UNIVERSITY OF GHANA

COLLEGE OF BASIC AND APPLIED SCIENCES

MICROBIAL CONTAMINATION OF FOOD AND FOOD SAFETY PRACTICES OF STREET FOOD VENDORS IN SELECTED MARKETS OF ACCRA, TAKORADI AND SENCHI, GHANA.

BY

FLORENCE DZIFA BANSAH
(ID. NO. 10192781)

THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF PHD ENVIRONMENTAL SCIENCE DEGREE.

INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES

JULY, 2018

DECLARATION

This is to certify that this thesis is the result of research undertaken by FLORENCE DZIFA BANSAH towards the award of the Doctor of Philosophy in Environmental Science in the Institute for Environment and Sanitation Studies, University of Ghana.

……………………………………….   ...…………………………………

Florence Dzifa Banasah
　　(Student)   Date

………………………………………   ………………………………

Prof. Esther Sakyi-Dawson
　　(Supervisor)   Date

……………………………………….   …………………………..

　Prof. Patrick Ayeh-Kumi
　　(Supervisor)   Date

……………………………………….   ………………………………

Dr. Jesse S. Ayivor
　　(Supervisor)   Date

ABSTRACT

Street food vending plays an important role in the economies of developing countries. The process of preparing, handling and storing food by streetfood vendors, however, leaves much to be desired as basic hygiene and food safety issues are particularly important because food and water are essential requirements for living. Failure to observe proper food safety practices exposes people to all manner of foodborne diseases and death. In Ghana, though the state agencies responsible for food safety have been providing food safety education for many years, not much has been achieved. This study sought to investigate food safety and hygienic practices of street food vendors in selected markets in Accra, Takoradi and Senchi. Primary data was derived from administration of a set of 300 questionnaires among randomly selected respondents aged 18 to 66 years who took part in the study. A total of 15 stakeholders from the FDA, EPA, GSA, MMDAs and 1 metro health directorate of the Assemblies were also interviewed using a structured interview schedule developed for the purpose. Additionally, 116 food and 22 water samples for the two seasons (Wet/Dry) were collected and analysed in the laboratory and the results analysed using Bivariate and Multivariate regression analysis. The results showed that age and education appeared to be important factors for food safety perception while education and training on food safety were factors influencing attitude on good hygiene practices. The study revealed that majority of respondents had limited knowledge on microorganisms and their effect on human health. In all, attitude/perception, age, education, training, medical screening and certification of food vendors largely influence food safety practice. The number of years in street food vending had no relationship with the adherence to food safety practices (0<0.05). Results on laboratory analysis of food and water samples for the study sites revealed varying levels of microbial contamination. It was concluded that Coliform and *Salmonella sp.* observed in food/water samples implies

that sanitary conditions at most food vending sites were due to poor personal/food hygiene and poor temperature control of food due to frequent power outages ('Dumsor'). The study recommended that regulatory bodies such as the Environmental Protection Authority, Food and Drugs Authority and the Metropolitan/Municipal/District Assemblies (MMDAs) should be more aggressive in enforcing safety standards to avoid foodborne diseases and food poisoning. Community members must participate in communal labour activities during National Sanitation Day to promote sanitation and good health. Policy makers and leaders should exercise the political will and commitment to sustain, control and eliminate activities in scaling up known interventions to produce better health outcomes. This will help improve the health status of people, reduce morbidity and mortality associated with unsafe food, water, poor sanitation and hygiene.

DEDICATION

This work is dedicated to my beloved late mother, Mrs. Agnes Maku Bansah and my two lovely daughters, Stella and Amanda.

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADA   Asuogyaman District Assembly

AMA   Accra Metropolitan Assembly

ARI   Animal Research Institute

BPA   Baird Parker Agar

BVA   Bivariate Analysis

CAC   Codex Allimentarius Commission

CBAS   College of Basic and Applied Sciences

CCPs   Critical Control Points

CDC   Centres for Disease Control

CFHC   Codex Food Hygiene Committee

Cfu/g   Colony Forming Units per gram

CHPS   Community Health Planning Systems

CSIR   Centre for Scientific and Industrial Research

CSPI   Centre for Science in the Public Interest

COI   Cost of Illness

DDT   Dichlorodiphenyltrichloroethane

DHS   Director of Health Services

ECHCPD-G European Commission Health and Consumer Protection Directorate-General

Ec   *Escherichia coli*

EMBA   Eosin Methylene Blue Agar

EPA   Environmental Protection Agency

ERC   Ethical Review Committee

ETHEC   Enterohaemorrhagic *Escherichia coli*

EU   European Union

FAO	Food and Agriculture Organization
FCA	Food Control Agency
FDA	Food and Drugs Authority
FM	Frequency Moderation
FRI	Food Research Institute
g	gram
GES	Ghana Education Service
GDPs	Gross Domestic Products
GHP	Good Hygiene Practices
GHS	Ghana Health Service
GMP	Good Manufacturing Practices
GMJE	Ghana Medical Journal Editorial
GNA	Ghana News Agency
GSA	Ghana Standards Authority
GSFP	Ghana School Feeding Programme
GSS	Global Salmonella Surveillance
GWC	Ghana Water Company
HACCPs	Hazard Analysis and Critical Control Points
ICMSF	International Commission on Microbiological Specifications for Foods
IEC	Information, Education and Communication
IESS	Institute for Environment and Sanitation Studies
JHS	Junior High School
KAP	Knowledge, Attitude and Practices
LIs	Legislative Instruments
MANOVA	Multivariate Analysis of Variance

MDHDs   Metro/District Health Directorates

MIDA   Millennium Development Authority

MLG   Ministry of Local Government

MMDAs   Metropolitan/Municipal/District Assemblies

MMDHDs   Metropolitan, Municipal & District Health Directorates

MoFA   Ministry of Food and Agriculture

MoH   Ministry of Health

MVA   Multivariate Analysis

ND   Not Detected

NFS   Nutrition and Food Science

NSD   National Sanitation Day

OPD   Out Patient Department

OPDA   Oxoid Potato Dextrose Agar

PCA   Plate Count Analysis

PNDCL   People's National Defence Council Law

PPM   Pour Plate Method

PPP   Punishment, Penalties and Prosecution

RICP   Recommended International Code of Practice

RTEs   Ready to Eat Foods

SHEP   School Health Education Policy

SLDFBs   Small and/or Less Developed Food Businesses

SMSTQA   Standards, Metrology, Standardization, Testing and Quality Assurance

SPSS   Statistical Package for Social Sciences

SSA   Salmonella/Shigella Agar

STMA   Sekondi-Takoradi Metropolitan Assembly

TCBSS   Thiosulphate Citrate Bile Salt Sucrose

USA   United States of America

USDs   United States Dollars

USFDA   United States Food and Drugs Administration

USNRC   United States National Research Council

USNACMCF   United States National Advisory Committee on Microbiological Criteria

               for Foods

VRBA   Violet Red Bile Agar

WC   Water Closet

WHO   World Health Organization

WTP   Willingness to Pay

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Globally, urbanization has brought about street food consumption in providing the nutritional requirements of the increasing population. Consumers have become victims of food and waterborne diseases and as a result, many people fall sick and die of eating and drinking unsafe food and water World Health Organization (WHO, 2012). According to WHO (2007), food and waterborne illnesses cost nations millions of United States Dollars (USD) in reduced or lost economic productivity, medical and legal expenses. The United States of America (USA), for instance, spends about $5 billion to $17 billion on health care on annual basis (Doyle and Erickson, 2007; Tribe, 2008). Water-Aid (2006) and WHO, (2008) revealed that 2.2 million people die annually of food and waterborne illnesses with 1.9 million of them being children, students and the immune-compromised.

In developing countries, 80% of foodborne diseases are associated with the presence of microorganisms due to poor sanitation and personal hygiene (Water-Aid/WHO, 2006; Rheinlander *et al*., 2008). Ministry of Health (2010) indicated that 420,000 cases of foodborne diseases are recorded in the outpatient departments of Ghana annually with death estimate of about 65,000 per a total cost of US$69 million to the Ghanaian economy. According to WHO (2013), the safety of food depends on freedom from pathogenic microorganisms and contamination resulting from careless storage, exposure and handling. A study by Elmi (2004), showed that food safety embraces anything in the production, processing, preparation, distribution from retail, handling and food service business in ensuring its safety for consumption. The food chain and food safety do not do not depend on producers and processors alone but involves consumers also. The GMJE

1

(2005) and WHO, (2010) revealed that there is the possibility of food becoming contaminated at any point in the food chain by pathogens. Pathogens for example, *Escherichia coli*, *Salmonella sp. Staphylococcus aureus*, *Listeria sp.* and other viruses such as Hepatitis A and E are transmitted by food where they grow to cause foodborne illnesses to the susceptible consumer.

1.1.1 Street foods

The Food and Agriculture Organization (FAO) in 2012, explained 'street food' as a variety of ready-to-eat (RTE) foods and beverages. Types of street foods include:

- foods that are prepared, vended at various public places and sometimes prepared at home and transported to sell at a particular location or at vending sites during some specific occasions;

- foods prepared and sold *in-situ;*

- foods which are prepared halfway at one location and completed at another location for immediate consumption or later in the day;

- food cooked elsewhere and moved from point to point where there is heavy human activity or potential customers along the streets during festivals/carnivals, fun games, markets, roadsides, lorry stations, parks, schools, military, nursing homes, prisons, hospitals, construction sites and virtually all locations (WHO, 2010; Yadav *et al*., 2011).

Gadi *et al.,* (2013) posited that about 2.5 million people consume street food daily. According to Feglo and Sakyi, (2012) and FAO, (2012) eating fresh fruits and vegetables are believed to be of major health hazard. Street food business in Africa is booming due to rapid population growth, urbanization and the pattern of food demands by the populace William, (2009); Donkor *et al*., (2011). Street food-vending reduces unemployment in the

2

cities and distinctively provides basic need to the urban inhabitants (Fellows and Hilmi, 2012; WHO 2013). It also provides abundant informal but scarce labour opportunities, particularly for unskilled workers and in comparison with the formal sector, employs more than 37% of the labour force averagely, and adds about 38% to the total Gross Domestic Product (GDP) in Africa. Street foods vary from countries, regions and ranges from western/traditional types of snacks and fruits to complete meals (Collison *et al.,* 1995).

Ackah *et al.,* (2011) in their studies estimated that about 60,000 street food vendors were in Accra. Ayeh-Kumi *et al.,* (2009) posited that in Accra, selling ready to eat foods serves as a source of employment among persons with little education and training and as a source of livelihood for many immigrants generating an amount of over US$24million annually. It contributes to substantial income inflows for households in alleviating poverty (Lues *et al.,* 2006; Muinde and Kuria, 2005; WHO, 2013). Even though street-vended foods have become the most important aspect of the food chain, safety is not well considered. This study sets to investigate food safety practices of street food vendors and consumers at selected study sites so as to generate information through education and advocacy for improvement.

1.2 Problem Statement

Food and water are essential to life but if contaminated can have a debilitating effect. Food safety is highly dependent on sanitation and hygiene and vital to all consumers because contaminated food contains pathogenic bacteria and viruses which when consumed, causes infection later destroying the cells and vital organs. Proietti *et al.,* (2014) stated that 98% of population increase with rapid urbanization and rising unemployment occurs in developing countries, with high demand for cheap food. An average of 10,000-20,000 persons per 1,000,000 of the world's population suffers yearly from foodborne diseases in

developing countries (Blackburn de wit *et al.*, 2002; WHO, 2012). MOH (2010) revealed that food related illnesses are on the rise in Ghana due to the high rate of unemployment and the burden of the poor urban women to take care of the home; proliferation of ready-to-eat food vendors not observing sanitation and hygiene practices around their premises during food preparation and inadequate monitoring of street food vendors by public health practioners; large numbers of less educated informal sector workers who care little about safety; and general low levels of income may prevent people from patronizing standard catering services thereby exposing them to food safety hazards. Reports of unsafe food with no epidemiological data on foodborne illness and related infections are grossly under reported (GMJE, 2005; MOH, 2010). Also food regulatory authorities such as the Food and Drugs Authority (FDA), the Environmental Protection Agency (EPA), Ghana Standards Authority (GSA) and the MMDAs have been providing food safety education for many years but with relatively poor results in protecting consumers. This may be due to lack of adequate or coherent information, education and communication (IEC) to inform policy makers. This study therefore seeks to find obstacles to food safety, and causes of food poisoning to help direct the necessary intervention programmes to improve the situation.

1.3 Objectives of the Study

The main goal of this study is to investigate obstacles to food safety and causes of food poisoning to help direct the necessary intervention programmes to improve the situation. The specific objectives are to:-

i. find out the attitude and perceptions of food vendors/consumers on food safety practices;

ii.   investigate measures for food safety compliance put in place by street food vendors during purchasing of food items and storage, and assess the cleanliness of utensils used in food preparation and food services;

iii.   evaluate the kinds of food safety hazards that consumers are exposed to due to leftover food handling; and the risk factors associated with consumption of leftover food;

iv.   assess the food laws and compliance put in place by institutions responsible to ensure food safety by food vendors and consumers and;

v.   determine microbial levels of selected food items and water samples.

1.4 Hypotheses of the Study

Ho_1 Food handling under hygienic and sanitation condition does not reduce food contamination and poisoning.

Ha_1 Food handling under proper hygiene and sanitation condition reduces food contamination and poisoning.

Ho_2 Food handling under proper purchasing of raw materials/foodstuff, storage and utensils used during food preparation/food services cannot prevent food contamination.

Ha_2 Food handling under proper purchasing of raw materials/foodstuff, storage and utensils used during food preparation/food service can prevent street food contamination.

Ho_3 Compliance with food laws is not directly correlated to food safety.

Ha_3 Compliance with food laws is directly correlated to food safety.

1.5 Research Questions

Based on the objectives, the study sought to answer the following questions:

5

1) What are the attitudes and perceptions of food vendors/consumers about food safety practices?

2) What measures in food safety compliance do street food vendors put in place during purchasing and storage, and the nature of utensils used during food preparation and other services?

3) How are leftover foods handled by street food vendors and what type of food safety hazards are consumers exposed to?

4) What are the microbial levels of selected food items (cooked and uncooked) and water samples under study?

5) How does food laws/compliance by stakeholder institutions ensure food safety?

1.6 Rationale of the Study

Studies have shown that in developing countries, selling ready to eat foods remain the main contributor to the economy especially in urban centres (FAO/WHO, 2005). A study by the WHO, (2013) revealed that even though it helps to reduce unemployment rate, it also contributes positively to the national economy and greater part of the budget is spent on it. It was estimated by WHO, (2010) that about 1.5 billion diseases of diarrhoeal cases which occurred globally are of food and waterborne origin. Sefa-Dedeh (1993) proposed in a study that food prepared outside the home, can be a potential source of serious health risk. Tortoe *et al.,* (2013) observed that food safety matters a lot because food is an essential requirement for living and failure to observe safety practices exposes people to all manner of foodborne diseases.

Food safety according to (FAO/WHO, 2007; Velusamy *et al*., 2010; WHO, 2013) is a global health concern and knowledge of microbial pathogens and detection in food promotes easy recognition and prevention of foodborne related problems to health and

safety. Effective food safety programmes are focusing on reducing foodborne diseases to prevent global catastrophy (WHO, 2005/2013). Food control and safety issues involves careful understanding of every step from raw materials to consumption and a number of factors (MOH, 2010; Schmidt and Rodrick, 2003). This study is very significant since findings could help to assess good hygiene and sanitation practices that affect ready-to-eat foods, determine the microbial quality of selected street food and water samples and to establish a baseline for future studies of microbial contamination of street foods by giving useful recommendations on appropriate policies and strategies which enhances utilization of food safety, hygiene, health and food services in Ghana.

1.7 Significance of the Study

The WHO in (2013) reported that street food vending is a major contributor in reducing unemployment and boosting the economy of most developing countries. Consumption of street foods often features prominently in many national statistics as a source of foodborne diseases outbreak (MOH, 2010). According to Mead *et al.*, (2009), foodborne illnesses recorded 1.3 million cases, 21,000 hospitalizations and 5000 deaths yearly. It is therefore envisaged that;

1. This study will be useful in assessing the impact of food laws and various policies implemented by the government to improve health.

2. The study will assist policy makers to develop sustainable policies that consider the socio-cultural/demographic and economic factors that affect food safety and nutritional health services.

3. This study will help to determine the effectiveness of preventive measures such as good hygiene and sanitation practices that affect street food safety, improve the

health status of people, reduce morbidity, mortality and enhance future studies of microbial contamination of street foods in Ghana.

1.8 Organization of the Thesis

The chapters of the study are as follows:

1. Chapter One: Covers the general introduction and a brief background of the study, problem statement, objectives, research questions, hypotheses, rationale, significance of the study and chapters of the study.

2. Chapter Two**:** Looks at related literature on food safety.

3. Chapter Three: Presents various materials, methods and procedures employed for the study.

4. Chapter Four: Provides information on the analysis of the reults.

5. Chapter Five: Presents discussion of the results

6. Chapter Six: Presents the conclusions and recommendations respectively.

   References: Provides a list of references used in the study.

   Appendices: Presents a list of relevant appendices.

CHAPTER TWO

2.0 REVIEW OF LITERATURE

2.1 Overview of Food Safety

Over the past few decades, most countries have documented significant increase in the diseases and pathogens in food, e.g. *Salmonella sp. Escherichia coli*, *Staphylococcus aureus* and parasites such as *Cryptosporidium* (Okolie *et al*., 2012). Studies have shown that street foods serve as a source of cheap but necessary source of nutritious food for urban and rural poor. In contrast to these benefits it provides, it is also a potential source of gastrointestinal infections (USDA, 2008). The WHO, (2007) revealed that the risk of ready-to-eat food consumption depend mainly on the kind of food, its mode of preparation, the manner of handling and the source of water.

2.2 What is Food Safety?

Food safety is the "assurance that food products do not cause adverse effects on the health of the consumer when it is prepared and or eaten according to its intended use" (FAO/WHO, 2007). This means that when food has been exposed to harmful agents could be potentially harmful to consumers when safety guidelines are not followed. Over the years, most countries have documented increase in the diseases and pathogens in food, e.g. *Salmonella sp., Escherichia coli, Staphylococcus aureus* and parasites such as *Cryptosporidium* (WHO, 2007). Satin (2008) explains food safety as a scientific discipline in handling, preparation, and storage so as to prevent foodborne illness with steps that are followed to avoid hazards.

Codex Allimentarius Commission (CAC, 2007) explains food hazard as "a biological, chemical or physical agents in food, or condition of food, with the potential to cause an adverse health effect". For example an injury, foodborne diseases or death. Food safety in

this context looks at the wholesomeness of food and water being free from microbial pathogens (Centre for Food Safety, 2007). This may involve series of routines which when observed prevents severe health hazards. According to Bryan, (1990) for food hazard to occur, the following events are likely:

1. The hazard must be in the food handlers, in the food, or the premises where the food is being processed or handled;

2. The food must be contaminated by the hazard;

3. The hazard must proliferate in sufficient numbers to cause illness;

4. The hazard must survive the processing and handling system; and

5. The victim must ingest a sufficient amount of the hazard to become ill.

Essentially, food safety procedures seek to protect against, contain and eliminate hazards from foods (WHO, 2013). For the past few years, most developed countries have documented significant increases in the diseases caused by microorganisms and pathogens in food. In Ghana, studies conducted by Ayeh-Kumi *et al*., (2009) revealed increase in parasitic intestinal infections in food vendors in Accra. Donkor *et al*., (2011) in a study applied the '5 Keys' by WHO (2007) to improve safer food handling practices by vendors in Chorkor while microbial quality of foods sold on the streets of Accra was investigated by Mensah *et al*., (2002) as factors responsible for food contamination. The '5' Key Principles of food hygiene by the WHO (2006) are the practices that prevent food related hazards. These are as follows:

1. Prevent spreading of contaminants from people, pets and pests.

2. Prevent contaminating cooked foods by separating raw and cooked foods.

3. Adequate time and temperature to destroy pathogens when cooking.

4. Storing food at the appropriate temperature.

5. Using clean water, utensils and raw materials that are safe for cooking.

10

2.2.1 Sanitation, hygiene and safety

Sanitation, according to Marriot and Gravani, (2006); WHO, (2007) is the provision of facilities and sanitary services for the safe but effective processing and disposal of liquid and solid wastes, maintaining hygienic conditions in reducing environmental pollution, causes of foodborne illness and food spoilage. Effective sanitation promotes health, prevents human contact with hazards related to contaminants and the control of vectors or living organisms that transmit diseases. Improper sanitation is the major cause of illnesses world-wide and effective sanitation is significant on health in households and among communities.

According to Hui (2004), sanitation encompass cleanliness and housekeeping of premises and surroundings, equipment/utensil production and maintenance, cleaning and sanitizing, pest control, water supply, personal hygiene, waste disposal and many more because these are potential points of contamination. Marriott and Gravani, (2006) found out that to achieve a high level of safety and sanitation there must be a food safety manual to cover each process, step, systems and procedures to ensure safe food across all aspect of food service.

2.2.1.1 Hygiene

The CAC (2007) defined hygiene as the conditions and practices that prevent or reduces the spread of infectious diseases transmission in social settings e.g. public transport and work places. Hygiene is also the various practices performed for the maintainance of health which mainly focuses on personal cleanliness in preventing infectious diseases. Hygiene includes procedures in food/water, kitchen/utensils, environmental hygiene and many others. Bas *et al*., (2007) explained Hazard Analysis and Critical Control Point (HACCP) as "targeted hygiene" which is a risk-based approach developed by the International

11

Scientific Forum on Hygiene in detecting the spread of pathogens and observing hygienic steps at critical points and times in breaking the chains of infection.

Hygiene promotion and improvement focuses on the skill, knowledge and practices of personal cleanliness to change an individual's attitude towards good health (WHO, 2012). Safe hygiene practice includes handwashing before eating and safe faeces disposal. Transfer of knowledge and understanding of hygiene through education and associated health risks are promoted and carried-out in order to help people change their attitude and enhance practices of hygiene (MOH, 2010).
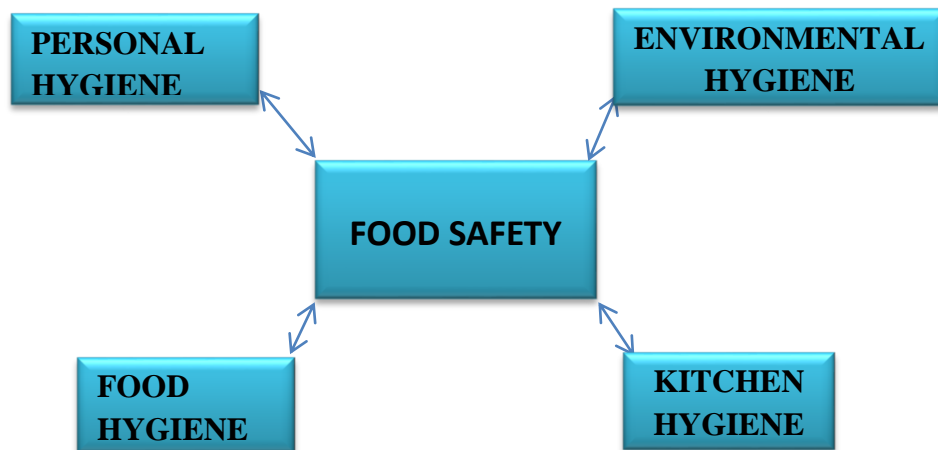
Figure 2. 1: Four Arms of Hygiene in Food Safety
Author's construct: 2016-2017

2.2.1.1.1 Personal hygiene

Gordon (2006) revealed that personal hygiene is the basic concept and principle in maintaining cleanliness and grooming, and caring for the body as an integral aspect of our daily lives. It is the maintenance of health in general and primarily directed towards preventing diseases and discomfort. Personal hygiene however, is often not regarded and improper hand washing, for example, results in contracting foodborne diseases. It behoves food handlers and stakeholder companies to promulgate specific rules and regulations

12

regarding personal hygiene procedures such as employee illness policy, wearing of appropriate uniform and following other safety procedures to prevent the spread of foodborne illness (WHO, 2010). As employers/food handlers are educated in the industry, the cook in the domestic setting must learn to keep surfaces clean regularly in maintaining standard hygiene practices and cleanliness to prevent food contamination.

Food handlers should therefore be encouraged to observe the following practices when handling/preparing food: thoroughly but frequently wash and dry hands before handling food, dry hands with clean towels or disposable paper towels or under an air dryer; never smoke, chew gum, spit, change a baby's nappy or eat in a food handling or food storage area; never cough or sneeze over food or where food is prepared or stored; wear clean protective clothing, such as an apron; keep spare clothes and other personal items away from where food is stored and prepared; always keep hair covered; keep finger nails short so they are easy to clean, and avoid wearing nail polish as it can chip into the food; avoid wearing jewelry; cuts or wounds must be completely covered by a waterproof wound strip or a bandage; use brightly coloured wound strip if they have wounds on their hands; change disposable gloves regularly; and report illnesses with the following symptoms (jaundice, diarrhoea, vomiting, fever, sore throat and visible infected skin lesions) to the employer/doctor (CAC, 2003; 2007; Schmidt and Rodrick, 2003; WHO, 2006).

2.2.1.1.2 Kitchen hygiene

The WHO, (2006) stated that the kitchen is the most important place in the food preparation sector. Neglect of care in cleaning the environment and utensils during food preparation could result in foodborne infection. Kitchen hygiene is of great importance to:

i. Workers in the kitchen: because clean working conditions are agreeable to work in than dirty conditions.

13

ii.   The owners: because customers would increase when the public knows the

kitchen is clean.

iii.   No customer would want to eat food prepared in a dirty kitchen.

Kitchen premises must have adequate ventilation so that fumes from stoves and stale air

are extracted from the kitchen (WHO, 2010). Screening of fitted windows and doors with

clean mesh prevents dust, insects and birds from entering. Glass windows and doors should

be thoroughly cleaned to allow maximum entry of light.

2.2.1.1.3 Food hygiene

Food hygiene is the sanitary science and an element of food safety though not the entirety

of it, aims to produce safe food of good keeping quality for the consumer (Hobbs and

Gilbert, 2008). Other definitions of food hygiene are as follows:-

1. Conditions, practices and services in preserving food quality in preventing
   contamination.

2. Compliance with safety measures to ensure the wholesomeness of food items
   according to EU's General Food Hygiene Directive (Anonymous, 1997).

3. Compliance ensures food safety at all stages of the food chain (Anonymous, 1997;
   CAC, 2007).

4. Food safety compliance ensures the safety and control of hazard of a food item for its
   intended use (Taylor, 2008).

Food is obviously not clean nor guaranteed to be safe from hazardous toxins or chemical

residues, or potential harmful microorganisms (WHO, 2006). Good hygiene practices

however enhance the chances of achieving food safety. Taylor (2008) posited that

microbiological status of food when finally served or retailed should, reflect the

14

effectiveness of compliance with the principles of food hygiene. The most important thing to consider when serving food, is to consider the unsafe aspects and take precautions. Food Hygiene practices include:

- Adequate cleaning and disinfection of the premises, avoid the use of same utensils and cutting boards for raw ingredients (Centre for Food Safety, 2007). Disinfectants e.g. chlorine bleach, ethanol, ultraviolet light, may be used in cleaning.

- Cooking of meats adequately and handling raw foods with extreme care to avoid cross-contamination by *Salmonella* and other pathogens.

- Washing dishes with soap and clean water, not using serving utensils that have been licked, washing hands thoroughly before and after touching any uncooked food during cooking, not using the same utensils in preparing different dishes nor sharing cutlery when eating and not licking fingers and plates when or after eating.

- Adequate storage and refrigeration of foods (first in-first out) in safe environments as well as labelling food to show its date of manufacture e.g. "best before" date (Centre for Food Safety, 2007).

2.2.1.1.4 Environmental hygiene

Environmental hygiene is sanitary science and an element of food safety which considers the environment, necessary conditions in controlling hazards to ensure the survival of living things (Ofori, 2010; Ameyaw, 2000). It takes into account activities such as solid waste collection and liquid waste disposal, cleaning and sanitizing, water supply, pest control in reducing food contamination, food spoilage and foodborne illness. This involves improving and maintaining basic conditions and standards in the protection of food from biological, physical or chemical contaminants, clean but safe surroundings for ambient air.

15

Environmental hygiene is focused on prevention of health hazards and maintaining safety of the environment (Centre for Food Safety, 2007).

2.2.2 Food safety issues in Ghana

The Centre for Food Safety (2007) observed that foodborne diseases are perceived by most countries and for that matter developing countries e.g. Ghana as issues of daily life. Diarrhoea is regarded by most people as an inconvenience rather than a symptom of disease (Elmi, 2004). The FDA, (2012) revealed that food related issues are on the rise in Ghana. Ayeh-Kumi *et al*., (2009) observed that most local farmers irrigate their vegetable farms with water from drains and farm yard waste as fertilizer which are potential sources of microorganisms e.g. *Salmonella* and *Escherichia coli* that affect the wholesomeness of these food crops. Floor water systems are polluted with animal and human waste due to poor sanitation which eventually pollute farm lands, crops and water bodies during the raining season (Melnick *et al*., 2008).

2.2.3 Markets

Addo (1998) stated that markets are important components of the economic landscape which serves as places for commodity, services and sources of information exchange, local administration, health delivery, education, entertainment and many others. A study by Ofori, (2010) revealed that globally, local markets are organized periodically and are basis for the convergence of people in exchange of goods and services. According to Aryeetey and Nyanteng, (2006) urban markets operate daily and do not have overly of periodicity, that is, special market days when there is significant increase in marketing and trading activities contributing to the livelihoods of the population in the informal sector.

In Ghana, markets are popular for their buzzing trade activities which hosts traders from all walks of life, including international traders (Addo, 1998). Most of these markets have their peak market days especially on Saturdays where goods such as staple foods,

vegetables, fish, oils, second-hand clothing to appliances are sold. These markets also need expansion and upgrading of facilities. Ofori (2010) in his study of local markets also revealed that trading activities and issues of sanitation and hygiene adversely affect the environment therefore needs greater attention.

2.2.3.1 Selected bye- laws of the MMDAs relevant to the study

Bye-laws are rules and regulations made by local governments to guide the behaviour of a group of people in that organization to obey. For this study, the following bye-laws are deemed relevant.

2.2.4 Summary of contents of Bye-laws of the MMDAs

A. Markets Bye-laws (2000)

B. Restaurants and Eating Houses Bye-laws (2000)

C. Hawkers Bye-laws (2000)

D. Solid and Liquid Wastes Management Bye-laws (2000)

E. Growing and sale of fruits/vegetable Bye-laws (2000)

F. Cleansing Bye-laws (2000)
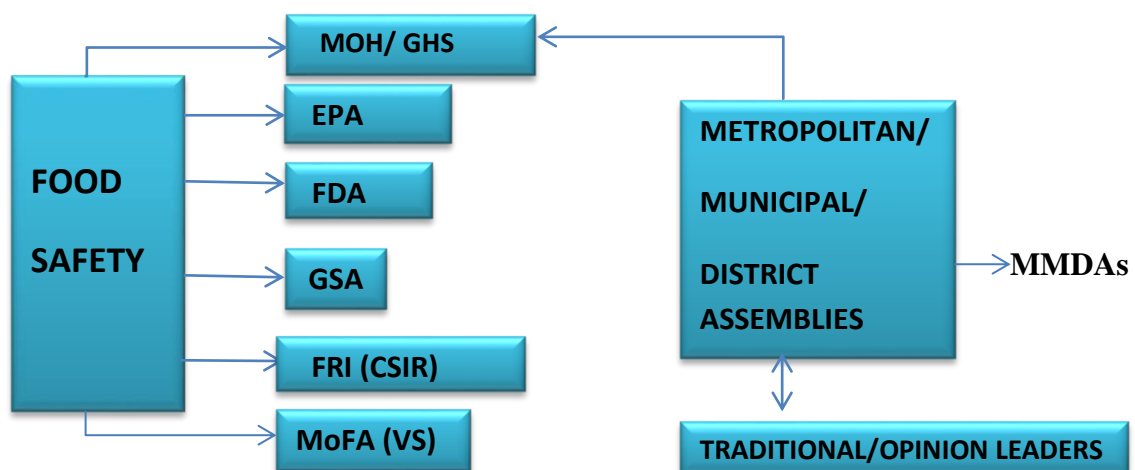
Figure 2. 2: Stakeholder Relations of Food Safety

17

2.2.4.1 Relevant stakeholder relations of food safety and their functions

Functions of the stakeholders are deemed relevant in this study. The MOH works with these institutions for the provision of health services. It carries out steps in protecting public health, administration and enforcement of legislation in relation to environmental health and providing assistance to minimize health and safety challenges. This helps to enhance both public and private sector practitioners to provide congenial environment for efficient management decisions with traditional and opinion leaders at the national, district and community levels. Even though there are no collaborations among these institutions, they work towards the same goal in ensuring public health. These responsibilities are summarized as follows:

- Food hygiene and market sanitation

- Vector and pest control

- Promoting/monitoring activities for environmental health education

- Enforcement of sanitation bye-laws

- Collection, transportation, disposing of both solid and liquid waste

- Compilation and reporting of problems requiring inter-sectorial collaboration (Appendix 1).

2.3 Microbial Safety of Street Foods

Rahman *et al*., (2012) stated that food safety is a relevant global issue, because foodborne illnesses caused by microorganisms result in many illnesses and deaths annually. Microbial contamination of foods revealed high levels of Total coliforms and *Vibrio cholerae* which causes diarrhoea, vomiting and sometimes death in most developing countries especially in at-risk groups (Yeboah-Manu *et al.*, 2010). It has been revealed that controlling and supervising large number of people is difficult when they are to be served with inadequate utensils (WHO, 2010).

18

It is important for food handlers to adhere to adequate personal cleanliness to avoid contaminating or transmitting foodborne pathogens to susceptible consumers who patronize their food. Ackah *et al*., (2011) posited that public health requirements in Ghana enjoins food vendors to undergo medical check-ups to prevent diseases e.g. tuberculosis, cholera, typhoid fever, dysentery and other contagious diseases. Food handlers must therefore be screened by appropriate regulatory bodies to ensure that they are in good health before selling to the public (WHO, 2008). In Ghana, one way of ensuring food safety is by periodic medical screening and certification of food vendors (Kissiedu and Tano-Debrah, 2002). Musa and Akande (2007) posited that the common means by which foodborne diseases can be regulated in developing countries is through medical screening.

2.3.1 Vulnerability of consumers

Street food serves as the nutritional source of food for consumers who may be particularly vulnerable and more seriously affected by an infection than a normal healthy person. These vulnerable groups include children, pregnant and lactating women, malnourished and the immune-compromised (Buccheri *et al*., 2007; Lund *et al.,* 2000). Food supply sources should be protected from hazards right from the farm to the table to ensure its safety. The potential sources of physical contaminants for example insect parts, hair pieces, finger nails, and others which may not be seen, poses a great danger especially to the consumer (WHO, 2004). They are likely to cause fatalities in these vulnerable groups especially children sometimes by obstructing the airways or by lacerating internal organs when swallowed.

2.3.2 Chemical contaminants in food

Chemical substances such as expired antibiotics used in animal feed and in water, or as drugs given to livestock/poultry sometimes renders these animals/products unsafe and

result in food poisoning. These interact with the tissues and tend to accumulate in the various organs of the body or with the body's natural flora, which releases compounds to combact the unfamiliar chemical (WHO, 2005). Barker *et al*., (2014) posited that risks associated with different toxicants levels of exposure vary ranging from simple or mild reactions to complex or chronic diseases and allergies. The FDA, in 2012, reported that contaminants result from the use of food additives adversely affect health. Institutions such as the European Union (EU), the United States Food and Drugs Administration (U.S.FDA, 2009) and other intitutions e.g. the (CAC, 2007) have set maximum levels for contaminants and additives to consumers for respective regions and member states. These maximum levels are purposely set to control the toxicity or the level of potential contaminants present in the food chain (European Commission Health and Consumer Protection Directorate-General (ECHCPD-G, 2008; CAC, 2007). For example, aflatoxins, lead, mercury, nitrates, and many others found in naturally raw food may occur as a result of processing (ECHCPD-G, 2008). Most foodborne illnesses resulting from consumption of tainted or chemical farm products enter the body through the alimentary canal and may cause abdominal discomfort, diarrhoea, nausea and vomiting. These sources of chemical contaminants may only be identified and traced if good farm records are kept by farmers; and if consumers can be able to identify the source from which the food was obtained.

2.3.3 Risk factors and etiological agents for foodborne illness in street food

Foodborne illnesses occur by ingesting unwholesome food *(*Gadaga *et al.,* 2004; MOH, 2010*)*. Low standards of personal hygiene in communities have shown that street foods are a significant cause of diarrhoea and high risk of infectious diseases. Legnani *et al*., (2008) observed that these diseases associated with street foods are substantially under-reported or not documented. It is estimated that (15%) – (70%) of all diarrhoeal outbreaks are due to potential sources of pathogens transmitted through food, water,

20

utensils/equipment, practices associated with food preparation, handling, raw ingredients, storage methods and the environment Gadaga *et al.,* (2004); MOH, (2010).

Many studies have investigated the most significant foodborne cases in street food services. The risk factors identified fell into five categories: improper preparation, inadequate temperature holding equipment, cross-contamination during food handling, purchasing food items from unsafe food sources as well as poor personal hygiene (Clayton and Griffith, (2009); Grintzali and Babatsikou, (2010). The latter three factors are associated with contamination while improper cooking and inadequate holding temperatures allow the growth and survival of the microorganisms present. However, diseases outbreaks are usually due to many factors (single/multiple causes) including pathogens (e.g. bacteria, viruses, parasites and algae) and their toxins, chemical and physical contaminants (Schmidt and Rodrick, 2003).

Daniels *et al.,* (2002) and Mead *et al*., (2009) stated that foodborne illnesses in the United States are those outbreaks with identifiable etiology, bacterial pathogens remain and caused the largest percentage of outbreaks in street foods (85%) chemical agents (7%) and viral agents (6%) are the cause of significant disease outbreaks and parasitic pathogens (1%). A similar review of gastrointestinal outbreaks by Lee and Greig, (2010) showed that majority of the 121 outbreaks were caused by bacteria (51%). However, in their review viral agents were responsible for (40%) of outbreaks.

The WHO (2007), revealed that exposing food to hazardous agents results into several foodborne ailments. According to the report during diseases outbreak, most of the patients do not consult a doctor and blood and faecal specimens are often not obtained. This is further compounded by the fact that some pathogens causing foodborne illness may be transmitted in water or from people while others are emerging and are not yet identifiable

or able to be diagnosed (Bloomfield *et al*., 2007). Consequently poor hygiene practices when preparing and preserving food, leads to frequent outbreaks in the various groups of consumers.

