spread plate on Bairde Parker Agar (BP, CM 275 Oxoid Ltd, Hampshire, England) with Egg Yolk Tellurite Emulsion (SR75) added and Blood Agar Base (BAB, CM 55 Oxoid Ltd, Hampshire, England). Both media were incubated at 37^0C for 48 h. S. aureus counts were confirmed by biochemical tests according to NMKL Method No. 66 (2009).

Salmonella spp. was determined by weighing 25 g of a sample and re-suspended using 225 mL Buffered Peptone Water (BPW, Condalab CAT) pH 7.4 and incubated at 37^0C (Lab Incubator, Model NE8-240S, England) for 24 h. After pre-enrichment in BPW, (Condalab CAT) 0.1 mL portions were transferred into 10 mL Rappaport and Vassiliadis broth (RV, Condalab CAT)

pH 7.2 and incubated at 41.9^{0}C (Lab Incubator, Model) for 24 hrs. After enrichment in RV, loop full of the culture was streak-plated on Xylose Lysine Deoxycholate (XLD, Condalab CAT)), pH 7.2 and incubated at 37^{0}C (Model NE8-240S) for 24h. Well isolated colonies giving typical reactions were considered as presumptive *Salmonella* were purified by streaking onto nutrient agar plates (Condalab CAT) and confirmed according to NMKL Method No.71 (1999).

From each cut fruit sample, 25-g was aseptically transferred into a stomacher bag with 225 ml of *Listeria* primary enrichment broth (UVM I, CM 863 - SR 142E, Oxoid). Samples were homogenized for 2 min at normal speed with a Seward laboratory stomacher and then incubated at 30^{0}C for 24 or 48 hrs. Samples (0.1 ml) of the UVM I broth were also transferred into a secondary selective enrichment medium (10 ml of UVM II, CM 863 _ SR 142E, Oxoid). After 24 hrs of incubation at 30 ^{0}C, 0.1-ml samples of this secondary enrichment were plated onto Oxford *Listeria* selective agar (LSA; CM 856 _ SR 206E, Oxoid) and polymyxin–acriflavin–lithium chloride–ceftazidime–aesculin–mannitol agar (PALCAM, CM 877_ SR 150E, Oxoid). Typical small brown-black colonies with sunken black centres and halos on Oxford LSA and gray-green colonies with sunken black centres and black halos on PALCAM agar were selected and confirmed according to ISO 1129O-2 (2017).

Ethical considerations

Ethical considerations were duly followed before the data collection. The researcher sought approval from the Institutional Review Board of the University of Cape Coast before going to the field for data collection. This

ensured that the research work did not violate any legislation or the rights of any group of persons or bodies. Also, the researcher obtained an introductory letter from the Department of Vocational and Technical Education of the University of Cape Coast to serve as evidence that the research is purely for academic purpose. The purpose of the study was explained to the respondents and their anonymity and confidentiality were protected in the instrument by not asking for any personal identity such as names and contacts. Finally, the respondents were not coerced to be part of the study, and also had the free will to withdraw at any point they felt like doing so. Finally, samples collected were tagged with codes and not names.

Data Processing and Analysis

The data collected was edited, coded and keyed into Statistical Package for Social Sciences (SPSS) Version 22 statistical software for processing. The data collected from the two sources were analyzed using descriptive statistics (frequency, percentages, means and standard deviation). Microsoft Excel 2010 was used to generate means and standard deviations for the microbial load for each of the samples taken from each the ten venders. In cases where bacterial levels were below the detectable limit, a value of zero was assigned for statistical analysis. Significant differences between means were calculated using one-way Analysis of Variance (ANOVA). A p-value ≤ 0.05 was considered as significant.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

Introduction

The study was conducted to assess the microbial load in cut- street fruits and to make inferences from practices of vendors and the implications on food safety within the Tamale Metropolis. The study was guided by the following research questions: What is the knowledge level of street vendors on food hygiene. What are the practices of street fruits vendors during fruits storage and selling? What is the microbial load of freshly cut street fruits in the Tamale Metropolis? What are the health implications of microbial load found in sample cut fruits in the Tamale Metropolis? The study employed a descriptive cross sectional study design to assess the knowledge on food safety and practice of the food vendors, and used laboratory analysis to determine the microbial load of cut fruits among street fruits vendors and its implications in the study setting.

The population included street food vendors in the Tamale Metropolis who were available at the time of the study, who were 18 years or more and were willing to take part in the study at the time. The sample involved one hundred and thirteen study participants (113) sampled in the study setting. Questionnaire and observation guide were used to gather data on the knowledge level of the vendors on food safety and its practice. The study achieved a 100% response rate. Again, samples of cut fruits were collected for laboratory tests which were conducted to assess the microbial load of the samples. Fifty samples each of cut watermelon and pawpaw were used to assess the microbial load. Ethical considerations were duly followed before

and during the data collection. The data was analysed using descriptive statistics (means, standard deviation, frequencies and percentages).

The information presented in this chapter is based on the data gathered from the field. The presentation of the findings was done based on sub headings which would provide answers for the research questions. The first part presented the demographic data of the respondents whilst the rest of the sections presented the results on the various research questions of the study.

Demographic characteristics of respondents

This section presents the demographic data gathered and includes the age of respondents, sex of respondents, educational categories of respondents, religious categories of respondents, and duration of business engagement. Data for each variable is presented under the variable category.

Table 1: Demographic data of respondents

Variable	Frequency (113)	Percent (%)
Age		
18-28	38	33.6
29-38	20	17.7
39-48	20	17.7
35+	35	31.0
Sex		
Male	5	4.4
Female	108	95.6
Education		
No formal education	65	57.5
Certificate	40	35.4
Diploma	8	7.1
Religion		
Christianity	24	21.2
Islam	89	78.8
Duration of selling fruits		
1-2	34	30.1
3-4	24	21.2
5-6	25	22.2
6+	30	26.5

Source: Field survey, (2022)

From the findings in Table 1, 31% of the respondents representing were aged above 35+ years at the time of the study whilst 33.6% respondents were aged between 18-28 years. Findings further showed that, majority of the respondents representing 95.6% were females. Finding the sex factor in the study was to help to check if there were any differences in the practices of males and females hence enhancing the validity of the study findings. It also came up that, 57.5% of the respondents had no formal education at the time of the study and 7.1% of the respondents said that, they had diploma certificate. Assessing the educational factor of the study participants was to help in knowing if education had any connection with the knowledge of vendors on food hygiene and safety. It was further revealed that, about 78.8% of the respondents were Muslims. The finding was that, most of the respondents representing 30.1% had been engaged in selling fruits for between 1-2 years.

Knowledge level of street vendors on fruits and personal hygiene, pathogens transmission, and symptoms of fruit borne diseases

The study assessed the knowledge level of street vendors on food hygiene and its practice. Tables 2, 3 and 4 present the findings on what respondents know about the best way to maintain food and personal hygiene in the handling of food, as well as some effects of poor hygiene practices. This was to check if they practice what they know or just do what is convenient for them.

Table 2: Respondents knowledge on fruit safety and personal hygiene

Statement	Mean	SD
Always wash hands after coughing or sneezing	2.72	0.99
It is not enough just by washing hands under running water to remove bacteria before touching fruit	1.90	1.37
Exposing hair to fruit can cause fruit-borne disease	1.63	0.67
Avoid bare hand contact with ready to eat fruits	2.02	1.05
The best way to avoid fruit poisoning is to wash them under running water.	2.00	1.04
Always store fruits in the fridge/ basket/tray before cutting.	1.20	0.40
Packaged cut fruits should be carried on trays /transparent plastic containers for hawking	3.00	1.16
Cover the cut fruits whiles selling.	2.56	1.08
Sell the cut fruits roaming under the sun.	3.06	0.69
Overall, Knowledge level	**2.23**	**0.94**

1= Very Low, 2= Low, 3= High, 4=Very High
Source: Field survey, (2022)

In Table 2, the overall knowledge of vendors on fruit safety and personal hygiene among the respondents is low with a (M= 2.23, SD= 0.94). Respondents however have high knowledge in promoting food safety and personal hygiene when sell cut fruit while roaming with (M=3.06, SD=0.69) and knowledge of packaging cut fruits in plastic containers for hawking (M=3.00, SD= 1.16). All other aspects of knowledge and food safety measurement revealed either a low or very low level.

Table 3: Respondents knowledge on fruit borne pathogens transmission

Statements	Mean	SD
consumers can complain of sickness after the consumption of cut street fruits	2.72	0.99
I know the type of illness people complain of after eating contaminated fruits	2.06	1.00
I know bacteria can be transmitted through reused gloves	3.12	1.00
I know bacteria can be transmitted when buyers touch cut fruits	1.20	0.40
I know bacteria can be transmitted when I talk over fruits during processing	2.06	1.00
Overall, Knowledge of Pathogens transmissions	**2.23**	**0.88**

1= Very Low, 2= Low, 3= High, 4=Very High
Source: Field survey, (2022)

Table 3 presents the knowledge level of respondents on fruit borne pathogens and their transmission. The overall knowledge level of respondents is low with (M=2.23, SD=0.88). Although respondents had high knowledge that germs can be transmitted through reused gloves with (M=3.12, SD=1.00), the findings of the study reveal a very low-level knowledge of respondents about transmission of germs or pathogens by buyers touching cut fruits (M=1.20, SD=0.40). The findings indicate that vendors do not control the rate at which their customers touch their vended fruits and since an eye detection cannot be made to know which customer carries pathogens or not, this lower knowledge is an open window to pathogen spread.

Table 4: Knowledge on symptoms related to fruit borne diseases

Statement	Mean	SD
I know stomach pain is a symptom of fruit-borne disease	2.72	0.99
I Know diarrhoea is a symptom of fruit-borne disease	2.04	1.00
I know vomiting is a symptom of fruit-borne disease	3.10	1.00
I know fever is a symptom of fruit-borne disease	1.20	0.40
I know skin rashes is a symptom of fruit-borne disease	1.53	0.50
I know seizure is a symptom of fruit-borne disease	1.20	0.40
Overall knowledge on symptoms related to fruit borne diseases	**1.97**	**0.72**

1= Very Low, 2= Low, 3= High, 4=Very High
Source: Field survey, (2022)

Table 4 presents the knowledge on symptoms related to fruit borne diseases. The overall knowledge level of respondents was very low (M=1.97, SD=0.72). Respondents had high knowledge level in relation to vomiting as a symptom of fruit borne diseases (M=3.10, SD=1.00). Other symptoms as measured either showed a low or very low knowledge level.