This finding was attributed to the following: epidemiological selection i.e. tracing back to the source of production, non-adherence to quality assurance in food services, and refusal of employees and food vendors in observing critical steps (GMP/GHP) that helps to reduce foodborne illness. A study revealed that street food catering and other food services cause a substantial amount of foodborne diseases in many national surveillance data in Africa, Malaysia, United Kingdom and the Netherlands. The Centres for Disease Control (2006); Mead *et al*., (2009) revealed that disease outbreaks results in 700,000 deaths in Africa, 76 million illnesses, 325,000 hospitalizations and 5000 deaths yearly in England and Wales. The FDA (2012) and MOH, (2010) indicated that about 84,000 people die of diarrhoea and dehydration especially about (25%) of children under five years while staphylococcal food poisoning is estimated to cause 185,000 cases of foodborne illnesses yearly.

2.3.3.1 Cross-contamination

Cross-contamination occurs at any time through contacts of food with utensils and from hands to food. Brynestad *et al*., 2008 reported that cross-contamination is transferring physical but potential harmful bacteria from a place, a person, on the surface of an object or raw materials to other foods. Re-contamination also occurs when cooked food gets into contact with other raw food items or drippings with pathogens. Gadaga *et al*., (2004); Ayeh- Kumi *et al.,* (2009) observed that using contaminated water in preparing street food often causes diarrhoea. For example, fresh fruits and vegetables become contaminated when cleaned with water contaminated by animal/human waste.

According to Nagai *et al.,* (2009) there are two sources of contamination that occur by pathogens in raw materials to humans; undercooking and cross-contamination. It also showed that risk associated with locating pathogens in raw materials is due to low temperature and time which affects microbial quality of cooked food. This include raw eggs used in preparing different foods and fresh cream made with pasteurized milk (Yoon *et al*., 2008; Marzano and Balzeratti, 2011). The use of raw food items from unknown sources in the preparation of street foods remains a problem to contend with.

2.3.3.2 Role of (heat) temperature for cooking/cooling/reheating

Cooking is a very significant procedure in food preparation aside sensorial properties. Thermal heat in food preparation is able to enhance the safety of raw food items by destroying foodborne microorganisms and eliminating some of their toxins (CAC, 2007; Schmidt and Rodrick, 2003; WHO, 2006). The "5 keys to safe food manual" published by WHO, (2006) indicates that cooking food adequately at 70ºC ensures its safety for consumption. According to Schmidt and Rodrick (2003), foods vary in size therefore various temperatures give the culinary quality desired. Codex has stressed that the various time/temperature combinations should be sufficient so as to destroy non-sporing pathogenic microorganisms (CAC, 2007). The cooking process should be checked regularly to ensure adequate distribution of heat in all parts of the food to reduce bacterial load and activity. This prevents undercooking which may lead to survival and growth of microorganisms when the temperature of the food reaches the danger zone. A study by Omemu and Aderoju (2007), indicated that some street food handlers often sometimes cook food partially or completely ahead of time by storing and reheating them when customers request for it. Food is reheated mainly to warm and improve its palatability rather than destroying pathogens. This allows for rapid multiplication of bacteria and

23

production of toxins (Schmidt and Rodrick, 2003; Prescott *et al*., 2005; Muzaffar *et al*., 2009).

Poor practices of uneducated food vendors include serving/selling contaminated raw food items, inadequate cooking and reheating of food, purchasing food items from unsafe sources, inadequately thawing/cooling of foods and allowing many hours between preparation and eating (WHO Department of Food Safety, Zoonooses and Foodborne Diseases, 2002). It is not possible to differenciate taste, smell or appearance of a particular food is liable to cause food poisoning. Ray and Bhunia (2014) stated that during cooking, foods must be heated to the optimum temperature for mesophilic pathogens during cooling and reheating to lessen the period of heating food. Heated foods items that may be in this category must pass through the hazardous region, 60°C to 10°C, within 2 hours and immediately stored at or below 4° C (CAC, 2007).

Adequate reheating is necessary to improve food safety in serving as a safety tool when foods have been kept for less than 4 hours. This applies to food items that were already cooked and cooled so the reheating step is to control and reduce the vegetative cells from multiplying and contaminating food during preceding steps (Schmidt and Rodrick, 2003). CAC (2007) revealed that refrigerated foods must be reheated to 75°C within an hour. However, moderate temperatures can be employed during reheating provided sufficient time and temperature are used for destroying microorganisms is adequate to ensure the safety of food.

2.3.3.3 Cold holding/storage

According to the WHO, (2006) chilling and storage temperatures for chilled foods at or below 5°C are widely considered to be safe. Adams and Moss (2008), discovered that temperatures of up to 7°C are considered safe by some jurisdictions as such temperatures

are below the minimum for most spoilage and pathogenic organisms and are capable of preserving perishable foods. Psychrotrophic pathogens such as *Aeromonas hydrophila*, *Clostridium botulinum* (non-proteolytic), *Listeria monocytogenes*, *Yersinia enterocolitica* are able to grow at temperatures below 8ºC (CAC, 2007; Gandhi and Chikindas, 2007; Kilonzo-Nthenge, 2008), although they grow very slowly. Adams and Moss (2008), posited that when pathogens proliferate in greater amounts before chilling, or if temperature is improperly maintained during the storage period, the food could become contaminated and cause sickness.

Many studies conducted globally by Gilbert *et al.,* (2007) on refrigeration temperatures revealed that there is lack of knowledge relating to quality refrigeration practices. This affects the efficient use of refrigerators resulting in food contamination and spoilage. Frozen raw products which would not be used immediately should be stored at or -18OºC or below to prevent microbial multiplication and the effect of low temperature and low water activity because water in the food becomes ice (CAC, 2007). Some bacteria are destroyed or become dormant when foods are frozen but many survive and resume growth if the food is thawed and stored at a temperature within the danger zone (Adams and Moss, 2008). Thawing foods at temperatures above 5ºC allows pathogens on the surface of the food to thrive (Schmidt and Rodrick, 2003). Safe methods of thawing foods include using a refrigerator chamber below or thawing at a temperature of 4ºC; or under clean running water at a temperature of 21ºC within 4 hours; and using a commercial microwave oven followed immediately by convention cooking (CAC, 2007; WHO, 2006).

2.3.3.4 Unsafe food sources

During harvesting, transportation, storage and distribution, raw materials or ingredients used in food preparation may be contaminated through food contact with soil, water,

plants/utensils, humans, animal and air. In the year 2000, a study by Jay revealed that the premises where food is kept must be free from filth and sources of contaminants. During food handling, preparation, service or storage, hazardous sources e.g. chemical containers, over grown surroundings, refuse dumps as well as choked drains must not be near to the facility (Jay, 2000). Raw materials and water provide ideal conditions for pathogens to survive and proliferate. Some raw materials such as meat, poultry and seafood may contain some microorganisms because live animals may naturally harbour different microorganisms in the intestinal tracts and other vital organs (Borch and Arinder, 2002; Marriott and Gravani, 2006).

2.4 Organisms and Toxins of Food Safety Significance

Several sources of organisms affecting food safety, including microorganisms are known as biological sources of food contamination. Two important categories of microorganisms that exist are: pathogens and indicators (U.S National Research Council, 1985). Pathogens are microorganisms that causes harm to the consumer when they or their toxin(s) are ingested. Indicators are microorganisms whose presence in a food suggests at least one of the following:

- The presence of a pathogen or toxin.

- Non-conforming manufacturing procedure which may negatively affect shelf-stability.

- (An) ingredient of food not being fit for consumption.

Sainsbury and Singleton, (2006) reported that bacteria are free-living organisms that rely on pre-formed organic elements such as human beings for survival. In that study, they concluded that only a few bacteria occur as intracellular or extracellular parasites in man and/or other animals. For this reason, they exist discretely in the ecosystem and in foods

26

eaten by human beings. They can multiply in a living host with infectious particles that are shed into the immediate environment. This can result in a direct chain of infection spreading to other people if the opportunity arises directly or indirectly with other agents serving as carriers for foodborne pathogen transmission. It was estimated by Sainsbury and Singleton, (2006) that about 80% of foodborne diseases affecting consumers were attributed to the presence of microorganisms and/or their toxins introduced into food through diverse means. According to WHO (2010), most viral infections are spread through the enteric tract and are normally shed in faeces and become a potential source of foodborne disease transmission. Foodborne viruses that cause sickness are Hepatitis A, calicivirus and Norwalk virus (Newman, 2005). The body's systems and organs such as the brain are sometimes invaded by viruses which are able to cause debilitating illness.

Helminthes and other protozoans from meat and many species of animals are able to cause sickness by transiting into any organ during their developmental stages. For example, parasites such as *Giardia sp.* and *Toxoplasma gondii,* flukes, tapeworms and roundworms (Ayeh-Kumi *et al*., 2009; Newman, 2005). Most of these infections can be prevented if the food is thoroughly cooked to destroy them. However, most infections are commonly related to cultural and eating habits that have been in practice in populations for generations. The main reason for this behaviourcan not be clearly comprehended. This makes it easy for lapses to occur resulting in a threat to food safety. Microbes produce either enterotoxins or exotoxins which can cause harm to man and animals. The difference depends on either being produced before or after consumption of the infected food item. The following symptoms may be registered as a result of food infection e.g. enteric fever, vomiting, diarrhoea, headache and many others.

2.4.1 Food Safety: Possible health implications and associated risks

Ejemot *et al.,* (2009) revealed that touching prepared foods with bare hands serves as a potential source of pathogens contaminating food and water. Regular washing of hands and adequate washing of surfaces with soap and clean water not only drastically remove or reduce contamination of food by pathogens and utensils but mechanically and chemically destroy any colonizing flora, for effective washing. According to Ehiri *et al.,* (2001) washing of hands, surfaces and utensils with soap under clean running water or using large volumes of water and vigorous rubbing reduces contamination and believed to be more effective compared to washing hands without soap under running water which may be a significant source of contamination rather than preventing it since pathogens on human hands and surfaces are transferred to others who may wash their hands in a bowl of water (Schmitt *et al*., 2007).

2.4.2 Food safety knowledge, attitude and practices (KAP) of food handlers

Food handlers are a people who directly handle, package or unpackage food, equipment and utensils, or food contact surfaces and therefore necessary to comply with food hygiene requirements (CAC, 2003). In assessing perception, attitude and practices of food handlers on food safety in food service establishment has been widely conducted using questionnaires. The topics usually covered include foodborne disease, cross-contamination, temperature control, high-risk foods, personal hygiene and sanitation. Most studies have reported ignorance about control of temperatures of hot and cold prepared foods, as well as adequate refrigeration temperature ranges among street food vendors (Buccheri *et al*., 2010; Marriott and Gravani, 2006; Tokuc *et al*., 2009). However, perceptions about adequate temperatures was significantly high with those who had attained a higher standard of education and attended training and certification courses on safe food handling (Buccheri *et al*., 2007; Buccheri *et al*., 2010; Todd *et al.,* 2009).

28

Most studies recorded positive attitudes for storing food safely, adequate temperature control, effective food handling and use of clean clothing Buccheri *et al*., (2007); Tokuc *et al*., (2009); Buccheri *et al*., (2010), but respondents lacked knowledge on refreezing thawed foods. Angelillo *et al*., (2003) and Clayton and Griffith, (2009) asserted that though positive attitudes were expressed towards food safety by majority of the food vendors, self-reported practices were not consistently associated with positive attitude and knowledge. Tokuc *et al.,* (2009) suggested that this inconsistency might be as a result of poor training. Clayton and Griffith, (2009) showed that attitudinal changes in food handling are positively associated with safety training and improved attitudes. Buccheri *et al*., (2010) have suggested that improved knowledge alone is not always sufficient to stimulate preventive practices, and other steps are needed to encourage and generate positive behaviour into food handling.

2.4.3 Food preparation environment/premises

According to the ECHCPD-G (2008) the food preparation and processing premises although important are not regarded as source of contamination. Unhygienic design, construction, maintenance and repair activities that prevent easy cleaning and disinfection can promote the growth of pathogens and spoilage microorganisms that may be transferred directly onto product or carried into additional niches where they survive for long periods of time. Cracks and crevices in floors and walls, interfaces between floor and utensils, holes in the building or in the equipment serves as microbial hide-outs. Studies by Rzezutka and Cook (2004) have shown that wet environments encourage the survival and growth of pathogens than dry environments. Also, places where moisture accumulates e.g. sinks, kitchen floor and wet wiping cloths, supports bacterial growth and serves as sources of contamination. Todd *et al*., (2009) revealed that relative humidity around 50% in the

food preparation environment has been observed to be highly detrimental to most bacterial and viral species survival.

The FAO/WHO, (2006) have reported that the location of the physical facilities like kitchens is important since proximity to polluted environments are prone to flooding, infestations of pests where sewers and garbage dumps may affect the quality of food. Airborne microbes can easily diffuse from dust and aerosols to these areas to the food preparation environment due to air flow to contaminate food. Pest and domestic animals according to Marriott and Gravani, (2006) are recognized carriers of pathogenic bacteria and their presence in and around the food preparation environment can bring about contamination of food.

Ideally, the following conditions enhances food safety: the kitchen should be well lit, well ventilated and tidy; premises where food is prepared must be clean and easy to clean, storage areas in the kitchen should be protected from insects, pets/pests and domestic animals should be kept away from such facilities (CAC, 2003; Schmdit and Rodrick, 2003). Appropriate facilities must be provided to enhance cleaning, heating, cooling, cooking, refrigerating and freezing food, monitoring food temperatures, dry storage and waste disposal. Cold temperature holding equipments must be well-maintained and serviced regularly to ensure they operate in the right condition. Napkins and dish cloths must be washed and changed regularly. The WHO in 2006, revealed that adequate level of personnel cleanliness should be observed in facilities to prevent food contamination (Campos *et al.,* 2009).

2.4.4 Application of HACCP and temperature control of microbial hazards in food operations

The WHO (2007) explains Hazard Analysis and Critical Control Point (HACCP) as scientific and systematic steps taken to ensure food safety. HACCP is internationally recognized strategies on preventing known hazards by controlling the processes of food handling rather than the steps within the structure and layout of premises (Egan *et al*., 2007; Bas *et al.,* 2007). HACCP is accepted and approved as an effective means of preventing foodborne diseases when correctly implemented (FAO/WHO, 2007). It helps to identify risk factors that are critical and serve as basis for training and education of street food vendors and consumers.

CAC (2007) defines HACCP as "a system that manages food safety in addressing and analysing the control of biological, chemical, and physical hazards from raw material production, procurement, handling to manufacturing, distribution, and consumption of the finished product." HACCP is mainly to prevent occurrences of potential food safety challenges. This depends purposely on the type of food operation and identifying inherent risks specifically in the production or the preparation and serving of foods, and taking necessary steps to control the identified risks. According to the WHO, (2006) it places emphasis on monitoring and evaluating the critical control points by persons directly involved in handling food and serve as inexpensive food safety compliance.

The HACCP system replaces endproduct testing with a preventive system for producing safe food that has universal application to any type of food operation. In 2007, CAC elaborated a 12-part method of HACCP. The Codex protocol for the application of HACCP principles consists of five preliminary procedures and seven standard principles which serve as standard for both export and the supply of food to major retailers in most

countries and are recognized globally (FAO/WHO, 2007; Taylor, 2008). Though food manufacturing industries and larger companies have adopted HACCP in their operations, there have been challenges of implementation by smaller businesses.

Sun and Ockerman (2005) reported that implementation of HACCP in manufacturing companies differ from the foodservice business system. More hazards may occur as a result of time and procedures involved in preparing variety of foods to serving of meals. The handling and assembling, holding time and temperature, reheating procedure, and hygiene of personnel are factors that make street food operations distinct from food manufacturing. Challenges in HACCP implementation in smaller businesses have been identified and generally discussed. These include lack of expertise, regulations, legal requirements, financial constraints, purchasing power and more complex practices of food handling, infrastructure, facilities, education, training and non-government commitment. Seward (2000) suggested that there should be an easy way of 'HACCP' implementation for foodservice operations since they vary tremendously. Clayton and Griffith (2009) developed a system for catering services with possible critical control points (CCPs) which included cooking, hot holding, cold storage and reheating.

In 2006, the Codex Food Hygiene Committee (CFHC) developed a guidance document on 'HACCP' application in small and/or less developed food businesses. The term "small and/or less developed food business" (SLDFBs) means businesses due to their small size, lack of technical expertise, economic resources, or by how they operate, and the challenges in implementing 'HACCP' in their food service operations. The term SLDFBs also refers to the status of the food safety system and the number of staff or volume of production (FAO/WHO, 2006). The document aims to assist in national policy development, strategies and action plans in improving food safety and trade through the application of

'HACCP' in SLDFBs throughout the world. It identifies the barriers to the application of 'HACCP' in SLDFBs and provides solutions based on the experience of experts in their respective countries. In this regard, flexible approaches to the implementation of "HACCP" are described (Bas *et al.*, 2007).

Different approaches have been adopted by governments to facilitate 'HACCP' implementation in 'SLDFBs'. Catering/foodservice operations are the last part of the food production system before consumption hence implementing 'HACCP' in this area is essential in producing safe foods. According to Walker *et al.*, (2003); Bas *et al.*, (2007) the 'HACCP' system helps food handlers/managers to identify and control potential problems in their operation i.e. food preparation and cleaning and reduce the incidence of foodborne illness. The FDA, (2012) observed that most food services operations have components for 'HACCP' already in place. However, difficulties in attitudes of food vendors about food safety are mainly due to lack of education and proper training about 'HACCP' still exist.

2.5 Food Control Systems and Good Hygienic Practices (GHP) Applied to Small Food Operation Establishments

Allimentarius (2003) came out with the Recommended International Code of Practice (RICP)-General Principles of Food Hygiene (GPFH) which has been revised for four times (CAC, 2007). According to Codex, the principles ensures food hygiene and should be used with each specific code of hygienic practice, where necessary, and guidelines on microbiological criteria. It also recommended a documented food safety management system based on HACCP principles wherever possible to enhance food safety. The General Principles serve as prerequisite practices (PRPs) of HACCP and are recommended

to Governments, industry, individual primary producers, manufacturers, processors, foodservice operators, retailers and consumers alike (CAC, 2007; Clute, 2008).

According to WHO (2007), the rules of good hygienic practices applied to small food operations deal broadly with three different areas: physical factors relating to the premises and utensils used, operational factors relating to the hygienic handling of food, and personal factors relating to issues of personal hygiene and training. According to MOH (2010); Disease Control Division, (2008) education/training of food handlers in basic food hygiene is important so that rules are not seen as pointless irritants dreamed-up by bureaucrats. If food handlers understand the reasons for the rules, this will encourage them to comply rigorously and consistently especially, in situations where it is not possible to control such operations completely through official inspection. Control must be exercised by food handlers themselves.

2.5.1 Water supply/water borne diseases and cleaning

Globally, and especially in parts of Africa, many people live in areas where water is scarce. This scarcity compels people to use contaminated sources of water with human and animal excreta, and thus posing risk to human health (Ayeh-Kumi *et al*., 2009). In developing countries, inadequate or lack of basic sanitary facilities affect water quality. Non-availability of effective facilities to monitor the extent of contamination results into serious epidemics consequences (WHO, 2012). Health Canada (2012) revealed that direct or indirect use of water for drinking as well as for washing during food preparation, has been the most popular means of contracting enteric viruses. It is the obvious means of spreading these viruses to plants through irrigation or sprays and also foodborne viral ailments in consuming molluscan shellfish.

A study by Rzezutka and Cook (2004), stated that many foodborne viruses thrive well in water and in wet environments where they are supported by the following: adequate protein content, sufficient calcium and magnesium ions which particularly tend to stabilize the particles. Food hygiene and food safety demands effective but regular cleaning of utensils and facility. This is accomplished by application of a cleaning medium mostly water, cleaning compounds and sanitizers to remove soils, microorganisms and undesirable materials such as grease (Huss and Ryder, 2003; Gundry *et al*., 2004). Cleaning has to be done before and end of preparation with cleaning schedules and inspections to assist in achieving clean utensils.

2.5.2 Environmental issues and waste management

The environment is a major consideration in planning for health, sanitation and food safety. There is the need therefore to assess the environmental situation of the food preparation and vending sites to identify environmental challenges which acts as constraints to development (Schmdit and Rodrick 2003). A variety of wastes are produced in food processing facilities with a major proportion being liquid waste which is mainly waste water from cleaning of facilities, equipment/utensils, raw materials and processes such as blanching. Liquid waste is relatively easier to dispose off than solid wastes when screened of solid residues and pretreated using sanitizers to purify and destroy microorganisms before discharge into the municipal sewers or reuse (Marriott and Gravani, 2006; Polanski, 2009). Solid wastes are mainly the peels and unwanted portion of raw materials, most difficult to manage and comprise of inorganic and organic materials (Polanski, 2009). Its accumulation for even a short period of time attracts insects, rodents and produce odours.

Methods of disposing garbage include land fill, incineration, recycling and composting. Institutions employ the services of waste management companies to dispose of the waste (Russ and Meyer-Pittroff, 2004). Incineration is a way of discarding waste where solid organic wastes are subjected to combustion (Marriott and Gravani, 2006). Composting is a method of discarding organic waste such as the unused portion of the raw materials to decompose and used as fertilizers (Russ and Meyer-Pittroff, 2004). Recycling wastes such as aluminium beverage cans, plastic, polyethylene are sold to recycling companies (Russ and Meyer-Pittroff, 2004). Waste disposal needs to be done properly and often because they can attract pests resulting in infestation in food storage facilities, the plant and the environment. Trash cans must have a tight fitting lid, lined with polyethylene and be easy to clean (Marriott and Gravani, 2006). Every food processing institution must have an adequate system for collection, managing and disposing waste materials.

2.5.3 Pest and pest control

Pests especially rodents and insects pose problems in food processing and vending facilities. Insect pests such as cockroaches are carriers of *Salmonella sp*. and *Vibrio cholerae.* According to Eicher (2004), the most effective form of pest control is effective sanitation and hygiene. Marriott and Gravani (2006) stated that houseflies are carriers of dysentery and typhoid and installation of air and mesh screens discourage their entry as well as birds and bats. Mice and rats are rodents that are nocturnal, destructive and gnaw at non-food items like electrical wiring therefore difficult to control due to their senses of sound, touch and smell. They are able to swim through floor drains into the facility and transmit diseases like *Leptospirosis* and *Salmonellosis* (Marriott and Gravani, 2006).

Quality pest control as a preventive action is recommended to address pest before they cause real problems. Such precautions include structural maintenance to close entry points,

effective sanitation deprivation of harbourage and elimination of food sources (Siddiqui, 2001). Marriott and Gravani (2006) observed that frequent inspection helps to identify and target pest control challenges. The most appropriate methods of pest control should be without chemicals such as trapping, ultrasonic devices which repels entry of pest and filling cracks on floors and walls with caulking or other sealants because of potential danger of pesticides. According to Fusaro, (2013) fumigation is the most effective treatment because it penetrates cracks and crevices and provides a high degree of assurance in effective pest control.

2.5.4 Utensils

Utensils and the types of materials they are made of are greatly influenced by the kind of food being processed (Maynard and Heid, 2003). Although the primary aim of utensil design is to fulfill function, safety and hygienic requirements must be considered. The utensils used in food preparation and processing must not directly or indirectly transmit toxic substances and must be resistant to corrosion by food, detergent and other chemicals (Smith, 2007). They must not impact undesirable odour, colour or taste and surfaces must be free of pits and crevices and not be a source of contamination. Materials commonly used for utensil construction include stainless steel, cast iron, steel, wood and plastics. Wood is not recommended for utensil construction because it splits with time, it is porous and habour microorganisms. Stainless steel, aluminium, synthetic wood and rubber substitutes are most appropriate choice for utensil construction for use in food preparation, processing and services because they offer excellent protection against corrosion (CAC, 1993; Hauser *et al.*, 2005).

Moore and Griffith (2008) stated that during food preparation, residues of chemical, biological, organic/inorganic origin accumulate on surfaces which may come into contact with food. Undesirable attachments of microorganisms to surfaces results in cross-

37

contamination events which may lead to serious economic and health problems particularly if contamination occurs after a bactericidal step (Marriott and Gravani, 2006). It was observed that pathogenic and non-pathogenic microorganisms have been isolated from most food contact surfaces on working tables, cutting boards, sinks and refrigerators in street foods. According to Sneed *et al*., (2004); Cosby *et al.,* (2008) and Marzano and Balzaretti, (2011) bacterial contaminants detected on these surfaces were *E. coli*, coliforms and *Staphylococcus aureus*.

Staskel *et al.,* (2007) detected different types of bacteria from food contact surfaces where these organisms are able to survive for longer periods after initial contact (Scott and Bloomfield, 1990); (Kusumaningrum *et al.,* (2005). Most of these bacteria pose serious health challenges to the vulnerable groups who are immune compromised such as young children (Staskel *et al*., 2007). Other studies have reported that bacterial contamination levels on surfaces were higher than standards established for these surfaces (Marzano and Balzaretti, 2011). In some cases, wet surfaces or after cleaning procedures, some bacteria often increase to higher levels (Rzezutka and Cook, 2004). Bacteria can easily form a biofilm with accumulation of organic residues that may be protected from the sanitizer which may easily cause post-processing contamination (Marzano and Balzaretti, 2011).

A study by Marriott and Gravani, (2006) revealed that contamination of foods occurs due to poor cleaning, inadequate disinfection and improper hygienic design of utensils/equipment. There is a divided opinion on the kind of surface materials that pose the greatest risk to consumer health in terms of cross-contamination during food preparation. Arguably, it is generally observed that bacteria are capable of entering the pores of wood thereby causing contamination. Carrasco *et al*., (2012) reviewed this subject

and concluded that plastic cutting boards could improve safety due to its enhanced cleaning properties but it is insignificant as often stated.

2.5.5 Food safety legislation in Ghana

Government and industry collaborate in ensuring food safety but not as easily implemented as expected (Centre for Food Safety, 2007). Scientific systems are set by governmental and non-governmental institutions in providing formal and informal rules to ensure food safety in industries and institutions. The globalization of food trade offers many advantages to consumers. It provides greater but high quality foods which are cheaper, safe and meet consumer needs. The global food trade serves as an opportunity for countries which export food in earning foreign exchange, which is important for the growth of their economy. In Ghana, the MMDAs, under the Ministry of Local Government are in charge of all regulation regarding production of food for commercial purposes. This includes sale of food by street food vendors in a more organized environments or restaurants.

The laws of Ghana currently stipulates that people who sell food and others in the Ghana School Feeding Programme (GSFP) are screened for communicable diseases to ensure microbiological safety of food (Bomfeh and Tano-Debrah, 2008; Ghana Education Service, 2009). After the health screening, they are certified as being "free from infection" and permitted to prepare or sell food. The Metropolitan Health Authority (MHA) in charge of each district routinely carries out deworming and other health checks for food vendors. This is aimed at reducing risk of any food vendor transmitting a disease to consumers due to the fact that children are immunologically less developed than adults and may thus succumb far more easily to any infection.

2.5.5.1 Compliance with food safety regulation

Food safety hazards refer to everything that renders food unsafe thereby affecting the health of consumers (Antle, 1998). Negative qualities such as spoilage, contamination with filth, discolouration, as well as qualities e.g. texture, and sometimes the methods of processing enhances the value of a product in attracting a consumer. CAC (2003); Centre for Food Safety, (2007) revealed that safety and quality influences policies and the nature of food control system so as to meet predetermined national objectives before implementation. Food control can be explained as compulsory national or local regulatory activity of enforcement by authorities to protect consumers. This ensures the safety and quality of food during production, processing, handling, storage, distribution and retail which renders food wholesome and fit for human consumption; honest and accurately labeled as prescribed by law (CAC, 2003).

Formerly, food safety regulation was based on definitions and legal enforcement programmes for the withdrawal of unsafe food from the market and sanctions for the responsible parties. The traditional/cultural systems do not provide or stimulate prevention of hazards because these systems cannot respond to existing challenges of food safety. For instance, there is lack of better scientific knowledge on causes of foodborne diseases and a transition to risk analysis (Centre for Food Safety, 2007). At the national and international levels, it provides a preventive basis for regulatory measures for food safety (CAC, 2003).

2.5.5.2 Forms and content of food safety regulations/food laws

 Food safety legislation and regulatory instruments are based on and consist of basic laws which provide specific activities such as the production, processing, preservation and sale of food which are designed with specific purposes in protecting health and promoting food

commodities for fair trade (Antle, 1998). The food safety regulation commonly covers all products in addressing certain aspects of food safety, adulteration, quality control, inspection and labelling. However, some countries have promulgated these basic laws side by side food products/food production and or trade in foodstuffs in general (CAC, 2007).

Generally, highly industrialized countries depend on the legislative traditions and the basic law. The CAC (2007) revealed that promulgation of the common law is comprehensive and have detailed texts which may bring practical and general provisions concerning food together. Administratively, the authorities do not prescribe enforcement and technical procedures for particular foods. A different method is reducing the contents of the basic law to those that set up the administrative structures to enforce it together with a few very general principles. The structure or approach prevails in developing countries and where Roman, German or Scandinavian law prevails (CAC, 2007). Generaly, the framework is flexible and established by the law and authorized by the administrators in prescribing technical laws/regulations and standards for specific foods (CAC, 2003). Legal systems allow changes to be made easily and quickly to the basic law rather than parliament amending it (Antle, 1998; CAC, 2003). The minister(s) in charge have the authority in issuing the right regulations and opting for new changes. The basic food law has eight categories of provisions and are as follows:

2.5.5.2.1 Scope and definitions

This describes and provides the ambit and tools for interpretations of the food law with its purpose and objectives which precedes all others. It serves as a policy statement as to why it was promulgated, what purpose it is intended to serve and in stating areas covered by the law. Most countries, in drafting the definitions, include a list of internationally agreed sources with other nations on related issues. Definitions that appear are included in the

body of the food control terms and of the regulation (CAC, 2003). The definitions serve as interpretations of the law which are enacted. For instance, selling means exchanging a product for money but the law stops selling contaminated food, then any person who violates the law might conceal the proof of sale and try to argue that he/she did not sell but offered the food for free and not for money so has not violated the law (FAO/WHO, 2006).

2.5.5.2.2 General principles

Legally, the basic food law provides and articulates the general principles which govern the food control system in ensuring that all food industries and food products in circulation ensure food safety in the country (FAO/WHO, 2006). Basic rules are set out and observed by persons in the food service business or sale of food. Countries have many differences with a detailed statement of principles in the basic law, whilst others leave principles to be laid down in general enforcement regulations or include only objectives and purposes without elaborate principles at all.

2.5.5.2.3 Enabling provisions

Laws are defined by nature and limit the authority exercised under whom those powers are vested in for the public authorities. The two aspects of power are: formulation and control, which are not exercised at the same level or delegated to the same authority but it generally exercises these powers and establishes guidelines and limitations for law (CAC, 2007). In ensuring that the laws and regulations are observed, the legal right of enforcing the rules made by the executive authority in protecting private/government or executive authority to promulgate the laws and its accompanying regulations are provided and observed (FAO/WHO, 2006).

2.5.5.2.4 Administrative provisions

The provision of food law sets up administrative activities necessary for enforcement. For example, it could be established that a Food Control Agency (FCA), with numerous actors from the ministries are involved in food control in the country (Taylor, 2008). The functions of the FCA are not so much affected by the food law, does not usually delve into great detail on the functioning of the FCA, instead describes and explains its mandate, membership, outlines some basic rules regarding the appointment and resignation of members, the establishment of technical committees and provides for a secretariat, if any (Harrington and Portney, (2007). It provides also other details which govern the actions of the FCA established by regulations or bye-laws by the Agency itself. Inspection service and a licensing authority grants licenses to food manufacturers or importers are other administrative structures that are created or defined. These Agencies are empowered by law to delegate or license certain types of enforcement activities to different government agencies (Taylor, 2008).

2.5.5.2.5 Enforcement provisions

Penalties are usually imposed according to legal when executive delegates the power to sanction as well as to take preventive measures in the public interest by virtue of the law (Kenkel *et al*., 2006). Antle (2008) posited that the conditions and powers governing their exercises are laid down and offences are defined according to the nature and limits of the penalties that are imposed and the procedures for such imposition once the commission of an offence has been duly established. It outlines procedures for the protection of the public in the seizure and confiscation of unwholesome food or the recall of products. However, some offences and penalties in some countries are not elaborated instead, they are referred to the general provisions of the Criminal Code (CC) and the Code of Criminal Procedure (CCP) (CAC, 2003). Some countries have incorporated the (HACCP), into their food laws

which is achieved through the subsidiary regulation and consists of guidelines for the inspection service (WHO, 2006). Improper activities and an enforcement-oriented approach are described in the law, and their violations are perceived and acted upon by an inspector so charged by the law e.g. packaging and transportation. The inspectors might simply be charged with controlling the fact that a food enterprise is exercising its own controls on its production systems with a more collaborative and preventive approach (CAC, 2003).

2.5.5.2.6 Substantive provisions

The WHO, (2010) revealed that food law contains many substantive provisions relating to food control, production, export, transport, distribution and sale. These provisions may be very basic as "all food in the country must be safe for human consumption", in accordance with food control, production, export, transport, distribution and sale or may be more detailed, in which case the details and likely be in the subsidiary legislation. For instance, regulation of food law may outline all the precise information that must be on model food labels in a specific format that have to be followed throughout the country (weight of product, name of manufacturer, best before date, etc.) (FAO/WHO, 2006; CAC, 2003).

2.5.5.2.7 Food laws/regulations

In most legal systems food laws contain provisions listing many legal systems' subject matters that are addressed through regulations to meet the purposes of the law (Harrington and Portney, 2007). The main advantages of the regulations is that they can be easily changed or addressed. The list of the regulations may be extremely detailed or it may simply give broad outlines to the kinds of topics that the Minister may address. According to Kenkel *et al*., (2006) in either case, the food law generally contains a statement that the

Minister's powers are unlimited and may "make all regulations he or she deems necessary to achieve the purposes of this law."

2.5.5.2.8 Repeal and savings

Where a new food law makes significant changes to the food control system, existing food laws or regulation and the food control system may be amended or repealed (Harrington and Portney, 2007). In such cases the food law may indicate which provisions in which other laws are to be repealed or altered. For this reason, in order not to dismantle the food control system entirely, many laws and regulations do not get rid of the food control system but may contain a provision stating that any new food law or regulation made under any provision remain effective, just as they had been issued under the new food law (FAO/WHO, 2006).

2.5.6 Advantages of food safety regulation

Advantages of the food safety regulation are that it helps to reduce risks of food poisoning and death associated with the consumption of contaminated foods with pathogens and other hazardous substances (van Ravenswany, 2005). The advantages of the safety regulation rely mainly on economic strategies that were purposely developed in the reduction of health risk. Kenkel *et al.,* (2006) provide a brief description of the general literature whilst van Ravenswany, (2005) studied the set of ideas for the literature on food safety. According to Antle, (2008) the purchase of risky foods by the individual may affect income, prices, the aim and perceived risk about the food, the essence of exposure and his susceptibility to the risk.

Addo (1998) revealed that market demand for health risk foods may depend on income and prices, as factors determining the distribution of risk perceptions and susceptibilities which are distributed in the population of consumers. The following factors e.g. age,

education and policy on product labeling and availability of food safety information among consumers. Scientific ideas are sometimes used to obtain expressions for willingness to pay (WTP) so as to reduce morbidity and mortality. These ideas of WTP according to Kenkel *et al.,* (2006); Harrington and Portney, (2007) reduced morbidity risk and are classified into four parts which are: the costs of treating the illness, forgone income from lost work time, costs of averting illness, and the disutility of illness. Many methods to valuing health risks have been planned, with most basic and often used method to value morbidity is by estimating the cost-of-illness (COI) (Kenkel *et al*., 2006; Kroeger, 1983).

The method of valuing health risk is based on the medical costs of an illness and its measurement in addition to the forgone market income due to lost work time. This idea does not appeal to economists and scientifically controlled easily because it lacks a solid foundation with obvious shortcomings. The method is not equivalent to WTP, though it shows a lower bound for reducing morbidity under certain conditions (Harrington and Portney, 2007). It is not the same when morbidity and mortality are considered Kenkel *et al*., (2006), or is COI similar to WTP, and one can identify a number of situations in which the use of COI could negatively affect a benefit – cost analysis (Kenkel *et al*., 2006).

Scientific evidence shows that mean WTP in a sample does typically exceed mean COI for certain health symptoms (Kenkel *et al.,* 2006). The risk of dying is valued using the value of a statistical life. Many methods were used to form opinions about individuals' values placed on risk of death and using wage differences between occupations with different risks, for example, in discounting forgone income. The different methods produce a variety of values of a statistical life less than $1 million to tens of millions of dollars. Various research indicated that none of the findings has used avoidance of death due to

foodborne illness. Kenkel *et al*., (2006) observed that an unexplored issue is whether the values derived from a non-food context necessarily transfer the food risk case.

2.6 Microbial Safety and Microorganisms of Public Health Concern

Morton (2011) defined a total plate/aerobic plate count as an indicator of bacterial population in a sample. In assessing microbiological safety from food pathogens, species which are easily enumerated and exposed could be hazardous in foods. Thus, the total plate count acts as indicator of quality and not safety (Health Protection Agency, 2009). This count can give information about raw materials, processing and storage conditions, handling of the product, shelf life and organoleptic changes.

Kiranmayi and Krishnaiah, (2010) indicated that the number of colonies which develop in nutrient agar plates which have been inoculated with known amounts of diluted foods incubated under a particular condition becomes the count of viable bacteria. Microorganisms which develop during aerobic mesophillic condition becomes under the aerobic mesophilic conditions provided are used or counted or used. According to Nichol and Salek, (2007) some strains of bacteria with no connection to foodborne diseases have been detected to cause diseases when in large numbers. These recognized foodborne pathogens contribute to the detected plate count.

2.6.1 *Escherichia coli*

Escherichia coli, is from Enterobacteriacae family which may usually be the leading cause of food contamination and are detected in humans and animals (Park *et al.,* 1999; Pietrangelo, 2012). Epidemiological studies of foodborne disease outbreaks by the WHO, (2013) have indicated that *E. coli* can grow in foods with minimum water activity of 0.95, at an optimal temperature of 37°C and pH of 7-8 (Don, 2008). As few as 40 cells of the *E. coli* strains are found in meat and meat products e.g. minced beef, raw milk, chicken, raw

vegetables, cider, fresh fruits/juices and are harmless however, some group of *E. coli* causes intestinal infection in most vulnerable groups (Teunis *et al.,* 2004; Strachan *et al.,* 2005; Kiranmayi and Krishnaiah, 2010). Their study revealed that a total of 73,000 cases of *E. coli* infection and 61 deaths occur in the United States every year.