Since vending fruits in our part of the world is largely an income generating activity, and consumers mostly do not consider the conditions under which cut fruits are processed and served before patronizing, the vendors do not pay much attention to the nutrient preservation and safety of the food served. Notwithstanding the benefits we get from fruits, if not handled well, could be contaminated. Knowledge is a powerful tool that informs practice. It was with this conception that the researcher tried to find out about the knowledge of vendors on food safety and personal hygiene.

From the data presented on knowledge of respondents on street fruit safety and personal hygiene, the findings indicate that the knowledge level of respondents is low. The implication of this finding is that since their

knowledge level is low, their practice of fruit safety and personal hygiene is little. This finding from the study agrees with Odonkor et al. (2011) where it was found that, food vendors in developing countries, including fruit sellers, observed little hygienic practices to safeguard contamination. Sneezing has the potential to spread microbes through the droplets. For this reason, conscious efforts have to be made to prevent such contamination. The implications of the findings to safety practice are that, respondents did very little to protect the consumers from any related health issues in terms food hygiene due to their practices. When respondents said they sneeze without any proper barrier, it simply meant that they did not see the need to ensure the safety of the fruits they offer to consumers who come to buy, by their inadequate knowledge and ignorant practice. This therefore suggests that, respondents' ignorance on personal and food hygiene could be a potential source of contamination of what they sell to consumers.

Polythene bags which were the commonly used packages for the sliced fruits are waterproof and chemically resistant. However, the sliced pawpaw and watermelon were still contaminated. Bacteria found in the polythene packaged sliced pawpaw and watermelon could also have been introduced from exposure of sliced watermelon to contaminated environments before they were processed and packaged. Therefore, there is an unmet need for proper treatment to reduce microbial contamination from the fruit samples. Washing is an important step for the decontamination of microbes of any fresh fruits and vegetables in postharvest processing. The use of running tap water to clean fruits samples before consumption is a traditional method that has been used for centuries. However, washing fruits using tap water can cause cross-

contamination, as the safety of the source and its wholesomeness cannot be ascertained. Though it could reduce microbial load, it does not play a significant role in microbial reduction. Results from the present study leads to the significance of using decontaminating agents when washing fresh produce such as fruits and vegetables. In a study, among the different treatments, vinegar showed the highest microbial load reduction of tested fruits and salad vegetables, whereas washing with sterile water showed the lowest microbial reduction. (Rahman et al., 2021).

Additionally, the study found that, majority of the participants indicated they cut a lot of the fruits before packaging, and never covered the cut fruits whilst processing before selling. This means that, dust and flies were more likely to settle on these fruits before being sold to consumers. Exposing fruits to the environment could potentially make it get contaminated by microbes through the particles, flies and droplets likely to come from humans around the processing environment. This needs to be prevented to help reduce the menace it may likely cause to consumers. This finding from the study agrees with Makwande and Moyo (2013) who found that, dust was found to be settling on foods because the foods were not covered at the time of the processing and sometimes during sales.

Practices of street vendors during fruits processing, storage and selling,

The study asked for personal account of practices of respondents during fruits processing, storage and selling. It was also to determine if these have any connection with the load of microbes that may be present in the cut fruits, upon assessment. The findings are illustrated in Table 5.

Table 5: Fruit handling practices of respondents

Statement	Yes		No	
	N	%	N	%
I wear apron during fruit preparation and processing.	0	0	113	100
I wash my hands with warm running water without soap before preparing the fruit.	0	0	113	100
I wash my hands using soap and cold running water before preparing the fruit.	83	73.5	30	26.5
I wash my hands using soap and warm running water before preparing the fruits.	84	74.3	29	25.7
I go for medical health check yearly	0	0	113	100
I have undergone anti-typhoid injection.	83	73.5	30	26.5
I bath before vending fruits.	0	0	113	100
I bath after vending fruits.	83	73.5	30	26.5
I keep long and colored fingernail.	0	0	113	100
I keep strong perfume and make-ups during peeling of fruits.	78	69	35	31
I peel so much fruits at a time before packaging for sale.	113	100	0	0
I sell the unsold processed fruits the next day.	83	73.5	30	26.5
I do not wear glove during cutting of fresh fruits.	113	100	0	0
I do not clean the storage containers before packaging.	0	0	113	100
I wear gloves during cutting of fresh fruits.	0	0	113	100
I reuse gloves for processing fruits always.	0	0	113	100

Source: Field survey, (2022)

Table 5 presents results on the fruit handling practices among respondents. The results show that all respondents behaved commonly in terms of some practices in fruit handling and processing. All respondents indicated they did not practice the following; wearing aprons during processing and preparation of fruits, washing of hands in warm water without soap, going for medical check yearly, bathing before vending, keeping long and coloured finger nails, not cleaning storage container before packaging, wearing gloves during cutting of fresh fruits and reusing gloves for processing of fruits. While some of the practices they did not practice are commendable like; not keeping long and coloured fingernails, not washing containers and

not reusing gloves, some of the other practices vendors did not do were largely hygiene related practices that could improve fruit safety.

On the other hand, all respondents affirmed that they peel so much fruits at a time before packaging. This practice although is adopted by vendors to help them serve their market, it provides grounds for the infestation and spread of pathogens. On other practices such as using strong perfume and make-ups during peeling of fruits, selling the unsold processed fruits the next day, going for anti-typhoid injection, and washing of hand in running water with or without soap, majority of respondents practiced them while few vendors did not practice them.

Observed practices of Respondents

A checklist was used to determine the actual personal and food hygiene practices either being used by the respondents or not. Various personal and food hygiene practices were listed and observer was to check 'Yes' or 'No' depending on what is observed. This was to determine whether information given by respondents correspond with what they actually do, and to confirm the section C of the questionnaire. The practices observed are presented in Table 6.

Table 6: Fruits handling and personal hygiene practices observed

Statement	Yes		No	
	N	%	N	%
Vendor is wearing apron to prepare fruits.	5	4.4	108	95.6
Vendor washes hands with warm running water without soap before preparing the fruits.	0	0	113	100
Vendor washes hands with warm running water with soap before preparing the fruits.	0	0	113	100
Vendor washes hands with cold running water with soap before preparing the fruit.	40	35.4	73	64.6
Vendor has a clean outlook or appears clean.	78	69.0	35	31
Vendor's nails are long and colored.	0	0	113	100
Vendor smells of perfume.	78	69	35	31
Vendor has put on make ups.	69	61.1	44	38.9
Vendor has peeled so much at a time before packaging.	87	77	26	23.0
Vendor's storage container is clean.	90	79.6	23	20.4
Vendor used gloves during cutting of fruits.	0	0	113	100
Vendor is wearing face mask.	0	0	113	100
Vendor Allows buyers to touch fruits before picking.	70	61.9	43	38.1

Source: Field survey, (2022)

The findings in Table 6 are that, majority of the respondents 108 (95.6%) were not wearing apron to prepare fruits in the study setting. The study found that, all the respondents observed did not wash their hands with warm running water with soap before preparing the fruits. The findings further found that, majority of the respondents observed 78 (69.0%) appeared clean whilst selling fruits. The findings further found that, all the respondents observed did not wear long and colored nails at the time of the study. However, it was observed that majority of the respondents had strong

perfumes on, and a number of the respondents (38.9%) had put on make-ups whilst selling the fruits.

Additionally, the study found that, majority of the respondents representing, 77% had peeled so much fruits at a time before packaging into polythene bags. The findings further showed that, majority of the respondents, (79.6%) had clean storage containers. Based on the observation, all the participants did not have face mask and also did not use gloves during cutting of fruits though there was a prevalence of global pandemic COVID 19 at the time. The findings further found that, majority of the respondents representing 61.9% allowed buyers wanting to touch fruits to do so before picking or buying.

Practices of street food vendors during fruits processing, storage and selling,

The study examined the practices of participants during food processing, storage and selling. The findings showed that, majority of the respondents did not wear apron during fruit, processing and selling, at the time of the study. This finding from the study agrees with Odonkor et al. (2011) where it was found that study participants were not wearing aprons at the time of the study. The finding from the study of Osei-boateng (2012) is rather on the contrary as it was found that, food vendors in Ghana wore aprons to cover themselves always before serving customers. These may be due to the different settings used for the two studies, and the way the regulatory bodies within the settings also ensure vendors adhere to sanitary practices all the time. The use of aprons is ideal since that could serve as a barrier in preventing cross contamination. This means that study participants were not

providing adequate preventive measures that could safeguard the fruits they offer from microbes.

Similarly, Tango et al. (2018) used whole apple and tomato fruits with inoculated and un-inoculated cocktail strains of *E. coli O157:H7* and *Listeria monocytogenes*. Inoculated fruits were washed first with distilled water for 3 min and there was <1 log 10 reduction of inoculated fruits surface bacteria, which is similar to results of this study. It has also been reported that blanching as a physical method can eliminate microbes from the surface of FFVs, owing to the thermal effect, resulting in the inactivation of enzymes. Interestingly, with the help of chlorine-based solution treatment, the pathogenic bacteria introduced on tomatoes were reduced by more than 3.0 log (FSAI, 2016).

Again, a previous study by FSAI, (2016) showed that washing with chlorine solution could effectively reduce microbial populations by 10-100-fold. It has been reported that the efficacy of the decontaminating agents was highly influenced by the suitable concentration of chlorine. Losio et al., (2015) observed the naturally contaminated fruits by the bacterial population were reduced 1–2 log CFU/g with the sanitizer or decontaminating agents. Microbial load reduction was observed in fruits and vegetables washed in a vinegar solution. Organic acids, especially vinegar (acetic acid), generally recognized as safe by the FDA and European Commission, are being well accepted by consumers as antimicrobial agents that are also considered to have great potential to control a wide range of microorganisms. All these low-cost disinfectants are the emerging eco-friendly techniques for preserving the

quality and safety of fresh food products which could be adopted by vendors in this study.

Tango et al., (2018) reported high incidence of *Staphylococcus aureus* in assessment of the microbial safety of polythene packaged sliced fruits sold in Abeokuta, Ogun state. This affirmed the current study. Such high occurrence may have occurred as a result of the exposure of these ready-to-eat fruits to dusty or muddy areas. Most of these fruit vendors sell near gutters that are silted and contain stagnant water, which may serve as an entry for fruit contamination. This result was in line with the study by Abadias et al. (2012) who reported high microbial load on leafy vegetables and fruits in Nigeria. When these processed fruits are stored at inappropriate temperatures, they tend to attain conditions that are suitable for the microbial growth of these pathogens which have the potential of causing diseases when ingested.