Most *E. coli* cells have been identified as the most important serotype to survive in the stomach and are associated with severe foodborne diseases in sporadic cases and outbreaks worldwide (WHO, 2011). The main reservoirs of this pathogen are cattle and sheep but also has been isolated from horses, dogs, pigs and other farm animals. It is destroyed by effective cooking of foods at 70°C or higher and practices of good hygiene (GHP) greatly reduces the chances and developing intestinal infection (WHO, 2011; Pietrangelo, 2012). Most clinical symptoms are linked to the production of shiga toxins (verotoxins) which may sometimes include diarrhoea, abdominal pain, vomiting, hemorrhagic colitis (bloody diarrhoea) and hemolytic uraemic syndrome with acute kidney mulfunctioning (WHO, 2011; Pietrangelo, 2012). The principal means of transmission of *E. coli* infections in human beings is associated with the eating and drinking of contaminated food/water.

2.6.2 Coliforms

Coliforms are aerobic and anaerobic, rod-shaped bacteria that are found on plants, water, in the soil and on warm-blooded animals (Morton, 2011; Health Canada, 2012). Some Coliform species*,* including *Salmonella, Shigella,* and *Escherichia coli,* are enteric pathogens (Nkere, 2011). Coliforms in food and water indicate faecal contamination and when food and water are exposed to pathogens that cause gastrointestinal diseases, they result into food and water borne illnesses e.g. diarrhoea and typhoid fever (Nkere, 2011). There is much evidence that faecal contamination is very high and street foods may become contaminated when kept at ambient temperature, out of the refrigerator and the

inability to prepare new food during the day (Sinayobye and Saalia, 2011). These factors allow the proliferation of enteropathogens to unacceptable levels.

A study in Peru in 2008 revealed that faecal bacteria increased threefold in street foods. Studies from Bangladesh, India, Kenya and the Gambia have also shown evidence of coliform bacteria during storage. Coliforms, mainly enterobacteriaceae, may also be present in dry infant foods (ICMSF, 2008; Nagai *et al.,* 2009). These organisms are tested to check the effectiveness of good hygiene practices. Acceptable levels for enterobacteriaceae in food ranges from 10-102 cfu/g (ICMSF, 2008). The presence of coliforms in cooked food indicates health hazard depending upon the hygienic practices of the food handler, recontamination from the premises where food was prepared (Nagai *et al*., 2009; ICMSF, 2008). Although faecal coliform is an indicator in cooked foods, their presence in fruits and vegetables may always not indicate faecal contamination since there are other genera of the bacteria in the environment with non-faecal origin.

2.6.3 *Vibrio Species*

There are three *Vibrio species* of importance and these are *Vibrio sp. Vibrio parahaemolyticus* and *Vibrio vulnificus.* These and other species occur under levels below100–1000 cells depending on a person's body defense mechanism to cause severe diarrhoea and dehydration. *Cholerae* is typically waterborne bacteria which is caused by *Vibrio sp.* This causes foodborne diseases when contaminated seafood are undercooked or raw shellfish are ingested especially during warm weather months *(*Marie *et al.,* 2011).

According to WHO, (2010) *Vibrio cholerae* are generally isolated from molluscan shellfish in rivers and marine environments and can cause disease in healthy persons. The bacteria is mainly spread from the faeces of an infected person and generally through poor

49

disposal of human waste, contaminated water, poor personal and environmental hygiene (Hartley *et al.,* 2006; Marie *et al*., 2011). The disease is characterized by severe diarrhoea and often accompanied by vomiting often results in death when not treated on time. *Vibrio cholerae* has caused many outbreaks globally normally due to high temperatures, pollution of the environment and water bodies (FDA/CFSAN, 2012).

2.6.4 Yeasts

Yeasts causes fermentation in different types of foods and beverages (Omemu *et al.,* 2007). They are especially useful in fermenting maize for complimentary foods such as porridge to attain the right aroma, microbial stability and flavour. Yeasts accomplish this by their lipolytic activities to generate fatty acids that contribute to the final flavour of foods. Some yeast species used in fermentation include *Saccharomyces cerevisiae, Candida krusei, Candida tropicalis, Geotrichum fermentans, Rhodotorula graminis* (Omemu *et al.,* 2007). Yeasts produce mycotoxins which are not totally destroyed through processing.

Yeasts causes food spoilage, especially in acid foods e.g. fruits, fruit juices, and foods of reduced water activity such as confectionery (Nagai *et al*., 2009). Although lower doses of yeast may not cause health hazard, their metabolic activities may shift the pH of the cooked food and allow the multiplication of other harmful bacteria (FDA, 2012). Yeast spores are ever present in the air and environment and they get into foods through infected utensils. Their presence in cooked foods therefore indicates poor hygiene practices of food handlers for example, undercooking and not covering foods.

2.6.5 Moulds

Moulds are normally coloured and look cottony. They develop tiny spores that are transferred from place to place by people, air currents, equipment, or food (Marriot and

50

Gravani, 2006). Studies by Labspace (2014) showed that moulds generally survive wider ranges of temperature and pH, grow at various stages of development of foods during production, pre- harvest, post- harvest periods, below freezing temperature where they are not detected and can tolerate pH of 2.0 to 8.0. Nuts, pastries/bakery foods and other dry foods are affected by mould than bacteria and yeast. Moulds are responsible for food spoilage, with some strains growing at very low a_w values e.g. 0.6-0.7. Eventhough it does not result in food poisoning, but could produce compounds known as mycotoxins and may produce several species which may result into chronic illness when consumed (Labspace, 2014).

According to Yoon *et al.,* (2008) the presence of moulds in a cooked food may indicate the growth of other harmful fungi species including *Aspergillus flavus* and *Aspergillus niger*. These species of fungi have been implicated for the production of aflatoxins, a type of mycotoxin in foods. They do not cause immediate changes in the colour of the grains until they are in large numbers (Newman, 2005). Aflatoxin B_1 the most toxic among the mycotoxins (B_1, B_2, G_1, and G_2) is highly carcinogenic and may cause several adverse conditions including cancer of the liver. Children exposed to aflatoxins might suffer stunted growth or chronically become underweight and are exposed to infectious diseases in childhood and throughout their lifetime (Center for Science in the Public Interest 2005).

2.6.6 *Salmonella sp*.

The genus *Salmonella* has been identified as the leading cause of foodborne infection throughout the world (WHO, 2004). There are two species of *Salmonella*, *Salmonella enterica* and *Salmonella bongori* which include 2519 and 22 serovars respectively (D'Aoust and Maurer, 2007). *Salmonella sp.* are anaerobes, Gram-negative bacteria consisting of non-spore forming motile bacilli that belong to the group Enterobacteriaceae.

D'Aoust and Maurer, (2007) have observed that *Salmonella* readily adapt to unfavourable environmental conditions as evidenced by their ability to grow in temperature range of 2^oC-54^oC, with optimum growth rates at temperatures of 35^oC-37^oC. Human *Salmonella* infections occur as non-typhoidal enterocolitis or typhoid fever (enteric fever) and are associated with infections by *Salmonella typhi* and *Salmonella paratyphi* which could be fatal (D'Aoust and Maurer, 2007).

Clinical symptoms caused by *S. enteritidis* and *S. typhimurium* include non-bloody diarrhoea, spiking fever, severe abdominal pain and headache. Non-typhoidal enterocolities causes infection in the small intestine eventually resulting in gastroenteritis. *Salmonella gastroenteritis* is generally severe in vulnerable groups such as very young or elderly persons, immune-compromised individual, or patients with systemic infections (D'Aoust and Maurer, 2007). The infectious dose of *Salmonella sp*. could be as low as 1 to 100 viable cells and can survive for long periods in foods (FDA/CFSAN, 2012; D' Aoust and Maurer, 2007). Most frequent sources of infection are direct contact with infected human, animals, food contact surfaces and utensils that have not been properly washed, raw or poorly cooked foods such as meats, poultry, pork, especially foods containing egg and milk products, fruits and vegetables as potential sources of cross-contamination (Adams and Moss, 2008; D' Aoust and Maurer, 2007).

2.6.7 *Staphylococcus aureus*

Although other species of *Staphylococcus* are capable of causing disease in man, *staphylococcal* food poisoning is generally associated with a wide array of *S. aureus* toxins, causing various types of disease symptoms (Jay, 2000; Sandel and McKillip, 2004). *Staphylococcus aureus* belongs to the family micrococcaeae, and are non-motile, Gram-positive *cocci* that appear singly or in pairs, tetrads, short chains, or characteristic

"grapelike" clusters. *S. aureus* are widespread throughout nature and present on the body surfaces of humans and warm-blooded animals. Although usually regarded as human commensals, they are also opportunistic pathogens and are capable of causing skin infections, cellulitis, and post- operation infections and are related with other infections such as boils, pneumonia, osteomyelitis, meningitis, abscesses of muscle, urogenital tract, central nervous system, and various abdominal organs (Lund *et al.*, 2000; Wertheim *et al.*, 2004). The environment is the most common sources of food contamination and nasal carriers with about 30%-50% of food handlers are carriers of *S. aureus* on their skin surfaces (FDA, 2012).

S. aureus grows at temperatures of 6ºC to 48ºC but have an optimum growth at 40ºC-45ºC and produce enterotoxins between 10ºC and 46ºC. Enterotoxin production requires a minimum water activity of 0.86 (Jay, 2000; Lund *et al.*, 2000). *Staphylococcus enterotoxins* are extremely resistant to heat and also stable in frozen storage. It has been reported that viable cell population more than 10 per gram of contaminated food is sufficient to produce effective dose for staphylococcal enterotoxin (Doyle *et al.*, 1997). Clinical symptoms of food poison may result in the following illnesses e. g. vomiting, nausea, abdominal cramps, headache, dizziness, chills, perspiration, general weakness, muscular cramping and/or prostration, and bloodless diarrhoea. The illness is self-limiting and the mortality rate is very low. A mortality rate of 4.4% has been reported among children and the elderly who are vulnerable (Doyle *et al.*, 1997).

2.7 Strategies for Environmental Sanitation by the Assemblies (MMDAs)

The MMDAs are the entities that drive the development agenda of the government for the people at the district and metropolitan levels. The large population influx into the districts has put a lot of pressure on the limited sanitation facilities. Waste is also generated at an

alarming rate. There is the need therefore to come up with comprehensive strategies to combat the ever increasing challenges of environmental sanitation in the Assemblies. The capacity of the Assemblies to manage this situation in terms of availability of equipment is also a development challenge for the attainment of sustainable environmental sanitation. What government needs to do are regulation, legislation and advocacy.

2.7.1 Compliance requirements of food laws/regulations of MMDAs

Compliance requirements of food laws were adopted to solve food laws/regulation challenges (Harrington and Portney, 2007). "To improve the quality of life of people in the cities especially the poor, vulnerable and excluded is by providing and maintaining basic services and facilities in the areas of education, health (disease control e.g. cholera/malaria) sanitation, and nutrition (Kenkel *et al*., 2006). Intensify public sensitization and screening of food vendors against cholera and other communicable diseases, prosecute sanitation offenders, renovation and redevelopment of major markets through the Millennium Development Authority (MIDA) project and other social amenities, in context of discipline, ensure best practices, a sense of urgency and commitment to excellence" (FDA, 2012).

2.7.2 Component specific strategies of the Assemblies to ensure food safety

Component specific strategies were adopted to solve the various environmental sanitation problems (EPA, 2015). The current enforcement management activities include punishment, penalties and prosecution (PPP). The nature and types of offenses includes the following:

- Poor waste disposal, defaecation, dumping at unauthorized sites, weedy environments, selling food without medical certificate, unauthorized pit latrines /open pits breeding mosquito larvae and slaughtering at unauthorized places and

others. Punishment and penalties for the above-mentioned offenses include prosecutions, fines and jail terms. Efficiency of prosecution helps to deter offenders and used as the last resort (EPA, 2015). It is normally those who refuse to comply with notices of abatement that are prosecuted. Many offenders are prosecuted weekly by the councils and are fined sums of money according to their offences (MOH, 2010; EPA, 2015). Unfortunately, the revenue that could have been generated is not being realized due to non- availability of the Assemblies' bye-laws (yet to be gazetted).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Areas (A, B and C)

The study was conducted in three different locations within the southern sector of Ghana. These locations: Accra is in the Greater Accra region, Takoradi in the Western region and Senchi in the Asuogyaman district of the Eastern region.
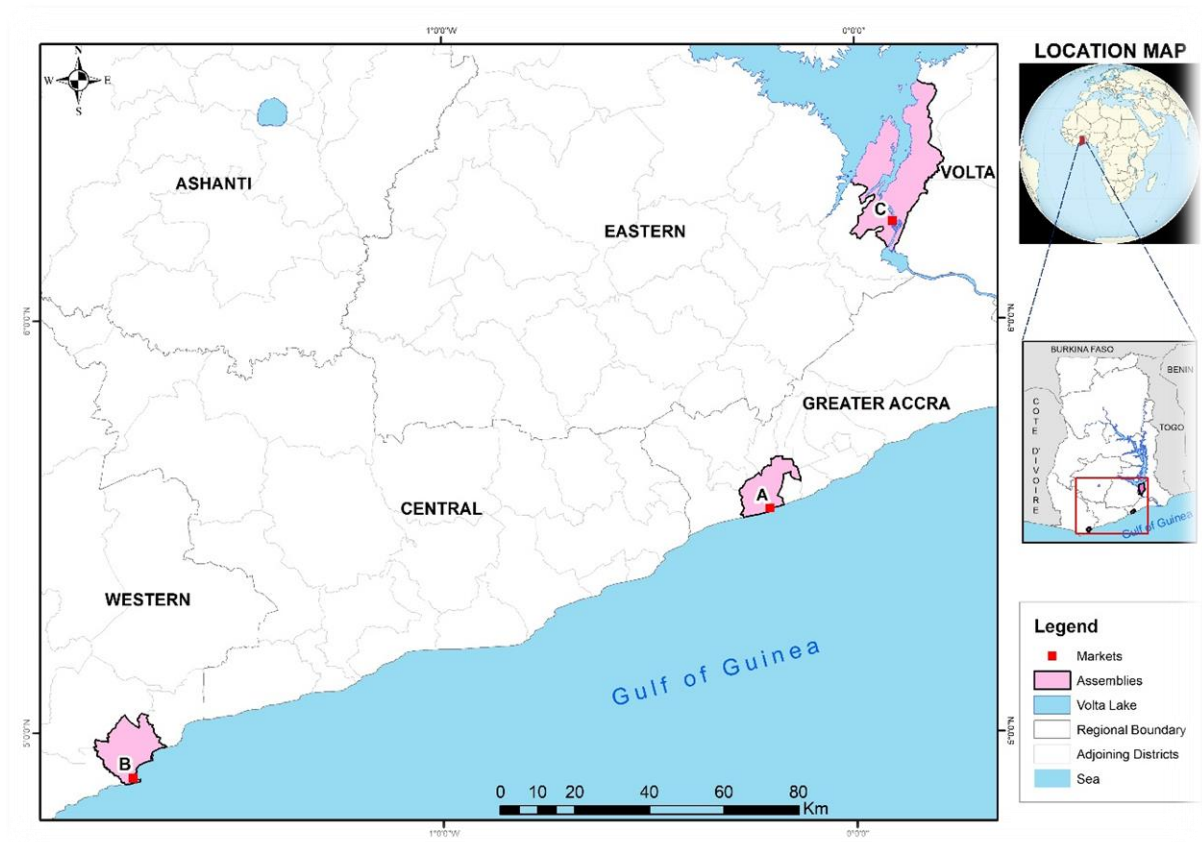
Figure 3. 1: Map of Study Areas (A, B / C)   Source: (CERGIS data base) 2016-2017

(A) ACCRA

The Accra Metropolitan Assembly (AMA) was founded in 1898 and has been the regional capital of the Greater Accra Region and the national capital of Ghana. Makola is sited in the heart of Accra, in the Ashiedu Keteke sub- metro. Geographically, the Accra metropolis covers 1% of the total area of the country and is bounded on the east by La

Dadekotopon Municipality, west by Ga South Municipal, north by Ga West municipality and on the south by the Gulf of Guinea (GSS, 2014). It lies within the coastal savannah plain of Ghana and is sub- divided into 11 administrative entities called Sub - Metropolitan District Councils, commonly referred to as "sub - metros." These are, Ablekuma North, Ablekuma South, Ablekuma Central, Ashiedu Keteke, Ayawaso East, Ayawaso West-Wuogon, Ayawaso Central, La, Okaikoi North, Okaikoi South and Osu Klottey. There are two rainy seasons from May to mid-July and mid-August to October with a uniform daylight due to its nearness to the Equator.

Accra has the fastest population growth in Ghana and West Africa of 1,665,086 with 800,906 males and 864,180 females, with 778, 267 (48%) being migrants due to the rapid rural-urban migration and urbanization, much more than the cities in Ghana as a result of worsening economic situations in the rural areas (GSS, 2014). There are different ethnic groups and foreign nationals in the metropolis but the most predominant group who are the indigenes are the Ga-Dangmes. Also, 70% of the population are 15-18years and above are zealous, economically active with the females more than the males. Makola, the second industrialized area after Tema contributes over 10% of the gross domestic product (GDP). Over 30% of the commercial activities with 50% of value added are located in this area. These commercial activities are grouped into large, medium and small scale enterprises in the import, export, wholesale, distribution and retail businesses of suppliers and transporters.

Different food and non-food items are sold around every corner including a variety of street foods. Communities along the coast engage in fishing. According to GSS (2012), Makola is the main business center of Accra noted for its economic and revenue generating activities, has resulted in high demand for street food-vending and patronage with its repercussions on poor sanitation practices (e.g. open defaecation and indiscriminate waste

57

disposal–liquid/solid). This create conditions for widespread and outbreak of food and waterborne diseases e.g. diarrhoea, cholerae and typhoid cases.

(B) TAKORADI (MARKET CIRCLE)

Takoradi Market Circle is the biggest market in the Takoradi Municipality under the Sekondi -Takoradi Metropolitan Assembly of the Western Region of Ghana. It has an area of 219 km^2. Due to the discovery and extraction of petroleum in near-by Cape Three Points, Takoradi has become a destination for most rural-urban migrants in recent times. The migrants are both young and old who have low levels of education and so are compelled to engage in menial jobs such as truck pushing, street food-vending and hawking. The environmentally inimical attitude of some of these residents such as littering, open defaecation and indiscriminate waste disposal has negative impact on the environment and sanitation (Addo, 1998; Ofori, 2010).

Takoradi is linked to Accra by the Cape-coast-Takoradi-Elubo-Ivory Coast main road and serves as the largest urban center in the municipality with most basic facilities and services. It functions as a commercial centre because of the large population which supports almost all economic activities due to its established market at "Market Circle". Takoradi has a lot of potentials for development for both private investment and joint ventures with the public sector due to its proximity to Ivory Coast.

(C). SENCHI ROADSIDE MARKET (ADA)

The Asuogyaman district is one of the newly-created districts of Eastern-Region, with Senchi as one of the area councils that lies in the lower belt of the Eastern and Volta Regions. It has an area of 1,507 square kilometers within the coastal savannah climatic zone of Ghana (GSS, 2010). The vegetation is grassland and shrubs or thicket with scrubby mangrove vegetation along the coastal fringe in the Volta Lake (Barry *et al*., 2005). Senchi

is bordered by Kpong to the West, Juapong to the North, Akosombo to the East and the Volta Lake to the South with Atimpoku as its district capital. Over the years, ecological changes have affected agricultural productivity which resulted in the migration of indigenes in search of better economic opportunities. The most predominant jobs with the communities along the Volta Basin are trading, farming and fishing.

The Senchi roadside market is stragetically located close to the magnificent Adomi Bridge on the River Volta which links and serves as a transitional and the shortest link between the southern and eastern parts of Ghana and beyond North, Upper East and West Regions, Burkina Faso, Mali, Togo, Benin, Nigeria and many other countries in the sub-region. It serves as a rest stop or stopover for travellers/motorists and a brisk business hub for hawkers and street food vendors who trade mostly in fresh water fish and other food items. The absence of modern lorry parks poses a challenge to the various transport unions due to the establishment of an unauthorized lorry station hence, the street market. Most of these unauthorized stations are by the road side compounding traffic situation especially at Adomi-Senchi.

3.2 Research Design

Two designs were used, cross sectional study, mixed-methods of quantitative and qualitative, for the study. The cross sectional design allows a subset of the target population to be used. It provides a picture of events appropriate for describing people's perception and behaviour on the basis of the data gathered. Stratification and proportional allocation using the table of random numbers was employed to obtain a reliable representation of the total number of respondents in the communities that constitute Makola, Takoradi and Senchi markets. The approach employed in soliciting information from food vendors/consumers at the various food joints or establishments across the study

areas was self-administered using semi-structured questionnaires with open and close-ended questions from previously validated questionnaires. This examined perception, attitude and practices of food handlers or vendors.

Microbial analysis was done on selected food/water samples in the laboratory regarding food safety. Data for the qualitative method was by in-depth face-to-face interviews, using the structured questionnaires, employing existing theories to explain findings, using Likert scale of five items (ranking) terms e.g. high, moderately high, very high, low and not aware to measure important trends/relationships and describe the perception, degree of intensity, severity of issues under investigation. Field observation and interaction as well as photographs were employed using on-site food safety audit checklist, based on the requirements of the Codex Code of Hygienic Practice for Precooked and Cooked Foods in Mass Catering (CAC, 2007) and recommended international code of practice-general principles of food hygiene (CAC, 2003). The study also involved observing:

1. the temperature of catering refrigerators and food contact surfaces;

2. the hands of food handlers (vendors) and

3. food prepared at the various food joints.

Emphasis was on key areas such as practice of personal, kitchen, food, environmental hygiene, utensils used in food handling and medical check-up/certification.

3.3 Target and Study Population

All food vendors and consumers constituted the population for the study who at the time of the study were 18 years of age and above in the three selected markets: Makola-Accra (Ashiedu-Keteke sub-metro district of the AMA), Takoradi Market Circle (STMA Western Region) and Senchi Market (ADA Eastern Region).

3.4 Sample Size

The sample size for the study was 300 i.e.150 (50%) street food vendors and 150 (50%) consumers being respondents. 50 food vendors and 50 consumers were selected for each study area giving a total of 100 each for the three study areas who are within the stated age groups, who live or sell food in Makola-Accra, Takoradi market circle and Senchi road side markets using the convenience approach. According to Babbie, (2003) and Annum, (2014), convenience sampling involves choosing the nearest or available individuals to serve as respondents and continuing the process until the required sample size is obtained. It is easy to execute, cost saving and produce information that are relevant to the study. It focuses on particular characteristics of the target population that are available at a point in time and have the requisite knowledge required to answer the research questions. It is employed in qualitative research and in other studies where representation is not an issue. Both food vendors/consumers were selected at the food joint premises through this convenience approach i.e. one food vendor-one consumer.

3.5 Sampling Techniques/ Procedure-Ethical Entry (Reconnaissance Survey)

Contact was initially made to establish working relation with some key influential and opinion leaders, market queens and a member each of key stakeholder institutions like Food and Drugs Authority (FDA), Ghana Standards Authority (GSA), Environmental Protection Agency (EPA), Accra Metropolitan Assembly (AMA), Sekondi-Takoradi Metropolitan Assembly (STMA), Asuogyaman District Assembly (ADA) and Health Directorates of the Assemblies at the study areas were interviewed. This helped to access relevant documents, validate the information gathered in relation to the study, and find out food hygiene and sanitation conditions prevailing at the study sites (Appendices 3 and 4). The researcher was introduced and taken round the selected markets by the market queens

and the administrative heads of stakeholder institutions. The purpose of the study was explained to potential respondents and they were assured of confidentiality as the nature of the study was purely for academic purposes.

Food joints were inspected to observe the sources of cross-contamination of street foods. Some service providing institutions such as hotels were surveyed to ascertain practices which affect sources of water. The sampling frame was street food vendors and consumers who sell, patronize or have patronized any kind of street food at the food joints or premises within the market setting. The catering establishments (food joints) were selected using the table of random numbers and SPSS Version 22.0 was used to evaluate differences in the stated variables. Purposive sampling was adopted in selecting stakeholders since they are assumed knowledgeable and has the needed characteristics in soliciting information for the study. The purpose of the survey helped in the choice of instrument and design which were appropriate for the study.

3.6 Data collection instruments

The following instruments were used in the collection of data for the study.

- Structured interview schedule (questionnaire administration) open and close-ended questions.

- Field observations (interaction, description by use of words and photographs).

- Collecting selected food/water samples and analyzing them for key biological parameters (cooked and uncooked) to determine plate counts or microbial qualities in them i.e. microbial analysis.

- Checklist of facilities, services offered and hygienic practices at food joint premises at the study areas (Appendix 5).

Structured interview schedule (Questionnaires) was administered based on validated questionnaires used in similar studies in other countries (Buccheri *et al*., 2010; Tokuc *et al*., 2009). The questions were categorized into four sections: demographic characteristics (age, sex, education, religion and marital status) length of years on the job or employment, knowledge/perception/attitudes towards food safety and measures taken in the prevention of foodborne diseases.

3.7 Pretesting

The questionnaire and interview schedule was tried out with a small sample similar to the potential respondents in a selected market environment outside the research areas. This helped to reveal ambiguities, poorly worded questions, repeated questions, identified response options and gauged likely interview duration. The instrument was revised on the basis of the pretest results and the revised version was used for the data collection (Appendices 2, 3 and 4).

3.8 Data Collection

Data for the study came from both primary and secondary sources. Primary data was collected through field work. The main instruments employed to collect the primary data was observation, interaction, simultaneous notes taking, in-depth face-to-face interviews with key stakeholders using structured interview schedule with open and close-ended questions. Questionnaire was self-administered to key stakeholders including officials of institutions: the Food and Drugs Authority (FDA), Environmental Protection Agency (EPA), Accra Metropolitan Assembly (AMA), Sekondi Takoradi Metropolitan Assembly (STMA), Asuogyaman District Assembly (ADA), the Metropolitan/District Health Directorates for hospital data and from other relevant departments such as law enforcement agencies, opinion and community leaders of other identifiable groups. It also involved on-

63

site inspection and institutional document search. Completed questionnaires were checked on the spot for completeness and filed for ease of verification.

The interview schedule/questionnaire instrument was administered to all food vendors, consumers and consulted stakeholders of health institutions on food safety in the country at the study areas who agreed to be part of the study. The questionnaires were developed in English language, were self-administered and where necessary explained in the local languages such as Ga-Dangme, Ewe and Akan.

Secondary sources of data were collected from the existing relevant literature, published and unpublished theses, books, scientific journals, project reports, workshop proceedings and internet sources. Some respondents were interviewed at their work places and offices at a previously appointed time. Each respondent was interviewed and observed in blocks of time during the day, divided into four blocks of time of early morning, mid-morning, afternoon and evening. Interview and observation began as early as 6.00am and ended at 9.00pm. The interview and observation covered background information and all activities that were performed in the day. Such activities included food services and occupation (Appendices 2, 3 and 4).

3.8.1 Interviews

Semi-Structured interviews were conducted to provide insight of participants' knowledge/perceptions and attitudes that were not directly observable. The interview was conducted with key stakeholders at the institution's premises. The criterion for selecting the interviewee was by a presupposed knowledge based on position of the institutions. For this, there were a total of fifteen respondents obtained which comprised one each from FDA, EPA, GSA and MOH (2) Metro Health Directorate Division (MHDD) at the Assemblies i.e. five respondents each of the stakeholder institutions. The maximum time

spent per respondent in an interview was ten minutes. All questions asked on perception and attitude on food hygiene practices were geared towards seeking more clarification and validating the responses gathered from the field. All formal interviews were audio recorded and written down to enable key points to be analyzed.

3.9 Sample Collection and Integrity Maintenance

A total of 116 food samples were purchased from 150 street food vendors, 26 each per season for the wet and dry seasons 52 each for Accra and Takoradi and 6 each for Senchi (12) respectively from the three study areas. These were categorized into breakfast, snack, lunch and supper, and comprised of Jollof rice, Meat Pies/Spring rolls, Spinach/Okro soups, Plain/Salads with cream, tomato-pepper sauce/stew/ black pepper sauce (shitor), sliced fruits like water melon, pineapple, pawpaw, and mango, mixed fruits of pineapple, water melon, mango and banana, "indomie", fried yam, roasted plantain, and snail "khebab". These were categorized with different labels to represent the batches of morning, afternoon and evening food respectively from the three study areas. The food and water samples from Accra and Senchi were put in sterilized food packs/containers and quickly sent to the laboratory within 1-2 hour(s) in an ice chest with ice blocks of about 5° C in order to be in a good condition for further refrigeration prior to analysis. Whiles food and water samples from Takoradi were kept frozen, transported by air and delivered to the Soil Science Microbiological Laboratory of the University of Ghana. The samples from the three study sites were kept in the fridge where the analysis was conducted. The samples were not stored for more than a day so as to present good analytical significance and to arrest any growth of microorganisms. The following microbiological tests and analyses were carried out on the samples to determine their microbial loads and quality of handling.

Table 3. 1: Breakdown of Food Samples per Study Area: (Wet/Dry) Seasons

Study Area	No.	Food Samples
Accra	26(52)	Fruits and Vegetables/others
Takoradi	26(52)	Fruits and Vegetables/others
Senchi	6(12)	Vegetables/others

Table 3.2: Breakdown of Water Samples per Study Area: (Wet/Dry) Seasons

Study Area	No.	Water Samples
Accra	3(6)	1) Drinking and Hand Washing (Morning)
		2) Drinking and Hand Washing (Afternoon)
		3) Drinking and Hand Washing (Evening)
Takoradi	3(6)	1) Drinking and Hand Washing (Morning)
		2) Drinking and Hand Washing (Afternoon)
		3) Drinking and Hand Washing (Evening)
Senchi	3(6)	1) Drinking and Hand Washing (Morning)
		2) Drinking and Hand Washing (Afternoon)
		3) Drinking and Hand Washing (Evening)
	2(4)	4) River Volta: i. Upper part (RVUP)(Morning)
		ii. Lower part (RVLP) (Morning)

Table 3. 3: Spatial Distribution of Food Samples per Study Area

No.	ACCRA	TIME	CODE	TAKORADI	TIME	CODE	SENCHI	TIME	CODE
1	Jollof	Evening	Aj	Jollof	Evening	Tj	Tomato Pepper Sauce	Morning	STPS
2	Adinkra Pie	Morning	AAP	Spring Roll (fried)	Afternoon	$TSRF_1$	Tomato Stew	Afternoon	STSW
3	Ordinary Pie	Afternoon	AOP	Spring Roll (baked)	Afternoon	$TSRB_2$	Black Sauce (shitor)	Evening	SBS
4	Spinach Soup	Afternoon	ASS	Okro Soup1	Afternoon	TOS_1	Snail Khebab[1]	Afternoon	$SSKB_1$
5	Okro Soup	Afternoon	AOS	Okro Soup2	Evening	TOS_2	Snail Khebab[2]	Evening	$SSKB_2$
6	Plain Soup	Morning	APS	Tomato Pepper Sauce1	Morning	$TTPS_1$	Senchi Okro Soup	Afternoon	SOS
7	Salad with Cream	Afternoon	ASAL	Tomato Pepper Sauce2	Afternoon	$TTPS_2$			

66

8	Tomato Pepper Sauce1	Morning	$ATPS_1$	Sliced Melon1	Morning	$TSME_1$
9	Tomato Pepper Sauce2	Afternoon	$ATPS_2$	Sliced Melon2	Afternoon	$TSME_2$
10	Tomato Pepper Sauce3	Evening	$ATPS_3$	Tomato Pepper Sauce3	Evening	$TTPS_3$
11	Sliced Melon1	Morning	ASME1	Sliced Melon3	Evening	$TSME_3$
12	Sliced Mixed Fruits (melon)	Morning	$ASMF_1$	Sliced Pineapple1	Morning	TSP_1
13	Sliced Mixed Fruits (pineapple)	Afternoon	$ASMPF_2$	Sliced Pineapple2	Afternoon	TSP_2
14	Sliced Mixed Fruits (mango)	Evening	$ASMF_3$	Sliced Mango1	Morning	TSM_1
15	Sliced Banana	Afternoon	ASB	Sliced Mango2	Afternoon	TSM_2
16	Sliced Pineapple1	Morning	ASP_1	Sliced Mango	Evening	TSM_3
17	Sliced Pineapple2	Afternoon	ASP_2	Mixed Fruits (melon)1	Morning	$TMFM_1$
18	Sliced Mango1	Morning	ASM_1	Mixed Fruits (pineapple)2	Afternoon	$TMFP_2$
19	Sliced Mango2	Afternoon	ASM_2	Mixed Fruits (mango)3	Evening	TMF_3
20	Sliced Mango3	Evening	ASM_3	Indomie	Evening	TIN
21	Indomie	Evening	AIN	Salad / Cream	Afternoon	TSC
22	Sliced Melon2	Afternoon	ASM_2	Plain Salad	Morning	TPS
23	Sliced Melon3	Evening	ASM_3	Sliced pineapple	Evening	SP
24	Sliced pawpaw	Morning	ASPA	Sliced pawpaw	Morning	TSPA
25	Roast Plantain	Afternoon	ARP	Roast Plantain	Afternoon	TRP
26	Fried Yam	Evening	AFY	Fried Yam	Evening	TFY

3.10 Water Samples

Water samples from the three study areas were obtained from the tap and comprised of water for drinking, hand washing and domestic use, also categorized into morning, afternoon and evening (Table 3.4). Water samples from the Volta River was collected from the upper and lower parts at Senchi (Table 3.2).

Table 3. 4: Distribution of Water for drinking, hand washing/ domestic use

				Water for drinking and handwashing purposes					
No	Accra	Time	Code	Takoradi	Time	Code	Senchi	Time	Code
1	Tap Water	Morning	AM	Tap water	Morning	TM	Tap water	Morning	SM
2	Tap Water	Afternoon	AA	Tap water	Afternoon	TA	Tap water	Afternoon	SA
3	Tap water	Evening	AE	Tap water	Evening	TE	Tap water	Evening	SE

The representative samples of the selected foods/water were analysed on the following. These include Coliform, *Salmonella sp*., *Escherichia coli, Vibrio cholerae, Staphylococcal count,* Yeasts and Moulds count as shown in Table 3.5.

Table 3.5: Microbial Analysis and Preparation of Media/ Diluents

Media	Microbes	Micro litres per gram
*Salmonella/Shigellar(*SS) Agar	*Salmonella sp.*	52.8g in 500g per litre
Eosin Methylene Blue (EMB) Agar	*Eschericia coli*	36.0g in 500g per litre
Violet Red Bile (VRB) Agar	Coliform	44.5g in 500g per litre
Thiosulphate Citrate Bile Salt Sucrose (TCBSS) Agar	*Vibrio cholerae/* Coliform sp.	44.5g in 500g per litre
Baird Parker (BP) Agar Base	*Staphylococcal Count*	63.0g in 950g per litre
Oxoid Potato Dextrose (OPD) Agar	Yeasts/Moulds	39.0gin 500g per litre

68

3.10.1 Preparation of diluent

About 900ML (µ) of saline water (sterile physiological saline) and 0.89% of sodium chloride solutio was dispensed into Ependolf tubes for diluting the samples. Disposable pipettes were used in taking diluents for mixing. For the various water samples pipettes were changed to avoid cross-contamination of each sample. Serial dilutions were made using 100 micro litres of the samples in 900micro litres of Phosphate buffer solution for all the samples. Each diluent was plated with Violet Red Bile agar for Coliform, Eosin Methylene Blue agar for *E. coli,* Potato Dextrose agar for Yeasts and Moulds, Thiosulphate Citrate Bile Salt Sucrose agar for *Vibrio sp.,* Baird Parker enrichment medium for *Staphylococcus sp.* and *Salmonella-Shigella* agar medium. All inoculated media were incubated at 35ºC- 37ºC except the Eosin Methylene Blue which was incubated at 44ºC.

3.10.2 Quality assurance

Quality control and assurance measures were carried out to ensure reliability of the results. All petri dishes, glassware and instruments were sterilized in hot air oven at a temperature of 250ºC for 2 hours. Other glassware and tips were autoclaved at 121°C for 2 hours at a pressure of 15 for 15minutes to destroy any bacteria before cutting food samples in the packs to avoid contamination. All food and water samples were analyzed and the values reported in log cfu/g of means of duplicates.

3.10.3 Plating and counting of colonies

Food samples were sorted-out from a safety cabinet working chamber class 11. One gram each of the samples taken i.e. micro litres, per gram were diluted and plated serially i.e. 10^1, 10^2 and 10^3 (serial dilution). The raw sample of 100µl were inoculated into 900µl of sterile physiological saline (1,000) well mixed by shaking (vortexed) and followed by

69

another 100µl taken from the mixture into the next diluent. Each diluent of 100µl were pipetted into sterile plates using the pour plate method (PPM) (i.e. mixture in the flat bottom flask) and were carefully arranged to ensure an even distribution of the media and sample. These were carried out in duplicates and incubated for 24 hours (1day) with the exception of the inoculated potato dextrose agar plates which were incubated at a temperature of 35°C-44°C in a Genlab incubator.

All incubation was carried out in an incubator at the desired temperature of 37°C which encourages the rapid growth of the organism for 24 hours. All colonies which had developed on the different media after the incubation period were counted using a Stuart colony counter. The counts were determined by counting the colonies and multiplying it by the dilution factor on the respective plate. The results were expressed as colony forming units per gram (cfu/g).

3.10.3.1 Purification method:-

Each discret colony was picked aseptically by flaming and purified by inoculating a sterile broth and streaking on a nutrient agar plate. Discret colonies that grew after incubating overnight were picked after repeated streaking on nutrient agar for pure isolates.

3.10.3.1.1 Isolation of Escherichia coli

To isolate *E. coli*, 100ml of prepared sample was aseptically plated using the pour plate method. The medium for isolation and culture was Eosin Methylene Blue (EMB) Agar and incubated at 35°C-37°C for 24 hours. The colonies were counted using colony counter as indicated. Dark red shiny colonies specific for *Escherichia coli* were identified, purified for their characterization and classification and expressed in colony forming unit per gram (cfu/g) (Lee and Choi, 2006; Yoon *et al*., 2008; Cheeptham, 2013).

70

3.10.3.1.2 Isolation of Salmonella

To isolate *Salmonella sp.*, 100ml of the sample was aseptically plated using the pour plate method. The medium for isolation and culture was the SS Agar and also incubated at 35℃-37℃ for 24hrs. Reddish colonies were picked, purified for their identification, characterized, classified and expressed as the number of colony forming unit per gram (cfu/g) (Kennedy *et al.,* 2005; Centre for Food Safety, 2007).

3.10.3.1.3 Isolation of Staphylococcus aureus

To isolate *S. aureus*, 100ml of the sample was aseptically plated using the pour plate method. The medium for isolation and culture was the Baird Parker Agar Base enriched with egg yolk tellurite and incubated at 35℃-37℃ for 24hrs. Colonies were picked and purified and isolates were identified, characterized and classified. The result was expressed as the number of *Staphylococcus* colony forming unit per gram (cfu/g). Purified colonies were confirmed by Gram staining (Yoon *et al.,* 2008).

3.10.3.1.4 Isolation of Total coliform count

Total coliform count 100micro litres of the sample was aseptically plated using the pour plate method. The medium for isolation and culture was Violet Red Bile (VRB) lactose agar base and also incubated at 35℃-37℃ for 24hours. Colonies were picked, purified and the isolates were identified, characterized and classified. The results were expressed as the number of Total coliform colony forming unit per gram (cfu/g).

3.10.3.1.5 Isolation of Yeasts and Mould count

For isolation of Yeasts and Moulds counts, 100micro litres of the sample was aseptically plated using Oxoid (Potato Dextrose Agar) and also incubated at 35℃-37℃ for 24hours for Yeasts and 1 week for Moulds using the pour plate method. Colonies were picked,

purified and isolates were identified, characterized and classified. The result was expressed as the number of Yeasts and Moulds colony forming unit per gram (cfu/g).

3.10.3.1.6 Isolation of Vibrio cholerae count

For isolation of *Vibrio cholerae* count, 100ml of the sample was aseptically plated using Thiosulphate Citrate Bile Salt Sucrose (TCBSS) agar base and incubated at 35ºC-37ºC for 24hours using the pour plate method. Colonies were picked, purified and the isolates were identified, characterized and classified. The result was expressed as the number of *Vibrio cholerae* colony forming unit per gram (cfu/g).

3.11 Data Analysis

The design of this study demanded that the data gathered be analysed qualitatively and quantitatively.

3.11.1 Qualitative analysis

The qualitative analysis was done using existing theories to explain findings. Important trends and relationships were considered by use of Likert scale of five items (ranking) terms such as high, moderately high, very high or low and not aware of how high or low to describe the perceptions, degree of intensity and severity of issues under investigation. Descriptive statistics help to organise, summarise and present the data in a way that can be easily understood for example, graphs, pie- charts, proportions were used in addressing stated objectives. Observation of the environment where food is prepared and served as well as hygiene practices by food vendors in food handling provided first hand encounters on the phenomena of interest to the researcher. The observational study focused on physical setting, participants and activities. Prior to the data entry, analysing information was obtained by coding and keying into the computer.

3.11.2 Quantitative analysis

The quantitative analysis was achieved using SPSS V. 22.0. The following were determined; frequency distribution, tables, percentages, cross tabulations and graphical techniques for illustrations and presentations with the use of Microsoft Excel. The interviews conducted were analysed for themes and contents. Interviews allow respondents to move back and through time by providing second hand accounts of experiences. Bivariate and multivariate (BMVA) statistical methods were employed to evaluate and summarize the data collected for this study. Bivariate is used when more than one independent variable e.g. 2 is investigated, as in factorial designs. Multivariate analysis of variance (MANOVA) on the other hand incorporates 2 or more dependent variables in the same analysis, thus permitting a more powerful test of differences among means. It is justified only when the researcher has reason to believe correlations exist among the dependent variables. Also, it was used to describe demographic, socio-economic variables and relate factors influencing food safety with perception and attitude. P-values less than 0.05 with 95% confidence interval was considered as statistically significant. This is because many of the variables were considered to be interrelated.

The study consisted of 116 food samples and 22 water samples for the 2 seasons (wet/dry) and the 3 study areas making a total of 138 data points for the microbial load analysis. The mean concentration values were first transformed to log base 10 for the microbial load data (Mensah *et al*., 2012). The log-transformed values were then standardized by the total method, which helped to normalize the distribution (Morton, 2011). Variables which recorded zero for all samples were not included in the statistical analysis. Several methods were applied in processing the variability between the mean concentrations obtained for the variables in this study. The differences and similarities between microbial load in the selected foods and water samples were examined and visualized using Multivariate

73

Analysis (MVA) technique for sorting and grouping (Gardiner, 1997). The 3 study areas had similar socio-economic, ethnic and sanitation challenges. For this reason, interview data collected was considered as a homogenous unit (Kighthinger *et al*., 1995).

3.12 Test of Hypotheses

➤ The chi-squared (X^2) test was used to test the stated hypotheses and to evaluate association between stated variables and the significance of any observed differences. The chi-square test was used to analyse data that were reported in categories. It was also based on a comparison between expected frequencies and actual, obtained frequencies. Data from the questionnaire was captured by use of frequency tables, graphs, charts and was entered into Microsoft Excel (2010 version) and finally imported into Statistical Package for Social Sciences (SPSS Version 22.0) for analysis with the formula below:

- $X^2 = \sum \dfrac{(fo - fe)^2}{fe}$

- Degrees of freedom

- X^2 = test of goodness of fit

- Where, 0 = observed frequency (that is assumptions (not fixed) one had earlier to the study).

- Where fo = Observed sample count

- Where fe = expected sample count

A list of key opinions expressed by respondents was categorized in relation to the objectives and identifying indicators under the various headings. Also cross tabulation of the various variables.

3.13 Checklist for Catering Facilities/Stakeholders

Structured questionnaire was used to administer a face-to-face interview to fifteen stakeholders (five each) at the study areas to get information on hospital data related to issues of unsafe food, top 10 diseases, poor sanitation, as well as health seeking behaviour of participants with compliance. The checklist was self- administered at the food joints and assemblies of the selected study areas through direct observation of environmental conditions around food-vending premises and also interviewing heads of stakeholder institutions at the time of the visit. The information gathered helped in assessing the activities and bye-laws of the Assemblies regarding supervision/certification/compliance of food vendors on sanitation and food safety and validating the responses from the field.

3.14 Ethical Clearance/Consideration

Ethical approval for the study was obtained from the Ethical Review Committee (ERC) of the College of Basic and Applied Sciences (CBAS) of University of Ghana, Legon (Appendix 6).

3.15 Limitations and biases of the study

The limitations and biases presented below are perceived to have had some effects on the study however, do not underscore the outcome of the study.

Various challenges encountered in the course of the study include the following:

The 3 study sites are predominantly the business centres of the various regions in which the study was done. Carrying out the study early in the morning was challenging since food vendors and consumers were in a hurry to organize, display their wares before food service to the teeming number of customers who were in

75

the queue. The researcher was compelled to carry out the study in the mornings, mid-mornings, afternoons and in the evenings.

The relative short period to carry out the research for the 2 seasons (Wet/Dry) coupled with resource constraints made it impossible for large food and water samples and respondents to be used for the study.

Most of the respondents (food vendors/consumers) were illiterates and semi-illiterates so additional time had to be spent in interpreting the questions to them in their local languages. The intended meaning and the possibility of distortion of the original English terms (message) was possible. In the process adversely affected the early completion of the study. Also, some food vendors were not willing to participate in the study. The researcher was therefore left with no alternative but to use the convenience sampling method to choose 300 respondents (150 food vendors/150 consumers) for the study.

The problem of responding to some of the questions could not be ruled out. Some of the respondents could have answered questions to please the researcher or exaggerated about the exact situation on the ground. This could have been overcome by validating responses from respondents over sometime, but time was a limited resource.

About (100%) of the respondents interviewed happened to have patronized street foods, hence the high level of street food knowledge. Also, the fact that respondents had access to electronic media and could access or participated in food hygiene messages explains the real source of food safety practices awareness.

1) Finally, the study deals with selected dependent and independent variables which have been used to explain food safety compliance and attitude/perceptions of street food vendors/consumers. It is therefore possible that some of the variables may

have some effect or have produced stronger predictive influence hence generate different patterns from the results obtained so far.

CHAPTER FOUR

4.0 RESULTS

4.1 Introduction

Results of analysis of the findings on food safety practices of street food vendors and consumers in Ghana are presented. It focus on sample distribution at the study sites, socio-demographic characteristics of street food vendors/consumers, attitudes, perceptions on food safety practices, compliance during purchase of raw materials/food items and storage, types of utensils used during food preparation/services, hazards consumers are exposed to due to leftover handling and assessing microbial quality of selected food and water samples. Further explored included compliance by food vendors and stakeholder institutions to ensure food safety.

4.2 Socio-Demographic Characteristics of Respondents

Socio-demographic issues are very important in any meaningful analysis and discussions, primarily due to the degree of influence or potential impact they exert on other variables of interest (Kroeger, 1983). These factors could vary depending on the focus at any given time. For this study, the age, educational attainment, marital status, religion and ethnic identities were considered. In addition, the economic activities of respondents as well as their migration history were considered relevant.

4.2.1 Age of respondents

The age of respondents ranged between 18 and 66 years. The number of respodents decrease with age as shown in Table 4.1. Age of respondents was broadly categorized into three, under 35 years, middle age of 35 to 59 years a werend 60 to 66 years. The age category of 18 to 34 years accounted for (14.7%) of the respondents, 35 to 39 accounted for (26.7%) with (1.3%) being 60 years and above.

78

4.2.2 Educational level of respondents

The analysis on education revealed varied literacy levels. About (23%) of the respondents had no formal education. Respondents with some level of education at the basic level was (48.0%), which could be those who had either completed or partially completed primary, middle or JHS level of education before entering their primary occupation, respondents with SHS/Commercial/Technical levels of education constituting (23.7%) while the highest level (tertiary education) was attained by (5.3%) of the respondents (Table 4.1).

4.2.3 Marital status of respondents

Majority of the respondents (49.7%) were either married or once married at the time of the study. About (33%) of the respondents had never married and were either single or in a relationship. Marital status as indicates that (5.0%) were divorced while (2.3%) were widowed. The number of married respondents was high (Table 4.1).

4.2.4 Religion of respondents

Though the study areas revealed diversity of religions, Christianity remains the most dominant religion (82%). Muslims constituted (18%) with rest being traditionalists or otherwise. Pockets of religions such as Hindu, Krishna, Eckanker and traditionalists were found (Table 4.1).

4.2.5 Ethnicity of respondents

Almost all the ethnic groups in Ghana exist in the study areas (Table 4.1). The respondents belong to four major ethnic groupings with the Ewes being the majority (40.0%). The Akans, Ga-Dangbes and the Northerners also constitute (19.0%), (18.0%) and (17.7%) respectively.

79

4.2.6 Occupation/economic/sources of income of respondents (vendors/consumers)

The analysis on occupation revealed that economic activities of the respondents were very diverse, with close to (99%) of them not engaged only in a single activity but have other sources of income to enhance their livelihood (Table 4.1). Most of the respondents (vendors/consumers) were traders (57.3%) who earn salary as a secondary source of income (14%), wage (20.7%) and remittance (8%). Other occupations included farming and petty trading which are considered as a secondary source of income are categorized into formal (14%) and informal (86%).

Table 4. 1: Socio-Demographic Characteristics of Respondents (Comparative)

Characteristic	Categories	Responses N (%)			Total
		Accra	**Takoradi**	**Senchi**	
Age(Years)	<18	6%	0%	0%	2.0%
	19-24	2%	15%	5%	7.3%
	25-29	14%	6%	15%	11.7%
	30-34	6%	15%	23%	14.7%
	35-39	24%	25%	31%	26.7%
	40-44	14%	20%	19%	17.7%
	45-49	18%	15%	4%	12.3%
	50-54	4%	3%	3%	3.3%
	55-59	8%	1%	0%	3.0%
	60-66	4%	0%	0%	1.3%
	Total	**100**	**100**	**100**	**300(100%)**
Sex (Gender)	Female	63%	70%	60%	64.3%
	Male	37%	30%	40%	35.7%
	Total	**100**	**100**	**100**	**300(100%)**
Education level	No formal education	38%	6%	25%	23.0%
	Basic (Primary/Middle/JHS)	36%	47%	61%	48.0%
	Secondary(SHS) Commercial/Technical	26%	31%	14%	23.7%
	Tertiary-Polytechnic, University	0%	16%	0%	5.3%
	Total	**100**	**100**	**100**	**300(100%)**
Marital Status	Single	46%	43%	10%	33.0%
	Married	44%	30%	75%	49.7%
	Separated	6%	13%	11%	10.0%
	Divorced	2%	9%	4%	5.0%
	Widowed	2%	5%	0%	2.3%
	Total	**100**	**100**	**100**	**300(100%)**
Religion	Christianity	87%	67%	92%	82%
	Muslims	13%	33%	8%	18%
	Traditional	0%	0%	0%	0%
	Total	**100**	**100**	**100**	**300(100%)**
Ethnicity	Ewe	48%	29%	45%	40.7%
	Akan	19%	10%	28%	19.0%
	Ga-Dangme	19%	23%	12%	18.0%
	Northern	14%	26%	13%	17.7%
	other	0%	12%	2%	4.7%
	Total	**100**	**100**	**100**	**300(100%)**
Occupation/Source of income	Petty trading	39%	63%	70%	57.3%
	Wage	28%	22%	12%	20.7%
	Salary	25%	15%	2%	14.0%
	Remittance	8%	0%	2%	8.0%
	Total	**100**	**100**	**100**	**300(100%)**

4.3 Reasons for Migrating to Study Areas (Vendors/Consumers)

Some of the respondents who currently live in the study areas are not natives. Most of the

respondents, (60.0%) had lived in their respective communities for more than 10 years

(Table 4.2). Majority of the respondents (70.05%) had either completed or partially

81

completed the Middle/JHS before entering the street food vending trade as primary occupation (Table 4.1). Respondents whose primary occupation was street food vending were both females (64.3%) and males (35.7%) (Table 4.1). A few others were involved in petty trading but consumers were mostly truck pushers, drivers, mechanics, video operators, security personnel, non-food sellers (50.0%). Table 4.1 shows the primary occupation of the respondents from the 3 study areas. About (27.0%) of the respondents had stayed in their respective occupations for more than 5 years (Table 4.3).

Table 4. 2: Reasons for Migrating to Accra/Takoradi/Senchi (vendors/consumers)

Reasons	Frequency (N=300)	Percent %
To stay with spouse	144	48.0
Came to look for job/job hunting	71	23.7
Transferred/Posted to the place	69	23.0
Came to stay with children	16	5.3

Table 4. 3 Length of Years of stay in Community/Business (vendors/consumers)

Number of Years	Frequency	Percentage %
< 1 year	25	8.3
1-5	15	5.0
6-10	80	26.7
> 10 years	180	60.0
Total	**300**	**100.00**

Table 4.4 presents results on food safety training variables and food safety compliance. The variables showed a significant value at P≤0.05 which indicates a significant relationship between food safety training/certification and food safety compliance.

Table 4. 4: Association between Food Safety Training Variables and Food Safety Compliance (Vendors)

Variable	Food Safety Compliance				
	Frequency	**%**	**χ2**	**Df**	**P-value**
Food safety training			4.54	5	0.132
None	55	36.7			
<1year	20	13.3			
1-2years	45	30.0			
>years	30	20.0			
Certification					
Yes	40	26.7		4	0.028*
			7.25		
No	110	73.3			

*Significant at P≤0.05

4.4 Association between Respondents' Perception Scales (Positive-High/Negative-Low)

The scores by individual respondents' perception scales were stratified into high 168 (56%) and low 132 (44%); while attitude scores were stratified into positive and negative categories. The scores of each of the respondents were assessed by considering their linear composite scores in perception and attitude scales. High and positive scores were represented by 1 while low and negative scores were represented by 2. The mean scores were determined and all respondents that had good ratings in perception and attitude above the mean score were rated as high perception and positive attitude and those with scores below the mean were rated as low perception and negative attitude to compliance with food safety regulation.

83

4.5 Perception and Compliance with Food Safety Regulation (high/low) (vendors /consumers)

In the study, 168 (56%) of food vendors and consumers had a high perception of compliance with food safety regulation whilst 132 (44%) had low perception.
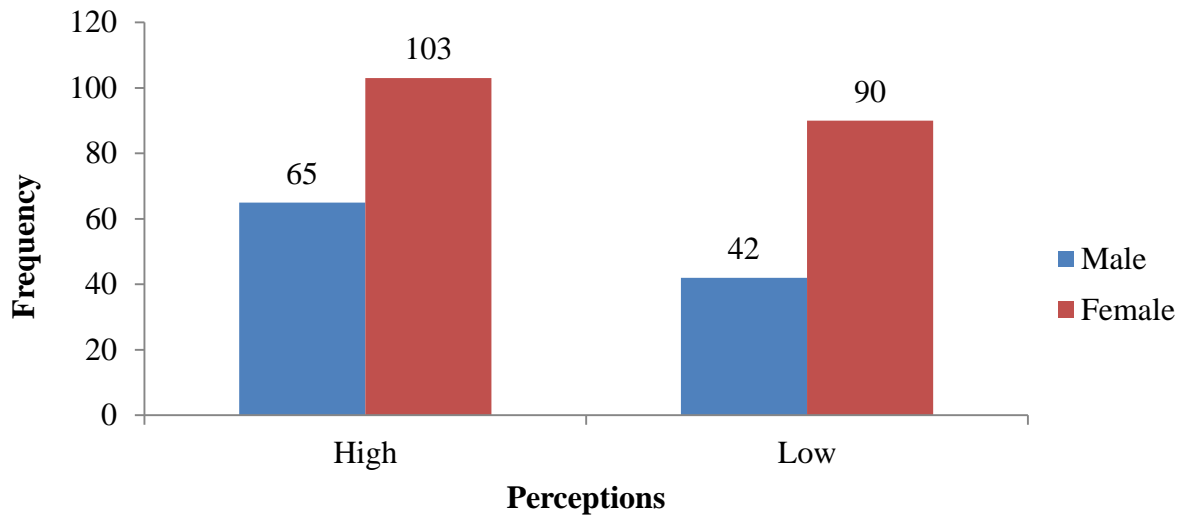
Figure 4.1: Perceptions of respondents on compliance with food safety regulations

In this study, 120 (40%) respondents had a positive attitude to compliance of food safety policy 180 (60%) had negative attitude (Table 4.5). With respect to gender on attitude to food safety policy compliance, females had high positive attitude (85%) compared to their male counterparts (60%) in the scaling technique and perception scores (Figure 4.2).

Table 4. 5 Respondents' Attitude on Compliance with Food Safety Regulation

Variable	Perception (N=300)	
	Positive	Negative
Compliance with food safety policy	120(40%)	180(60%)
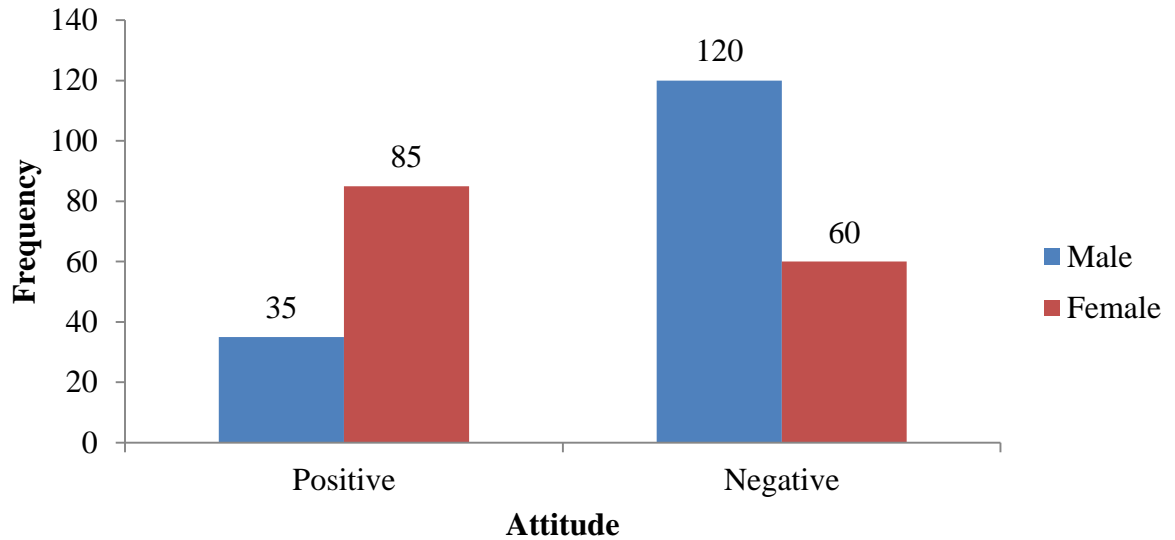
Figure 4. 2: Attitude of respondents on Compliance with Food Safety

In order to determine the ways by which food get contaminated by vendors, binary logistic regression was conducted, the results of which revealed that preparation of food in advance, using the same knife and cutting board for both raw and cooked food, the working surfaces, food handling, selling location, how leftover foods are treated, conditions of cloth used for cleaning hands, how often cloths for hands are washed, how utensils are washed, number of times dish water is changed and how leftover foods are stored were significantly associated with food contamination and significantly increased the risk of food contamination in the bivariate logistic model (P≤0.05, Crude OR>1). The source of water for food preparation was not associated with the contamination of food in this current study though it was statistically significant at (95%) confidence level (P>0.05).

Table 4. 6: Vendors'Attitude/Perceptions of ways by which food gets contaminated using binary logistic regression model

Variable	Crude OR	Food contamination sources 95%(CI)		P-value
		Lower	Upper	
Preparation of food in advance	1.046	0.247	4.435	0.95
Using the same knife / cutting board for both raw / cooked food	3.781	0.842	16.966	0.003*
Working surfaces	6.975	1.233	12.350	0.028*
Food handlers	10.250	5.344	27.520	0.000*
Source of water for food preparation	0.167	0.024	1.139	0.050*
Selling location	1.713	0.398	7.375	0.035*
How leftover foods are treated	1.400	0.284	6.897	0.048*
Conditions of cloth used for cleaning hands	4.240	1.250	9.270	0.001*
How often are cloths for hands washed	9.650	4.280	12.580	0.000*
How utensils are washed	1.507	0.331	6.870	0.000*
Number of times dish water is changed	2.430	0.033	4.580	0.010*
How leftover foods are stored	3.270	1.270	7.320	0.040*

*Significant (P≤0.05)

4.6 Association between Food Safety Compliance by Street Food Vendors during Purchasing/Storage/ Utensils used for Food Preparation and Services.

In assessing the association between food safety compliance by street food vendors during purchasing, storage, food preparation and food contamination, the chi-square test statistics was used. The results revealed that food safety compliance when purchasing food items in the market was significantly associated with food contamination ($\chi2= 34.849$, $P<0.05$).

86

The use of right utensils during food preparation was not significantly associated with contamination of food (χ2= 34.849, P>0.05) (Table 4.7).

Table 4. 7: Food safety compliance by street food vendors during purchasing /storage and types of utensils used for food preparation and services

Variable	Food contamination (N=150)			
	Frequency(F)	**(%)**	**χ2**	**P-value**
Food safety compliance when purchasing food items			34.849	0.000*
Check for one in good condition	48.0	64.0		
Buy cheaper and bruised ones	24.0	32.0		
Ignoring food safety measures and buy them	3.0	4.0		

*Significant (P≤0.05)

4.7 Use of Right Utensils during Purchase/Storage/Food Preparation by Food Vendors.

Generally, the respondents used various types of utensils during food preparation. With regards to using the right utensils during food purchases, storage and food preparation, the study showed that the majority of the food vendors (71%) had knowledge and use the right utensils to avoid cross-contamination whilst (29.0%) did not. However, the use of utensils during food preparation was not significantly associated with food contamination (P>0.05) (Figure 4.3).
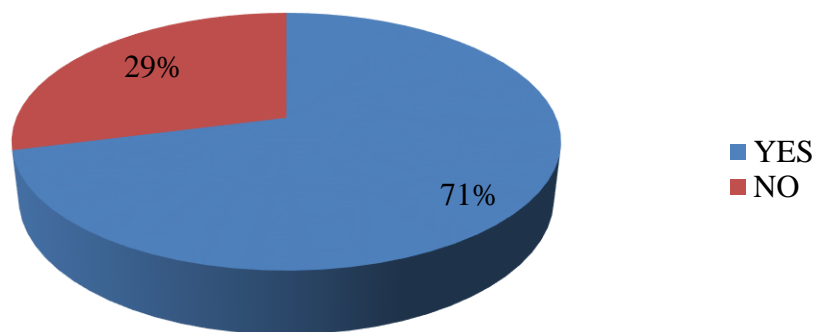
Figure 4. 3: Use of utensils during food preparation

87

Table 4.7.1 shows consumers' response to how the food vendors keep their environment and its association with food contamination. The results show that (38%) keep their environment clean, (33%) (very clean) and (12%) kept their environment dirty. The analysis show that how the environment is kept is significantly associated with food contamination (P<0.001) (Table 4.7.1).

Table 4.7. 1: How the environment is kept (consumers)

Variable	Food contamination (N=150)			
	Frequency(F)	**(%)**	**χ^2**	**p-value**
How the environment is kept			20.289	0.000*
Clean	38.0	38.0		
Very clean	25.0	33.3		
Dirty	12.0	16.0		

*Significant (P≤0.05)

With respect to the source of availability of water to the vendors during food preparation, most respondents use tap water as major source representing (94.8%), (74.7%) obtained water from water vendors and least representing (6%) obtained water from the well (Table 4.7.1.1). Use of the river Volta in Senchi by food vendors recorded (26.7%) for domestic chores. The source and availability of water was found not to be significantly associated with food contamination at 95% confidence level (P>0.05).

Table 4.7.1.1: Source and availability of water (vendors/consumers)

Variable	Food contamination (N=150)			
	Frequency(F)	(%)	χ²	p-value
Source and availability of water			4.428	0.109
Tap water	73.0	94.8		
Water vendor	56.0	74.7		
River water	20.0	26.7		
Pure water	45.0	8.0		
Well water	6.0			

Table 4.7.1.2 shows the relationship of the frequency of food vendors changing water for washing plates and its relationship with food contamination. The results shows that most vendors change their water about 2-3 times a day representing (95.9) and (4.1%) change their water once a day. The frequency of changing water significantly influence the contamination of food (P<0.05).

Table 4.7.1.1: Frequency of changing water for washing plates (vendors)

Variable	Food contamination (N=150)			
	Frequency(F)	(%)	χ²	p-value
Frequency of changing water washing plates			6.514	0.039*
2-3 times a day or more	72.3	95.9		
Once a day	3.0	4.1		
Never	0.0	0.0		

*Significant (P≤0.05)

With regards to the frequency of changing wiping cloths, (60.6 %) of respondents change their hand wiping cloths once per day and (36.4%) change 2-3 times per day. The frequency of changing hand wiping cloths was significantly associated with food contamination (P<0.05) (Table 4.7.1.3).

Table 4.7.1.2: Frequency of changing hand wiping cloths (vendors /consumers)

Variable	Food contamination (N=150)			
	Frequency(F)	(%)	χ²	p-value
Frequency of changing hand wiping cloths			19.493	0.001*
Once a day	100.0	60.6		
2-3 times a day or more	60.0	36.4		
Not washed or changed	5.0	3.0		

*Significant (P≤ 0.05)

Results on whether food hygiene practices ensured with vendors are associated with food contamination, indicated that good food hygyiene practices significantly associated with food contamination (P<0.05) (Table 4.1.7.4). With regards to health education on food hygiene, (71.1%) said they had received education on food hygiene whilst the remaining (28.9%) had not received any education on food hygiene. Receiving education on food hygiene was found to be significantly associated with food contamination (P<0.05) (Table 4.7.1.5).

Table 4.7.1.3: Food hygiene practices ensured (vendors)

Variable	Food contamination (N=150)			
	Frequency(F)	(%)	χ²	p-value
Food hygiene practices ensured			5.510	0.004*
Washing vegetables in salt solution	50.0	66.7		
Putting food in the fridge	47.0	62.7		
Washing hands frequently with soap/water	46.0	61.3		
Heating food thoroughly at a high temperature	45.0	60.0		
Washing vegetables in vinegar solution	41.0			

*Significant (P≤0.05)

Table 4.7.1.4: Health education on food hygiene received (vendors)

Variable	Food contamination (N=150)			
	Frequency(F)	**(%)**	**χ²**	**p-value**
Health education on food hygiene received			16.879	0.001*
Yes	55.0	71.1		
No	20.0	28.9		

*Significant (P≤0.05)

4.8 Factors influencing food safety attitude and perceptions

To determine the factors influencing knowledge and attitude of food safety, binary logistic regression was conducted with knowledge and attitude as the dependent variables. In the analysis demographic charactersitics with age and ethnicity were significant factors that influenced the knowledge and attitude of food safety at (95%) confidence level (P≥0.05) (Table 4.8). Food safety training, knowledge about foodborne diseases, how leftover foods are heated, conditions of cloths used for cleaning hands and how leftover foods are stored significantly influenced attitude and perception to food safety practices (P≤0.05).

Table 4. 8: Factors influencing food safety attitude and perception

Variable	OR	95%(CI)		P-value
		Lower	Upper	
Duration of food vending	1.046	0.247	4.435	0.047
Age	2.483	1.111	7.558	0.037*
Ethnicity	2.473	1.233	8.267	0.035*
Food safety training	3.247	1.248	8.450	0.000**
Ways of killing microorganisms or germs in food	0.148	0.025	1.139	0.095
Knowledge about foodborne diseases	2.324	0.374	4.276	0.039*
How leftover foods are treated	1.400	0.265	4.474	0.048*
Conditions of cloth used for cleaning hands	2.411	1.235	5.230	0.034*
How often are cloths for hands washed	3.650	2.280	10.452	0.003*
How leftover foods are stored	3.270	1.270	7.320	0.040*

*Significant (P≤0.05)

4.9 Source of information on food safety

Information sources available to the respondents on food safety were mainly from colleagues and relatives accounting for nearly (73.0%) and (71.70%) of the responses respectively (Figure 4.4). Other relevant sources included radio (66.70%), television (62.70%), church/mosque (51.30%) and workshop/training (34.30%).
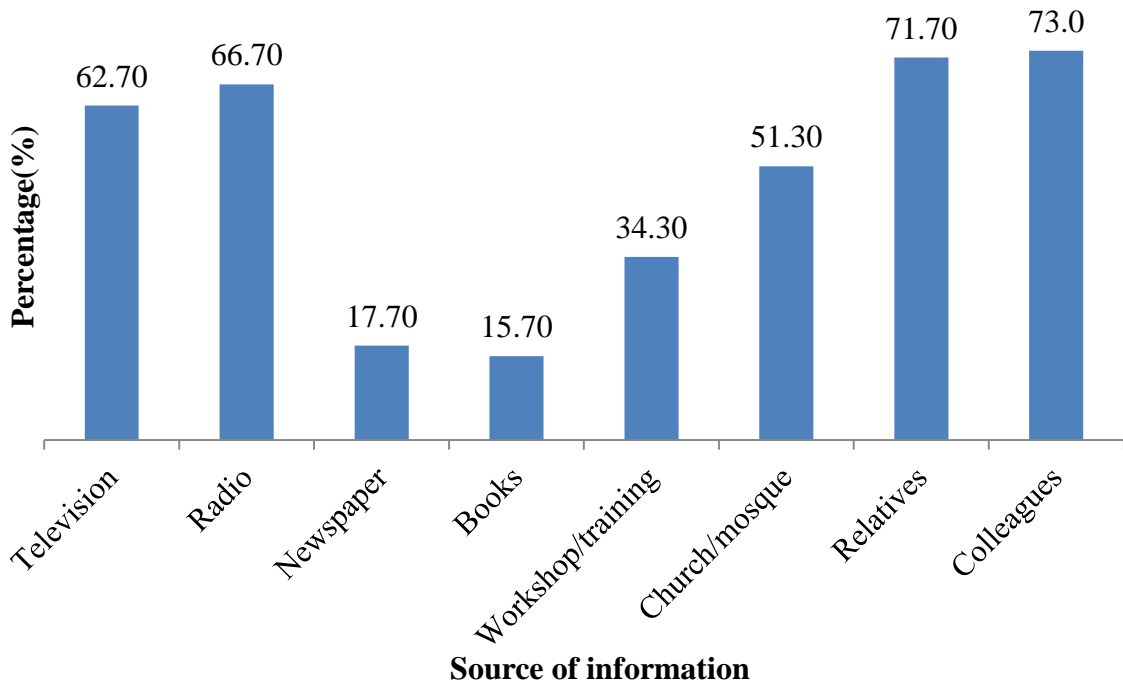
Figure 4. 4: Sources of information on food safety

4.10 Relationship between consumers' perception for street food patronage

Figure 4.5 and Table 4.9 below shows the relationship between consumers' perception and the reasons for patronage of street foods. The regression results revealed that independent variables such as saves time/energy (90.5%), the food being cheap, (76.0%), have more taste, (42.9%), the food being more nutritious, (37.3%) and flavour, (24.5%) influenced the decision of consumers to patronize street food in the multivariate analysis (P≤0.05) (Figure 4.5). An adjusted R^2 which is the coefficient of determination from the regression results however is 0.45 which is approximately (45%) of the total variation in street food consumption is attributed to or explained by the independent factors. The unexplained variation unaccounted for is approximately (55%). This is an indication that there are other factors that influence the decision of consumers to patronize street foods and not directly related to the tested independent factors (Table 4.9).

93
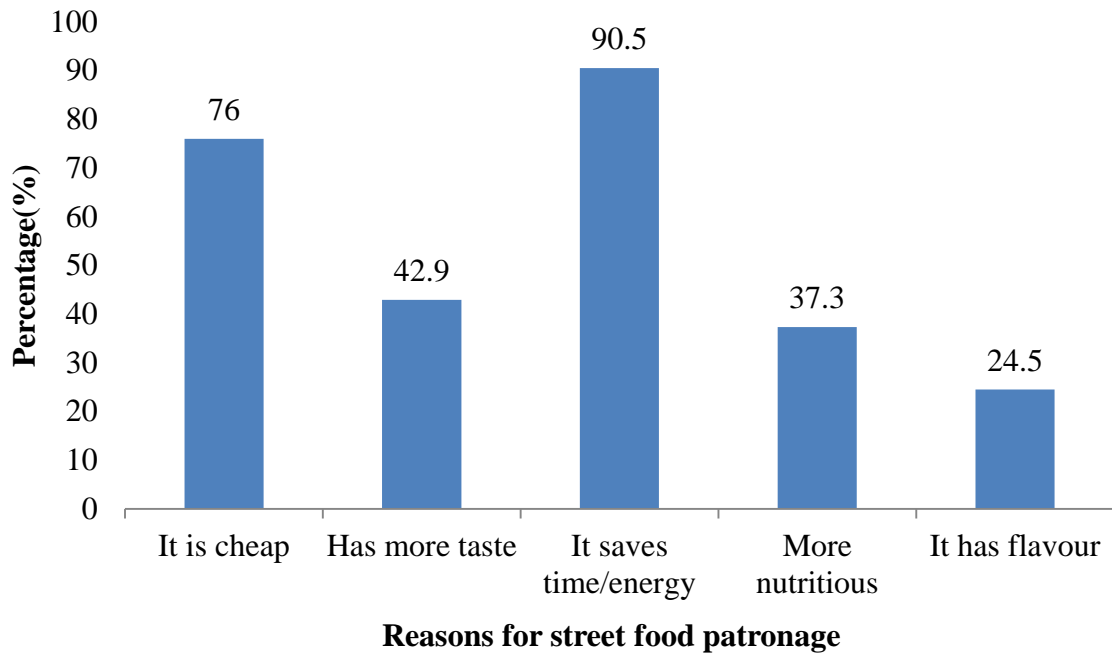
Figure 4. 5: Reasons for patronizing street food

Table 4. 9: Multivariate regression analysis of why consumers patronize street foods

Variable	Adjusted coefficient	SE	t-value	P-value	95.0CI for B	
					Lower	Upper
It is cheap	0.461	0.363	1.271	0.206	-0.256	1.178
Has more Taste/flavour	0.163	0.403	-0.404	0.687	-0.959	0.634
Saves time/energy	0.918	0.496	-1.850	0.048*	-1.898	0.063
More nutritious	0.168	0.423	0.397	0.692	-0.668	1.004

*Significant (P≤0.05) $R^2 = 0.45$

4.11 Handling of leftover foods by food vendors

Figure 4.6 provides how leftover foods are handled. The study indicated that (29%) of the food vendors remixed leftover food with new one and reheated before selling, (21%) heated leftover food and sold while (17%) sold leftover food without reheating sometimes

94

store them in a basin of water. It was largely considered that leftover foods are stored for between 1 and 2 days. A total of (88%) of food vendors sold leftover food from the previous day, whilst (12%) have ever sold food about 2 days old.
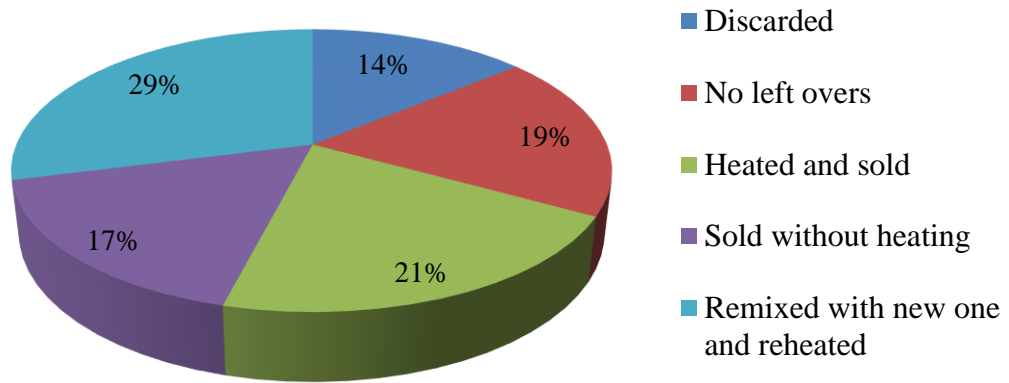
Figure 4. 6: Leftover food handling

4.12 Food safety compliance during purchasing of food items by food vendors

The study revealed that the majority of the food vendors (64.0%) ensured food items in good condition before purchase whilst (32.0%) of the food vendors buy cheaper and bruised ones and 4.0% never did food safety measures and buy them (Figure 4.7).
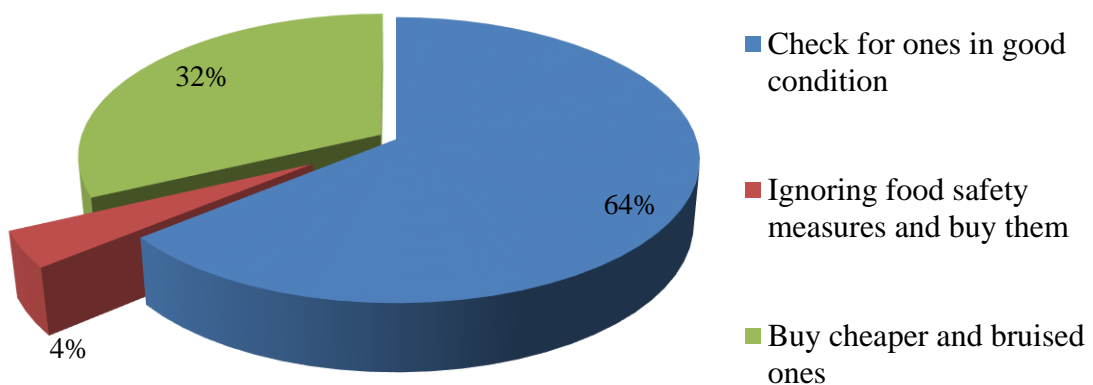
Figure 4. 7: Food Safety compliance during purchasing of food items

95

Table 4.10 provides association of the variables between compliance with food laws and food safety by food vendors. The results revealed that storing food in the fridge, vendors having waste bins, washing vegetables in salt or vinegar, washing hands with soap and water, heating food thoroughly at high a temperature, and having waste bins covered were significantly associated with food safety in this study (P ≤ 0.05).