The isolation of *Escherichia coli*, *Staphylococcus aureus* and *Listeria monocytogenes* in the present study was in line with the work by Daniyan and Ajibo, (2011) on sliced fresh fruits sold in Minna and Bida metropolis. *Escherichia coli* is regarded as primary indicator for microbiological quality of food and water. The outcome of this study's laboratory analysis however indicates that almost all the samples did not have *E. coli* detected except one. This was a good sign as the presence would have indicated that these fruits were not fully safe for human consumption. The main transmission of *Escherichia coli* is through faecal contaminated food or water (Harvey,2016). Some of these fruit vendors get their water from unclean sources like dirty streams. They may also use very little quantity of water to wash or rinse all the

fruits, or use same collection of water throughout the day. This can be a source of cross contamination.

Again, these ready-to-eat fruits may get contaminated from knives used for cutting or slicing, improper human handling and processing, tables or trays used during peeling and cutting, washing bowls or buckets and packaging materials, as these fruits are washed, cut and packaged with transparent polythene bags and sold to the consumers. *Salmonella* was also not detected in any of the samples collected from the vendors over the day. The fruits can therefore be said to be free from the *salmonella* contaminants, which make the fruits safe for consumption. However, the presence of the other pathogens in the analysed fruit samples should be of great concern to the vendors, consumers and health and food safety regulatory bodies.

Additionally, the current study found that, majority of the respondents indicated that they did not wash their hands with warm running water with soap before preparing the fruits. This finding was in agreement with the study done by Eni et al. (2010) who reported similar observation. Where these fruits are processed and sold lack the facilities that would enable the vendors use warm running water as a matter of fact, but using clean water with soap and frequently changing the rinse water could serve a better purpose in sanitation by inactivating any microbes present.

Similarly, the current study found that participants allowed consumers who wish to touch packaged fruits before picking them do so before buying. This means that participants were not adhering to standard hygienic practices. This finding from the study agrees with Makwande and Moyo (2013) who observed that their participants did not adhere to standard practices. Different

people may carry different microbes depending on the level of personal sanitary practices they undergo. Touching packages could mean depositing microbes and this could be picked by subsequent buyers before the package is opened. There is even more danger of ingestion if the consumers use their hands in picking the fruits from the packages to eat.

Most of the isolates in the current study, could have been introduced into these fruits through faecal polluted water used in washing utensils and tools like knives, trays and polythene bags used for the packaging of the fruits after slicing or cutting, and also exposure of these fruits to temperatures which encourage the microbial growth of these pathogens (Mahfuza et al., 2016). The presence of *Staphylococcus aureus* and *Escherichia coli* was in line with the work of Alamo-Tonelada et al., (2018) on pre-cut fruits sold in Ilorin. *Staphylococcus aureus*, and *Escherichia coli* are environmental isolates and they have been isolated from plants, human skin, animal, land and dairy products. Their presence in these ready-to-eat fruits may have been through unclean hands of the vendors, contact with sewage contaminated water (Ababio & Lovatt, 2015) and unclean hands of buyers who touch the packages before choosing to buy.

This implies that the fruit samples could serve as a vehicle in the transmission of these pathogens to the consumers of these contaminated fruits. The presence of *Staphylococcus aureus* may have been introduced into the ready-to-eat fruits through body contact of vendors with the fruits and even some clients who touch before picking, because the organism is a normal flora of the nasal passage, hands and skins of healthy individuals (Azanza et al., 2000). Boateng (2014) reported *Staphylococcus aureus* to be the highest

occurrence in fruits and other foods respectively. Slavin et al. (2012) have also reported that the incidence of *Staphylococcus aureus* in food is an indication of environmental and human contamination. This high incidence may have also occurred due to the use of contaminated polythene bags for the packaging of these fruits after slicing or cutting them. (Buted & Ylagan, 2014) Studies carried out by Paola, and Allan (2010) revealed that, street food vending in various parts of the world particularly in developing countries where epileptic water supply is usually observed reported wash water reuse.

Microbial Load in Sampled Freshly Cut Street Fruits

The study collected data through laboratory analysis of fruit samples taken from participants to examine the microbial load of five pathogens isolated in freshly cut street fruits in the Tamale Metropolis. This was to determine the connection of respondents' practices with possible microbial load of the fruits examined. Thirty (30) samples in total of cut pawpaw and watermelon samples from different vendors collected at different locations and at different times of the day were analysed at the laboratory, and the findings are presented in Tables 7, 8 and 9.

Table 7: Microbial population in CFUg-1 in freshly cut street fruits samples from respondents in the morning

Fruits Samples	*Aerobic Mesophiles*	*E.Coli*	*Staphylococus Aureus*	*Salmonella Spp*	*Listeria Monocytoge*
TUS_{1W}	3.56±02	0	2.85±00^{d}	ND	Detected
TUS2W	4.75±02^{ab}	0	3.67±01^{a}	ND	Detected
TCM_{3W}	4.52±02^{b}	0	3.66±01^{a}	ND	Detected
TCM_{4P}	4.54±02^{b}	0	3.25±01^{bc}	ND	ND
TCM_{5P}	3.98±01^{bc}	0	0	ND	Detected
TCM_{6P}	3.99±06^{bc}	0	3.22±02^{c}	ND	Detected
$HACK_{7P}$	5.41±02^{a}	0	0	ND	ND
$HACK_{8W}$	5.43±06^{a}	3.66±0	3.49±02^{ab}	ND	Detected
$HACK_{9P}$	3.52±02^{c}	0	0	ND	Detected
$HACK_{10W}$	4.64±02^{ab}	0	2.66±01^{d}	ND	ND

NOTE: TUS= Tamale Hospital Road, TCM= Tamale Central Market, HACK= Hawkers along Agric road to Choggu. The numbers 1-10 represent the vendors while W and P are watermelon and Pawpaw respectively.
ND= not detected. Means that do not share a letter are significantly different.
Source: Field survey, (2022)

The mean bacterial count obtained from the freshly cut fruits samples at zero hour from ten vendors are presented in Table 7. Aerobic mesophilic count ranged from 3.52 to 5.43log $CFUg^{-1}$ in samples collected from the ten different vendors. However, there were significant ($p < 0.05$) variation in aerobic mesophilic count among the vendors. Highest *aerobic mesophilic* count was recorded from vendor HACK7P while the lowest was Vendor HACK9P. *E. coli* was only detected in the freshly cut fruit sampled from HACK8W out of the ten different vendors. HACK8W had microbial population of 3.66 log $CFUg^{1}$.There were significant ($p < 0.05$) difference in *Staphylococcus aureus* counts among the vendors. *Staphylococcus aureus* counts ranged from 2.6 to 3.6logCFU/g. With regard to *Salmonella,* it was not detected in any of the freshly cut fruits samples from any of the ten different

vendors over the day. *Listeria monocytogenes* was detected in seven out of ten different vendors; Vendor TUS1W (Detected), Vendor TUS2W (Detected), Vendor TCM3W (Detected), Vendor TCM5 (Detected), Vendor TCM6P (Detected) Vendor, HACK8W (Detected) and Vendor HACK9P (Detected).

Table 8: Microbial population in CFUg-1 in freshly cut street fruits samples from respondents in the afternoon

Fruits Samples	*Aerobic Mesophiles*	*E. Coli*	*Staphylococcus Aureus*	*Salmonella Spp*	*Listeria Monocytogenes*
TUS_{1W}	4.41 ± 01^{e}	0	2.91 ± 01^{g}	ND	Detected
TUS2W	5.80 ± 01^{bc}	0	3.82 ± 01^{e}	ND	Detected
TCM_{3W}	5.56 ± 01^{cd}	0	4.73 ± 01^{a}	ND	Detected
TCM_{4P}	5.32 ± 01^{cd}	0	3.62 ± 01^{f}	ND	ND
TCM_{5P}	5.20 ± 01^{d}	0	0	ND	Detected
TCM_{6P}	6.37 ± 01^{ab}	0	4.24 ± 02^{d}	ND	Detected
$HACK_{7P}$	6.36 ± 05^{ab}	0	0	ND	ND
$HACK_{8W}$	6.38 ± 00^{ab}	4.81	4.591 ± 02^{b}	ND	Detected
$HACK_{9PW}$	6.59 ± 02^{a}	0	0	ND	Detected
$HACK_{10}$	6.65 ± 04^{a}	0	4.301 ± 00^{c}	ND	ND

NOTE: NOTE: TUS= Tamale Hospital Road, TCM= Tamale Central Market, HACK= Hawkers along Agric road to Choggu. The numbers 1-10 represent the vendors while **W** and **P** are watermelon and Pawpaw respectively.
ND= not detected. Means that do not share a letter are significantly different.
Source: Field survey, (2022)

Aerobic mesophilic count at four hours ranged from 4.41 to 6.65log $CFUg^{-1}$ in samples collected from the ten different vendors. However, there were significant ($p < 0.05$) variation in aerobic mesophilic count among the vendors. Aerobic mesophilic count was 1 log units higher than the concentrations recorded on the corresponding vendors. *E. coli* was only detected in the freshly cut fruit sampled from HACK8W out of the ten different vendors. HACK8W had microbial population of 4.81log $CFUg^{1}$. *E.*

coli count was 1 log units higher than the concentrations recorded on the corresponding vendors. There were significant ($p < 0.05$) difference in *Staphylococcus aureus* counts among the vendors. *Staphylococcus aureus* counts ranged from 2.9 to 4.7logCFU/g. With regard to *Salmonella*, it was not detected in any of the freshly cut fruits samples from any of the ten different vendors. Listeria monocytogenes was detected in seven out of ten different vendors Vendor TUS1W (Detected), Vendor TUS2W (Detected), Vendor TCM3W (Detected), Vendor TCM5P (Detected), Vendor TCM6P (Detected) Vendor HACK8W (Detected) and Vendor HACK9P (Detected) as showed in Table 8

Table 9: Microbial load of fruits sampled from respondents in the evening

Fruits Samples	*Aerobic Mesophiles*	*E. Coli*	*Staphylococcus Aureus*	*Salmonella spp*	*Listeria Monocytoge*
TUS_{1W}	6.67 ± 00^{b}	0	4.87 ± 01^{ac}	ND	Detected
TUS2W	6.61 ± 02^{b}	0	4.70 ± 00^{c}	ND	Detected
TCM_{3W}	7.82 ± 01^{a}	0	5.40 ± 00^{abc}	ND	Detected
TCM_{4P}	7.82 ± 01^{a}	0	5.40 ± 06^{abc}	ND	ND
TCM_{5P}	7.13 ± 06^{ab}	0	0	ND	Detected
TCM_{6P}	7.73 ± 04^{a}	0	5.48 ± 00^{abc}	ND	Detected
$HACK_{7P}$	7.45 ± 02^{a}	0	0	ND	ND
$HACK_{8W}$	7.80 ± 00^{a}	5.75±01	5.87 ± 00^{a}	ND	Detected
$HACK_{9P}$	$6{,}40 \pm 00^{b}$	0	0	ND	Detected
$HACK_{10W}$	7.45 ± 00^{a}	0	5.65 ± 00^{a}	ND	ND

NOTE: ND= not detected. Means that do not share a letter are significantly different**.**
Source: Field survey, (2022)

Aerobic mesophilic count at four hours ranged from 6.40 to 7.82log $CFUg^{-1}$ in samples collected from the ten different vendors. However, Aerobic mesophilic count was 2 log units higher than the concentrations recorded on

the corresponding vendors. *E. coli* was only detected in the freshly cut fruit sampled from HACK8W out of the ten different vendors. HACK8W had microbial population of 5.75log $CFUg^{1}$. *E. coli* count was 2 log units higher than the concentrations recorded on the corresponding vendors. There were significant ($p < 0.05$) difference in *Staphylococcus aureus* counts among the vendors. *Staphylococcus aureus* counts ranged from 4.7 to 5.8logCFU/g. With regard to *Salmonella*, it was not detected in any of the freshly cut fruits samples from any of the ten different vendors. Similar patterns were observed with regard to *Listeria monocytogenes* detection in ten different vendors as shown. Table 9.

ANOVA is used to compare means and standard deviations of table7,8, and 9. See appendix

Microbial load in freshly cut street fruits

Table 7, 8, and 9 above presents the data of microbial populations of the ten (10) samples taken in the morning, afternoon and in the evening and corresponding standard values to help establish the health implications of the microbial load measured from the samples**.** In this study, of the 30 samples analysed, 26 samples (87%) showed unacceptable *Aerobic mesophilic* bacteria counts (>3log CFU/g) while 4 samples (13%) showed acceptable *Aerobic mesophilic* counts (<3log CFU/g). An increase in *Aerobic mesophilic* bacteria count to levels above 3log CFU/g could be due the ambient temperatures from where the samples collected which is proximate to optimum temperature for growth of most *Aerobic mesophiles*. Also, it could due inappropriate processing, poor handling and unhygienic practices. Abisso *et al*. (2018) reported similar results for microbiological analyses of freshly cut fruit

collected from vendors in South Ethiopia markets, and more than 87% of samples tested were above aerobic mesophilic counts of 3 log CFU/g. Gomez-Govea *et al.* (2012) reported 20 of 32 of freshly cut fruit samples (62.5%) obtained from Nigeria markets, *Aerobic mesophilic* counts of 6.6log CFU/g. However, another study in Nigeria had reported a lower mean aerobic count of 2.05 CFU/ g (Adebayo-Tayo et al., 2012). According to Soares et al. (2014), the enumeration of *E coli* is a good indicator of the quality and expected shelf life of the product. Most freshly cut fruits samples (90%) showed acceptable enumeration *E. coli* (< 1log CFU/ g) and just three samples of the freshly cut fruits recorded higher count of *E coli* (3.6log CFU/ g, 4.2 CFU/ g and 5.7 CFU/ g respectively).

Aerobic mesophilic microorganisms found in food is one of the microbiological indicators for food quality. The presence of aerobic organisms reveals the existence of favorable conditions for the growth of microorganisms**.** The high aerobic mesophilic count recorded from freshly cut fruit from ten different vendors sampled in the morning, afternoon and evening could be due to contaminated water used in washing the fruits, inappropriate processing, poor handling and hygienic practices. Some of the samples from the vendors had loads which were above the standard requirement of both Ghana Standard Authority (< 5 logs CFU/g) (GSA, 2018) and UK Public Health Laboratory Services (6 to < 7 logs CFU/g) (PHLS, 2000), with exception of samples taken from vendors in the morning which were within the limit.

The data presented in Tables7,8 and 9 representing samples taken in the morning, afternoon and evening showed progressive increase in microbial

load over the day. Samples for HACK8W for example recorded *Aerobic Mesophiles* values of 5.43±06 [a], 6.38± 00 [ab] and 7.80±00[a] respectively over the day. This suggests that as the day advances, aerobic conditions for microbial growth such as presence of moisture and warmth improve, so do personal hygiene conditions of vendors who handle and process the fruits worsen over the day, making conditions favourable for them to multiply.

This justifies why samples were collected at different times of the day. Abisso *et al*. (2018) reported close similar aerobic mesophilic count ranged 3.4 to 4.8log CFU/g in South Ethiopia. Also, the findings were in line with the study of Gomez-Govea *et al*. (2012) who reported aerobic mesophilic counts ranging from 5.4 to 6.6log CFU/ g in Nigeria. However, another study in Nigeria had reported a lower mean aerobic count of 2.05 to 3.05 CFU/ g (Adebayo-Tayo et al., 2012). The conditions prevailing at the setting at the time of collecting data are largely responsible for the load recorded for the sample. HACK7P recorded Aerobic mesophilic count of 5.41±02[a], 6.36±05[ab] and 7.45±02[a] respectively over the three periods in the day when the samples were taken. This was the only pathogen detected in the samples collected for this respondent, which shows high level of food and personal hygiene practice, as compared with the other respondents. This is an indication that it is possible to have practices that would not compromise the safety of the fruits that are offered to consumers, as vendors. This makes the fruits safe for consumption and prevents any food borne disease outbreak within the setting. This notwithstanding, the presence of *Aerobic mesophiles* can also be a cause for concern on food safety.

The maximum value allowed for *E. coli* in fresh cut fruit is 1 log CFU/g according to (GSA, 2018). In the present study, thermos-tolerant coliforms detected could be due to poor hygienic practices and the use of water contaminated with faecal waste for washing utensils like knives and trays, and contaminated polythene bags used for the packaging of the fruits after slicing or cutting, and also exposure of these fruits to low temperatures which encourage the microbial growth of these pathogens. According to guidelines from the Health Protection Agency (2009), *E. coli* counts in 25g of ready-to-eat fruits > 10^2 CFU/g is considered. Hence, all samples that show the presence of *E. coli* were all considered unsatisfactory for consumption.

Contamination of food by enteric pathogens can arise from the vendors if water contaminated with human sewage is used to wash fruits. Such threats are further amplified if the fruits are mishandled during processing and preparations where pathogens could increase exponentially under advantageous conditions (Heaton *et al.*, 2007). As most of these products are eaten raw, their high microbial content may represent a risk factor for the consumer's health (Falomir et al., 2010).

The limit value for *Staphylococcus aureus* in fresh cut fruit is 1 log CFU/g according to GSA (2018). The presence of *Staphylococcus aureus* in the sliced fruits could be as a result of contamination from hands used for the processing and packaging of the sliced fruit and unhygienic practices. Improper handling of food with contaminated hands or other improper food handling practices such as coughing or sneezing during food preparation usually contribute significantly to contamination of food by *Staphylococcus*

aureus (Amoah et al., 2014). The present observation could therefore be in line with this assertion.

Al-Kharousi *et al.*, (2016) also isolated *Staphylococcus aureus* from street vended fruits juices in Amravati, India. Gitahi et al., (2012) recorded *Staphylococcus aureus* counts of 3.13 log CFU/g to 4.69 log CFU/g in street food. *Staphylococcus aureus* is known to cause food poisoning and diseases characterized by nausea, vomiting, and diarrhea (Gomez-Govea et al., 2012). Barro *et al.*, (2006) revealed that consumption of food contaminated with staphylococcal endotoxins of loads exceeding 10^5 CFU g^{-1} can also be very fatal.

The study upon examining the microbial load of freshly cut street fruits revealed that none of the participants' fruits had *Salmonella* detected at the laboratory during the analysis. This was an acceptable result because it shows the vendors did not pre-dispose the fruits to conditions that could cause food contamination by *Salmonella*. The present finding is contrary to what Manko (2018) found, which recorded a detection of *Salmonella* in freshly cut fruits sold in Nigeria.

Though the respondents seem to have some knowledge of proper food and personal hygienic practices, their actual conduct do not reflect what they know, and the presence of these microbes indicate that there has been a serious compromise, most probably because there are no serious regulations and monitoring by the bodies responsible, or probably because the consumers do not demand better conditions than what they are offered. Thus, there is a need for greater hygienic/sanitary control during the processing, and marketing stages, and proper and regular checks by the regulatory bodies as the presence

of potentially pathogenic microorganisms may pose a potential serious public health risk among fruit consumers in the Metropolis.

Determining the health implications of microbial load present in sample cut fruits

The final objective of the study is to determine the health implications of microbial load present in the sample cut fruits from vendors. The analysis of health implications was done by comparing the microbial loads detected in the samples with the standard load limits as proposed by the Ghana Standard Authority. The comparison was not the only means of answering the question but the researcher also discussed the results in reference to the 95% confidence level leaving only a 5% error level. The Tables 10, 11, and 12 presents that tables with standard load limits and measured load limits for all samples taken in the morning, afternoon, and evening.