Table 4. 10: Compliance with food laws by food vendors / association with food safety

Variabe	Food Safety	
Compliance with food laws	**Spearman's R**	**P-value**
Storing food in fridge	0.724	0.027*
Vendors have waste bins	0.655	0.029*
Washing vegetables in salt solution	0.648	0.038*
Washing vegetables in vinegar solution	0.538	0.019*
Washing hands with soap and water	0.386	0.125
Heating food thoroughly at a high temperature	0.245	0.345
Waste bins covered	0.145	0.428

*Significant (P≤0.05)

4.13 Consumers' views and ratings on the level of food poisoning in Ghana

Consumers' views and ratings on the level of food poisoning were ascertained. Majority of the consumers were not sure about the level of food poisoning in Ghana (45.3%), (32.7%) perceived the level of food poisoning as moderately high, (14.7%) perceived the level of food poisoning to be high, whilst (7.3%) asserted that food poisoning was very high (Figure 4.8).

14.70% — High
32.70% — Moderately high
7.30% — Very high
45.30% — Not sure
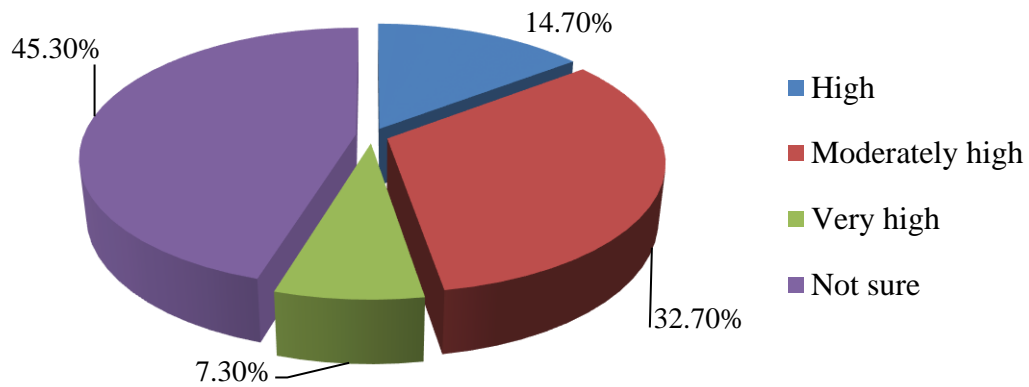
Figure 4. 8: Consumers' ratings on the level of food poisoning in Ghana

4.14 Views of consumers on how vendors keep their environment

The views of consumers on how vendors keep their environment around the selling area were ascertained. Most of the consumers, (50%), asserted that the environment was kept clean whilst (23.3%) asserted that, the selling area was very clean, with (26.7%) perceiving the environment to be dirty (Figure 4.9).

26.7% — Very clean
23.3% — Clean
50.0% — Dirty
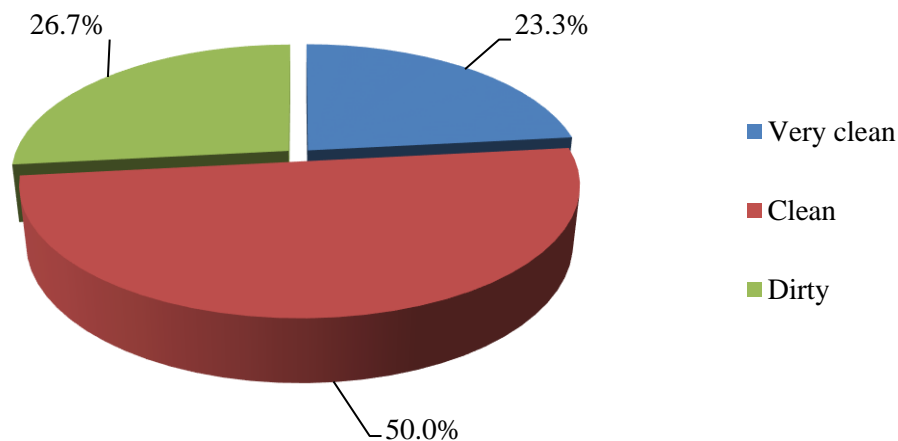
Figure 4. 9: Views of consumers on how vendors keep their environment

4.15 Consumers' views/perceptions concerning materials used in covering cooked food

Consumers' views and perceptions concerning materials used to cover cooked food were ascertained. Most of the consumers asserted that vendors use plastic as a covering material

97

(30%), whilst (21.3%) mentioned cloths and plastics. Paper was the least material used for

covering cooked food as reported by the consumers (5.3%) as shown in (Table 4.11).

Table 4. 11: Materials used by vendors to cover cooked food as perceived by consumers

Food covering materials	Frequency (150)	Percentage (%)
Plastic	45.0	30.0
Cloths and plastics	32.0	21.3
Cloths	28.0	18.7
None	25.0	16.7
Cloths, plastic and paper	12.0	8.0
Paper	8.0	5.3

Table 4.12 shows the frequency of observing specified food safety indicators at the study

sites, the observation revealed that (95.4%) of vendors had waste bins, (85.4%) had trash

cans orderly and covered, (90.6%) had waste disposal near selling area, (80%) had water

closets, (77.4%) each had their utensils left to accumulate with animals/birds/insects

hovering around. It was also observed that (69.4%) had waste bins opened with no lids,

(58.6%) had water closets unsuitably situated and (48%) had their waste scattered around

the serving area.

Table 4. 12: Observational checklist of Food Safety indicators

Food Safety indicator	Frequency (N=150)	Percentage (%)
Vendor has trash can	96	95.4
Trash can orderly and covered	76	85.4
Waste disposal near selling area	68	90.6
Availability of water closet (WC)	60	80.0
Dirty utensils/plates left to accumulate	58	77.4
Animals/birds/insects present around selling location	58	77.4
Trash can open/no lids	52	69.4
WC unsuitably situated	44	58.6
Waste scattered around serving area	36	48.0

98

4.16 Assessment of personal/food hygiene of food vendors by consumers as a tool for food control system (HACCP)

Table 4.13 shows assessment of personal hygiene of food vendors by consumers. The results indicated that 46 (30.7%) of the food vendors appreciated hygiene and were willing to improve on sanitation, whilst 40 (26.7%) indicated good and average personal hygiene practices respectively.

Table 4. 13: Assessing personal hygiene of food vendors (Consumers)

Variable	Frequency (N=150)	(%)
Very Good	46	30.7
Good	40	26.7
Average	40	26.7
Bad	14	9.3
Excellent	10	6.6

4.17 Microbiological Assessment

4.17.1 Coliform count

There were relatively high levels of coliforms in the food samples for the study sites in the two seasons. There were overall mean counts ranging between 3.0 $\log_{10}$ cfu/g and 200.0 $\log_{10}$ cfu/g in most of the food samples. Instances of food samples such as Accra meat pie, fried yam, plain salad/salad with cream, Takoradi jollof, sliced pineapple/water melon, roast plantain and sliced mango being the highest with Senchi (snail khebab[1]) showing high levels of coliform. There was a statistically significant difference (P< 0.05) for Total coliform count (Tables 4.14, 4.15, 4.16, 4.17, 4.18, 4.19 and 4.20). However, the limit for coliforms is P≤ 2.00 log cfu/g.

4.17.2 *Escherichia coli*

Most of the food samples had varying degrees of contamination of the bacteria in the two seasons (wet/dry). High counts of *E. coli* ranging from 0.2 $\log_{10}$ cfu/g to 0.40 $\log_{10}$ cfu/g were however recorded in Takoradi jollof and fried yam, Accra fried yam, baked spring roll and sliced mango, whilst others recorded lesser counts. According to the Ghana Standards Authority, (2003) these values were unacceptable compared to the reference value of zero cfu/g (Tables 4.14, 4.15 and 4.16).

4.17.3 *Vibrio cholerae count*

Vibrio cholerae count, was virtually absent in all food and water samples obtained from the three study sites (4.14, 4.15, 4.16, 4.17, 4.18, 4.19 and 4.20).

4.17.4 *Salmonella sp. count*

Salmonella sp. was generally present in most of the foods sampled. However, ordinary pie, sliced pawpaw, tomato pepper sauce, fried yam, Takoradi jollof, tomato stew, black pepper sauce and snail khebab[2] tested unacceptable levels are confirmed. The mean *Salmonella sp.* load ranged from 0.2 to 0.8 $\log_{10}$ cfu/g and 0.16 to 0.40 $\log_{10}$ cfu/g for the two seasons (wet/dry) at the three study sites. It was observed that Takoradi and Senchi food samples recorded levels highly unacceptable for human consumption (Tables 4.14, 4.15 and 4.16).

4.17.5 *Staphylococcus aureus*

In general, *Staphylococcus aureus* was present in almost all the food items sampled at the three study sites, with various levels of contamination ranging between 0.2 to 0.95 $\log_{10}$ cfu/g in the two seasons (wet/dry). Accra jollof, plain salad/fried spring rolls of Takoradi and Senchi snail khebab[1] had relatively higher counts of *S. aureus,* were above international limit in these street foods (Tables 4.14, 4.15 and 4.16).

4.17.6 Yeast / Mould count

Yeast counts in some of the food samples was high compared to the international reference standards value of 2.7 $\log_{10}$ cfu/g (Stannard, 1997; Omemu *et al*., 2007; Yoon *et al*., 2008). The yeast count ranged between 0.0-0.01 $\log_{10}$ cfu/g to 0.68 $\log_{10}$ for Accra, Takoradi and Senchi food samples in the wet and dry seasons respectively. There was a significant difference (P<0.05) in means for yeasts and moulds count (Tables 4.14, 4.15 and 4.16) respectively. Yeasts in cooked food is 6.00 log cfu/g and if the necessary steps were taken or adhered to in GMP/GHP the target would not exceed 3.00 log cfu/g (Nagai *et al*., 2009). Comparison tables showing the log transformed population of the microorganisms analysed for food and water samples at the study sites (Tables 4.14, 4.15, 4.16, 4.17, 4.18, 4.19 and 4.20).

Table 4. 14: Microbial load in selected food samples (Takoradi)

Food items	Total coliforms		*Escherichia coli*		*Vibrio cholerae*		*Salmonella sp.*		*Stapylococcus sp.*		Yeast/Mould	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Jollof	85	10	0	40	0	0	40	0	32	12	0	0
Tomato/Pepper Sauce	0	10	0	0	0	0	0	20	7	14	13	0
Okro soup	52	0	0	0	0	0	0	0	0	0	0	0
Sliced pineapple	3	124	0	0	0	0	0	0	3	0	0	0
Sliced water melon	4	90	3	0	0	0	0	0	3	13	13	0
Plain Salad	5	23	0	0	0	0	0	5	0	0	0	0
Salad/ cream	18	12	0	0	0	0	0	0	4	3	0	0
Sliced mango	0	530	0	0	0	0	0	0	0	5	0	60
Indomie	0	0	0	0	0	0	0	0	73	40	0	0
Spring roll (fried)	35	0	0	8	0	0	8	0	26	0	0	0
Spring roll (baked)	1	0	14	0	0	0	0	0	43	0	0	0
Fried yam	10	0	0	38	0	0	38	16	20	54	4	30
Roast Plaintan	80	61	0	0	0	0	0	0	0	0	0	0

0=Not Detected (ND)　　　　　　　　cfu/g: Colony forming units/per gram

Table 4. 15: Microbial load in selected food samples (Accra)

Food items	Total coliforms		*Escherichia coli*		*Vibrio cholera*		*Salmonella*		*Stapylococcus*		Yeast/Mould	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Jollof	30	0	0	0	0	0	0	0	95	20	0	0
Pie (Adinkra)	0	0	0	0	0	0	0	0	0	0	0	4
Pie (ordinary)	200	20	0	0	0	0	2	37	10	8	0	0
Tomato/Pepper Sauce	1	0	0	0	0	0	0	0	0	50	17	50
Okro soup	0	10	2	0	0	0	0	0	0	0	5	0
Spinach soup	0	12	0	0	0	0	0	0	0	22	0	0
Sliced pineapple	0	0	0	6	0	0	0	0	10	30	0	0
Sliced water melon	7	24	0	0	0	0	0	6	0	6	0	0
Sliced mango	15	5	13	0	0	0	0	0	0	0	18	42
Indomie	0	40	0	2	0	0	0	0	5	31	0	30
Fried yam	90	0	14	0	0	0	0	0	18	23	25	0
Salad with cream	25	38	0	4	0	0	0	0	12	0	0	68
Sliced Pawpaw	19	0	0	0	0	0	0	16	0	0	4	0
Roast Plaintan	0	0	0	0	0	0	0	0	0	0	0	60
Plain Salad	15	60	7	5	0	0	0	0	95	10	0	0

0=ND (Not Detected)   cfu/g: colony forming units/per gram

Table 4. 16: Microbial load in selected food samples (Senchi)

Food items	Total coliforms		*Escherichia coli*		*Vibrio cholerae*		*Salmonella*		*Stapylococcus*		Yeast/Mould	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Tomato stew	2	0	0	0	0	0	0	0	30	0	26	0
Snail khebab[1]	136	10	0	0	0	0	2	0	0	60	64	10
Black sauce (Shitor)	0	0	0	0	0	0	0	0	39	20	2	0
Tomato/Pepper Sauce	8	0	7	0	0	0	0	0	42	0	15	0
Okro soup	0	0	0	0	0	0	0	0	0	0	28	0
Snail khebab[2]	49	0	0	0	0	0	0	0	30	0	26	0

0=ND (Not Detected)   cfu/g: colony forming unit/per gram

4.18 Microbial Quality of Water Samples at the Study Area

(Accra/Takoradi/Senchi).

The results of this study indicated that, there were varying levels of microbial load in all water samples at the various study sites. Directly sourced pipe borne water and samples from the river Volta did not record any *E. coli* or *Vibrio cholerae.* This study further revealed that pipe borne water from Accra had a higher microbial load of Coliform, *Staphylococcus,* Yeasts and Moulds at 60, 89 and 110 cells cfu/g in the afternoon in drinking water samples of the wet season than Takoradi and Senchi. Whereas the Volta River recorded values higher at the upper part in Coliform than the lower part of the water samples collected. Senchi pipe borne water and the river Volta again recorded more but higher loads of *Salmonella, Staphylococcus,* Yeasts and Moulds than Accra and Takoradi for the two seasons (Tables 4.17, 4.18, 4.19 and 4.20).

Table 4. 17: Microbial quality of water (drinking/handwashing/domestic use) Accra

Water (Time)	Total coliforms		*Escherichia coli*		*Vibrio cholerae*		*Salmonella sp.*		*Stapylococcus sp.*		Yeast/Mould	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Morning	0	0	0	0	0	0	0	9	5	0	30	11
Afternoon	110	0	0	0	0	0	10	0	60	0	89	110
Evening	0	0	0	0	0	0	12	0	20	0	5	0

0=Not Detected (ND)   cfu/g: colony forming unit/per gram

Table 4. 18: Microbial quality of water (drinking/handwashing/domestic use) Takoradi

Water (Time)	Total coliforms		*Escherichia coli*		*Vibrio cholera*		*Salmonella sp.*		*Staphylococcus sp.*		Yeasts/Moulds	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Morning	30	0	0	0	0	0	10	0	5	0	0	12
Afternoon	10	0	0	0	0	0	3	0	30	0	16	0
Evening	32	0	0	0	0	0	5	0	22	1	10	1

0=Not Detected (ND)   cfu/g: colony forming unit/per gram

Table 4. 19: Microbial quality of water (drinking/hand washing/domestic use) SenchiA

Water (Time)	Total coliforms		*Escherichia coli*		*Vibrio cholerae*		*Salmonella sp.*		*Staphylococcus sp.*		Yeasts/Moulds	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Morning	10	0	0	0	0	0	10	81	22	35	20	0
Afternoon	36	2	0	0	0	0	31	0	30	25	16	9
Evening	67	0	0	0	0	0	60	0	60	0	50	17

0=Not Detected (ND)   cfu/g: colony forming unit per gram

Table 4. 20: Microbial quality of water (hand washing/domestic use) River Volta SenchiB

River Water (Source)	Total coliforms		*Escherichia coli*		*Vibrio cholerae*		*Salmonella sp.*		*Staphylococcus sp.*		Yeasts/Moulds	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Upper section	100	83	0	0	0	0	54	3	120	130	0	8
Lower section	20	62	0	0	0	0	50	16	13	72	30	23

0=Not Detected (ND)   cfu/g: colony forming unit/per gram

4.19 Top 10 diseases causing morbidity and mortality in the 3 study areas (Accra/ Takoradi/Senchi).

This study sought to investigate environmental conditions in relation to public health and food safety issues of concern at the three study sites. The study revealed that malaria recorded (46.2%) in the Greater Accra region (AMA) at the metropolitan level in 2014 - 2015, whilst (40.7%) and (33.7%) for the STMA[A&B], (27.2%) and (16.7%) in Sekondi Takoradi Metropolitan Assembly [C&D] at the municipal level in 2012-2013 and 2014-2015, whilst the Asuogyaman District Assembly recorded (11.9%) at the district level in 2015-2016 respectively. Other diseases of interest were diarrhoea/cholera, skin diseases/ulcers, intestinal worms and anaemia recorded varying levels of cases over the years. These are believed to have been caused by pathogenic bacteria due to poor hygiene and environmental practices (Tables 4.21, 4.22, 4.23 and 4.24).

104

Table 4. 21: Top 10 diseases in the (Gt. Accra) AMA Data on Diseases 2014-2015

No.	Disease	Cases	%
1	*Malaria	80,679	46.2
2	ARI (Acute Respiratory Tract Infections)	15,007	8.6
3	Hypertension	9,514	5.5
4	*Skin diseases /Ulcers	7,457	4.3
5	*Diarrhoea/*Cholerae*	4,253	2.4
6	Gynaecological Disorders	4,036	2.3
7	Diabetics Myelitus	2,093	1.2
8	Pregnancy related issues	1,986	1.1
9	*Anaemia	1,930	1.1
10	Chicken Pox	1,858	1.1
11	All other Diseases	45,698	26.2

Source: GHS-AMA, 2015 (MOH, 2007).

Table 4. 22: Top 10 causes of morbidity in 2012-2013 STMA [(A)] (Municipal)

Rank	2012 Disease	Cases	%
1	*Malaria	254,484	40.7
2	ARI (Acute Respiratory Tract Infections)	66,558	10.6
3	*Skin diseases /Ulcers	30,897	4.9
4	*Diarrhoea/*Cholerae*	21,520	3.4
5	*Anaemia	19,309	3.1
6	Rheumatism & Joint pains	18,961	3.0
7	Acute Eye infection	14,436	2.3
8	Intestinal worms	41,491	2.3
9	Dental caries	7,692	1.2
10	Asthma	7,523	1.2
11	All other Diseases	170,370	27.2
	Total New Cases	**625,939**	**100.0**

Source: STMHD, 2014

Table 4. 233: Top 10 causes of morbidity in 2012-2013 STMA [(B)] (Municipal)

Rank	2013 Disease	Cases	%
1	*Malaria	177,395	33.7
2	ARI (Acute Respiratory Tract Infections)	55,729	10.6
3	*Skin diseases /Ulcers	25,874	4.9
4	Rheumatism & Joint pains	17,711	3.4
5	*Diarrhoea/*Cholerae*	17,646	3.4
6	*Anaemia	16,435	3.1
7	Intestinal worms	15,315	2.9
8	Acute Eye infection	11,038	2.1
9	Hypertension	7,584	1.4
10	Dental caries	7,245	1.4
11	All other Diseases	171,402	33.1
	Total New Cases	**526,360**	**100.0**

Source: STMHD, 2014

Table 4. 244: Top 10 causes of morbidity in 2014-2015 (STMA) ^(C) (Municipal)

Rank	2014		
	Disease	**Cases**	**%**
1	*Malaria	98,980	27.2
2	ARI (Acute Respiratory Tract Infections)	44,413	12.2
3	*Diarrhoea/*Cholerae*	22,455	6.2
4	*Skin diseases /Ulcers	18,346	5.0
5	Rheumatism & Joint pains	14,340	3.9
6	Intestinal worms	13,996	3.8
7	*Anaemia	13,814	3.8
8	Acute Eye infection	10,750	3.0
9	Acute Urinary Track Infections	7,383	2.0
10	Dental caries	7,190	2.0
11	All other Diseases	112,676	30.9
	Total New Cases	**364,343**	**100.0**

Source: STMHD, 2015

Table 4. 255: Top 10 causes of morbidity in 2014-2015 (STMA) ^(D) (Municipal)

Rank	2015		
	Disease	**Cases**	**%**
1	ARI (Acute Respiratory Tract Infections)	74,136	16.7
2	*Malaria	70,861	16.0
3	*Diarrhoea/*Cholerae*	29,230	6.6
4	*Skin diseases /Ulcers	22,580	5.1
5	*Anaemia	21,742	4.9
6	Rheumatism & Joint pains	20,454	4.6
7	Intestinal worms	17,540	4.0
8	Acute Eye infection	12,104	2.7
9	Hypertension	10,398	2.3
10	Acute Urinary Track Infection	10,055	2.3
11	All other Diseases	154,839	34.8
	Total New Cases	**443,939**	**100.0**

Source: STMHD, 2015

106

Table 4.26: Top 10 diseases in the ADA (Senchi) 2015-2016 (District)

No.	Diseases	Cases	%
1	* Malaria	8,574	11.9
2	* Bilharzia/Guinea worm	4,041	5.6
3	* Diarrhoea/*Cholerae*	2,250	3.1
4	* Intestinal Worms	1,408	2.0
5	* Skin Diseases and Ulcers	1,407	1.9
6	*Acute Urinary Tract Infections	1,300	1.8
7	Acute Respiratory Tract Infections	767	1.1
8	Acute Eye Infection	737	1.0
9	Hypertension	717	0.9
10	Dental Caries	622	0.8
	All other Diseases	**50,236**	**69.9**

Source: STMHD, 2016

4.20 Test of hypotheses

➢ The chi-square (χ2) test of significance was used to test the stated hypotheses and to evaluate association between the stated variables and the significance of any observed differences. The chi-square is used to analyse data that are reported in categories. It is also based on a comparison between expected frequencies and actual, obtained frequencies. Data from the questionnaire was captured by use of frequency tables, graphs, charts and was entered into Microsoft Excel (2010 version) and finally imported into Statistical Package for Social Sciences (SPSS Version 22.0) for analysis with the formula below:

• $X^2 = \sum \frac{(fo-fe)^2}{fe}$

• Degrees of freedom

• X^2 = test of goodness of fit

• Where, 0 = observed frequency (that is assumptions (not fixed) one had earlier to the study).

107

- Where fo =Observed sample count

- Where fe =expected sample count

4.21 Chi –Square (χ2) Test Results

A chi-square (χ2) statistics was computed to test the various hypotheses stated.

Ha1. In testing for the hypothesis that food handling under proper hygiene and sanitation condition reduces food contamination and poisoning, the results showed that 46 (30.7%) of the food vendors appreciated hygiene and were willing to improve on sanitation, whilst 40 (26.7%) indicated good hygiene and average personal hygiene practices respectively (Table 4.13).

Ha2. The hypothesis was tested with the variables of food safety compliance put in place by food vendors in food handling, the results revealed that food safety compliance by food vendors were directly correlated to food safety and associated with food contamination (χ2=34.849, P<0.05) and was significant at 0.05% confidence level. The use of right utensils during food preparation was not significantly associated with food contamination (χ2 = 34.849, P>0.05) (Tables 4.7, 4.7.1, 4.7.1.1, 4.7.1.2, 4.7.1.3, 4.7.1.4, 4.7.1.5, 4.7.1.6, 4.8 and 4.10).

Ha3. In testing for the hypothesis that compliance with food laws is directly correlated with food safety, Spearman's correlation was conducted between food laws variables with food safety. The results indicated that, there was a positive correlation between compliance with food laws and food safety. Also, it showed a significant relationship between the correlation coefficient (R) in preventing food contamination as indicated in Table 4.9. Hence we reject the null hypotheses; thus food handling under proper hygiene and sanitation does not reduce food contamination and poisoning, food handling under proper

108

purchasing of raw materials/fooditems, storage and utensils used during food preparation/food services cannot prevent street food contamination and compliance with food laws are not directly correlated to food safety and was significant at P<0.05% confidence level.

CHAPTER FIVE

5.0 DISCUSSION

5.1 INTRODUCTION

Findings from the study are discussed here. The study focuses on the attitude and perception of food vendors and consumers on food safety and hygiene. The relevance of microbial level in food and water samples are also discussed.

5.2 General socio-demographic characteristics of respondents at the study sites

This study has revealed that most of the respondents were young men and women who represent economic productive group, more energetic, brisk and zealous about their businesses as well as working harder to improve their living standard. They are more likely to seek health and education than older respondents. For this study, age was significant in the demographic variables. Addo (1998), observed that factors determining the distribution of risk perceptions and susceptibilities are age, education and policy on product labeling, availability of food safety information. Majority of the respondents had either completed or partially completed their primary/middle/JHS before entering their primary occupation whilst (49.7%) of the respondents were either married or once married.

Various institutions, including religious groups such as Christians and Moslems educate members on food safety and hygiene practice issues. The low percentage of traditionalists however suggests that traditional/religious beliefs and practices would have lesser influence on preservation of flora and fauna (Ayivor, 2013). All ethnic groups exist in the study areas with Ewes slightly being the majority in Senchi, Ga-Dangmes slightly above the Akans, Ewes and Northerners in Accra whilst a mixture of the Akan groups slightly above the remaining ethnic groups in Takoradi. Ethnicity was a strong predictor for the study. This probably has to do with the fact that each group is unique in its own way of

110

life in terms of cultural norms, beliefs and values (Leslie and Gupta, 1989). About (57.3%) of the vendors/consumers interviewed were traders who earn salary as a secondary source of income (14.0%). Respondents whose primary occupation was street food vending were females (64.3%) and males (35.7%). Most of the respondents do farming as additional occupation and a source of livelihood of families. This can influence economic status and wellbeing of the respondents in patronizing quality but safe food for good health. It was found out that market demand for health risk foods may depend on income and prices (Addo, 1998).

5.2.1 Categories of economic activities in the study areas

There are four main economic activities observed in the study which the respondents and community members were into and these are:

  i.   Industry

  ii.   Service

  iii.   Agriculture and

  iv.   Commerce

1. Industrial sector– The industrial sector boasts of a number of industrial establishments particularly in Accra central (Makola), Takoradi market circle and Adomi-Senchi.

2. The service sector appears to be one of the fast developing sectors of the local economy. Banking services are provided by the Banks. There are hotels, motels and guest houses among others.

• Health services – Categories of adequate health facilities within these study areas include public, private, military, quasi government i.e. Community Health Planning Systems (CHPS) compound or a health centre are concentrated in these central business areas of the study areas. Monthly, weekly and quarterly returns

111

are submitted to the metropolitan, municipal and district (MMDAs) health directorates.

3. Agricultural sector- Farming is the major economic activity for most people who depend on agriculture as their main source of livelihood with the majority as small holders in crop production, livestock and fish farming. Vegetables for example, pepper, tomato, okro, garden egg and cabbage are grown and sold on these markets.

4. Commerce- The strategic location of these markets coupled with good accessibility has facilitated their growth leading to congestion and spill-off onto the nearby roads. With constant influx of people to these rural-urban centres, waste is generated at an alarming rate and been a matter of concern to the assemblies. Drains at these study sites were choked and roads littered with filth through the activities of petty traders and street food vendors who transact business daily along these roads and surroundings.

5.3 Reasons for migrating to study areas

Various reasons account for the decision of the respondents to move to these study areas. In this study, two most prominent among them were joining their spouses and job hunting hence their trading activities. The study has revealed a large number of respondents being migrants in the street food vending business which was probably because the study areas were relatively bigger and more economically vibrant compared to other communities in the regions.

5.3.1 Length of years of stay in community/business

It was observed that the respondents have been living in these study areas for between one to fifteen years. The average period of stay in these study areas by the immigrants was close to seven years. This could be attributed to rapid urbanization coupled with rising

112

unemployment with large number of people looking for greener pastures. Hence, people seeing street food vending as the immediate job available which needs no educational qualification nor training for skill acquisition before starting a food service business in earning a living.

5.3.2 Overview of attitude/perceptions of respondents on food safety practices and food contamination

This study provided a general outlook on the attitudes and perceptions about food safety practices of the respondents at the study areas such as ways by which food gets contaminated by vendors, binary logistic regression was conducted and the results revealed that; preparation of food in advance, using the same knife and cutting board for both raw and prepared food, working surfaces, food handling, selling location, how leftover foods are treated, conditions of cloth used for cleaning, how often these cloths for hands are washed, how utensils are washed, number of times dish water is changed and how leftover foods are stored were significantly associated with food contamination and significantly increased the risk of food contamination in the bivariate logistic model (P≤0.05, Crude OR>1).

Perception of adequate temperature to keep food in good condition and duration of food vending were found to be statistically significant and influenced good food safety practice (P<0.05) with respondents who had attained a higher educational level and had attended training courses on food safety (Buccheri *et al.,* 2007; Buccheri *et al*., 2010; Todd *et al*., 2009). This implies that knowledge and training on foodborne diseases significantly increased the food safety practices and it was 2-3times higher in good practice compared to no training in food safety. How the environment is kept, the frequency of changing water for washing plates, changing of hand wiping cloths, food vendors' medical/certification by relevant authority to legitimately sell food, ensuring food hygiene

113

practices and whether food vendor had received health education on food hygiene practices were significantly associated with food contamination (P<0.05).

Safe storage, temperature control and correct handling of food using adequate clothing was not the case in this study. Food vendors used dirty aprons to keep monies collected during sales, used them in wiping plates/leaves for food services and wiping wet or dirty hands. For these observations food vendors fared badly and in answering on refreezing thawed foods. The source of water for food preparation was associated with contamination of food in this current study though it was not statistically significant at 95% confidence level (P>0.05).

5.3.3 Food safety compliance during purchase/storage of food items by food vendors

The study revealed that the majority of the food vendors ensuring foodstuffs were in good condition before purchase whilst fewer food vendors buy cheaper and bruised ones and ignored food safety compliance and buy them. The reason for buying cheaper and bruised ones was that most of the foodstuffs come from the rural areas and by the time they reach the urban centres are affected. Unsafe food sources, poor hygiene practices, poor nature of the roads and the number of days/weeks spent before reaching the markets affect product quality and associated with contamination.

5.3.3.1 Use of right utensils during purchase/storage and food preparation

Generally, a majority of the respondents used various types of utensils during food preparation. With regards to using the right utensils during purchases, storage and food preparation, the results from the study showed that majority of the food vendors had fair knowledge and use of right utensils to avoid cross contamination whilst fewer of the food vendors did not. Even though the majority of respondents knew that cooking utensils and dirty hands are sources of food contamination yet uses the same utensils for cooked and raw foods thereby resulting in cross-contamination. The FDA (2012) reported that food contact surfaces and cooking utensils which have not been properly washed could be possible sources of cross- contamination and foodborne illnesses.

5.3.3.2 Views of consumers on how the environment is kept (consumers)

The views of consumers on how the environment was kept by food vendors and generally by the Assemblies was diverse. The environment around most of these food vending sites at the study areas were near rubbish tips and littered with filth. Liquid waste (sewage) was disposed of into municipal drains and left undesilted for weeks or months, waste bins were left uncovered with flies hovering around creating bad odour. It was discovered through the interviews conducted that most of the respondents were not aware of what happens when they indiscriminately dispose of their waste in drains. The MMDAs are responsible for waste management but unfortunately, this has become a challenge. Waste management needed improvement such as frequent lifting and quick disposal of waste to esure clean environment for safe food and healthy living. The Ministry of Health (2010), in a report observed that dirty and dusty environments are direct sources that affect food contamination. According to the report low standard of personal hygiene in communities are a significant cause of diarrhoea and high risk of infectious diseases.

115

5.3.3.3 Source and availability of water (vendors/consumers)

The most common source of water for food preparation at the study areas was pipe borne water with a few of Senchi street food vendors patronizing water from the river Volta. Adequate supply of safe water to urban and rural communities highly affects health and economic progress of the people. Microbial contamination of domestic source of water during and after collection from the source has been identified as a challenge for storage. Post source contamination results in poor quality in storage vessels at food vending sites (Centre for Food Safety, 2007). This could have accounted for the varying concentration observed for the study sites.

Among the water samples analyzed, Senchi source of water for food preparation, drinking and for domestic use was associated with the highest mean contamination of Total coliform*, Salmonella sp. staphylococcus* aureus and yeasts and moulds count in this study though it was not statistically significant at 95% confidence level (P> 0.05). This suggests that their distribution in the river Volta is far from being acceptable to human health. Ayeh-Kumi *et al*., (2009) posited that floor water systems are polluted with animal and human excreta due to poor sanitation which subsequently contaminate farmlands and rivers during the raining season.

5.4 Source of information on food safety (vendors/consumers)

Regarding the source of information on food safety, the study has revealed that colleagues/relatives and the radio were the most widely used source with the respondents respectively. This may be as a result of unstable energy supply/distribution at the time of the study where people could not watch television at work/home or attend workshops organized by some of the stakeholder institutions. This could have also been attributed to

public health education by some of the stakeholder institutions and agencies e.g. the FDA at the time of the study. A study by Addo (1998) revealed that markets serve as important places and components for commodity, services and centres of information exchange, local administration, health delivery, education and entertainment. Marriott and Gravani, (2006) states that knowledge sources of supplies of information are the strong predictors of food safety.

5.4.1 Reasons for patronizing street foods (consumers)

According to the study, street food patronage was largely approved among respondents in the study areas, with various reasons adduced for approval or otherwise. A few of the respondents approved of patronizing street food owing to the economical and social independence it provided as its ability to save time and energy. The WHO (2006) asserted that street foods have numerous benefits where they serve as a source of inexpensive, convenient and nutritious food for urban and rural poor. Street food vending provides income for many people, particularly women and serves as a self-employment opportunity in developing business skills with low capital investment (Ayeh-Kumi *et al*., 2009). Thus the variable patronizing street food was however, statistically significant (P=0.048).

5.4.2 Consumers' views and ratings on the level of food poisoning in Ghana and perception for street food patronage

Generally, individual's views and ratings of issues are significant because they form the basis for the individual's behavioural pattern and practices. The respondents' views of the prevailing microbial loads in food and water and dangers associated with consumption were likely to influence their choice of patronage. This was an area in which the study sought information. Information gathered in this research revealed that most of the respondents rated food poisoning as high in Ghana. Ayeh- Kumi *et al*., (2009) revealed that foodborne diseases remain real and formidable problem in both developed and

developing countries, causing great human suffering and significant economic loss. This study has revealed that apart from preventing negative impact on health through poor environmental practices, some of the respondents asserted that street food vending also provided a source of employment for others.

5.4.3 Perception and Attitude of respondents on compliance with food safety regulation

The study showed that majority of vendors did comply with food safety whilst some of the food vendors had no food safety training representing the minority. This suggests that training of vendors on food safety did not significantly influence food safety compliance ($\chi2 = 4.5$, p=0.132, d f = 5). However, medical certification of vendors significantly influenced food safety compliance at 95% confidence level ($\chi2 = 7.25$, p=0.028, d f = 4). Hence, with respect to gender on perception to food safety policy compliance, females had high perception compared to their male counterparts according the scaling technique and perception scores. This could be explained as girls/women are perceived to have acquired cooking and petty trading skills from their mothers and grandmothers even before job training.

Rheilander *et al*., (2008) indicated that women dominate the ready-to-eat food business but the success or failure of food control programmes largely depends on them. Clayton and Griffith, (2009) stated that self- reported changes in food safety practices are positively associated with safety training and improved attitudes. Buccheri *et al.,* 2010 suggested that improved knowledge alone is not always sufficient to trigger preventive practices, and that some mechanism is needed to motivate action and generate positive attitudes into compliance with food safety behaviours.

5.4.4 Vendors'Attitude/Perceptions on food contamination using binary logistic regression model

Studies by Buccheri *et al*., (2010) showed that although many factors come to play in attitudes and perceptions of how food gets contaminated, all the variables stated in this study revealed that there was a significant value at (P≤0.05) confidence interval with the exception of preparation of food in advance which recorded 0.952. It further showed that, the contamination of the study sites with these microbes may come from several sources which arise mainly as a consequence of municipal and industrial discharges in the environment, waters from offshore activities and dumping into rivers where most run offs end-up in the sea/rivers and thus constitute an important reservoir of microbial contamination of these water bodies e.g. river Volta. This also may be attributed to education and training received by respondents and also the markets serving as centres of information exchange (Addo, 1998).

5.5 Kinds of food hazards consumers are exposed to due to how leftovers are handled by street food vendors

This study revealed that keeping and treating leftover foods was mainly carried out in a rudimentary manner, resulting in the contamination of freshly prepared foods i.e. cross-contamination and its related challenges, unlike the developed countries where methods are combined with appropriate technology to minimize environmental impact on health (Brynestad *et al.,* 2008). Although a large number of food vendors stored leftovers in fridges and freezers, some of them also stored their leftovers in cupboards and in basins of water in the kitchen. According to Walker *et al.,* (2003) food vendors prepare ready-to-eat foods in bulk store them for many hours after cooking, sometimes overnight, holding at an ambient temperatures. This is as a result of low levels of knowledge of food handlers on hygiene and microbial safety of prepared foods.

119

Inappropriate methods of street food vending, and handling, lack of quality assurance in food services, failure of food vendors to follow critical practices i.e.good manufacturing practices and good hygiene practices (GMP/GHP) are leading sources of foodborne diseases outbreaks (Olsen *et al.,* 2000). All respondents in the study who mentioned (GMP/GHP) said it was the best practice to prevent foodborne illnesses because it helps consumers to save money which would be used in paying for drugs or cost of illness. This could further be explained that most of the food vendors had their training in food preparation and food vending as a skill inherited the traditional methods of cooking from their parents. It was largely considered that leftover foods are stored for between 1 and 2 days in fridges, sold food from the previous day or have ever sold food about 2 days old. This study has gathered from the heads of institutions (FDA/FRI/GSA) that to ensure food safety, the basic things needed are GMP/GHP and advised that the public should always look for FDA certificates/ logo for hygiene permits which are issued annually (FDA, 2012).

5.6 Food laws and compliance put in place by stakeholder institutions to ensure food safety by food vendors and consumers (HACCP)

Even though a significant number of food vendors cooked/stored food at appreciable temperatures and environments and treated raw vegetables with vinegar or salt solution, most of the food handlers either washed vegetables in ordinary water or cleaned them with kitchen napkins. In 2012, the FDA suggested that to ensure safer foods, it is important to integrate HACCP practices into daily operations (WHO, 2006). The FDA goes for inspections, looks out for raw material acquisition/specifications or high risk products, permits, appropriate utensils for food preparation/storage for temperature holding and for expiry dates on products.

This study further observed that to ensure implementation of national policies in the metropolitan/municipal/district and community levels, the heads of these institutions/agencies support, coordinates and oversee all social activities by circulating information on frequency moderation (FM) radio stations and mass media for publicity, organize workshops annually with reference to national exercises for groups such as teachers/nurses, communities, market women/men food vendors of all category, schools/institutions, churches/mosques in seasons of diseases such as *cholerae*/diarrhoea outbreak which occurs mostly in the rainy seasons.

Interactions at district and community level on food safety are usually conducted on topics such as open defaecation, poor sanitation issues and effect on the environment, on food and water bodies, use of agro-chemicals such as DDT and bad practices such as treating and preserving fish with formalin/omo, adulterating palmoil with Sudan111 and 1V chemicals. This study has revealed that the FDA and the Assemblies often penalize/fines or suspend culprits if food safety practices are not adhered to especially with high risk goods/products. Barker *et al*., (2014) asserted that this attitude of food vendors cannot guarantee the safety of salads and some pathogens are bound to remain on the fresh vegetables and cause foodborne illnesses to susceptible consumers. Educating food handlers for HACCP application is necessary in achieving food safety.

5.6.1 Correlation with food laws and food safety compliance

The correlation with food laws and food regulation are reduction in risks of morbidity and mortality associated with consuming foods that could be contaminated with microbial pathogens and other hazards (Kenkel *et al*., 2006). Antle (1998) indicated that an individual's demand for risky foods depend on income, prices, and objective risk associated with the food. The study provides a general outlook of food laws and food safety compliance. It further explored compliance by food vendors and stakeholder institutions

121

in ensuring food safety. The results indicated that, there are varying levels of microbial load in the food and water samples at the study areas. The variables showed a significant value at P≤ 0.05 which indicates a significant relationship between food laws and food safety compliance.

5.6.2 Relationship among stakeholder institutions

This study has revealed food quality regulators of different countries meet from time to time to formulate regulations and code of practice through consultations which are normally adopted to enhance people's health globally (CAC, 2007). Such fora share information on current food safety issues that may arise. For example, when there is any serious food and water related disease or contamination in any country e.g. mad cow disease, milk contamination, bird/swine flu, ebola, *cholerae* etc. which may likely spread to other countries that may be imported from the affected country, information is shared for action (CAC, 2007).

Data from the stakeholder institutions in Ghana showed that there is institutional or sectoral linkages among these agencies/institutions but they do not collaborate instead, work separately towards the same goal even though lapses in effective collaboration exist. The study also revealed that among these institutions, e.g. MoFA plays a major role in monitoring agro- chemical sellers after EPA detects the fake ones. MoFA collaborates with other sister institutions in creating awareness on plants and safety on humans and organizes education/training at district level. It was revealed that, extension officers go to the field to check compliance and illegal agro-chemical retailers who are arrested regularly through unannounced vists to the markets/communities. The interview outcome revealed that farmers and market women use vegetables immediately after application of chemicals on them. The results further show appreciable levels of these microbial/chemical

contaminants in these food/water samples which may be due to other diffuse sources such as run- offs from agricultural lands, industries and homes (Ayeh- Kumi *et al.,* 2009).

5.7 Microbiological survey of food and water samples analyzed in the study areas

The results on food and water samples provided varying levels of counts for all the microorganisms of interest (Total coliform*, E.coli, Salmonella, Staphylococcus,* Yeasts and Moulds*)* ranging from 0 - 530 cfu/g. Generally, tomato/pepper sauce, black pepper sauce (shitor) and plain vegetable salad recorded levels of contamination higher than the acceptable reference value of < 5.0 $\log_{10}$ cfu/g the prescribed by the Ghana Standard Authority (GSA, 2003). The variation indicate a typical lack of good hygiene practices affecting quality. The varying amounts of microorganisms from the replicate samples indicate that sanitation and hygienic practices e.g. preparing food in hygienic environment, clean utensils, hands, clothes and hand cloths, maintenance of kitchen, food, environment, surfaces and personal hygiene are not always observed.

Street foods prepared anywhere and at anytime are not tested to meet the needed specifications or quality indices. For these reasons, there should be effective education, training/post training and monitoring programmes and measures put in place to ensure consistent but quality street foods to prevent foodborne illnesses, morbidity and mortality. All the food and water samples at the study sites did not record any *Vibrio cholera* strains when tested. The enumeration of Total coliform and *E. coli* in the food and water samples provides a measure to the extent of pollution which may be attributed to the presence of various unhygienic practices in food handling, insanitary environment as well as improper storage or a combination of these which exist at the study areas (FDA/CFSAN, 2012). Although high counts of coliform in food is highly undesirable, it is not possible to eliminate it all from fresh vegetables and frozen foods. Low counts of coliforms are usually

permitted in sensitive foods at numbers ranging from 1 to not more than 100cfu/g or ml (Dingham, 2003). Most clinical symptons sometimes include diarrhea, abdominal pain, vomiting, hemorrhagic colitis, hemolytic uraemic syndrome with acute kidney malfunctioning (Pietrangelo, 2012).

5.7.1 Knowledge of microbes of Public Health significance (vendors /consumers)

Generally, knowledge or perception about microbes that contaminate food and water in making them unsafe is expected to have positive impact on behavioural pattern regarding attitude and perception. Knowledge on negative effects on poor hygiene and food safety practices is necessary to promote public education and participation in good hygiene, sanitation policies and strategies by government. This study indicated that most of the respondents had no knowledge of microbes and related diseases/illnesses under investigation. Even though they mentioned stomachache and diarrhoea as possible symptons of foodborne illnesses they attributed it to being transcient.

The low level of respondents' awareness of microbes and related diseases on human health due to unsafe food/water was further confirmed by the responses given to the related questions. However, those who had an idea of microbial contamination referred to it as germs which causes *cholerae* and diarrhoea. This could be possible reasons for food vendors to sell contaminated food to consumers. Also, it was revealed that, diseases that could prevent these food vendors from selling was fever (meaning malaria). Through interactions, it was revealed that cholera/diarrhoeal diseases mostly occur in the rainy seasons due to poor sanitation and unhygienic practice e.g. open defaecation (FDA, 2012). The food vendors stated that, during outbreak of diarrhoeal/cholera cases there is less patronage of their foods therefore, do not prepare food in large quantities and this affects their source of income as well as livelihood. Rzezutka and Cook, (2004) revealed that wet environments promote the survival and growth of pathogens than dry environment.

5.7.2 Presence of microbes of Public Health significance in selected food samples

Microbes in food are of public health concern. These microbes contaminate food and water therefore survive and proliferate when held for a longer period of time at an ambient teperature (WHO, 2006). Consumers are thus exposed to foodborne infections and diseases when these foods are patronized.

5.7.2.1 Coliforms

Acceptable levels for enterobacteriaceae in food ranges from 10-102 cfu/g (ICMSF, 2011). Most of Accra, Takoradi and Senchi food samples had relatively high levels of coliform contamination which were beyond the acceptable coliform count in food in the two seasons. Moreover, sliced mango, meat pie, snail khebab[1], sliced mango, fried yam, sliced water melon Takoradi jollof, roast plantain and plain salad recorded the highest mean level of contamination (2.0 to 530 $\log_{10}$ cfu/g) among the study areas. The rest of the food and water samples had relatively high levels of coliform contamination in the morning, afternoon and evening which are relative to international reference value of zero cfu/g (Centre for Food Safety, 2007).

The relatively low level of coliform contamination in Takoradi "indomie," baked spring roll, fried yam, Accra okro/spinarch soups, roasted plantain, Senchi black sauce and okro soup are expected due to the high temperatures these foods are subjected to during preparation. The presence of high or excess coliform counts in street foods and water could be an indication of poor personal hygiene, improper handling, storage of the food throughout its preparation and for sale by food vendors. Food vendors' handling other materials such as coins and currency notes and not using clean utensils might have resulted in cross-contamination from foods e.g. vegetables, raw meat and fish (Kissiedu and Tano-

125

Debrah, 2002). According to (Nagai *et al.,* 2009) the acceptable level of coliforms in a food product should not exceed P≤ 4.00 cfu/g.

5.7.2.2 Escherichia coli

According to the WHO, (2007) factors such as lack of knowledge of food safety practices may favour the proliferation of enteropathogens to unacceptable levels especially when street foods are kept at ambient temperature. *E. coli* count among the three study sites recorded counts higher than the acceptable level (GSA, 2003). The relatively high microbial counts for some food samples such as Takoradi jollof and fried yams of Accra/Takoradi ranged from 2.0 to 40.0 mean cells in the wet/dry seasons respectively.

The presence of *E. coli* could be as a result of contamination within the value chain which may be attributed to poor hygiene and sanitation, use of contaminated water, improper reheating of leftovers or faecal contamination probably at one stage or from the raw materials used. Other contributing factors may include wearing dirty clothing, improper dish washing, unhygiene processes of handling and services, and probably inadequate level of knowledge of food and personal hygiene (Nagai *et al*., 2009). *E. coli* is destroyed by cooking thoroughly until all parts reach a temperature of 70°C or higher (Lee and Choi, 2006; WHO, 2011).

5.7.2.3 Vibrio sp.

The microbe generally spread through inadequate human waste disposal, contaminated water sources, poor personal and environmental hygiene (WHO, 2004). Its symptoms are severe diarrhoea and vomiting which could result in death if not treated on time. *Vibrio cholera* was virtually absent from all food and water samples analysed from the three study areas. Absence of *Vibrio cholerae* in food and water samples could be attributed to good

126

hygiene, environmental practices as well as thorough cooking and adequate temperature holdings.

5.7.2.4 *Salmonella sp.*

A few of the food samples analysed were unacceptably contaminated with *Salmonella,* vegetables, fruits and other food samples, with the highest for Takoradi jollof, fried yam and water samples of Senchi in the wet/dry seasons when tested, hence these foods and water are not safe for human consumption. It could be that food vendors were not adhering to good hygiene practices by using contaminated water in cooking, washing dishes and for driking throughout the day. Otherwise these food vendors may be carriers of the *Salmonella* organism due to poor personal hygiene, poor handling and preparation where food is a vector. In this study, *Salmonella* cells ranged from 2 to 40 cfu/g.

The infectious dose of *Salmonella sp*. could be as low as 1 to 100 viable cells and can survive for long periods in foods (FDA/CFSAN, 2012). Studies by (Ayeh-Kumi *et al*., 2009; Centre for Food Safety, 2007) revealed that any trace of *Salmonella sp.* and its presence in cooked food or water no matter the count poses health risk to the consumer. The maximum acceptable limit of *Salmonella sp.* in cooked food in Ghana is zero cfu/g (GSA, 2003). Adams and Moss (2008) reported that *Salmonella* is resistant to various environmental conditions, thrives at various temperature ranges, in water and infect consumers.

5.7.2.5 *Staphylococcus aureus*

Generally, a mean *Staphylococcus* count of 3cfu/g was recorded in most of the food samples of the three study sites. Although some food samples had relatively higher counts of *Staphylococcus aureus* in Accra jollof, plain salad, tomato pepper sauce, Takoradi indomie in the wet season and Senchi snail khebab[1&2] in the wet/dry seasons, the values

were below the international unacceptable limit. This could be as a result of contaminants introduced directly into food by the hands/arms coming into contact with the food. Sometimes sneezing/coughing onto food or around the premises from infections, poor sanitation/personal hygiene practices and temperature for cooking was inadequate.

Studies by Ackah *et al.,* (2011) and Mensah *et al.,* (2002) revealed that cooked foods in Accra recorded high counts of pathogenic bacteria including *Staphylococcus aureus*. According to Kissiedu and Tano-Debrah (2002), handling dirty currency notes can lead to transmission of bacteria from the hands of food vendors and consumers to food and are potential sources of contamination. The significance of the presence of *Staphylococcus aureus* in food may be due to the capacity of certain types of the bacteria to produce enterotoxins when conditions permitting growth prevails. For this reason, sufficient or less toxins in the food may however not be adequate enough to provoke food poisoning and not a complete assurance that a suspect food is safe (Prescott *et al.,* 2005). This study revealed counts above the international acceptable limit in street foods of Takoradi jollof, indomie, baked/fried spring rolls, fried yam, Accra jollof, indomie, fried yam, spinarch soup, plain salad and in Senchi tomato stew, snail khebabs and tomato/pepper sauce respectively. Their presence in street foods implies non-adherence to standard hygiene practices (Sandel andMcKillip, 2004).

5.7.2.6 Yeast and Mould

Different loads of yeasts and moulds count found in most food and water samples made the lower limit. However, apart from the samples taken from Takoradi and Senchi, Accra showed the most statistically significant ($P < 0.05$) samples with highest Yeast, S*almonella sp*. and *Staphylococcus sp*. count whilst Takoradi showed maximum level of Total coliform. The high level of bacteria on some food and water samples could be attributed to poor sanitation and hygiene practices, raw materials, unfavourable temperature

128

conditions during processing or storage, use of contaminated water, hand contact with ready-to-eat food as a potential source of contaminating food and water or a combination of these (Ejemot *et al.,* 2009). Surface contamination of food and utensils is significantly reduced by washing hands and surfaces with soap and water (Moore and Griffith, 2002). All food and water samples taken from the three study areas were devoid of *Vibrio cholerae*.

5.8 Top 10 diseases causing mobidity and mortality in the 3 study sites (Accra, Takoradi and Senchi)

The study has revealed that malaria is endemic in all health institution reports and facilities at the study areas. Malaria is placed top of the ten diseases most frequently reported to the out-patient department (OPD) attendance which accounts for about (40.8%) of morbidity nationwide (WHO, 2013). Malaria cases often peak in the major rainy seasons between May and August and the minor rainy seasons in September and October. Also children under 5years and pregnant women were noted to be at a higher risk of malaria contraction. Frequent outbreak of *cholerae* in Ghana is of great concern. Sporadic cases have also been recorded in other parts of the nation and districts. Other diseases of interest were diarrhoea, skin diseases, ulcers, intestinal worms, ARI and anaemia which recorded varying levels of cases over the years in the study areas. The study indicated poor environmental sanitation as a major contributory factor (Schmdit and Rodrick, 2003).

5.9 Distribution of detected microorganisms in water samples at the 3 study areas

Water is vital to safety and therefore has to be free of disease causing microorganisms, toxic metals and offensive odour or taste (Marriott and Gravani, 2006). It was observed that the major source of water supply for food vendors and consumers was pipe borne water for cooking, handwashing and other domestic uses (washing of utensils, hand wiping

129

cloths, cleaning floors). Potable water is safe and reduces drastically microbial content of water from the three study areas. The enumeration of these microbial loads in water samples provides a measure of the extent of pollution in the environment as well as its storage. For the study, it was revealed that both pipe borne water and the river Volta at Senchi were highly polluted due to activities of inhabitants and island community dwellers. This suggests a general lack of sanitation and hygiene practices in the environment, improper handling and storage of water. The use of the river Volta without treatment to remove contaminants, poses a high risk to safe food (Health Canada, 2012).

5.9.1 Microbial variations and results of water samples

A WHO, (2008) report revealed that food and waterborne diarrhoeal diseases kill about 2.2 million people annually worldwide, 1.9 million being children. Developing countries do not have accurate record-keeping and reporting mechanisms, therefore there is the possibility of inaccurate figures being recorded and so the real figures could be much higher than reported (WHO, 2010). Waterborne diseases affecting people in communities drinking directly from the Volta Lake and streams. Diseases such as bilharzia, guineaworm and diarrhoea are more prevalent in the settlements along the Volta Lake (ADA 2015). The contamination of water at Senchi indicated by this study may come from several sources and may be attributed to unacceptable methods of disposal of industrial and municipal waste from hotels, hospitals, offshore fishing activities that are discharged into the river Volta. Run-offs from the rain often end- up in the river thereby polluting it hence, the high levels of pathogenic bacteria as compared to the tap water sources of the three study sites.

Water samples obtained from the three study areas revealed the absence of *Escherichia coli* and *Vibrio cholerae* strains but registered varying levels of Total coliform, *E. coli*, *Salmonella sp., Staphylococcus sp.* and Yeasts/Moulds. The significant high levels of

130

microbes such as Total coliform*, Salmonella, Staphylococcus,* Yeast and Mould may be attributed to the presence of various unhygienic practices e.g. using same cups in fetching water by the consumers and not changing stored water frequently on daily basis. Food vendors and consumers' exposure to these microbes could lead to food contamination and foodborne diseases especially uncooked vegetables that are eaten raw or not thoroughly cooked (Barker *et al.,* 2014). According to Gadaga *et al.,* (2004) contamination after cooking and using contaminated water in preparing food is often cited as causes of diarrhoea in street food consumption. In this study, Yeast and Mould counts were low in Accra and Takoradi food/water samples compared to Senchi.

A study by Ayeh-Kumi *et al*., (2009) on the microbiological quality of lettuce and tomatoes grown in Accra, discovered high levels of faecal coliform on the vegetables due to the use of unsafe sources of water in irrigating the vegetable farms. Though almost all microbial contaminants were below WHO level and other international standards, the hazard levels for some of the water samples were high and may increase the chances of contracting waterborne diseases. Nkere (2011) asserted that the persistent and bio-accumulative nature of these microorganisms in the environment, food and water may gradually lead to unacceptable levels if sources of contamination are not controlled. It behoves stakeholders to enforce food laws and regulations to encourage best practices that enhances good health and safety. It is also necessary to continue monitoring microbial contamination in the environment for the purpose of public health protection through education, training, medical check-ups and certification of street food vendors to help reduce food and waterborne diseases.

5.10 Field Observation

a) Markets

The choice of these markets at the study areas of Accra, Takoradi and Senchi was influenced by the following factors :- their variation in terms of size, accessibility, days of continuous trading, number of permanent trading establishments, types of street foods being vended, language, rampant diseases outbreak e.g. diarrhoea, cholera, guinea worm, bilharzia, malaria, typhoid fever and the levels of other functions. Generally, the presence of different ethnic groups and their busy nature in hospitality and vibrant but daily activities for revenue generation to the Assemblies based on the relatively large numbers of customers that are served on regular basis some of them belong to the vulnerable group and their proximity to the researcher. The markets have numerous challenges e.g. facilities allocated for sanitation and waste management, accessibility, lack of good drains and toilet facilities, elements of safe water, inadequate sheds and stalls, limited space which has compounded congestion and above all improved sanitation and hygiene promotion to ensure health benefits through safe food are maximized for productivity and poverty reduction in the study areas.

The differences in the food vendors at the study areas are that food vendors of Accra and Takoradi were much older in age as compared to Senchi and have either partially or completed their basic educational level and had acquired culinary skills in a secondary/ vocational school or at the polytechnic level. Whereas majority of Senchi food vendors were younger and either or partially completed basic level of education but none of them reached the polytechnic level. The differences in these study areas are that Accra and Takoradi markets sell variety of foods and non-food items and consumers were mainly workers of varied institutions who patronize these street foods and other items. The Senchi

132

market is basically a reststop or stopover for travellers and consumers are mainly passengers travelling to and fro the eastern corridor who may alight to freshen- up, stretch their limbs from the long journey, also need something to eat or as presents for their relations and friends. The street food vendors at Senchi specialize in "Abolo", polished kenkey and fried fish and the notable fish, "one-mouth-thousand". This brings a sharp contrast in the various foods sold at the study areas with less number of food being sold at Senchi.

The Senchi street market is basically noted for its economic and revenue generating activities through daily street food vending in the catchment area. It is worrying to note that the ADA has no modern lorry parks as compared to Accra and Takoradi so the various transport unions have taken advantage of the situation and established stations at unauthorized places hence, the street market. The stations are by the road side compounding traffic situation especially at Adomi-Senchi. Markets along the lake constitute point-source pollution for the Volta River this is because local residents and downstream settler communities and market participants dump waste into the river and are potentially exposed to health hazards associated with drinking from the river in some waterborne diseases. According to Ofori, (2010) environmental and sanitary conditions at market centres in the country portend adverse public health implications for the resident populations and market participants. A study in 2010 by Ofori revealed that market places are potential sites for infection and channels for diseases transmission. For this reason, there is the need to understand the linkages between organization of trading activities at market centres and conditions of the environment.

b) Utensils

Ideally, pathogenic microoganisms such as Coliforms, *Salmonella sp., Escherichia coli*, *Staphylococcus,* Yeasts and Moulds should not be found if the necessary steps of hygiene

133

are observed. The enumeration of these microbial load in the street food/water samples provides a measure of the extent of contamination in the food environment. This study indicates that utensils were used for both raw and cooked or ready-to-eat foods. There were no separate knives and cutting boards for raw meat/fish and vegetables for other purposes, utensils for food preparation as well as for keeping food were interchanged along the way during the process and display glass/gauzed boxes were stained of grease and dust.

Other factors such as inadequate cooking, poor personal, food, kitchen and environmental hygiene might have influenced the numbers detected. Using same utensils for raw and cooked but ready-to-eat foods poses a health risk of cross contaminatin (CAC, 2003). A study by Nichol and Salek, (2007); Addo *et al*., (2007) indicated that ready-to-eat foods are mostly prepared and sold under poor hygiene conditions with food vendors not being aware that they could be possible sources of contamination to raw/cooked food.

c) Water supply

The major source of water supply is pipe-borne supplied by the Government to the communities. It is safer, requires minimum treatment however it is expensive and used for drinking. The Volta River, down stream of Akosombo and Kpong dams, serves as an important resource for the inhabitants, as a major source of domestic water supply, water transport, supports fish aquaculture industry and for emerging river sand winning business (Barry *et al.,* 2005). The water system also provides a suitable environment for malaria, schistosomiasis vectors, water-related diseases and infections such as diarrhoea/cholera, guinea worm, skin diseases, elephantiasis and river blindness (Ding *et al.,* 2013; Tempark *et al.,* 2013; De Souza *et al.,* 2012; Joshi *et al.,* 2011; Kondo *et al*., 2002; El Sayed *et al*., 2000) to thrive. Damming of the river has affected the livelihood opportunities, impacted on the public health of communities in close proximity of the dam and along the river

down stream. This has brought into being the brisk street food vending business along the stretch of Senchi road. A study by Rheilander *et al.*, (2008) revealed that (80%) of foodborne diseases are associated with the presence of microorganisms due to poor sanitation and personal hygiene in developing countries.

d) Waste management

Waste management is a major problem at the study sites. Waste generated by hotels, restaurants, chop bars and street food vendors at these markets are liquid, organic and inorganic. Most of the food joints were near rubbish tips and though the food vendors complained of this situation, but said they had no better place to vend their foods. This could be a very high tendency of selling contaminated food to consumers due to the presence of flies and other pests that might contaminate the foods. Some of these institutions lack storage facilities hence dump waste into open spaces and munucipal drains. For this reason, the Assemblies contract the services of waste management companies e.g. Zoomlion waste management company. This makes waste disposal easy but unfortunately, collecting waste at food service areas posed a challenge. The findings thereof contradicts the study by Monney *et al.,* (2003) that food vendors in Ghana generally adhered to hygiene and sanitation practices in food handling.

Waste disposal need to be done properly and often to avoid attracting pests resulting in infestation in food storage facilities (Marriott and Gravani, 2006). A study by Schmdit and Rodrick in 2003 discovered that dirty and dusty environments are direct sources that contaminate food. There is the need therefore to assess the environmental situation of the study sites to identify environmental challenges which acts as constraints to development (Schmdit and Rodrick, 2003). The effective handling and disposal of waste prevents food

contamination, foodborne illness, harborage of pests and generation of odours in the surroundings (Marriott and Gravani, 2006; Ofori, 2010).

e) Pests and Pest control

It was observed that, markets at the study sites were littered with rubbish and most of the dustbins at food vending sites had no lids. This situation allowed houseflies hover and mice creep around vending premises. Domestic animals such as goats/sheep, dogs and fowls were seen peeling-off and drinking from cooking pots and washing basins. The FAO/WHO in a study on pests and pest control in 2008 revealed that pests such as rodents and insects are carriers of pathogenic microorganisms and their presence around kitchen or food preparation and vending premises can cause contamination and poses a great health risk. Insect pests such as cockroaches, houseflies are careers of *Salmonella* and *Vibrio cholerae* which cause dysentry and typhoid fever.

Eicher (2009) agreed that effective sanitation practices and frequent inspection are the most important steps which helps to identify and target pest control challenges as well as thorough fumigation. Very few of the respondents recommended only general cleaning or both general cleaning and pesticide use (fumigation) as methods of pest control. This study has revealed lapses in general cleaning and pest control at the study sites. There is lukewarm attitude towards the "National Sanitation Day" (NSD) nationwide thereby compounding effective sanitation nation wide.

5.11 Test of hypotheses / chi-square (X^2) test results

In this study, the chi-square test results in testing the mean scores of the stated hypotheses for the association of individual respondents' degree of knowledge, perceptions and attitude revealed positive and negative relationship between the knowledge/perceptions variables were stratified into high-positive and low-negative. The chi-square test result for

136

food vendors' knowledge on use of right utensils, the number of times they washed their hands as possible means of contamination indicated that most of the food vendors were informed. Most of the food vendors had a high perception of compliance with food safety regulation 168 (56%) whilst 132 (44%) had low perception. With regards to attitudes on compliance with food safety regulation 120 (40%) had positive-high, whilst 180 (60%) had negative-low. The results of gender on food safety policy compliance indicated that females had high but positive attitudes (85%) and their male counterparts had (60%) according to the scaling technique and perception scores. A plausible explanation could be that females learn the rudiments of food services from their parents than their male counterparts.

The study indicated that education and training on food safety were factors influencing attitude on good hygiene practices (GHP) whilst the number of years in street food vending had no relationship with adherence to food safety ($0<0.05$). These results are in conformity with numerous studies discussed in the literature which have shown that there is powerful association or relationship between education and knowledge, attitude, perception and food safety traning/certification. The study has revealed that the percentage of food vendors reduced with age. Age was significant in the food vending and health variables. Younger food vendors are more vibrant and energetic in going about their businesses, seek health education than older street food vendors. As far as vending and patronage variables are concerned it can be argued that younger respondents are more likely to vend and patronize street foods and services than older respondents (Donkor *et al.,* 2009).

There is appreciable difference in the total microbial contamination among the study areas in the food and water samples for the two seasons. This trend was expected because the temperature holdings and sanitation in the environment of the study sites differ. It could be attributed to storage and serving of food at ambient temperature without adequate

137

reheating of leftovers or not changing water and cleaning the storage facilities regularly. It was observed that most food vendors/ handlers have components for HACCP already in place however, difficulties in attitudes of these food vendors about food safety are mainly due to lack of education and proper training about HACCP still exist.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

This study was conducted to investigate microbial contamination of food and food safety practices of street food vendors in selected markets of Accra, Takoradi and Senchi, Ghana. The general objective of the study was to investigate food safety practices of street food vendors and consumers at the study areas so as to generate a baseline data for improvement.

Based on the findings of this study, it was concluded that:

- Street food-vending reduces unemployment rates particularly in cities and is distinctive because it provides basic need to the urban inhabitants.

- This study revealed that only a few scientific studies on food safety, hygiene practices in street food vending and sanitation have been documented as compared to the developed countries. This could be due to lack of national accredited libraries, analytical laboratories/tools and funding for research.

- Majority of the respondents were not aware of bacterial pathogens that affect food items whether raw or cooked. The microbial quality analysis of food and water samples revealed counts of different patterns that are of great concern to human health.

- *Vibrio cholerae* species and *E. coli* were not detected in water samples from the three study areas. Coliform*, E. coli, Staphylococcus aureus, Salmonella sp.,* Yeasts and Moulds revealed disturbing levels were above the required allowable limits. Among the microbes in this study, Coliforms were in relatively higher concentration in Takoradi sliced mango (530) in the dry season. The presence of

139

Coliforms*, Salmonella sp., Staphylococcus aureus*, Yeast and Mould counts in the various food and water samples implies that the sanitary conditions at some of the food vending sites were, poor personal and food hygiene practices might have contributed to these findings.

Reheating of food/leftovers as well as proper storage with adequate temperature control will reduce microbial growth and contamination in these foods.

- The microbial levels in the food samples could also be largely attributed to poor temperature control which created an ambient temperature for the rapid multiplication of microbes. Food storage and holding equipment and utensils could not retain high temperatures for a longer period perhaps due to frequent opening and serving of customers and also power outages.

- Almost all food vendors in the three study sites were females and majority of them had some level of basic education and therefore generally showed some level of knowledge on foodborne diseases and food hygiene.

- Most of them have heard of germs, and mentioned cholera and diarrhoea, washing of hands before food preparation, after visiting the toilet and how food items are handled before use.

- Although most of the respondents (food vendors and consumers) had fair knowledge about foodborne diseases, they could not distinguish foodborne diseases and symptoms from other non-contagious diseases.

- Most food vending activities were operated in unhealthy environments and insanitary conditions.

- Although a sizeable number of the respondents had adequate knowledge on foodborne diseases and food hygiene, their hygiene practices were poor. There is

lack of adequate data on foodborne diseases, corrective and preventive measures in the form of coherent policies from the Government and effective collaboration among stakeholder institutions. Varied studies on pathogenic bacteria in foods considering the wide range of microbes in the environment will be worthwhile to continue studies on the health of consumers and effective monitoring to assess the impact of microbes in street foods that affect human health.

6.2 Recommendations

Based on the findings of the study, the following recommendations are made:

- It is recommended that monitoring of foods sold in the various streets, markets be conducted by regulatory authorities e.g. $MMDA_S$, FDA, GSA and EPA. Sanitation directorates and other environmental but stakeholder institutions:

- A collective action by stakeholder institutions in a timely and decisive manner is needed to protect consumers from the threats of unsafe food and water.

- Educational lessons by stakeholders and schools should place emphasis on the following:

• Food laws should require exceedingly high threshold for intervention. There should be prospects for sustainable policies by government and stakeholders since prevention beats cure.

• All citizens should be educated by the MMDAs and stakeholders on food hygiene to address issues on one's civic rights and responsibilities towards the food industry.

- There should be public lectures, workshops and hygiene lessons in schools, markets, churches, mosques and other public places to make a lasting impact on the populace for attitudinal change on good sanitation and hygiene.

a) Research should be intensified in food safety at all levels so as to be able to reduce morbidity and mortality as a result of food poisoning. Propose solutions in doing research in elimination of diseases and death by the Ministry of Health and stakeholders.

- Political leaders should cultivate the political will and commitment to sustain, control and eliminate activities in scaling up of known interventions. Provide a multifaceted approach in fighting food poisoning, poor sanitation and hygiene.

- Policy makers and Ghana Water Company (GWC) should pay greater attention to water quality at the point of use so that factors that result in post-source contamination of water are addressed through a more holistic approach to community water provision, sanitation and hygiene to produce better health outcomes than improvements in water sources alone.

- The public should be educated on simple water storage techniques to make water safer from contamination. Avoiding the use of containers that previously stored food or chemicals, emptying, washing and refilling storage containers regularly, filtering and boiling stored water before drinking should be encouraged.

*Efforts should be made to create producer, consumer and food handling awareness; through the mass media stakeholder institutions to educate the public on what to look for from street food vendors before patronizing their food. Food vendors could be educated on what consumers expect from them which included good hygiene practices.

- Regulatory bodies such as EPA, FDA and the Assemblies should be more aggressive on food vendors in enforcing legislation on appropriate policies and strategies through advocacy and setting standards to enhance utilization of food safety, sanitation and healthcare services.

- Public health education campaigns should be organized often to remind community members on methods to prevent diarrhoeal diseases, malaria, cholera and typhoid fever infection through workshops, schools, adult literacy classes and public mobile cinemas at the market places.

- Finally, 'National Sanitation Day' activities aimed at improving upon the sanitary conditions in the communities, should be revived and improved.

6.2.1 Recommendation for further research

Based on the findings of the study, there is the need for further research on:

Effective education on food hygiene, training, medical check–ups/screening and certification of food vendors is vital in curbing the spread of foodborne diseases in the nation.

REFERENCES

Ackah, M., Gyamfi, E.T., Anim, A.K., Osei, J., Hansen, J.K. and Agyemang, O. (2011). Socio-economic profile, knowledge of hygiene and food safety practices among street food vendors in some parts of Accra, Ghana. *Internet Journal of Food Safety, 13:191-197.*

ADA. (2015). Asuogyaman District Assembly Institutional and District Health Survey Document, Ghana.

Adams, M.R. and Moss, M.O. (2008). *Food Microbiology (3*d Edition*).* Royal Society of Chemistry, Cambridge. Pg. 27- 30.

Addo, K.K., Mensah, G.I., Bonsu, C. and Ayeh, M.L. (2007). Food and its preparation in hotels in Accra, Ghana. A concern for Food Safety. *African Journal of Food Agriculture Nutrition and Development*. (7), 5.

Addo, S.T. (1998). Traditional Markets in the Development Process in Manya Krobo in Ghana. *Singapore Journal of Tropical Geography*. Vol. 9. No. 1

Afele, M. (2006). Street food boom in Ghana spurs calls for better hygiene. Bull. *World Health Organization, (84),* 772-773.

Allimentarius, C. (2003). Code of hygiene practice for precooked and cooked foods in mass catering. CAC/RCP 39, 1993. Rome, Italy. FAO of United Nations, WHO. Available at:
file:///C:\Users\ICDUGL\Downloads\CXP_039e.pdf.Accessed 8/6/16.

Ameyaw, A. (2000). "Biodiversity" Lecture note. University of Education, Winneba.

Angelillo, I.F., Viggiani, N.M.A., Rizzo, L. and Bianco, A. (2003). Food handlers and foodborne diseases: knowledge, attitudes and reported behaviour in Italy.

Annum, G. (2014). Research Instrument for Data Collection. Kumasi, University Press.

Anonymous, C.K. (1997). Codex Allimentarius Commission, CAC/RCP 1-1969, Revised. Aspen Publishers, London.

Antle, J.M. (1998). Efficient Food Safety Regulation in the Food Manufacturing Sector, *American Journal of Agricultural Economics,* 78:1242-47.

Aryeetey, E. and Nyanteng, V. (2006). Agriculture Market Access in Ghana. Discussion Paper No. 30. Institute of Statistical, Social and Economic Research (ISSER), University of Ghana.

Ayeh-Kumi, P.F., Quarcoo, S., Kwakye-Nuako, G., Kretchy, J.P., Osafo-Katanka, A. and Mortu, S. (2009). Prevalence of intestinal parasitic infections among food

vendors in Accra, Ghana. *Journal of Tropical Medical Parasitology*, (32), 1-8.

Ayivor, J.S. (2013). Management Effectiveness Evaluation of Protected Areas in the Volta Basin of Ghana. Thesis submitted to the School of Graduate Studies, University of Ghana, Legon.

Babbie, E. (2003). The Practice of Social Research: 9th Edition. Belmont, CA: Wadsworth Thomson.

Barker, S.F., Amoah, P. and Drechstreetsel, P. (2014). A Probabilistic model of gastroenteritis risks associated with consumption of street salads in Kumasi, Ghana: Evaluation of methods to estimate pathogen dose from water, produce or food quality. *Science of the Total Environment,* 487, 130-142.

Barry, B., Obuobie, E., Andreini, M., Andah, W. and Pluquet, M. (2005). The Volta river basin. Comparative study of river development, Rapport, IWMI, CAWMA.

Bas, M., Yuksel, M. and Cavuooflu, T. (2007). Difficulties and barriers for the implementation of HACCP and food safety systems in food businesses in Turkey. *Food Control,* 18:124-130.

Blackburn de Wit, C. (2002). Microbiological analysis and food safety management: GMP and HACCP systems, in detecting pathogens in food. Ed. McMeekin T.A. Cambridge, U.K, Woodhead Publishing, Pp. 3-19.

Bloomfield, S., Aiello, A., Cookson, B., O'Boyle, C. and Larson, E. (2007). The effectiveness of hand hygiene procedures in reducing the risks of infections in home and community settings including handwashing and alcohol-based hand sanitizers. *American Journal of Infection Control. 35:*27-64.

Bomfeh, K. and Tano-Debrah, K. (2008). Microbiological safety of foods served in the Ghana School Feeding Programme: a case study of the Ga East District of Accra. A BSc. Dissertation presented to the Department of Nutrition and Food Science, University of Ghana, Legon.

Borch, E. and Arinder, P. (2002). Bacteriological safety issues in red meat and ready-to eat meat products, as well as control measures. *Meat Science,* 62:381-390.

Bryan, F.L. (1990). Hazard analysis critical control point (HACCP) Systems for retail food and restaurant operations. *Journal of Food Protection*, 53 (11): 978-983.

Brynestad, S., Luber, P., Braute, L. and Bartelt, E. (2008). Quantitative microbiological risk assessment of campylobacteriosis cases in the German population due to consumption of chicken prepared in homes. *International Journal of Risk Assessment and Management, 8:*194-213.

Buccheri, C., Casuccio, A., Giammanco, S., Giammanco, M., La Guradia, M. and Mammnina, C. (2007). Food Safety in hospital: Knowledge, attitudes and practices of *Research,* 7:45-56.