Table 10: Microbial population in CFUg-1 in freshly cut street fruits samples from respondents in the morning and Standard values

Fruits samples	*Aerobic Mesophiles*		*E.Coli*		*Staphylococus Aureus*		*Salmonella Spp*		*Listeria Monocytoge*	
	Measured	**Stand.**	**Measured**	**Stand.**	**Measured**	**Stand.**	**M**	**S**	**M**	**S**
TUS_{1W}	3.56±02	3logCFUg^{-1}	0	2logCFUg^{-1}	2.85±00^{d}	2logCFUg^{-1}	ND	ND	Detected	ND
TUS2W	4.75±02^{ab}	3logCFUg^{-1}	0	2logCFUg^{-1}	3.67±01^{a}	2logCFUg^{-1}	ND	ND	Detected	ND
TCM_{3W}	4.52±02^{b}	3logCFUg^{-1}	0	2logCFUg^{-1}	3.66±01^{a}	2logCFUg^{-1}	ND	ND	Detected	ND
TCM_{4P}	4.54±02^{b}	3logCFUg^{-1}	0	2logCFUg^{-1}	3.25±01^{bc}	2logCFUg^{-1}	ND	ND	ND	ND
TCM_{5P}	3.98±01^{bc}	3logCFUg^{-1}	0	2logCFUg^{-1}	0	2logCFUg^{-1}	ND	ND	Detected	ND
TCM_{6P}	3.99±06^{bc}	3logCFUg^{-1}	0	2logCFUg^{-1}	3.22±02^{c}	2logCFUg^{-1}	ND	ND	Detected	ND
$HACK_{7P}$	5.41±02^{a}	3logCFUg^{-1}	0	2logCFUg^{-1}	0	2logCFUg^{-1}	ND	ND	ND	ND
$HACK_{8W}$	5.43±06^{a}	3logCFUg^{-1}	3.66±0	2logCFUg^{-1}	3.49±02^{ab}	2logCFUg^{-1}	ND	ND	Detected	ND
$HACK_{9P}$	3.52±02^{c}	3logCFUg^{-1}	0	2logCFUg^{-1}	0	2logCFUg^{-1}	ND	ND	Detected	ND
$HACK_{10W}$	4.64±02^{ab}	3logCFUg^{-1}	0	2logCFUg^{-1}	2.66±01^{d}	2logCFUg^{-1}	ND	ND	ND	ND

Source: Field survey, (2022), Ghana Standards Authority (2018)

Table 11: Microbial population in CFUg-1 in freshly cut street fruits samples from respondents in the afternoon and Standard values

Fruits Samples	*Aerobic Mesophiles*		*E. Coli*		*Staphylococcus Aureus*		*Salmonella Spp*		*Listeria Monocytogenes*	
	Measured	**Stand.**	**M**	**Stand.**	**Measured**	**Stand.**	**M**	**S**	**M**	**S**
TUS_{1W}	4.41 ± 01^{e}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	2.91 ± 01^{g}	$2logCFUg^{-1}$	ND	ND	Detected	ND
TUS2W	5.80 ± 01^{bc}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	3.82 ± 01^{e}	$2logCFUg^{-1}$	ND	ND	Detected	ND
TCM_{3W}	5.56 ± 01^{cd}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	4.73 ± 01^{a}	$2logCFUg^{-1}$	ND	ND	Detected	ND
TCM_{4P}	5.32 ± 01^{cd}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	3.62 ± 01^{f}	$2logCFUg^{-1}$	ND	ND	ND	ND
TCM_{5P}	5.20 ± 01^{d}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	0	$2logCFUg^{-1}$	ND	ND	Detected	ND
TCM_{6P}	6.37 ± 01^{ab}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	4.24 ± 02^{d}	$2logCFUg^{-1}$	ND	ND	Detected	ND
$HACK_{7P}$	6.36 ± 05^{ab}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	0	$2logCFUg^{-1}$	ND	ND	ND	ND
$HACK_{8W}$	6.38 ± 00^{ab}	$3logCFUg^{-1}$	4.81	$2logCFUg^{-1}$	4.591 ± 02^{b}	$2logCFUg^{-1}$	ND	ND	Detected	ND
$HACK_{9P}$	6.59 ± 02^{a}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	0	$2logCFUg^{-1}$	ND	ND	Detected	ND
$HACK_{10W}$	6.65 ± 04^{a}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	4.301 ± 00^{c}	$2logCFUg^{-1}$	ND	ND	ND	ND

Source: Field survey, (2022), Ghana Standards Authority (2018)

Table 12: Microbial load of fruits sampled from respondents in the evening and Standard values

Fruits Samples	*Aerobic Mesophiles*		*E. Coli*		*Staphylococcus Aureus*		*Salmonella spp*		*Listeria Monocytoge*	
	Measured	**Stand.**	**M**	**Stand.**	**Measured**	**Stand.**	**M**	**S**	**M**	**S**
TUS_{1W}	6.67 ± 00^{b}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	4.87 ± 01^{ac}	$2logCFUg^{-1}$	ND	ND	Detected	ND
TUS2W	6.61 ± 02^{b}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	4.70 ± 00^{c}	$2logCFUg^{-1}$	ND	ND	Detected	ND
TCM_{3W}	7.82 ± 01^{a}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	5.40 ± 00^{abc}	$2logCFUg^{-1}$	ND	ND	Detected	ND
TCM_{4P}	7.82 ± 01^{a}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	5.40 ± 06^{abc}	$2logCFUg^{-1}$	ND	ND	ND	ND
TCM_{5P}	7.13 ± 06^{ab}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	0	$2logCFUg^{-1}$	ND	ND	Detected	ND
TCM_{6P}	7.73 ± 04^{a}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	5.48 ± 00^{abc}	$2logCFUg^{-1}$	ND	ND	Detected	ND
$HACK_{7P}$	7.45 ± 02^{a}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	0	$2logCFUg^{-1}$	ND	ND	ND	ND
$HACK_{8W}$	7.80 ± 00^{a}	$3logCFUg^{-1}$	5.75±01	$2logCFUg^{-1}$	5.87 ± 00^{a}	$2logCFUg^{-1}$	ND	ND	Detected	ND
$HACK_{9P}$	$6,40 \pm 00^{b}$	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	0	$2logCFUg^{-1}$	ND	ND	Detected	ND
$HACK_{10W}$	7.45 ± 00^{a}	$3logCFUg^{-1}$	0	$2logCFUg^{-1}$	5.65 ± 00^{a}	$2logCFUg^{-1}$	ND	ND	ND	ND

Source: Field survey, (2022), Ghana Standards Authority (2018)

Table 10, 11, and 12 above presents the data of microbial populations of the ten (10) samples taken in the morning, afternoon and in the evening and corresponding standard values to help establish the health implications of the microbial load measured from the samples. In reference to the standard scores from GSS 955 of the Ghana Standards Authority, *Salmonella Spp* should not be detected in any of the sample by standard. Based on the standard therefore, the samples have met the standard of the regulatory body with none of the samples in any of the period recording a microbial load of *Salmonella Spp.* On a similar account, *Listeria Monocytoge* according to the standard should not be detected in any of the samples. However, the results reveal that seven out of every ten samples had traces of *Listeria Monocytoge* in them. Fruit safety - wise, the consumption of these fruits is capable of resulting in fruit-borne diseases caused by the presence of *Listeria Monocytoge.* The impacts of *Listeria Monocytoge* on different groups of persons cannot be ignored.

The results for *Staphylococcus Aureus, E. Coli,* and *Aerobic Mesophiles* revealed that three samples of *Staphylococcus Aureus* met the standard level of microbial load, whereas in the aspect of E. *Coli,* all but one sample failed to meet the standard load measure. Finally, considering Aerobic *Mesophiles,* all samples failed to find the standard load measure. The dynamics in the samples for all the periods for which data was collected indicate that although some samples passed the standard levels of the microbial load, largely many samples had microbial traces in them. The findings clearly show that the patronage of fresh cut fruits from streets may result in some fruit-borne diseases since there are fruits which may have high levels of microbial loads beyond the standard levels as recorded.

The health implication for the in appropriate levels has various impacts for different groups of people. The presence of *Listeria Monocytoge is* capable of affecting pregnant women adversely if higher loads are found in them by resulting in miscarriages, and stillbirths. Persons with weakened immune systems like the aged, may experience meningitis (Lani & Hassan, 2016). The presence of *Staphylococcus Aureus* load can result in skin infections (Pal, Gutama, & Koliopoulos 2021). The presence of *E. Coli* is capable of causing diarrhoea disease among consumers (Kaspar, Doyle & Archer, 2010). The presence of the bacteria in fruit has many implications for health and requires that proper hygienic measures be employed.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The study was conducted to examine the knowledge and practices of street fruits vendors on food and personal hygiene. The study further analyzed the microbial load in some selected cut and vended fruits in the Tamale metropolis. The essence was to examine the implication on food safety for consumers in the Tamale metropolis. The study used descriptive cross sectional study design and was guided by the following research questions: 'What is the knowledge level of street vendors on fruit hygiene in the Tamale metropolis?', 'What are the practices of street vendors during fruits processing, storage and selling?' and 'What is the microbial load of freshly cut street fruits in the Tamale metropolis? and 'What are the health implications of microbial load present in sample cut fruits?"

Out of the estimated number of 158, 113 was sampled through a non-probability sampling method, convenience sampling, with Yamane formula as the basis for the size. Products of ten of the respondents were used for the laboratory analysis of microbial load. Two fruits, pawpaw and watermelon, that are known to be favourite of consumers, according to the vendors, were purchased for laboratory tests. In all 30 samples of fifteen each of pawpaw and watermelon were collected and preserved for laboratory analysis. To ensure that the research work did not violate any legislation or the rights of any group of persons or bodies, all ethical protocols were observed during the study to ensure anonymity and confidentiality. Validity and reliability of the results were tested and Cronbach's alpha coefficient of 0.71 – 0.91 was obtained, which according to Taber, (2018) is considered good.

Questionnaire was the main instrument used for data collection and the food analysis was also done at a standard laboratory, Food Research Institute in Ghana, where specialized instruments were utilized to find the load of the microbes *E. coli*, *Salmonella*, *Listeria monocytogens*, and *Staphylococuss aureus*. Data obtained on demographic characteristics, knowledge of food vendors on food and personal hygiene and their personal account of how they practice, as well as their practices observed were collated edited, coded and keyed into statistical software called Statistical Package for Social Sciences (SPSS) Version 22 for processing. Analysis was done using descriptive statistics (means, frequencies and percentages) and then presented in tables. The laboratory assessment of the fruit samples also yielded data which had their means presented according to the specific vendor code and the microbes that were targeted. Mean values were calculated for each sample for the different categories and used to determine the load level of the fruits for the different vendors.

Summary of the finding

The study assessed the knowledge level of street fruits vendors on fruits hygiene in the study setting. The findings revealed that, overall knowledge level of respondents is low with (M=2.23, SD=0.88). Although respondents had high knowledge that germs can be transmitted through reused gloves with (M=3.12, SD=1.00), the findings of the study reveal a very low-level knowledge of respondents about transmission of germs or pathogens by buyers touching cut fruits (M=1.20, SD=0.40). The findings indicate that vendors do not control the rate at which their customers touch their vended fruits and since an eye detection cannot be made to know which customer

carries pathogens or not, this lower knowledge is an open window to pathogen spread.

On respondents' knowledge on symptoms of fruits borne pathogens diseases, overall knowledge level of respondents was very low (M=1.97, SD=0.72). Respondents had high knowledge level in relation to vomiting as a symptom of fruit borne diseases (M=3.10, SD=1.00). Other symptoms as measured either showed a low or very low knowledge level.

The study further assessed the personal account of practices of street fruits vendors during food preparations, selling, processing and storage. The results show that all respondents behaved commonly in terms of some practices in fruit handling and processing. All respondents indicated they did not practice the following; wearing aprons during processing and preparation of fruits, washing of hands in warm water without soap, going for medical check yearly, bathing before vending, keeping long and coloured finger nails, not cleaning storage container before packaging, wearing gloves during cutting of fresh fruits and reusing gloves for processing of fruits. While some of the practices they did not practice are commendable like; not keeping long and coloured fingernails, not washing containers and not reusing gloves, some of the other practices vendors did not do were largely hygiene related practices that could improve fruit safety.

On the other hand, all respondents affirmed that they peel so much fruits at a time before packaging. This practice although is adopted by vendors to help them serve their market, it provides grounds for the infestation and spread of pathogens. On other practices such as using strong perfume and make-ups during peeling of fruits, selling the unsold processed fruits the next

day, going for anti-typhoid injection, and washing of hand in running water with or without soap, majority of respondents practiced them while few vendors did not practice them.

Similarly, the study collected data to examine the microbial load in freshly cut street fruits in the Tamale metropolis. Based on the findings, out of the sampled fruits from the ten respondents, the mean values indicated seven samples had *Staphylococcus aureus* and at levels higher than the recommended by Ghana Standard Authority (< 3 logs CFU/g) (GSA, 2018), and only one vendor had fruit with *E. coli* present. It was also revealed that, only fruits from three respondents sampled had no *Listeria monocyte*.

Finally, the study sort to determine the health implications of microbial load in cut fresh fruits in the Tamale metropolis. The results showed that in reference to the standard scores from GSS 955 of the Ghana Standards Authority, *Salmonella Spp* should not be detected in any of the sample by standard. Based on the standard therefore, the samples have met the standard of the regulatory body with none of the samples in any of the period recording a microbial load of *Salmonella Spp.* On a similar account, *Listeria Monocytoge* according to the standard should not be detected in any of the samples. However, the results reveal that seven out of the ten samples had traces of *Listeria Monocytoge* in them. Fruit safety -wise, the consumption of these fruits is capable of resulting in fruit-borne diseases caused by the presence of *Listeria Monocytoge*. The impacts of *Listeria Monocytoge* on different groups of persons cannot be ignored.

The results for *Staphylococcus Aureus, E. Coli,* and *Aerobic Mesophiles* revealed that three samples of *Staphylococcus Aureus* met the

standard level of microbial load, whereas in the aspect of E. *Coli,* all but one sample failed to meet the standard load measure. Finally, considering *Aerobic Mesophiles,* all samples failed to find the standard load measure. The dynamics in the samples for all the periods for which data was collected indicate that although some samples passed the standard levels of the microbial load, largely many samples had microbial traces in them. The findings clearly show that the patronage of fresh cut fruits from streets may result in some fruit-borne diseases since there are fruits which may have high levels of microbial loads beyond the standard levels as recorded.

Conclusion

Based on the findings, street fruit vendors can be said to have moderate knowledge on fruits and personal hygiene. Despite the moderate knowledge of respondents concerning fruits, personal hygiene, and practices leave much to be desired. Their actions are based more on convenience than for safety. By respondents own account and through the observation made, majority of the participants did not engage in safe and hygienic food safety practices and personal hygiene, which could lead to incidence of food borne related diseases among consumers. There were however some participants who are practicing proper personal hygiene, and ensuring food safety practices, though they did not practice total hygiene which made all the samples register microbial loads of pathogens with some at levels that are not required in wholesome foods.

The sampled fruits in the study setting had different levels of one or more of the microbes investigated in them, some of which were above the accepted levels for human consumption. The implication is that, the fruits being offered for sale are not totally safe for consumers as they could acquire

foodborne illnesses after eating the contaminated fruits depending on the specific pathogen and the load present at the time of purchase.

Recommendations

The following suggestions were given based on the results to aid policy makers and practitioners in strengthening the shortcomings found, particularly among street fruit sellers in respect to sanitary practises in the research context.

i. Street fruit vendors and handlers should be educated on fruit hygiene practices through engagement by the Health Directorate Unit of Tamale Metropolis and the Ministry of health.
ii. The Tamale Metropolitan assembly must strictly enforce compliance with regulations on operation permits and health clearance certificates to keep consumers safe.
iii. Fruit vendors must be regularly monitored by the Metropolitan sanitation officers to ensure compliance with good hygiene practices

Suggestions for Further Studies

1. The study can be replicated in another geographical area with entirely different weather condition from the prevailing conditions in the Tamale Metropolitan area.
2. A study may also be carried out on other cut fruits to see if there would be any differences in the load recorded for this study.
3. The use of hazard analysis critical control point (HACCP) approach to determine the point of contamination of cut street fruits for remediation could be varied in another study to investigate the phenomenon. This is because using the HACCP during post-harvest processing, frequent

washing can completely remove soil and debris but not pathogenic microorganisms, which can cause cross-contamination of other foodstuffs, cookware, utensils, and so on (Adebayo-Tayo et al., 2012).

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APPENDICES

APPENDIX A

QUESTIONNAIRE

My name is Patience Kpekurah; am a master's student of the above University and will be very appreciative if you could assist provide me with key information leading to the completion of this questionnaire to aid me conduct my study. Any information you might want to know about the study, we can discuss it before, we proceed.

This questionnaire is designed to assist the researcher to collect data for a research study on the topic: Microbial load in some selected cut and vended fruits and their implication on food safety in the Tamale Metropolis

Your opinion is very important and your participation is voluntary. All information you provide will be used solely for academic purposes and will be kept confidential.

Instructions: Kindly provide answers where necessary by writing in the spaces or tick against the option (s) where appropriate

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS	
1	What is your Age? a. Below 18yrs ☐ b.18-28yrs ☐ 29-38yrs ☐ d.39-48yrs ☐ e. above 35yrs ☐
2	What is your Sex? a. Male ☐ b. Female ☐
3	How long have you been selling fruits? ? a. Below 1year ☐ b. 1-2years ☐ c. 3-4 years ☐ d. 5-6years ☐ d. above 6years ☐
4	What is your current highest level of formal education? a. Certificate ☐ b. Diploma ☐ c. 1st Degree ☐ d. no formal education ☐
5	What religion do you belong to? a. Christianity ☐ b. Islam ☐ c. ATR ☐ d. Others (specify) ☐……

SECTION B: KNOWLEDGE ON FRUIT CLEANLINESS AND PERSONAL HYGIENE						
Please indicate to what extent you agree to the following statements by ticking the corresponding box		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
6	I should always wash hands after coughing or sneezing	☐	☐	☐	☐	☐
7	It is not enough just by washing your hands under running water to remove bacteria before touching fruit	☐	☐	☐	☐	☐
8	Exposing hair to fruit can cause fruit-borne disease	☐	☐	☐	☐	☐
9	Avoid bare hand contact with ready to eat fruits	☐	☐	☐	☐	☐
10	The best way to avoid fruit poisoning is to wash them under running water.	☐	☐	☐	☐	☐
11	I always store my fruits in the fridge/ basket/tray before cutting	☐	☐	☐	☐	☐
12	Packaged cut fruits should be carried on trays /transparent plastic containers for hawking.	☐	☐	☐	☐	☐
14	I cover my cut fruits whiles selling	☐	☐	☐	☐	☐
15	I sell my cut fruits roaming under the sun	☐	☐	☐	☐	☐

SECTION C: KNOWLEDGE ON FRUITBORNE PATHOGENS TRANSMISSION						
Please indicate to what extent you agree to the following statements by ticking the corresponding box		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
16	I know that people can complain of sickness after the consumption of fruits	☐	☐	☐	☐	☐
17	I know the type of illness people complain of after eating fruits	☐	☐	☐	☐	☐
18	I wear gloves and reuse them	☐	☐	☐	☐	☐
19	I allow buyers to touch the cut fruits	☐	☐	☐	☐	☐
20	I talk over fruits during processing for sale	☐	☐	☐	☐	☐

SECTION D: KNOWLEDGE ON SYMPTOMS RELATED TO FRUITBORNE DISEASES						
Please indicate to what extent you agree to the following statements by ticking the corresponding box		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
21	Stomach pain is a symptom of fruit-borne illness	☐	☐	☐	☐	☐
22	Diarrhea is a symptom of fruit-borne illness	☐	☐	☐	☐	☐
23	Vomit is a symptom of fruit-borne illness	☐	☐	☐	☐	☐
24	Fever is a symptom of fruit-borne illness	☐	☐	☐	☐	☐
25	Skin rashes is a symptom of fruit-borne illness	☐	☐	☐	☐	☐
26	Seizure is a symptom of fruit-borne illness	☐	☐	☐	☐	☐

SECTION E: FRUIT HANDLING PRACTICE						
Please indicate to what extent you agree to the following statements by ticking the corresponding box		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
29	I wear apron during fruit preparation and processing	☐	☐	☐	☐	☐
30	I wash my hands with warm running water without soap before preparing the fruit	☐	☐	☐	☐	☐
31	I wash my hands using soap and cold running water before preparing the fruit	☐	☐	☐	☐	☐
32	I wash my hands using soap and warm running water before preparing the fruit	☐	☐	☐	☐	☐
33	I go for medical health check yearly	☐	☐	☐	☐	☐
34	I have undergone anti-typhoid injection	☐	☐	☐	☐	☐
35	I bath before vending fruits	☐	☐	☐	☐	☐
36	I bath after vending fruits	☐	☐	☐	☐	☐
37	I keep long and colored fingernail	☐	☐	☐	☐	☐
38	I use strong perfume and make-ups during peeling of fruits	☐	☐	☐	☐	☐
39	I peel so much fruits at a time before packaging for sale.	☐	☐	☐	☐	☐
40	I sell the unsold processed fruits the next day	☐	☐	☐	☐	☐
41	I do not wear glove during cutting of fresh fruits	☐	☐	☐	☐	☐
42	I do not clean the storage containers before packaging	☐	☐	☐	☐	☐
43	I wear glove during cutting of fresh fruits I reuse my gloves for processing fruits always.	☐	☐	☐	☐	☐
THANKS SO MUCH FOR YOUR TIME						

OBSERVATIONAL CHECK LIST FOR THE RESEARCHER

This observational check list is to examine the practices of streets fruits venders. Tick [√] whether yes or no any statement that corresponds to the observation.