Buccheri, C., Mammina, C., Giammanco, G., Giammanco, M., La Guardia, M., and Casuccio, A. (2010). Knowledge, attitudes and self-reported practices of food service staff in nursing homes and long-term care facilities. *Food Control, 21:1367-1373.*

CAC (2003[A]). Code of Hygiene Practice for precooked and cooked foods in mass catering. CAC/RICP Rome, Italy. Food and Agriculture Organization of United Nations, World Health Organisation. Available at: file://C:/Users/ICDUGL/Downloads/CXP_039e.pdf. Accessed: 11/05/16.

CAC (2007). Basic texts on Food Hygiene, revised and republished in compact form from Volume 1B- General Requirement (Food Hygiene) of the CAC: Pp. 31-32, 48-51. Available at: http://www.haccphelp.com/Documents/Codex.pdf. Accessed: 24-6-15.

CAC (2003[B]). Recommended International Code of Practice; General Principles of Food Hygiene, Cambridge. Pp. 27-30.

Campos, A.K.C., Cardonha, A.M.S., Pinheiro, L.B.G., Ferriera, N.R., Medeiros de Azevedo, P.R. and Stamford, T.L.M. (2009). Assessment of personal hygiene and practices of food handlers in municipal public schools of Natal, Brazil. *Food Control 20; 807-810.*

Carrasco, E., Morales-Rueda, A. and Garcia-Gimeno, M.R. (2012). Cross-contamination and recontamination by Salmonella in foods: A review. *Food Research International 45:545-556.*

Centres for Disease Control and Prevention (2006). Foodborne illness: Frequently asked questions. Atlanta: CDC.

Centre for Food Safety, (2007). Microbiological guidelines for ready- to-eat foods. Available At: www.cfc.gov.hk/english/whatsnew/...act/.../MBGL_RTE%20food_e.pdf Accessed on 19/6/2017.

Center for Science in the Public Interest, (CSPI) (2005). Global and Local: Food safety around the world. Available at www.cpsinet.org/new/pdf: Accessed on 04-06-16.

Center for Remote Sensing and Geographical Information Services (CERGIS) (2016-2017) University of Ghana, Legon.

Cheeptham, N. (2013). Eosin Methylene Blue Agar Plates Protocol. American Society for Microbiology. Pg. 1.

Clute, M. (2008). Food Industry Quality Control Systems. CRC Press, Taylor and Francis. Pg. 11.

Clayton, D. A. and Griffith, C. J. (2009). Observation of food safety practices in catering using notational analysis. *British Food Journal, 106 (***3***):221-227.*

Collison, E.K., Ntiforo, A., Yankey, L., Laryea, J., Lokko, P. and Marfo, E. (1995). Street Food situation in Ghana. A Review, Commission by the Food and Agriculture Organisation (F.A.O). Contaminations in lettuce, tomatoes, beef and goat meat from metropolitan Accra. *Ghana Medical Journal,* 35:1-6.

Cosby, C.M., Costello, C.A., Morris, W.C., Haughton, B., Davereaux, M. J. and Harte, F. (2008). Microbial analysis of food contact surfaces in child care centers. Countries. *Social Science and Medicine* Vol.17, No. 3, pp. 147-161.

Daniels, N. A., Mackinnon, L., Rowe, S. M., Bean, N. H., Griffith, P. M. and Mead, P. S. (2002). Food borne disease outbreaks in United States schools. *The Pediatric Infectious Disease Journal. 21 (7): 623-628.*

D'Aoust, J.Y. and Maurer, J. (2007). Food microbiology: fundamentals and frontiers. ASM Press. Pp 187-236.

De Souza, D.K., Koudou, B., Kelly-Hope, L.A., Wilson, M.D., Bockarie, M.J. and Boakye, D.A. (2012). Diversity and transmission competence in lymphatic filariasis vectors in West Africa, and the implications for accelerated elimination of Anopheles-transmitted filariasis. *Parasites and vectors, 5(*1): 1-6.

Ding, G., Zhang, Y., Gao, L., Ma, W., Li, X., Liu, J., Liu, Q. and Jiang, B. (2013). Quantitative Analysis of Burden of Infectious Diarrhoea Associated with Floods in Northwest of Anhui Province China: A Mixed Method Evaluation. *PLoS ONE* 8 (6): e 65112. doi: 10. 1371/ journal. Pone. 0065112.

Dingham, B. (2003). Growing vegetables in developing countries for local/urban populations and export markets: problems confronting small-scale producers. *Pest Management Science*, 59: 575-582.

Disease Control Division. (2008). Infectious disease news local. Ministry of Health, Infectious Disease Weekly Report, 4 (1), Available at: http://www.dph.gov/my/survelans>Jan.2008. Epid. Week 1 Accessed 20/1/2015.

Don, S.M. (2008). Optimal conditions for the growth of *E.coli*. Pg. 2.

Donkor, E.S., Aning, K.G. and Quaye, J. (2011). Application of the WHO keys of safer food to improve food handling practices of food vendors in a poor resource community in Ghana. *International Journal of Environmental Resource and Public*

Health, 6, 2834.

Doyle, M. P., Beuchat, L. R. and Montville, T. J. (1997). Food Microbiology: Fundamentals and Frontiers. ASM Press, Washington D C.

Doyle, M.P. and Erickson, M.C. (2007). Reducing the carriage of foodborne pathogens in Livestock and poultry (PDF). Available at:
http://www.poultryscience.org/ps/paperpdfs/06/p0660960.Pdf.Accessed/17/1/15.

ECHCD-G (2008). Facts sheet on Food Contaminants. Directorate-General for Health and Consumer Protection, European Commission, Brussels. Available at:
http://ec.europa.eu/food/food/chemicalsafety/contaminant_final_web_en.pdf
Retrieved on 01-01-16.

Egan, M.B., Raats, M.M., Grubb, S.M., Eves, A., Lumbers, M.L. and Dean, M.S. (2007). A review of food safety and food hygiene training studies in the commercial sector. Food Control, 18 (10): 1180-1190.

Ehiri, J.E., Azubuike, M.C., Ubbaonu, C.N., Anyanwu, E.C., Ibe, K.M. and Ogbonna, M.O. (2001). Critical Control Points of Complementary Food Preparation and Handlingin Eastern Nigeria. Bulletin of World Health Organization; 79 (5):423-33.

Eicher, E. (2009). Environmentally responsible pest management- Food Quality. 11; 5:29.

Ejemot, R.I., Ehuri, J.E., Meremikwu, M.M. and Critchley, J.A. (2009). Handwashing for preventing diarrhoea, *Cochrane Database Systems Review:* CD004265 (23), 1.

Elmi, M. (2004). Food Safety: current situation, unaddressed issues and the emerging priorities. Invited paper. J. Eastern Mediterranean Health ID (6): 795-797.

El Sayed, B.B., Arnot, D.E., Mukhutar, M.M., Baraka, O.Z., Dafalla, A.A., Elnaiem, D.E.A. and Nugud, A.H.D. (2000). A study of the urban malaria transmission problem in Khartoum. *Acta Tropica* 75(2): 163-171. doi: 10. 1016/s0001-706x (99) 00098-4.

EPA (2015). Statutory functions of Environmental Protection Agency Executive Summary Policy Document of Ghana.

FAO/WHO. (2005[A]). Assuring food safety and quality: Guidelines for strengthening national food control systems. FAO Food and Nutrition Paper 76, 2003, Rome.

FAO/WHO. (2005[B]). Informal food distribution sector in Africa (street foods): importance and challenges. *Regional conference on food safety for Africa.* FAO, Harare. Pp.97-98.

FAO (2012). Street food vending in West Africa cities: Potential and challenges. Available at: http//www.fao.org.../streetfoodvending in12%west%. Retrieved on 27/

4/14.

FDA/CFSAN (2012). Bad bug book: Foodborne pathogenic microorganisms and natural toxins handbook. (2nd Edition) Maryland: Springfield. P. 69-93. Available at: http://www.fda.gov/food/foodborneiiinesscontaminants/causesofiiinessbugbook/ ucm 2006773.htm. Retrieved on 20/ 06 /15.

FDA (2012). Evaluation and definition of potentially Hazardous Foods. *Retrieved from http://www.fda.gov/Food Processes/ucm094141.html. Accessed on 21-05-15.*

Feglo, P. and Sakyi, K. (2012). Bacterial contamination of street vended foods in Kumasi, Ghana. *Journal of Medical and Biomedical Sciences,* 1 (1),

Fellows, P. and Hilmi, M. (2012). Selling street and snack foods. *Diversification booklet*, 18th edition FAO, Rome. Pg. 2.

Fusaro, D. (2013). FSMA Changes Pest Control for Food Manufacturers, Food Processing. http://www.foodprocessing.com/article/2013/pest-control-fsma.html. Retrieved on 1/ 1/ 17.

Gadaga, T.H., Nyanga L.K. and Mutukumira, A.N. (2004). The Occurrence, growth and Control of pathogens in African Fermented Foods. *African Journal of Food, Agriculture, Nutrition and Development.* 4 (1).

Gadi, C., Bala, K. L. and Kumar, A. (2013). Study of hygiene practices of street food vendors in Allahahab city, India and determination of critical control points for safe street foods. *The Allahahab Farmer. IXVIII* (2), 1.

Gandhi, M. and Chikindas, M.L. (2007). Listeria: A foodborne pathogen that knows how to survive. *International Journal of Food Microbiology, 96: 85-96.*

Gardiner, W.P. (1997). Statistical Analysis for Chemists: A software Approach. The Royal Society of Chemistry, Glasgow, UK. Pp. 293-328.

Ghana Education Service. (2009). School Health Education Programme Policy Document- Final Draft for Approval by GES. Accra. Pp. 18 and 19.

Ghana Medical Journal Editorial (2005). Food Safety. Edited by Mercy J. Newman. *Department of Microbiology*, *University of Ghana*, *Korle-bu*, Ghana. Volume 39, No.2.

GNA. (2010). Producing unsafe food is unwise. Available at:http://www.ghanaweb.com Accessed on: June 5, 2016.

GNA. (2013). Contaminated Food, Water Causes 700,000 Deaths in Africa Annually. http://www.modernghana.com/new/203772/1/contaminated-food-water-causes 700000-deaths-in-af.html. Accessed on 19-4-14.

Ghana Standard Authority (2003). *Local Reference Standards*. *GS (7006).* P *1-44.*

Ghana Statistical Service (2010). "Population and Housing Census of Ghana." District analytical report, Accra Metropolitan Assembly: Ghana. Sakoa Press Limited.

Ghana Statistical Service (2012). "2010 Population and Housing Census of Ghana." Summary report of final results Accra, Ghana: Sakoa Press Limited. Available at: http://www..statsghana.gov.gh/docfiles/2010phc/Census2010_Summary_report_ of_final_results.pdf. Accessed June 8, 2015.

Ghana Statistical Service (2014). 2010 Population and housing census. District analytical report, Accra Metropolitan Assembly, Accra, Ghana: Sakoa Press Limited.

Gilbert, S.E., Whyte, R., Bayne, G., Lake, R.J. and van der Logt, P. (2007). Survey of internal temperatures of New Zealand domestic refrigerators. *British Food Journal, 109(4): 323-329.*

Gordon, C. (2006). Consumer Domestic Hygiene Practices and Public Health. Wood Head Publishing Limited, England.

Grintzali, G.P. and Babatsikou, F. (2010). The significance of the application of Hazard Analysis Critical Control Point System in hospital catering. *Health Science Journal, 4(2): 84-93.*

Gundry, S., Wright, J. and Conroy, R. (2004). A systematic review of the health outcomes related to household water quality in developing countries. J. Water and Health 2 (1): 1-13.

Hartley, D.M., Morris, M and Smith, D.L. (2006). Hyperinfectivity; A Critical Element in the Ability of V. cholerae to cause Epidemics? PLoS. Med. 3(1): e7.

Harrington, W. and Portney, P. R. (2007). "Valuing the Benefits of Health and Safety Regulation. "Journal of Urban Economics 22:101-112.

Hassan, A.N., Brit, D.M. and Frank, J.F. (2010). Behaviour of Listeria monocytogens in a Pseudomonos putida biofilm on a condesate-forming surface. *Journal of Food Protection. (2),* 322-327.

Hauser, G., Curiel, G.J., Bellin, H., Cnossen, H.J., Hoffman, J., Kastelein, J., Partington, E., Peltier, Y. and Timperley, A.W. (2005). Hygienic Equipment Design Criteria. Doc 8, 2nd Ed. European Hygienic Engineering and Design Group. Available at: http://www.ehedg.org. Retrieved on 22/11/14.

Health Canada (2012). Guidelines for Canadian Drinking Water Quality: Guideline Technical Document-*Total coliforms*. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa,

Ontario.

Health Protection Agency (2009). Aerobic Colony Counts. Guidelines for Assessing the Microbiological Safety of Ready-to-Eat Foods Placed on the Market. Pg.14, Healthcare International Centre for Research on Women, Washington.

Hobbs, B.C. and Gilbert, R.J. (2008). Food Poisoning and Food Hygiene 6th ed. Edward Arnold (Publishers) Limited, London.

Hui, Y.H. (2004). Food Plant Sanitation and Quality Assurance. Ch 17; In Food Processing Principles and Application. Smith, J.S. and Hui, Y.H (Ed. 1). Blackwell Publishing, Oxford Pp. 151- 152.

Huss, H.H. and Ryder, J. (2003). In Assessment and Management of Sea Food Safety and Quality; Huss, H. H., Ababouch, L. and Gram, L. Food and Agriculture Organization of United Nations. Available at http://www.fao.org/docrep/y4743e.html. Retrieved on 22-6-14.

ICMSF. (2008). *Microbial Ecology of foods: Factors affecting life and death of microorganisms.* (J. Silliker, Ed.) Academic Press, New York.

Jay, J.M. (2000). Modern Food Microbiology, Gaitherburg, MD: Aspen Publishers. *Journal of Food Protection,* (63): 381-385.

Joshi, P.C., Kaushal, S., Aribam, B.S., Khattri, P., D'Aoust, O., Singh, M.M., Marx, M. and Guba-Sapir, D. (2011). Recurrent floods and prevalence of diarrhoea among under five children: observations from Bahraich district, Uttar Pradesh, India. Global Health Action 4:6355/ doi: 10.3402/gha.v4i0.6355.

Kenkel, D., Berger, M. and Blomquist, G. (2006). Contingent Valuation of Health. G. Tolley, D. Kenkel, and R., Fabian, eds. Valuing Health for Policy: An Economic Approach, Chicago: The University of Chicago Press.

Kennedy, J., Jackson, V., Blair, I.S., McDowell, D.A., Cowan, C. and Bolton, D. J. (2005) Food safety knowledge of consumers and the microbiological and temperature status of their refrigerators. *Journal of Food Protection, 68:1421-143.*

Kighthinger, L.K., Seed, J.S. and Kighthinger, S. (1995). The Epidemiology of Ascaris lumbricoides, Trichuris lumbricoides, Trichuris trichiura and Hookworm in children of the Ranomatana forest. J. Parasit. 81 (2) I59- 169.

Kilonzo-Nthenge, A., Fur-Chi, C., Sandria, L.G. (2008). Occurrence of Listeria and enterobacteriaceae in domestic refrigerators. *Journal of Food Protection, 71:608-612.*

Kiranmayi, C.H. and Krishnaiah, N. (2010). Detection of *Escherichia coli* 0157:H7 Prevalence in foods of animal origin by cultural methods and PCR technique.

Veterinary World, 3:13-16.

Kissiedu, K.O. and Tano-Debrah, K. (2002). Evaluation of currency notes as agent of microbial cross contamination. BSc, Dissertation, Department of Nutrition and Food Science. University of Ghana, Legon.

Kondo, H., Seo. N., Yasuda, T., Hasimezu, M., Koido, Y., Ninomiya, N. and Yamamoto, Y. (2002). Post-flood- infectious diseases in Mozambique. Prehospital and disaster medicine, 17 (03): 126- 133.

Kroeger, A. (1983). Anthropology and Socio-Medical Health Care Research in Developing Countries. *Social Science and Medicine*: Vol. 17, No. 3, Pp. 147- 161.

Kusumaningrum, H.D., Riboldi, G., Hazeleger, W.C. and Beumer, R.R. (2005). Survival of foodborne pathogens on stainless steel surfaces and cross-contamination to foods, *International Journal of Food Microbiology, 85:227-236.*

Labspace. (2014). *Intrinsic factors.* Available at:
http://labspace.open.ac.uk/mod/oucontent/view.php?id=452286&section=1.4.2
Retrieved on June 18, 2017.

Lee, J.H. and Choi, S.J. (2006). Isolation and characteristics of sorbitol-fermenting *Escherichia coli* O157 strains from cattle. *Microbes and Infection. 8:2021-2026.*

Lee, M.B. and Greig, J.D. (2010). A review of gastrointestinal outbreaks in schools: effective infection control interventions. *Journal of School Health, 80:588-598.*

Legnani, P., Leoni, E., Berveglieri, M., Mirolo, G. and Alvaro, N. (2008). Hygienic contro of mass catering establishments, microbiological monitoring of food and equipment. Food Control, 15:205-211.

Leslie, J. and Gupta, G.R. (1989). Utilization of formal services for Maternal Nutrition and livestock and poultry. (PDF) Available at:
http://www.poultryscience.org/ps/paperpdfs/06/p00660960. PDF. Retrieved on 1/4/15.

Lues, F.R.J., Rasephei, M.R., Venter, P. and Theron, M.M. (2006). Assessing food safety and associated food handling practices in street food vending. *International Journal of Environmental Health Research,16(5), 319.*

Lund, B. M., Baird-Parket, T. C. and Gould, G.W. (2000). The Microbiological Safety and Quality of Food. Aspen Publishers, Inc., Gaithersburg, MD.

Marie, L., Bertuzzo, E., Righetto, L., Kasagranda, R., Gatto, M., Rodriguez, H. and Rinaldo, A. (2011). Modelling cholera epidemics: the role of waterways, human mobility and sanitation interface. 3rd Edition. Macmillan press. Pp. 67- 76.

Marriott, N.G. and Gravani, R.B. (2006). Principles of Food Sanitation. Springer Science Business Media, Inc. New York. U.S.A.

Marzzano, M.A. and Balzaretti, C.M. (2011). Cook-serve method in mass catering establishments: Is it still appropriate to ensure a high level of microbiological quality and safety? *Food Control, 22:1844-1850.*

Maynard, A.J. and Heid, J.L. (2003). Food Processing Operations: Their Management, Materials and Methods. The AVI Publishing Company Inc. Westport, Connecticut.

Mead, P. S., Slutsker, L., Dietz, V., McCaig, L. F., Breese, J. S., Shapiro, C., Griffin, P. M. and Tauxe, R.V. (2009). Food-related illness and death in the United States. *Emerging Infectious Diseases*, (5): 607-625.

Melnick, D., McNeely, j., Navaro, Y.K., Traub, G.S. and Sears, R.R. (2008). Environment and human well-being: a practical strategy: UN Millenium Project Task Force on Environmental Sustainability, Earthscan, UK and USA, ppxvi-xvii.

Mensah, P., Yeboah-Manu, D., Owusu-Darko, K. and Ablordey, A. (2002). Street foods in Accra, Ghana: How safe are they? Bulletin of the *World Health Organization (80),* 546-550.

Mensah, P., Armar-Klemensu, A., Hammond, S., Haruna, A. and Nyarko, R. (2012). Bacterial contamination in lettuce, tomatoes, beef and goat meat from metropolitan *Accra, Ghana. Medical Journal, 35:* 1- 6.

MOH (2007). Summary of the top 20 causes of out-patient morbidity in 2007. Available At:

http://www.moh/ghana.org/moh/docs/healthservice/SUMMARYOFTOPTWENTYCAUSESOFOUTPATIENTMORBIDITY2007.pdf. Accessed on 25/04/2016.

MOH (2010). Health Facts 2009. Ministry of Health. Available at:

http://www.moh.gov.my/images/gallery/stats/heal_fact/healthfact_L_2009.pdf. Accessed on 25/4/2016.

Monney, I., Agyei, D. and Owusu, W. (2003). Hygiene practices among food vendors in educational institutions in Ghana: The case of Konongo Foods, (2): 282 – 294.

Moore, G. and Griffith, C. (2002). A comparison of surface sampling methods for detecting Coliform on food contact surfaces. *Food Microbiology, 19*: 65 – 73.

Morton, R.D. (2011). Aerobic Plate Count. In: Downes, F.P and Ito, K., Compendium of Methods for the Microbiological Examination of Foods (4th Edition). American Public Association, Washington DC. Pp. 63; 70.

Muinde, O. K. and Kuria, E. (2005). Hygienic and sanitary practices of vendors of street

foods in Nairobi, Kenya. *African Journal of Food Agriculture and Nutritional Development,* (1), 2.

Musa, O.I. and Akande, T.M. (2007). Routine medical examination of food vendors in secondary schools in Ilorin. *Nigeria Journal of Medicine.* 11(1): 9-12.

Muzaffar, A. T., Huq, I. and Mallik, B. A. (2009). Entrepreneurs of the streets: Analytical Work on Street Food Vendors of Dhaka City. *International Journal of Business and Management*, 4(2): 80-88.

Nagai, T., Staatz, J.M., Bernsten, R.H., Sakyi-Dawson, E.O. and Annor, G.A. (2009). Locally Processed Roasted-Maize-based Weaning Foods Fortified with Legumes: Factors Affecting Their Availability and Competitiveness in Accra, Ghana. *African Journal of Food, Agriculture, Nutrition and Development.* 9: 1927-1944.

Newman, M. (2005). Editorial commentary on Food Safety, *Ghana Medical Journal*. 39 (2): 44-45.

New Zealand Food Safety Authority (1995). Microbiological reference criteria for food. New Zealand: NZFSA. P. 16 – 18.

Nichol, T.H. and Salek, H.D. (2007). Clinical Microbiology Procedures Handbook. Washington, D.C: American Society for Microbiology. P. 76.

Nkere, C.K., Ibe, N.I. and Iroegbu, C.U. (2011). Bacteriological Quality of Foods and Water sold by Vendors and in Restaurants in Nsukka, Enugu State, Nigeria: A Comparative Study of Three Microbiological Methods. *Journal of Health, Population and Nutrition*. 29 (6): 560-566.

Ofori, B.D. (2010). A Geographical Study of Market Centres and Trading Activities along the Volta Lake. Ph.D Thesis submitted to the School of Research and Graduate Studies, University of Ghana, Legon.

Okolie, N.P., Omonigbehin, E., Badru, O.A. and Akande, I.S. (2012). Isolation of pathogenic bacteria from soe foods sold at selected private schools in Akora area of Yaba-Lagos, Nigeria, *African Journal of Food Science* 6(3):65-69

Olsen, S.J. (2000). Surveillance for foodborne-disease outbreaks: United States, 1993 1997 Morbidity and Mortality Weekly Report *CDC Surveillance Summary* 49 (1): 60-62.

Omemu, A.M. and Aderoju, S.T. (2007). Food Safety knowledge and practices of street food vendors in the city of Abeokuta, Nigeria. *Food Control, (19)*, 396-402.

Omemu, A.M., Oyewole, O.B. and Bankole, M.O. (2007). Significance of yeasts in the fermentation of maize for ogi production. *Food Microbiology.* 24 (6): 571-576.

Park, S., Worobo, R.W. and Durst, R.A. (1999). *Escherichia coli* O157:H7 as an emerging foodborne pathogen: A Literature Review, *Critical Reviews in Food Science and Nutrition,* 39:6, 481-502.

Pietrangelo, A. (2012). What is an intestinal infection due to *E. coli*? Healthline Networks, Inc., New York.

Polanski, J. (2009). Water and Waste water issues. Retrieved from http://www.foodprocessing.mntap.mntap.umn.edu/food/wastewater.html.Accessed on 01-07-16.

Prescott, L.M., Harley, J.P. and Klein, D.A. (2005). Microbiology (6th Edition). The McGraw- Hill Companies, Boston. Pp. 554.

Proietti, I., Frazzoli, C. and Mantovani, A. (2014). Identification and management of toxicological hazards of street foods in developing countries. *Food and Chemical Toxicology, 63, 144.*

Rahman, M.M., Arif, T.M., Bakar, K. and Tambi, B.Z. (2012). Food safety knowledge, attitude and hygiene practices among the street food vendors in northern Kuching city, Sarawak, *Borneo Science,* 31, 98.

Ray, B. and Bhunia, A. (2014). *Fundamental Food Microbiology* (5 edition). Taylor and Francis Group, New York City. Pg. 65.

Rheilander, T., Olsen, M., Bakang, J.A., Takyi, H., Konradsen, F. and Samuel, H. (2008). Keeping up appearances: perceptions of street food safety in urban Kumasi, Ghana. *Journal of Urban Health*, (85):952- 964.

Russ, W. and Meyer-Pittroff, R. (2004). Utilizing waste products from the food production and processing industries. Crit. Rev. Food Sci. Nutr; 44(1): 57-62. Retrieved from http://www.ncbi.nlm.nih.gov/m/pubmed/150777881. Accessed on 20/6/15.

Rzezutka, A. and Cook, N. (2004). Survival of human enteric viruses in the environment and food. Federation of European Microbiological Societies Microbiology, 28: 441 453.

Sainsbury, D. and Singleton, P. (2006). Dictionary of Microbiology and Molecular Biology; Third Edition, revised John Wiley and Sons Ltd. West Sussex. Pp.70- 71.

Sandel, M.K. and McKillip, J.L. (2004). Virulence and recovery of *Staphylococcus aureus* relevant to the food industry using improvements on traditional approaches. *Food Control 15*:5-10.

Satin, M. (2008). Food Alert: The Ultimate Sourcebook for Food Safety, Facts on Files

Inc., 2nd Edition.

Schmdit, R.H. and Rodrick, G.E. (2003). Food Safety Handbook. John Wiley and Sons Inc., Hoboken, New Jersey. Pp. 528.

Schmitt, R., Bryan, F.L., Jermini, M., Chilufya, E.N., Hakalima, A.T. and Zuulu, M. (2007). Hazard and critical control points of food preparation in homes in which persons had diarrhoea in Zambia. *Journal of Food Protection.* 60 (2): 161-71.

Scott, E. and Bloomfield. S. (1990). The survival and transfer of microbial contamination via cloths, hand and utensils. *Journal of Applied Bacteriology,* 68:271-277.

Sefa-Dedeh, S. (1993). Street Food-Nutrition Safety and Management, Research and Improvement of Street Food. Report on seminar on Street Food Organized by the Ghana Institute of Nutrition and Food Technology.

Seward, S. (2000). Application of HACCP in food service. *Irish Journal of Agricultural and Food Research, 39(2), 221-227.*

Siddiqui, Z. (2001). New technologies in pest management prevent pathogen spread. *Food Processing*. 62: 2: 63.

Sinayobye, E. and Saalia, F.K. (2011) Size Reduction of Food Commodities and Food Safety in some Accra Markets. *African Journal of Food, Agriculture, Nutrition and Development.* 11 (6); 5282-5299.

Smith, D.A. (2007). Small Scale Food Equipment. Food Processing for Entrepreneurs Series, Nebbguide. Available at: http://www.ianrpubs.unl.edu/pages/publications.d.jsp?publicationld=684. Accessed on 1/6/15.

Sneed, J., Strobeh. C. and Gilmore, S.A. (2004). Food safety practices and readiness to implement HACCP programmes in assisted- living facilities in Iowa. *Journal of the American Dietetic Association*, 104:1678-1683.

Stannard, C. (1997). Development and use of microbiological criteria for foods. *Food Science and Technology Today.* 11 (3): 137-176.

Staskel, D.M., Briley, M.E., Field, L.H. and Barth, S.S. (2007). Microbial evaluation of food service surfaces in Texas child-care centers. *Journal of the American Dietetic Association*, 107(5): 854-859.

STMA. (2014). Sekondi- Takoradi Metropolitan Assembly Institutional Document.

Strachan, N.J.C., Doyle, M.P., Kasuga, F., Rotariu, O. and Ogden, I.D. (2005). Dose response modeling of *Escherichia coli* O157 incorporating data from foodborne and environmental outbreaks. *International Journal of Food Microbiology,* 103:35-47.

156

Sun, Y.M, and Ockerman, H.W. (2005). A review of the needs and current applications of hazard analysis and critical control point (HACCP) system in foodservice areas. *Food Control, 16(4):325-332.*

Taylor, E. (2008). A new method of HACCP for the catering and food service industry. *Food Control, 19(2), 126-134.*

Tempark, T., Lueangarun, S., Chatproedprai, S. and Wananukul, S. (2013). Flood- related skin diseases: a literature review. International *Journal of Dermatology*, 52:1168 1176. doi: 10.1111/ijd. 12064.

Teunis, P., Takumi, K. and Shinagawa, K. (2004). Dose response for infection by *Escherichia coli* O157:H7 from outbreak data. *Risk Analysis, 24:401-407.*

Todd, E.C.D., Greig, J.D., Bartleson, C.A. and Michaels, B.S. (2009). Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 6. Transmission and survival of pathogens in the food processing and preparation environment. *Journal of Food Protection, 72:202-219.*

Tokuc, B., Ekuklu, G., Berberoglu, U., Bilge, E. and Dedeler, H. (2009). Knowledge, attitudes and self-reported practices of food service staff regarding food hygiene in Edirne, Turkey. *Food Control, 20 (6), 565-568.*

Tortoe, C., Johnson O_N.T., Ottah-Atikpo, M. and Tomlins, K.I. (2013). Systematic Approach for the Management and Control of Food Safety for the Street/Informal Food Sector in Ghana. *Food and Public Health, 3* (1), 60.

Tribe, I. G. (2008). An outbreak of Salmonella typhimurium phage type 135 infection linked to the consumption of raw shell eggs in an aged care facility. *Communicable Disease Intelligence, 26:38-39.* Available at: http://www.health.gov.au/internet/main/publishing.nsf/content/cda-pubs-cdi-2002-cdi2601h.htm. Accessed on 14 / 5 / 15.

United States Department of Agriculture, Foreign Agriculture Service. (2008). Economic research service. Household food security in the United State. Economic research report no. (FRR-83) 66pp, November, 2009.

United States Food and Drugs Administration. (2009). Food Code. Available at: http://www.iit.edu/ncfst/news_and_events/media_room/pdfs/FDAIssues2009FDA FoodCode.pdf. Accessed on 20/6/16.

United States National Research Council. (1985). An Evaluation of the Microbiological Criteria for Foods and Food Ingredients. National Academy of Sciences.

van Ravenswaay, E. O. (2005). Valuing Food Safety and Nutrition: The Research Needs.

Valuing Food Safety and Nutrition, J.A. Caswell, ed. Westview Press: Boulder.

Velusamy, V., Arshak, K., Korostyaka, O., Oliwa, K. and Adley, C. (2010). An overview of foodborne pathogen detection: In the perspective of biosensors. Biotechnology Advances 28:232-254. Retrieved from www.elsivier.com/locate/biotechadv. Accessed on 10 /5/15.

Walker, E., Pritchard, C. and Forsythe, S. (2003). Hazard analysis critical control point and prerequisite programme implementation in small and medium size food business. *Food Control, 14, 160-174.*

Water-Aid/WHO (2006). Key Facts. Available at: http://www.Wateraid.org/internaional/what we do/statistics/default/asp.

Wertheim, H. F., Vos, M., van Belkum, A., Voss, A. and Kluytmans, J. A. (2004). Risk and outcome of nosocomial *Staphylococcus aureus* bacteraemia in nasal carriers versus non-carriers. *Lancet,* 364 (9435): 703-5.

WHO. (2007). Food safety and foodborne illness. Fact sheet no.237 Accessed 7/3/15.

WHO. (2008). The global burden of disease: 2004 update. World Heath Organization, Geneva, Switzerland.

WHO. (2010). Basic steps to improve safety of street- vended food. *International food safety authorities network* (3) pp.1-2 Retrieved from http://www.who.int/foodsafety/fs_management/no_03_Streetfood_Jun10_en.pdf? Ua=1. Accessed June 20, 2014.

WHO. (2011). Enterohaemorrhagic *Escherichia coli* (EHEC). Fact sheet No. 125. Available at: http://www.who.int/mediacentre/factsheets/fs125/en/Accessed June 27, 2012.

WHO. (2012). *Foodsafety.* Available at: http://www.who.int/topics/foodsafety/en/index.html. Accessed on May 23, 2014.

WHO. (2013). *Essential safety requirements for street-vended foods (revised edition).* Available at: http://www.who.int/foodsafety/publication/fsmanagement/en/streetvend.pdf. Accessed on: 15-5-2014.

Williams, P.G. (2009). Food service perspective in institutions. Wood Head Publishing Ltd. Cambridge. Pp. 2-7.

World Health Organization (FAO/WHO). (2002): Food safety and foodborne illness. Available at: http://www.who. Int / media center/fact sheet. Retrieved on 20-6-15.

World Health Organization (WHO). (2004). Global *Salmonella* Surveillance (GSS).

Available at: http://www.who.int/slmsurvifaq/eni. Accessed on 15/03/14.

World Health Organization (2005). Cholera, 2004. *Weekly Epidemiological Record* 2005, 81:297-308.

World Bank/WHO (2006). Five keys to safer food manual. Available at: http://www.who.int/food safety/publications/ consumer/manual keys.pdf. Reviewed on: 1- 4-15.

Yadav, N., Siani, P., Kaur, D., Srivasta, N. and Pandey, D. (2011). Microbial quality and safety of ready to serve street foods vended in Allahahab City. India. *Internet journal of Food safety,* 13, 6.

Yeboah-Manu, D., Kpeli, G., Akyeh, M. and Bimi, L. (2010). Bacteriological quality of ready-to-eat foods sold on and around University of Ghana campus. *Journal of Microbiology, 5(2), 130.*

Yoon, J.Y., Moon, B.M., Oh, I.G., Back, B.K., Li, L.G., Kim, B.S., Stein, B.D. and Lee, J.H. (2008). Antimicrobial resistance of *Escherichia coli* O157 from cattle in Korea. *International Journal of Food Microbiology. 106(1): 74*

APPENDICES

APPENDIX 1

STAKEHOLDER RELATIONS/SELECTED BYE-LAWS OF THE MMDAs AND THEIR RELEVANCE TO FOOD SAFETY

	Stakeholder	Bye-Law	Year of coming into force	Key components	Relevance to food safety
1.	Ministry of Health (MOH)	MOH Act 525	1996	• Ministry of Health, an umbrella instituition. • Provides public health services, administering and enforcing legislation related to environmental health.	• Providing support to minimize health and safety/food safety hazards.
2.	Ghana Health Service (GHS)	GHS Act 525	1996	• Main implementing agency of the Ministry of health. • Provides comprehensive primary health care at regional, district and sub-districtlevels in accordance with policies. • Policy formulation, monitoring/evaluation, resource mobilization and regulation of health service delivery.	• In ensuring food safety, the nutrition unit promotes assessment and consumption of iodized salt and other food items.
3.	Environmental Protection Agency (EPA)	EPA Act (490)	1994	• Implementing agency and a regulatory body for change towards sound environmental stewardship at the national, district and community levels. • Co-ordinate activities of bodies for permit in controlling the generation, treatement, storage, transportation and disposal of industrial waste, emissions, other source of pollutants and substances hazardous to the environment. • Prescribe standards and guidelines relating to the pollution of air, water, land and other forms of environmental pollution e.g. control of toxic substances.	• Ensure compliance with any laid down environmental impact assessment procedures in planning/execution of existing projects including safe food environment. • Co-operate with government agencies, district Assemblies, other bodies and instituitions to control pollution and generally protect the environment.

4.	Food and Drugs Authority (FDA)	FDA law (PNDCL305B) Amendment act 523 Public Heath act 151	1992 1997 2012	• Ensure that Legislative Instruments (LIs) are passed for the laws and guidance of its clients to promote the functions of the FDA and matters relating to the health of the consumer. • Visit firms to ensure that product information and advertisement are not misleading. • Ensure that all local manufacturers of products are licensed and that their operations conform to codes of good manufacturing practices (GMP). • Ensure food and beverages offered by firms are to the accepted standard of the authority.	• Provision against sale of unwholesome, poisonous or adulterated food. • Food offered as prize, etc. and deception of consumers. • Manufacture and standards of food under supervision • Prohibition against sales of food not of nature, substance or quality demanded. • Sale of food under insanitary conditions and unfit for human consumption • Penalty and defense under this part and closure of premises where there is risk of contaminated food.
5.	Ghana Standards Authority (GSA)	GSA Decree (NRCD 173)	1973	• Government of Ghana Agency responsible for the maintenance of acceptable standards for products, quality assuranceof goods and services, sound management practices in industries and institutions. • Ensuring compliance with government policies on Standards, Metrology, Standardization, Testing and Quality Assurance (SMSTQA) for locally manufactured imported products and services in order to prevent importation/distribution of substandard products into the Ghanaian market.	• Testing Programme: Offers services including physical, chemical and microbiological analysis in the following areas:- - Food, Chemical, materials, drugs and forensic samples • Quality Assurance programme. - Product and system certification. - Factory/Consignment/Import and Export Certification. - Fish and destination inspection.
6.	Food Research Institute (FRI)	FRI (CSRI)		• Scientific and Technological Institute of Ghana's food processing industry for the growth of food and agriculture sectors. • Food safety, processing, preservation and storage • Food marketing, distribution and utilization, in support of the food industry and on government's food policy. • Research/Development - Collaborative research with other organizations and/or clients.	• Research activities in products: Grains, cereals and legumes, Roots/Tubers, Fish, Meat/Diary, Fruits, Vegetables and spices. • International certified analytical services: - Microbiological, chemical, physical and toxicological analysis. • Shelf-life studies on food products

					• Undertake sensory evaluation of products to assess their acceptability by consumers for clients.
7.	Ministry of Food and Agriculture/Veterinary Services	MoFA/VS Animal act Food law 438 (Amended) Fisheries act	VS-1961 1963 1965 2002	• Creates quality but stable animal health services and crop production. - By controlling crop/animal diseases communicable to human beings and strengthen institutional capacity for improved health management and services delivery for efficient management decision. - Establish, strengthen and maintain linkages within the sector and other relevant institutions to help regulate imports of food products so that products from other countries are certified to be disease-free. - Control movement of animals and food products in that only quality food products and healthy animals are permitted to be moved from one area to another and are safe for consumption.	• Liaises with MoH with regards to diseases common to humans/animals. • Maintaining and enforcement of regulations on inport of crops, food products, livestock, poultry and their products • CRI/ARI develop drugs/vaccines to protect humans, sheep and goats against diseases causing high mortality amongst them. • Ensure that meat and other food products are safe for humans and animals through timely healthcare/veterinary intervention and educating the populace on healthcare issues.
8.	Metropolitan, Municipal and District Assemblies	MMDAs A.Markets	2000 2000	• No occupier shall expose for sale any food item. It should be placed on a table or on a support raised at least one metre from the ground of any stall, space or selling site in the market. • At the requests of officers of theAssembly every person using a market either as a seller, purchaser or every other member of the public using or frequenting a market shall obey all reasonable directions and requests of officers of the Assembly or police officers given for the preservation of cleanliness, order and regularity in the market, or for facilitating the dispatch of business therein.	• No article likely to be used for human consumption shall be exposed or sold without adequate protection from dust, flies, insects or harmful substances and no box, container or be placed in pathway or avenue of a market.
		B.Restaurants	2000	• Every restaurant or eating house shall be provided with- - A separate room which shall be used solely as a public eating room; and solely as a kitchen for cooking and provided for preparing food and liquid refreshments for use in the restaurant or eating house.	• Every kitchen in a restaurant or eating house shall be approved by the Assembly and must have suitable fly-proof storage for foodstuffs with one or more tables with non-absorbent surface for the preparation and serving of food.

				- Every public eating room must have shelves or cupboards for the storage of plates, other utensils and suitable tables/chairs or benches.	• An adequately covered receptacle for the disposal of garbage shall be provided and maintained by the owner or proprietor. • Any person wishing to operate a restaurant or an eating house or anyone who is engaged in the preparation, handling, serving or otherwise deals with food prepared and served in any eating house/restaurant or hawk shall first be certified to be free from any communicable disease by the appropriate medical authority.
		C.Hawkers	2000		• All food sold in the state in which it is to be consumed must be protected by covering with wire gauze or netting against dust and flies • No one shall sell within 100 metres of the perimeters of any market nor do hawkers loiter to sell any food item in a state that is to be consumed within 50 metres of a public latrine or a refuse collection area.
		D.Solid/Liquid waste management	2000	• All waste deposited in the public domain is the property of the Assembly and/or its registered agents or contractors are exclusively responsible for the management of both solid and liquid wastes within the entire administrative area of the Assembly. • Every household, industry, office and other premises within the MMDA shall make its solid and liquid wastes available to the Assembly or its authorized agents or contractors for disposal or otherwise and shall be collected, treated and disposed of at designated sites or given out to interested persons to be recycled by the Assembly or its authorized agents or contractors.	•

				• All occupiers or owners of premises with the exception of household premises shall designate a member of their staff to be directly responsible in all matters relating to waste management. The designated staff shall liaisewith the Assembly or its authorized agents or contractors on all waste management issues.	
		E.Sale of Fruits/Vegetabl es	2000	• The MMDA Director of Health Services (DHS) prohibit the sale of fruits and vegetablescontaminated from any source and any other vegetables likely to be consumed in an uncooked state.	• No crops shall be watered with or irrigated by the effluent from any drain from any premises, or any surface water drain receiving the waste water from any street. • No person who is suffering from a discharging wound, sores on the arms or legs or from any symptoms of infectious disease shall take part in the growing or sale of fruits and vegetables.
		F.Cleansing	2000	• Where the Assembly acting under its powers institutes a "NATIONAL SANITATION DAY", any person who on the sanitation day obstructs any pupil or teacher of any school or any other person authorized to clean any area of the metropolis commits an offence.	• Owners or occupiers of stores, shops, market stalls and market places shall keep their floors and frontages clean and clear of litter, rubbish or filth. • A person who, for the purpose of a trade, vocation or other business causes offensive smell or other nuisance to the detriment of neighbours or the public commits an offence.

APPENDIX 2

UNIVERSITY OF GHANA, LEGON
COLLEGE OF BASIC AND APPLIED SCIENCES
INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES (IESS)

MICROBIAL CONTAMINATION OF FOOD AND FOOD SAFETY PRACTICES OF STREET FOOD VENDORS IN SELECTED MARKETS OF ACCRA, TAKORADI AND SENCHI, GHANA.

QUESTIONNAIRE/INTERVIEW SCHEDULE FOR STREET FOOD VENDORS OF ACCRA, TAKORADI AND SENCHI MARKETS.

INTRODUCTION

I am **FLORENCE DZIFA BANSAH** a final year PhD student of the Institute for Environment and Sanitation Studies (IESS) of the University of Ghana. This study aims at investigating to discover obstacles to food safety, hygienic practices and causes of food poisoning so as to obtain relevant information which would be used to educate and improve safe food services delivery in the study areas. The research is solely for academic purpose. I count on your cooperation to accurately respond to the questions which is vital to this study. All response will be treated as confidential.

Thank you very much.

INSTRUCTION: Please tick [√] or write down the information where necessary in the provided.

SECTION (1): BACKGROUND INFORMATION

1. **Age**

Age	Tick
Below 18	
19-24	
25-29	
30-34	
35-39	
40-44	
45-49	
50-54	
55-59	
60-66	

2. **Sex (Gender)**　　　　　　　　[   ] Female　　　　　　　[   ] Male

3. What is your educational level? (Underline or tick where appropriate)

(i) No formal education　　　　　　　　　　　　　　[   ]

(ii) Basic (Primary/Middle/JHS)　　　　　　　　　　[   ]

(iii) Secondary/Commercial/Technical School　　　　　[   ]

(iv) College (Teacher/Nurse, any other)　　　　　　　[   ]

(v) Tertiary level e.g. Polytechnic, University, and others　　[   ]

4. Martial Status (Tick where appropriate)　　　　[   ]

(ii) Single (Not in relationship)　　　　　　　　　　[   ]

(iii) Married　　　　　　　　　　　　　　　　　　[   ]

(iv) Separated　　　　　　　　　　　　　　　　　[   ]

(v) Divorced　　　　　　　　　　　　　　　　　　[   ]

(vi)Widowed　　　　　　　　　　　　　　　　　　[   ]

166

5. Religion (Tick where appropriate)

(i) Christianity   [   ]

(ii) Islam   [   ]

(iii) Traditional   [   ]

 others specify …………………………………………………………….

6. Ethnic Group: Akan [   ] Ewe [   ] Ga-Dangme [   ] Northern [   ]

others specify…………………...

Or, if you are not a native of Accra/Takoradi/Senchi or Ghanaian, then when did you

come here and why? ....

7. Have you ever lived in any other place apart from Accra/Takoradi/Senchi for more

than months?   Yes [   ]   No [   ]

8. What was your age when you started this food business and for how long?

(a) less than 1year

9. Are you living with your husband/wife/partner/parents? Yes [   ]   No [   ]

10. Occupation or what work do you do? ....

(a) Is this your only source of income?   Yes [   ]   No [   ]

(b) Indicate your source(s) of income in order of the major.

Salary   [   ]   Petty Trading   [   ]

Wage   [   ]   Remittance   [   ]

Farming (crop/animal) [   ] other specify …………………………………………

167

SECTION 2: KNOWLEDGE IN FOOD SAFETY

11. In your own words and understanding what is food safety? …………………………

....

(a)What is street food? ………………………………………………………………….

(b)Why do people patronize street food? (i) It is cheap [   ] (ii) It saves time/energy [   ]

(ii) It is nutritious   [   ]   (iv) It is tasty [   ]   (v) Has flavour [   ]

12. How would you rate the level of food poisoning in Ghana?

(i) High [   ] (ii) Moderately high [   ] (iii) Very High [   ] (iv)Not aware how high [   ]

13. Where do you usually get information on food safety/food poisoning issues?

Television	[ ]	Workshops/Training	[ ]
Radio	[ ]	Church/Mosque	[ ]
Newspaper	[ ]	Relatives/Friends	[ ]
Books	[ ]	other specify	………………………………………….

14. Which of these are symptoms of foodborne illness?

Diarrhoea	[ ]	Nausea	[ ]
Abdominal Pain	[ ]	Headache	[ ]
Vomiting	[ ]	Dizziness	[ ]
Fever	[ ]	Fatigue	[ ] other, specify………………

15. Which of these can cause foodborne illness? (Tick as many as appropriate)

Germs	[ ]	Food allergens	[ ]
Toxic chemicals	[ ]	Fatty foods	[ ]
Pesticides	[ ]	Sugary foods	[ ]
Insecticides	[ ]	Extraneous matter in food [ ]	
Expired foods	[ ]	other specify……………………………………	

16. Which of the following practices in food preparation may reduce the risk of food

contamination?

(a) Preparation of food in advance   [   ]

(b) Washing of hands before handling food   [   ]

(c) Using clean water   [   ]

(d) Keeping fingernails short, unpolished and clean   [   ]

(e) Using cap, masks and adequate clothing   [   ]

(f) Using appropriate utensils to minimize bare hand contact with food   [   ]

(g) Using the same knife and cutting board for both raw and ready to eat food [   ]

(h) Cooling hot food at room temperature   [   ]

17. Have you heard about germs/microorganisms? Yes [   ]   No [   ]

18. Where in your opinion can germs be found?

Human body   [   ]   Soil   [   ]

Animals   [   ]   Water   [   ]

Cooking Utensils   [   ]   Air   [   ]

Working surfaces   [   ]   Food   [   ] other, specify………………………..

19. Which of the following are ways by which germs get into food?

Food handlers   [   ]   Raw material and ingredients   [   ]

Cooking water   [   ]   Working surfaces   [   ]

Cooking utensils   [   ] other, specify…………………………………………………

20. Which of the following food condition best facilitate the growth of germs?

a. Cold food   [   ]

b. Hot food   [   ]

c. Luke - warm food   [   ]

d. Not sure   [   ]

169

21. Which of the following are ways of storing/ handling food in order to kill microorganisms or germs in food?

Cooking food thoroughly [   ] Microwaving of food   [   ]

Freezing   [   ] Washing of fresh fruits/vegetables in salt solution [   ]

Refrigeration   [   ] other, specify………………………………………….

22. Which of the option selected in Q21 is the best way of killing germs in food?

....

23. Which of the following can result from germs getting in food?

Loss of food   [   ]   Foodborne illness   [   ]

Loss of job   [   ]   Potential law-suits   [   ]

Loss of human life   [   ]   other, specify…………………………………….

24. How are your ingredients handled before meal preparation?

....

25. What food safety compliance are put in place during purchasing of fooditems?

a. Check for the one in good condition   [   ]

b. Buy cheaper and bruised ones   [   ]

c. Buy rotten ones   [   ]

d. Ignoring food safety measures and buy them [   ]   other, specify……………………

26. Are the right equipment used during food preparation?   Yes [   ]   No   [   ]

If Yes/No explain……………………………………………………………………………

27. What methods of cooking are used when preparing dishes?

a. All method   [   ]

b. Some of the methods   [   ]

List some of the methods used…………………………………………………………………

28. How is the environment kept?

170

a. Very clean   [   ]

b. Clean   [   ]

c. Dirty   [   ]

29. If cleaned, by who? Yourself [   ] Zoomlion [   ] any other person [   ]

Explain…………………………………………………………………………………..

30. Do you have a medical certificate that allows you to work?   Yes [   ]   No [   ]

 If Yes/No explain why? …………………………………………………………………

SECTION 3: STORAGE/HANDLING OF LEFTOVER FOODS

31. How are leftover foods handled?

No.	Type of food	Place	Cover			Left-over foods	
			Material	Condition	Frequency	Treatment	Usage
1							
2							
3							
4							
5							
6							
		i	Ii	iii	iv	v	Vi

(i) Condition of place, covered/open air:

a. Clean and well kept   [   ]

b. Dusty, mouldy, dirty   [   ]

c. Stained with food remains   [   ]

d. Wet, rusty   [   ]   other, specify…………………………………….

(ii) Material used to cover stored food:

a) cloth [   ] b) plastic [   ] c) paper [   ] d) other [   ] e) none [   ]

(iii) Frequency of use of cover:

a. Often used   [   ]

171

b. During selling, open partly   [   ]

c. Rarely used   [   ]

(iv)What is done with left-over foods?   [   ]

a. Discarded (not used anymore)   [   ]

b. No leftovers   [   ]

c. Used again with re-heating   [   ]

d. Used again with no re-heating   [   ]

e. remixed with new one and reheated   [   ]

(v) How many days are leftovers stored?

a. 1 day   [   ]

b. 2 days   [   ]

c. 3 days   [   ]

d. above 3 days   [   ] Additional comments ... ………………………………………….

SECTION 4: HANDLING OF EQUIPMENT AND UTENSILS

32. Type of equipment and utensils

No.	Equipment/Utensils	Condition	Usage	Washing	
				Frequency	Method
1					
2					
3					
4					
5					
6					
		i	ii	iii	iv

How do you see the…………………………………..

i. Condition of serving and preparation of utensils?

a. clean and shiny   [   ]

b. Dusty, mouldy, stained   [   ]

c. Stained with food, greasy   [   ]

d Wet, rusty   [   ] other, specify…………………………………………..

172

 ii. How are the utensils used?

a.   For one food only   [   ]

b.   For cooked and raw food   [   ]

c.   For cooked and raw food but washed in between   [   ]

iii. Frequency of use of cover

a. Several times per day   [   ]

b. Once a day   [   ]

c. 3-4 times per week   [   ]

d. 1-2 times per week   [   ]

e. Never   [   ]

iv. How is the utensil washed?

a. With soap and hot water   [   ]

b. With hot water   [   ]

c. With soap and freshwater   [   ]

d. Fresh water only   [   ]

Additional comments …………………………………………………………………..

33. FOOD HANDLING (Serving)

No.	Type of food	Serving	Contact	Handling
1				
2				
3				
4				
5				
6				
		I	ii	Iii

i. Is food served with a utensil reserved for the purpose? Yes   [   ]   No   [   ]

If Yes/No, please explain…………………………………………………………………..

ii. Does the food contact the server's hands directly?   Yes   [   ]   No   [   ]

173

If Yes/No, please explain……………………………………………………………………..

iii. Is the food held at an appropriate temperature?   Yes [   ]   No   [   ]

If Yes/No, please explain…………… ……………………………………………………

34. USE OF CLOTHS, SPONGES, BRUSHES ETC

No.	Usage	Condition	Washing
1			
2			
3			
4			
	i	Ii	iii

i. Used for:

a. Utensils   [   ]

b. Table (s)   [   ]

c. Hands   [   ]

ii. Condition of cloths, sponges etc.

a. Clean and dry   [   ]

b. Dry but dirty or mouldy   [   ]

c. Wet and dirty   [   ]

iii. Are the cloths washed / changed?

a. 2-3 times a day or more   [   ]

b. Once a day   [   ]

c. Not washed or changed   [   ]

iv. If cloths are not used why?

Please, explain………………………………………………………………………

35. WATER SOURCES, AVAILABILITY AND USE

1. SOURCE

a. Tap water   [   ]

174

b. Well water   [   ]

c. Water vendor   [   ]   other, specify………………………

2. WATER CONTAINER

a. Shiny and clean   [   ]

b. Dirty, dusty, stained   [   ]

c. Stained with food, greasy   [   ]

d. Rusty   [   ] other, specify………………………

3. Is dish washing water also used for washing foods?   a. Yes [   ]b. No   [   ]

c. If Yes/No, please explain why?..

4. How many times is the dishwater changed?

a. Never   [   ]

b. Once a day   [   ]

c. 2-3 times a day   [   ]

36. If water from a stream or river is used, describe the area and the other uses of the

source………………………………………………………………………………...

37. Are there communal washing areas?   Yes [   ]   No [   ]

38. How often do you get water supplies……………………………………………….

39. SELLING LOCATION

WASTE DISPOSAL (Circle all that apply)

(a) Waste disposal near to selling area   [   ]

(b) Waste scattered around serving area   [   ]

(c) Dirty utensils/plates etc. left to accumulate   [   ]

(d) Proximity of river or stream   [   ]

(e)WC available   [   ]

(f) WC unsuitable situated   [   ]

(g) Vendor has trash can   [   ]

(f) Vendor has no trash can   [   ]

(g) Trash cans orderly and covered   [   ]

(h) Trash can open/lids available/unavailable   [   ]

(i) Animals/birds/insects present around the selling location   [   ]

40. What are some of the activities that go on at the area?..

…………………………………………………………………………………....

41. PERSONAL HYGIENE (OBSERVING THE FOOD VENDOR FOR SOME TIME)

i. Do you know what germs, bacteria, viruses are?   Yes [   ]   No [   ]

Please

explain…………………………………………………………………………..

ii. Are these surfaces/utensils clean or dirty?

....

iii. Do you still sell food when you are ill or sick?   Yes [   ]   No [   ]

If Yes/No, please explain

…………………………………………………………………………..

Do you still serve food when your hands get infected   Yes [   ]   No [   ]

v. How often do you wash your hands when cooking and serving food?

....

vi. Do you understand what hygiene means?   Yes [   ]   No [   ]

If Yes, please explain…………………………………………………………………….

vii. Do you consider your stand (joint) to be hygienic?   Yes [   ]   No [   ]

viii. Have you ever received any lessons in food handling? Yes [   ]   No [   ]

If Yes, from who and for how many times in a year? ....

If No, why please explain……………………………………………………………………

ix. How did you acquire your cooking skill and in preparing food?

....

42. Which of the following are ways of killing germs? (Tick as many as applicable)

a. Washing vegetables in salt solution   [   ]

b. Washing vegetables in vinegar solution   [   ]

c. Washing hands frequently with soap and water   [   ]

d. Heating food thoroughly at a high temperature   [   ]

e. Putting food in the fridge.   [   ]

43. ASSESSMENT OF PERSONAL HYGIENE OF FOOD VENDOR

(1=Bad, 2=Average 3=Good 4=Very Good 5 = Excellent)

a. The level of personal hygiene of food vendor   [   ]

b. Vendor's appreciation of hygiene   [   ]

c. Vendor's willingness to improve on sanitization and hygiene   [   ]

b. Any other, please state it………………………………………………………

APPENDIX 3

UNIVERSITY OF GHANA, LEGON
SCHOOL OF BASIC AND APPLIED SCIENCES

INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES (IESS)

MICROBIAL CONTAMINATION OF FOOD AND FOOD SAFETY PRACTICES
OF STREET FOOD VENDORS IN SELECTED MARKETS OF ACCRA,
TAKORADI AND SENCHI, GHANA.

QUESTIONNAIRE/INTERVIEW SCHEDULE FOR CONSUMERS OF ACCRA,
TAKORADI AND SENCHI MARKETS.

INTRODUCTION

I am **FLORENCE DZIFA BANSAH**

a final year PhD student of the Institute for Environment and Sanitation Studies (IESS)

of the University of Ghana. This study aims at investigating to discover obstacles to food

safety, hygienic practices and causes of food poisoning so as to obtain relevant

information which would be used to educate and improve safe food services delivery in

the study areas. The research is solely for academic purpose. I count on your cooperation

to accurately respond to the questions which is vital to this study. All response will be

treated as confidential.

Thank you very much.

INSTRUCTION: Please tick [√] or write down the information where necessary in the provided.

SECTION (1): BACKGROUND INFORMATION

1. **Age**

Age	Tick
Below 18	
19-24	
25-29	
30-34	
35-39	
40-44	
45-49	
50-54	
55-59	
60-66	

2. **Sex (Gender)**   [   ] Female   [   ] Male

3. What is your educational level? (Underline or tick where appropriate)

(i) No formal education   [   ]

(ii) Basic (Primary/Middle/JHS)   [   ]

(iii) Secondary/Commercial/Technical School   [   ]

(iv) College (Teacher/Nurse, and other)   [   ]

(v) Tertiary level e.g. Polytechnic, University, and other   [   ]

4. Martial Status (Tick where appropriate)

(i) Single (in relationship)   [   ]

(ii) Single (Not in relationship)   [   ]

(iii) Married   [   ]

(iv) Separated   [   ]

(v) Divorced   [   ]

(vi)Widowed   [   ]

179

5. Religion (Tick where appropriate)

(i) Christianity [   ]

(ii) Islam [   ]

(iii) Traditional [   ]

(iv) other specify [   ]

6. Ethnic Group: Akan [   ] Ewe [   ] Ga-Dangme [   ] Northern [   ]

Others, specify……………………………………………………………………

Or, If you are not a native of Accra/Takoradi/Senchi or Ghanaian, then when did you

come here and why?

....

7. Have you ever lived in any other place apart from Accra/Takoradi/Senchi for more

than 6 months? Yes [   ] No [   ]

8. What was your age when you started patronizing street food and for how long?

....

9. Are you living with your husband/wife/partner/parents? Yes [   ] No [   ]

10. Occupation or what work do you do? ....

(a) Is this your only source of income? Yes [   ] No [   ]

(b) Indicate your source of income in order of the major

 Salary [   ] Petty Trading [   ]

 Wage [   ] Remittance [   ]

 Farming (crop/animal) [   ] other, specify ……………………………………………

SECTION 2: KNOWLEDGE IN FOOD SAFETY

11. In your own words and understanding what is food safety? …………………………

 ....

a) What is street food?...

180

b) Why do people patronize street food? (i) it is cheap [   ] (ii) it saves time/energy [   ]

   (iii) it is nutritious [   ]   (iv) it has flavour [   ]   (v) it is tasty [   ]

12. How would you rate the level of food poisoning in Ghana?

(i) High [   ] (ii) Moderately high [   ] (iii) Very High [   ] (iv) Not aware [   ]

13. Where do you usually get information on food safety/food poisoning issues?

Television	[ ]	Workshops/Training	[ ]
Radio	[ ]	Church / Mosque	[ ]
Newspaper	[ ]	Relatives/ Friends	[ ]
Books	[ ] other, specify…. ……………………………………………		

14. Which of these are symptoms of food borne illness?

Diarrhoea	[ ]	Nausea	[ ]
Abdominal Pain	[ ]	Headache	[ ]
Vomiting	[ ]	Dizziness	[ ]
Fever	[ ]	Fatigue	[ ]

other specify:………………………………………………………………………………

15. Which of these can cause food borne illness? (Tick as many as appropriate)

Germs	[ ]	Food allergens	[ ]
Toxic chemicals	[ ]	Fatty foods	[ ]
Pesticides	[ ]	Sugary foods	[ ]
Insecticides	[ ]	Extraneous matter in food	[ ]
Expired foods	[ ] other specify…………………………………………….		

16. Which of the following practices in food preparation may reduce the risk of food

contamination?

(a) Preparation of food in advance   [   ]

(b) Washing of hands before handling food   [   ]

(c) Using clean water   [   ]

(d) Keeping fingernails short, unpolished and clean   [   ]

(e) Using cap, masks and adequate clothing   [   ]

(f) Using appropriate utensils to minimize bare hand contact with food   [   ]

(g) Using the same knife and cutting board for both raw and ready to eat food   [   ]

(h) Cooling hot food at room temperature   [   ]

17. Have you heard about germs/microorganisms?   Yes [   ]   No [   ]

18. Where in your opinion can germs be found?

Human body   [   ]   Soil   [   ]

Animals   [   ]   Water   [   ]

Cooking Utensils   [   ]   Air   [   ]

Working surfaces   [   ]   Food   [   ] other specify……………………………….

19. Which of the following are ways by which germs get into food?

Food handlers   [   ]   Raw material and ingredients   [   ]

Cooking water   [   ]   Cooking utensils   [   ]

Working surfaces   [   ]   other, specify……………………………………

20. Which of the following food condition best facilitate the growth of germs?

Cold food   [   ]   Luke – warm food   [   ]

Hot food   [   ]   Not sure   [   ]

21. Which of the following are ways of storing/ handling food in order to kill

microorganisms or germs in food?

Cooking food thoroughly [   ] Microwaving of food   [   ]

Freezing   [   ] Washing of fresh fruits/vegetables in salt solution [   ]

Refrigeration   [   ] other, specify……………………………………….

182

22. Which of the option selected in Q21 is the best way of killing germs in food?

....

23. Which of the following can result from germs getting into food?

Loss of food   [   ]   Foodborne illness   [   ]

Loss of job   [   ]   Potential law-suits   [   ]

Loss of human life   [   ] other, specify…………………………………………………

24. How are your ingredients handled before meal preparation?

....

25. What food safety compliance are put in place during purchasing of fooditems?

a. Check for the one in good condition   [   ]

b. Buy cheaper and bruised ones   [   ]

c. Buy rotten ones   [   ]

d. Ignoring food safety measures and buy them   [   ]

Others, specify…………………………………………………………………………….

26. Are the right equipment used during food preparation? Yes [   ]   No [   ]

If Yes/No explain……………………………………………………………………………

27. What methods of cooking are used when preparing dishes?

a. All method   [   ]

b. Some of the methods   [   ]

List some of the methods used……………………………………………………………

28. How is the environment kept?

a. Very clean   [   ]

b. Clean   [   ]

c. Dirty   [   ]

29. If cleaned, by who? (a) Themselves [   ] (b) Zoomlion [   ] (c) any other person [   ]

183

Explain……………………………………………………………………………...

30. Do they have a medical certificate that allows them to work? Yes [   ]   No [   ]

If Yes/No explain why…………………………………………………………………..

SECTION 3: STORAGE/HANDLING OF LEFT-OVER FOODS

31. How are leftover foods handled?

No.	Type of food	Place	Cover			Leftover foods	
			Material	**Condition**	**Frequency**	**Treatment**	**Usage**
1							
2							
3							
4							
5							
6							
		i	Ii	iii	iv	V	vi

 As a consumer how do you see the ……………………

(i) Condition of place, covered/open air?

a. clean and well kept   [   ]

b. Dusty, mouldy, dirty   [   ]

c. stained with food remains   [   ]

d. wet, rusty   [   ] other specify……………………………

(ii) Material used to cover stored food:

(a) Cloth [   ] (b) plastic [   ] (c) sack [   ] (d) paper [   ] (e) other [   ] (f) none [   ]

(iii) Frequency of use of cover:

a. Often used   [   ]

b. During selling, open partly   [   ]

c. Rarely used   [   ]

(iv)What is done with left-over foods?

184

a. Discarded (not used anymore)   [   ]

b. No leftovers   [   ]

c. Used again with re-heating   [   ]

d. Used again with no re-heating   [   ]

(v) Are you aware if there are leftovers how long they are stored? Yes [   ]   No [   ]

a. 1 day   [   ]

 b. 2 days   [   ]

 c. 3 days   [   ]

 d. above 3 days   [   ]

Additional comments………………………………………………………………

SECTION 4: HANDLING OF UTENSILS

32. Type of utensils

No.	Utensils	Condition	Usage	Washing	
				Frequency	Method
1					
2					
3					
4					
5					
6					
		I	ii	Iii	iv

As a consumer, how do you see the…………………………

i. Condition of serving and preparation of utensils?

a. clean and shiny   [   ]

b. Dusty, mouldy, stained   [   ]

c. Stained with food, greasy   [   ]

d. Wet, rusty   [   ]

    other specify…………………………………………………………………………

185

ii. How are the utensils used?

a. For one food only [   ]

b. For cooked and raw food [   ]

c. For cooked and raw food but washed in between [   ]

iii. Frequency of use of cover

a. Several times per day [   ]

b. Once a day [   ]

c. 3- 4 times per week [   ]

d. 1- 2 times per week [   ]

e. Never [   ]

iv. How is the utensil washed?

a. With soap and hot water [   ]

b. With hot water [   ]

c. With soap and freshwater [   ]

d. Fresh water only [   ]

Additional comments……………………………………………………………….

33. FOOD HANDLING (Serving)

No.	Type of Food	Serving	Contact	Handling
1				
2				
3				
4				
5				
6				
		i	**ii**	**Iii**

i. Is food served with a utensil reserved for the purpose? Yes [   ]   No [   ]

If Yes/No, please explain……………………………………………………………..

ii. Does the food contact the server's hands directly?   Yes [   ]   No [   ]

186

If Yes/No, please explain……………………………………………………………

iii. Is the food held at an appropriate temperature?   Yes [   ]   No [   ]

If Yes/No, please explain……………………………………………………………

34. USE OF CLOTHS, SPONGES, BRUSHES ETC.

No.	Usage	Condition	Washing
1			
2			
3			
4			
	i	ii	Iii

i. Used for:

a. Utensils   [   ]

b. Table(s)   [   ]

c. Hands   [   ]

ii. Condition of cloths, sponges etc.

a. Clean and dry   [   ]

b. Dry but dirty or mouldy   [   ]

c. Wet and dirty   [   ]

iii. Are the cloths washed /changed?

a. 2-3 times a day or more   [   ]

b. Once a day   [   ]

c. Not washed or changed   [   ]

iv. If cloths are not used why?

Please, explain…………………………………………………………………………

35. WATER SOURCES, AVAILABILITY AND USE

1. SOURCE

a. Tap water   [   ]

187

b. Well water   [   ]

c. Water vendor   [   ] other specify…………………………………………………………

2. WATER CONTAINER

a. Shiny and clean   [   ]

b. Dirty, dusty, stained   [   ]

c. Stained with food, greasy   [   ]

d. Rusty   [   ]   other specify……………………………………..

3. Is dish washing water also used for washing foods?   Yes [   ]   No   [   ]

   If Yes/No, please explain why?..

4. How many times is the dishwater changed?

a. Never

b. Once a day

c 2-3 times a day

36. If water from a stream/river is used describe the area and other uses of the source…

   …………………………………………………………………………………………

37. Are there communal washing areas?   Yes [   ]   No [   ]

38. How often do you get water supplies………………………………………………….

39. SELLING LOCATION

WASTE DISPOSAL (Circle all that apply)

   a.   Waste disposal near to selling area   [   ]

   b.   Waste scattered around serving area   [   ]

   c.   Dirty utensils/plates etc. left to accumulate   [   ]

   d.   Proximity of river or stream   [   ]

   e.   Water Closet (WC) available   [   ]

   f.   WC unsuitable situated   [   ]

188

g. Vendor has trash can   [   ]

h. Vendor has no trash can   [   ]

i. Trash cans orderly and covered   [   ]

j. Trash can open/lids available/unavailable   [   ]

k. Animals/birds/insects present around the selling location   [   ]

40. What are some of the activities that go on at the area? ……....................................

41. PERSONAL HYGIENE (OBSERVING THE FOOD VENDOR FOR SOME TIME)

i. What are germs, bacteria and viruses? Explain……………………………………

   …………………………………………………………………………………..

ii. Are these surfaces/utensils clean or dirty?...

iii. Do they still sell food when they are ill or sick?   Yes [   ] No [   ]

If Yes/No, please explain why…………………………………………………………..

iv. Do you still serve food when your hands get infected?   Yes [   ] No [   ]

v. How often do you wash your hands when cooking and serving food?

....

vi. Do you understand what hygiene means?   Yes [   ] No [   ]

If Yes, please explain……………………………………………………………………..

vii. Do you consider hygiene before eating or buying at a food joint? Yes [   ] No [   ]

Please explain…………………………………………………………………………

viii. Have you ever received any lessons in food handling/hygiene?   Yes [   ] No [   ]

If Yes, from who and for how many times in a year?..

If No, why? Please explain…………………………………………………………………

ix. How did they acquire their cooking skill and in preparing food?..............................

   …………………………………………………………………………………..

42. Which of the following are ways of destroying germs? (Tick as many as applicable)

a. Washing vegetables in salt solution   [   ]

b. Washing vegetables in vinegar solution   [   ]

c. Washing hands frequently with soap and water   [   ]

d. Heating food thoroughly at a high temperature   [   ]

e. Putting food in the fridge.   [   ]

43. ASSESSMENT OF PERSONAL HYGIENE LEVEL OF FOOD VENDORS BY CONSUMERS

As a consumer how do you assess the personal hygiene level of a food vendor?

(1=Bad, 2=Average 3=Good 4=Very Good 5 = Excellent)

(a) The level of personal hygiene of food vendor

(b) Vendor's appreciation of hygiene

(c) Vendor's willingness to improve on sanitization and hygiene

Any other, please state it…………………………………………………………

APPENDIX 4

UNIVERSITY OF GHANA, LEGON
COLLEGE OF BASIC AND APPLIED SCIENCES
INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES (IESS)

MICROBIAL CONTAMINATION OF FOOD AND FOOD SAFETY PRACTICES
OF STREET FOOD VENDORS IN SELECTED MARKETS OF ACCRA,
TAKORADI AND SENCHI, GHANA.

QUESTIONNAIRE/INTERVIEW SCHEDULE FOR STAKE HOLDERS IN
FOOD SAFETY

INTRODUCTION

I am **FLORENCE DZIFA BANSAH** a final year PhD student of the Institute for

Environment and Sanitation Studies (IESS) of the University of Ghana. This study aims

at investigating to discover obstacles to food safety, hygienic practices and causes of

food poisoning so as to obtain relevant information which would be used to educate and

improve safe food services delivery in the study area. The research is solely for academic

purpose. I count on your cooperation to accurately respond to the questions which is vital

to this study. All response will be treated as confidential.

Thank you very much.

INSTRUCTION: Please tick [√] or write down the information where necessary in the space provided.

SECTION (1): BACKGROUND INFORMATION

1. **Age**

Age	Tick(√)
Below 18	
19-24	
25-29	
30-34	
35-39	
40-44	
45-49	
50-54	
55-59	
60	

2. **Gender (Sex)**   [   ] Female   [   ] Male

3. What sector are you employed in? MoH [   ] EPA [   ] FDA [   ]   GSA [   ]

MMDAs [   ] other, specify………………………………………………………….

4. How long have you been in this employment?...

5. What is your role/rank?...

6. What is your current station?   Accra [   ]   Takoradi [   ]   Senchi [   ]

7. How long have you been at this station?..

Section 2: KNOWLEDGE IN FOOD SAFETY

8. In your words and understanding what is food safety?..

a) What is street food?..

b) Why do people patronize street food?..

9. How would you rate the level of food poisoning in Ghana?   (i) High [   ]

(ii) Moderately high [   ] (iii) Very High [   ]   (iv) Not aware of how high or low [   ]

10. Which of these food-poisoning related symptoms are common in your work area?

Diarrhoea   [   ]   Nausea   [   ]   Fatigue [   ]   Vomiting   [   ]

Abdominal   [   ]   Headache   [   ]   Fever   [   ]   Dizziness [   ]

11. What are the most probable sources of food-poisoning cases reported in your area?

....

12. Are you involved in food safety education in your station? Yes [   ]   No [   ]

13. How do you disseminate information on food safety/food poisoning issues?

Television   [   ]   Workshops/Training [   ]

Radio   [   ]   Church/Mosque   [   ]

Newspaper   [   ]   Books/Pamphlets   [   ] other specify………………………..

14. How often do you organize training workshop for food vendors?

Monthly [   ] Bimonthly [   ] Quarterly [   ] Annually [   ] other specify……………….

15. Who are usually the targets of such workshops/programmes?....................................

16. What are the main topics/issues treated at these workshops?.....................................

17. How responsive are participants to the knowledge shared at training workshops?

   ……………………………………………………………………………………

18. What are your perceived challenges in the dissemination of information on food

safety?...

19. In your view, what needs to be done to overcome the challenges in food safety

education?...

20. Are there feedback mechanisms to evaluate the effectiveness of these training

sessions?   Yes [   ]   No   [   ] other

comments..

…………………………………………………………………………...

193

APPENDIX 5

Checklist/Availability of utensils for food vendors/consumers

Below is the situation of utensils available for food storage, preparation/services of the various markets at the study areas (Accra, Takoradi and Senchi).

NO.	FOOD UTENSIL	ITEM	QTY	ABSENT	REMARKS
1	Food safe (Glass box, mesh)/Food storage(basins)				
2	Table/chairs (sales/service)				
3	Plates/serving bowls/cutlery sets/drinking cups				
4	Food serving ladles				
5	Hand washing basins				
6	Dustbins (plastic/metal) with/without lid				
7	Napkins (paper/fabrics)				
8	Foodcover(cloth/plastic/poly sack, paper sheets)				
9	Hand gloves/headgears/caps				
10	Aprons/over coats				
11	Footwear (sleepers/socks)				
12	Water (drinking/hand washing)				
13	State of sales environment (clean/dirty/dusty/wet)				
14	Light/ventilation (aerated, dark, stuffy, bright)				

APPENDIX 6

MICROBIOLOGICAL SPECIFICATIONS

i) G S A's Microbiological Standards for Food Samples (1988)

Organism	Standard Requirements
Yeasts and Moulds	$<1.0x10^{-4}$cfu/g
Escherichia coli	*Zero cfu/g*
Total viable count	$<1.0x10^{-6}$
Staphylococcus aureus	Zero cfu/g
Salmonella species	Zero cfu/g
Bacillus cereus	$<1.0x10^{-4}$cfu/g

ii) International Commission on Microbiological Specification (1982)

Organism	Standard Specification
Yeasts and Moulds	$<1.0x10^{-4}$ cfu/g
E. coli	$<1.0x10^{-1}$ cfu/g
Total viable counts	$<1.0x10^{-6}$ cfu/g
Staphylococcus aureus	$<1.0x10^{-2}$ cfu/g
Salmonella sp.	Zero cfu/g
Bacillus cereus	$<1.0x10^{-4}$ cfu/g

APPENDIX 7

ETHICS CLEARANCE/CONSIDERATION

UNIVERSITY OF GHANA
ETHICS COMMITTEE FOR BASIC AND APPLIED SCIENCES (ECBAS)

P. O. Box LG 1195, Legon, Accra, Ghana

Ref. No: ECBAS 043/15-16

21st July, 2017

Ms. Florence Dzifa Bansah
IESS
University of Ghana
P.O. Box LG 209,
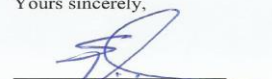Legon, Accra

Dear Ms. Florence Dzifa Bansah,

ECBAS 043/15-16: FOOD SAFETY PRACTICES OF STREET FOOD VENDORS IN SELECTED MARKETS IN ACCRA, TAKORADI AND SENCHI, GHANA

This is to inform you that the above reference study has been presented to the Ethics Committee for Basic and Applied Sciences for a full board review and the following actions taken subject to the conditions and explanation provided below:

Expiry Date:	20/07/18
On Agenda for:	Initial Submission
Date of Submission:	6/05/2016
ECBAS Action:	Approved
Reporting:	Annual

Please accept my congratulations.

Yours sincerely,

Professor Daniel Bruce Sarpong
ECBAS Chairperson

APPROVED
2 1 JUL 2017
ETHICS COMMITTEE FOR BASIC AND APPLIED SCIENCES
UNIVERSITY OF GHANA

Tel: +233-277493259   Email: ekacquaah@ug.edu.gh / ethicscbas@ug.edu.gh

196

APPENDIX 8

PHOTOGRAPHS

A:Sorting-out food samples in a working chamber at the microbiological laboratory

B: Microbial load determination after plating and incubation

C: Senchi street food vendors at night

197

D: Collecting water sample from River Volta, Senchi

E: Food samples in a working chamber yet to be sorted-out

F: Foodstuffs displayed on the ground at Makola

G: Laboratory analysis using Stuart Colony Counter

H: Poor sanitation in Accra suburb

I: Open drain discharging liquid waste from the hotel into the River Volta at Senchi