Please tick [√] YES or NO to indicate your position as to whether the following are observed by street fruit vendors or not.		**YES**	**NO**
1	Vendor is wearing apron to prepare fruits	**YES** ☐	**NO** ☐
2	Vendor washes hands with warm running water without soap before preparing the fruits	**YES** ☐	**NO** ☐
3	Vendor washes hands with warm running water with soap before preparing the fruits	**YES** ☐	**NO** ☐
4	Vendor washes hands with cold running water with soap before preparing the fruit	**YES** ☐	**NO** ☐
5	Vendor has a clean outlook or appears clean.	**YES** ☐	**NO** ☐
6	Vendor's nails are long and colored.	**YES** ☐	**NO** ☐
7	Vendor has put on perfume	**YES** ☐	**NO** ☐
	Vendor has put on make ups		
8	Vendor has peeled so much at a time before packaging.	**YES** ☐	**NO** ☐
9	Vendor's storage container is clean.	**YES** ☐	**NO** ☐
10	Vendor used gloves during cutting of fruits.	**YES** ☐	**NO** ☐
11	Wearing face mask.	**YES** ☐	**NO** ☐
12	Allowing buyers to touch fruits before picking.	**YES** ☐	**NO** ☐

APPENDIX B

One-way ANOVA: STAPH versus Sample

Method

Null hypothesis All means are equal
Alternative hypothesis At least one mean is different
Significance level $\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor Levels Values
Sample 10 HACK10, HACK7, HACK8, HACK9, TCM3, TCM4, TCM5, TCM6, TUS1, TUS2

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Sample	9	23.2510	2.58345	716.02	0.000
Error	10	0.0361	0.00361		
Total	19	23.2871			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0600672	99.85%	99.71%	99.38%

Means

Sample	N	Mean	StDev	95% CI
HACK10	2	2.65799	0.00675	(2.56335, 2.75262)
HACK7	2	1.000	0.000	(0.905, 1.095)
HACK8	2	3.493	0.185	(3.398, 3.587)
HACK9	2	1.000	0.000	(0.905, 1.095)
TCM3	2	3.66275	0.01335	(3.56811, 3.75739)
TCM4	2	3.2548	0.0341	(3.1602, 3.3495)
TCM5	2	1.000	0.000	(0.905, 1.095)
TCM6	2	3.2175	0.0186	(3.1229, 3.3122)
TUS1	2	2.84541	0.00044	(2.75077, 2.94005)

TUS2 2 3.67209 0.01307 (3.57745, 3.76673)

Pooled StDev = 0.0600672

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

Sample	N	Mean	Grouping
TUS2	2	3.67209	A
TCM3	2	3.66275	A
HACK8	2	3.493	A B
TCM4	2	3.2548	B C
TCM6	2	3.2175	C
TUS1	2	2.84541	D
HACK10	2	2.65799	D
TCM5	2	1.000	E
HACK9	2	1.000	E
HACK7	2	1.000	E

Means that do not share a letter are significantly different.

Tukey Simultaneous 95% CIs

Interval Plot of STAPH vs Sample

One-way ANOVA: PCA versus Sample

Method

Null hypothesis All means are equal
Alternative hypothesis At least one mean is different
Significance level $\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor Levels Values
Sample 10 HACK10, HACK7, HACK8, HACK9, TCM3, TCM4, TCM5, TCM6, TUS1, TUS2

Analysis of Variance

Source DF Adj SS Adj MS F-Value P-Value

Sample 9 8.2155 0.91284 21.97 0.000
Error 10 0.4155 0.04155
Total 19 8.6310

Model Summary

S R-sq R-sq(adj) R-sq(pred)
0.203828 95.19% 90.85% 80.75%

Means

Sample N Mean StDev 95% CI
HACK10 2 4.6382 0.0212 (4.3171, 4.9594)
HACK7 2 5.4147 0.0236 (5.0935, 5.7358)
HACK8 2 5.4287 0.0685 (5.1075, 5.7498)
HACK9 2 3.5184 0.0186 (3.1973, 3.8396)
TCM3 2 4.5183 0.0186 (4.1972, 4.8395)
TCM4 2 4.5439 0.0176 (4.2228, 4.8650)
TCM5 2 3.98222 0.01280 (3.66108, 4.30336)
TCM6 2 3.996 0.639 (3.675, 4.317)
TUS1 2 3.5620 0.0252 (3.2409, 3.8832)
TUS2 2 4.7519 0.0163 (4.4308, 5.0730)

Pooled StDev = 0.203828

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

Sample N Mean Grouping
HACK8 2 5.4287 A
HACK7 2 5.4147 A
TUS2 2 4.7519 A B
HACK10 2 4.6382 A B
TCM4 2 4.5439 B
TCM3 2 4.5183 B
TCM6 2 3.996 B C
TCM5 2 3.98222 B C
TUS1 2 3.5620 C
HACK9 2 3.5184 C

Means that do not share a letter are significantly different.

Tukey Simultaneous 95% CIs

Interval Plot of PCA vs Sample

One-way ANOVA: E COLI versus Sample

* ERROR * All complete, included rows have the same response.
One-way ANOVA: E COLI versus Sample

Method

Null hypothesis All means are equal
Alternative hypothesis At least one mean is different
Significance level $\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor Levels Values
Sample 10 HACK10, HACK7, HACK8, HACK9, TCM3, TCM4, TCM5, TCM6, TUS1, TUS2

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Sample	9	24.1497	2.68330	*	*
Error	10	0.0000	0.00000		
Total	19	24.1497			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0	100.00%	100.00%	100.00%

Means

Sample	N	Mean	StDev	95% CI
HACK10	2	0.000000	0.000000	(-0.000000, -0.000000)
HACK7	2	0.000000	0.000000	(-0.000000, -0.000000)
HACK8	2	3.663	0.000	(3.663, 3.663)
HACK9	2	0.000000	0.000000	(0.000000, 0.000000)

TCM3 2 0.000000 0.000000 (0.000000, 0.000000)
TCM4 2 0.000000 0.000000 (0.000000, 0.000000)
TCM5 2 0.000000 0.000000 (0.000000, 0.000000)
TCM6 2 0.000000 0.000000 (0.000000, 0.000000)
TUS1 2 0.000000 0.000000 (0.000000, 0.000000)
TUS2 2 0.000000 0.000000 (-0.000000, -0.000000)

Pooled StDev = 0

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

Sample	N	Mean	Grouping
HACK8	2	3.663	A
TUS2	2	0.000000	B
TUS1	2	0.000000	C
TCM6	2	0.000000	D
TCM5	2	0.000000	E
TCM4	2	0.000000	F
TCM3	2	0.000000	G
HACK9	2	0.000000	H
HACK7	2	0.000000	I
HACK10	2	0.000000	J

Means that do not share a letter are significantly different.

Tukey Simultaneous 95% CIs

Interval Plot of E COLI vs Sample

———— **18/09/2022 1:05:36 PM** ————————————————————

Welcome to Minitab, press F1 for help.
Retrieving project from file: 'C:\Users\nana\Documents\TAMALE.MPJ'

———— **22/09/2022 11:15:44 AM** ————————————————————

Welcome to Minitab, press F1 for help.
Retrieving project from file: 'C:\Users\nana\Documents\TAMALE.MPJ'

One-way ANOVA: PCA versus Samples

Method

Null hypothesis All means are equal
Alternative hypothesis At least one mean is different
Significance level $\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor Levels Values
Samples 10 HACK10, HACK6, HACK7, HACK8, HACK9, TCM3, TCM4, TCM5, TUS1, TUS2

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Samples	9	9.7300	1.08111	49.96	0.000
Error	10	0.2164	0.02164		
Total	19	9.9463			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.147100	97.82%	95.87%	91.30%

Means

Samples	N	Mean	StDev	95% CI
HACK10	2	6.6522	0.0410	(6.4205, 6.8840)
HACK6	2	6.37097	0.01307	(6.13921, 6.60273)
HACK7	2	6.3601	0.0535	(6.1283, 6.5918)
HACK8	2	6.380	0.000	(6.148, 6.612)
HACK9	2	6.5851	0.0239	(6.3534, 6.8169)
TCM3	2	5.5624	0.1005	(5.3307, 5.7942)
TCM4	2	5.317	0.448	(5.085, 5.548)
TCM5	2	5.204	0.000	(4.972, 5.436)
TUS1	2	4.40647	0.01204	(4.17471, 4.63823)
TUS2	2	5.8027	0.0145	(5.5709, 6.0344)

Pooled StDev = 0.147100

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

Samples	N	Mean	Grouping
HACK10	2	6.6522	A
HACK9	2	6.5851	A
HACK8	2	6.380	A B
HACK6	2	6.37097	A B
HACK7	2	6.3601	A B
TUS2	2	5.8027	B C
TCM3	2	5.5624	C D
TCM4	2	5.317	C D
TCM5	2	5.204	D
TUS1	2	4.40647	E

Means that do not share a letter are significantly different.

One-way ANOVA: PCA versus Samples

Method

Null hypothesis	All means are equal
Alternative hypothesis	At least one mean is different
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Samples	10	HACK10, HACK6, HACK7, HACK8, HACK9, TCM3, TCM4, TCM5, TUS1, TUS2

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Samples	9	9.7300	1.08111	49.96	0.000
Error	10	0.2164	0.02164		
Total	19	9.9463			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.147100	97.82%	95.87%	91.30%

Means

Samples	N	Mean	StDev	95% CI
HACK10	2	6.6522	0.0410	(6.4205, 6.8840)
HACK6	2	6.37097	0.01307	(6.13921, 6.60273)
HACK7	2	6.3601	0.0535	(6.1283, 6.5918)
HACK8	2	6.380	0.000	(6.148, 6.612)
HACK9	2	6.5851	0.0239	(6.3534, 6.8169)
TCM3	2	5.5624	0.1005	(5.3307, 5.7942)
TCM4	2	5.317	0.448	(5.085, 5.548)
TCM5	2	5.204	0.000	(4.972, 5.436)
TUS1	2	4.40647	0.01204	(4.17471, 4.63823)
TUS2	2	5.8027	0.0145	(5.5709, 6.0344)

Pooled StDev = 0.147100

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

Samples	N	Mean	Grouping
HACK10	2	6.6522	A
HACK9	2	6.5851	A
HACK8	2	6.380	A B
HACK6	2	6.37097	A B
HACK7	2	6.3601	A B
TUS2	2	5.8027	B C
TCM3	2	5.5624	C D
TCM4	2	5.317	C D
TCM5	2	5.204	D
TUS1	2	4.40647	E

Means that do not share a letter are significantly different.

One-way ANOVA: E coli versus Samples

Method

Null hypothesis All means are equal

Alternative hypothesis At least one mean is different

Significance level $\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor Levels Values
Samples 10 HACK10, HACK6, HACK7, HACK8, HACK9, TCM3, TCM4, TCM5, TUS1, TUS2

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Samples	9	26.0767	2.89741	*	*
Error	10	0.0000	0.00000		
Total	19	26.0767			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0	100.00%	100.00%	100.00%

Means

Samples	N	Mean	StDev	95% CI
HACK10	2	1.000	0.000	(1.000, 1.000)
HACK6	2	1.000	0.000	(1.000, 1.000)
HACK7	2	1.000	0.000	(1.000, 1.000)
HACK8	2	4.806	0.000	(4.806, 4.806)
HACK9	2	1.000	0.000	(1.000, 1.000)
TCM3	2	1.000	0.000	(1.000, 1.000)
TCM4	2	1.000	0.000	(1.000, 1.000)
TCM5	2	1.000	0.000	(1.000, 1.000)
TUS1	2	1.000	0.000	(1.000, 1.000)
TUS2	2	1.000	0.000	(1.000, 1.000)

Pooled StDev = 0

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

Samples	N	Mean	Grouping
HACK8	2	4.806	A
TUS2	2	1.000	B
TUS1	2	1.000	C
TCM5	2	1.000	D
TCM4	2	1.000	E
TCM3	2	1.000	F
HACK9	2	1.000	G

HACK7	2	1.000	H
HACK6	2	1.000	I
HACK10	2	1.000	J

Means that do not share a letter are significantly different.

One-way ANOVA: Staph versus Samples

Method
Null hypothesis All means are equal
Alternative hypothesis At least one mean is different
Significance level $\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Samples	10	HACK10, HACK6, HACK7, HACK8, HACK9, TCM3, TCM4, TCM5, TUS1, TUS2

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Samples	9	43.3465	4.81628	32193.13	0.000
Error	10	0.0015	0.00015		
Total	19	43.3480			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0122313	100.00%	99.99%	99.99%

Means

Samples	N	Mean	StDev	95% CI
HACK10	2	4.301	0.000	(4.282, 4.320)
HACK6	2	4.2429	0.0176	(4.2236, 4.2622)
HACK7	2	1.000	0.000	(0.981, 1.019)
HACK8	2	4.5909	0.0158	(4.5717, 4.6102)
HACK9	2	1.000	0.000	(0.981, 1.019)
TCM3	2	4.72834	0.00574	(4.70907, 4.74761)
TCM4	2	3.6232	0.0146	(3.6040, 3.6425)
TCM5	2	1.000	0.000	(0.981, 1.019)
TUS1	2	2.9163	0.0186	(2.8970, 2.9355)
TUS2	2	3.8194	0.0186	(3.8001, 3.8387)

Pooled StDev = 0.0122313

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

Samples	N	Mean	Grouping
TCM3	2	4.72834	A
HACK8	2	4.5909	B
HACK10	2	4.301	C
HACK6	2	4.2429	D
TUS2	2	3.8194	E
TCM4	2	3.6232	F
TUS1	2	2.9163	G
TCM5	2	1.000	H
HACK9	2	1.000	H
HACK7	2	1.000	H

Means that do not share a letter are significantly different.

One-way ANOVA: PCA versus SAMPLES

Method

Null hypothesis All means are equal

Alternative hypothesis At least one mean is different

Significance level $\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
SAMPLES	10	HACK10, HACK6, HACK7, HACK8, HACK9, TCM3, TCM4, TCM5, TUS1, TUS2

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
SAMPLES	9	6.1203	0.68004	12.97	0.000
Error	10	0.5244	0.05244		
Total	19	6.6448			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.229008	92.11%	85.00%	68.43%

Means

SAMPLES	N	Mean	StDev	95% CI
HACK10	2	7.748	0.000	(7.387, 8.109)
HACK6	2	7.7312	0.0456	(7.3704, 8.0920)

HACK7	2	7.7479	0.0219	(7.3871, 8.1087)
HACK8	2	7.7955	0.0246	(7.4347, 8.1563)
HACK9	2	6.398	0.000	(6.037, 6.759)
TCM3	2	7.82271	0.01386	(7.46190, 8.18352)
TCM4	2	7.81949	0.00931	(7.45868, 8.18030)
TCM5	2	7.132	0.664	(6.772, 7.493)
TUS1	2	6.6717	0.0262	(6.3109, 7.0325)
TUS2	2	6.614	0.281	(6.253, 6.975)

Pooled StDev = 0.229008

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

SAMPLES	N	Mean	Grouping
TCM3	2	7.82271	A
TCM4	2	7.81949	A
HACK8	2	7.7955	A
HACK10	2	7.748	A
HACK7	2	7.7479	A
HACK6	2	7.7312	A
TCM5	2	7.132	A B
TUS1	2	6.6717	B
TUS2	2	6.614	B
HACK9	2	6.398	B

Means that do not share a letter are significantly different.

Tukey Simultaneous 95% CIs

Interval Plot of PCA vs SAMPLES

One-way ANOVA: E.COLI versus SAMPLES

Method

Null hypothesis	All means are equal
Alternative hypothesis	At least one mean is different
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor Levels Values
SAMPLES 10 HACK10, HACK6, HACK7, HACK8, HACK9, TCM3, TCM4, TCM5, TUS1, TUS2

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
SAMPLES	9	40.5815	4.50906	*	*
Error	10	0.0000	0.00000		
Total	19	40.5815			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0	100.00%	100.00%	100.00%

Means

SAMPLES	N	Mean	StDev	95% CI
HACK10	2	1.000	0.000	(1.000, 1.000)
HACK6	2	1.000	0.000	(1.000, 1.000)
HACK7	2	1.000	0.000	(1.000, 1.000)
HACK8	2	5.748	0.000	(5.748, 5.748)
HACK9	2	1.000	0.000	(1.000, 1.000)
TCM3	2	1.000	0.000	(1.000, 1.000)
TCM4	2	1.000	0.000	(1.000, 1.000)
TCM5	2	1.000	0.000	(1.000, 1.000)
TUS1	2	1.000	0.000	(1.000, 1.000)
TUS2	2	1.000	0.000	(1.000, 1.000)

Pooled StDev = 0

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

SAMPLES	N	Mean	Grouping
HACK8	2	5.748	A
TUS2	2	1.000	B
TUS1	2	1.000	C
TCM5	2	1.000	D
TCM4	2	1.000	E
TCM3	2	1.000	F
HACK9	2	1.000	G

HACK7 2 1.000 H
HACK6 2 1.000 I
HACK10 2 1.000 J

Means that do not share a letter are significantly different.

Tukey Simultaneous 95% CIs

Interval Plot of E.COLI vs SAMPLES

One-way ANOVA: STAPH versus SAMPLES

Method

Null hypothesis All means are equal
Alternative hypothesis At least one mean is different
Significance level $\alpha = 0.05$

Equal variances were assumed for the analysis.

Factor Information

Factor Levels Values
SAMPLES 10 HACK10, HACK6, HACK7, HACK8, HACK9, TCM3, TCM4, TCM5, TUS1, TUS2
Analysis of Variance

Source DF Adj SS Adj MS F-Value P-Value
SAMPLES 9 81.0962 9.01069 218.54 0.000
Error 10 0.4123 0.04123
Total 19 81.5085

Model Summary

S R-sq R-sq(adj) R-sq(pred)
0.203055 99.49% 99.04% 97.98%
Means
SAMPLES N Mean StDev 95% CI
HACK10 2 5.653 0.000 (5.333, 5.973)
HACK6 2 5.477 0.000 (5.157, 5.797)
HACK7 2 1.000 0.000 (0.680, 1.320)
HACK8 2 5.869 0.000 (5.549, 6.189)
HACK9 2 1.000 0.000 (0.680, 1.320)
TCM3 2 5.398 0.000 (5.078, 5.718)

TCM4 2 5.400 0.630 (5.080, 5.720)
TCM5 2 1.000 0.000 (0.680, 1.320)
TUS1 2 4.8662 0.1245 (4.5463, 5.1861)
TUS2 2 4.699 0.000 (4.379, 5.019)

Pooled StDev = 0.203055

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

SAMPLES N Mean Grouping
HACK8 2 5.869 A
HACK10 2 5.653 A B
HACK6 2 5.477 A B C
TCM4 2 5.400 A B C
TCM3 2 5.398 A B C
TUS1 2 4.8662 B C
TUS2 2 4.699 C
TCM5 2 1.000 D
HACK9 2 1.000 D
HACK7 2 1.000 D

Means that do not share a letter are significantly different.

Tukey Simultaneous 95% CIs

Interval Plot of STAPH vs SAMPLES

APPENDIX C

INTRODUCTORY LETTER

Department of Vocational and Technical Education,
Faculty of Science and Tech. Education
University of Cape Coast,
28th June, 2022.

The Chairperson
Institutional Review Board
University of Cape Coast

Dear Sir,

INTRODUCTORY LETTER (PATIENCE KPEKURAH)

I write as a thesis supervisor to introduce Miss Patience Kpekurah an MPhil student with registration number ET/HET/19/0003 in the above Department who is writing on 'Microbial load in cut and packaged street fruits: The implications for food safety in Tamale Metropolis" for her thesis.

As required, this student is submitting her proposal on the above stated topic to your outfit for ethical clearance, and this is to introduce her to complete the process that would enable her proceed to collect data for the study Kindly give her the needed attention.

Counting on your cooperation.

Yours Faithfully,

Irene Ampong (Ms.)

(SENIOR LECTURER)

APPENDIX D

ETHICAL CLEARANCE

University of Cape Coast
Department of VOTECT
28th June, 2022.

The Chairperson
Institutional Review Board
University of Cape Coast
Cape Coast

Dear Sir,

Application for Ethical Clearance

I am Patience Kpekurah (ET/HEP/19/0003), an MPhil. Home Economics student.

I would be grateful if your outfit could grant me ethical clearance. This is to enable me carry out my research work on the thesis topic; Microbial load in cut and packaged street fruits; the implication on food safety within the Tamale Metropolis.

Attached are copies of my documents for your perusal.

Thank you.

Your faithfully,

Patience Kpekurah

(0541390392/0208977896)

Direct: 03320-91097

Telegrams & Cables: University, Cape

University of Cape Coast

Coast Cape Coast

Our Ref: VTE/1AP/V.4/257

28th June, 2022.

The Chairman
Institutional Review Board
UCC

Dear Sir,

REQUEST FOR ETHICAL CLEARANCE

We have the pleasure of introducing to you Ms. Patience Kpekurah who is an M.Phil. Home Economics student of this Department and working on the research topic "Microbial load in cut and packaged street fruits: The implications for food safety in Tamale Metropolis".

We would be most grateful if you could give her the necessary assistance from your outfit to enable her progress to the collection of data.

Thank you.

Yours faithfully,

Dr. Augustina Araba Amissah
HEAD OF DEPARTMENT