COMPLIANCE TO FOOD SAFETY MANAGEMENT SYSTEMS FOR FRUITS AND VEGETABLE SALADS IN FINE DINING HOTELS IN NAIROBI COUNTY, KENYA

MERAB AWINO ANNETTE
A56/37959/2020

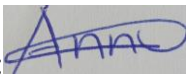
A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN FOOD SAFETY AND QUALITY

DEPARTMENT OF FOOD SCIENCE, NUTRITION, AND TECHNOLOGY
FACULTY OF AGRICULTURE
UNIVERSITY OF NAIROBI

2023

DECLARATION

I, MERAB AWINO ANNETTE, declare that this dissertation is my original work and has not been submitted to award a degree in any other University.

Signature:  Date:02/10/2023

This research project has been submitted with our approval as university supervisors:

Signature  Date: 2/10/2023

Dr. Lucy Njue

Department of Food Science Nutrition and Technology

University of Nairobi

Signature……  …… Date: 3/10/2023

Dr. Dasel Wambua Mulwa Kaindi

Department of Food Science Nutrition and Technology

University of Nairobi

UNIVERSITY OF NAIROBI

Name of Student**: MERAB AWINO ANNETTE**

Registration Number**: A56/37959/2020**

College: **AGRICULTURE AND VETERINARY SCIENCES**

Faculty/School/Institute**: AGRICULTURE**

Department**: FOOD SCIENCE, NUTRITION, AND TECHNOLOGY**

Course Name: **FOOD SAFETY AND QUALITY**

Title of the work: **COMPLIANCE TO FOOD SAFETY MANAGEMENT SYSTEMS FOR FRUITS AND VEGETABLE SALADS IN FINE DINING HOTELS IN NAIROBI COUNTY, KENYA**

Plagiarism Declaration Form for Students

DECLARATION

1. I understand what Plagiarism is, and I am aware of the University's policy in this regard

2. I declare that this research proposal is my original work and has not been submitted elsewhere for examination, award of a degree, or publication. Where other people's work or my work has been used, this has properly been acknowledged and referenced per the University of Nairobi's requirements.

3. I have not sought or used the services of any professional agencies to produce this work.

4. I have not allowed, and shall not allow anyone to copy my work to pass it off as their work

5. I understand that any false claim regarding this work shall result in disciplinary action under University Plagiarism Policy.

Signature:  Date: 02-10-2023

Dedication

I devote this work to my mother Racheal Okuku, grandmother Anne Okuku, my uncles and my sister Ruphens for their unconditional support, prayers and encouragement throughout the entire period of my study to complete this scholarly work.

Acknowledgements

Am grateful to the Almighty God for guidance, wisdom, energy, health and academic intellect He bestowed upon me during study and research project which has enabled me to accomplish this work. I offer my profound gratitude to my supervisors Dr. Lucy Njue and Dr. Dasel Mulwa Kaindi for their productive suggestions, right critics and guidance that has helped me stay on course to finish this scholarly work. Last but very importantly to my lab technician Edith Cherotich for her technical assistance, family, friends, and course mates for their support and encouragement, God bless you all.

LIST OF ABBREVIATIONS AND ACRONYMS

AFIPEK: Kenya Fish Processors and Exporters Associations

BRC-: British Retail Consortium

CAC: Codex Alimentarius Commission

CCP: Critical Control Point

CDC: Centre for Disease Control

CL: Critical Limit

DPH: Department of Public Health

FAO: Food and Agriculture Organization

FBD: Food-borne Diseases

FDA: Food and Drug Administration

FPEAK: Fresh Produce Exporters Associations of Kenya

FSMS: Food Safety Management System

GMP: Good Manufacturing Practices

HACCP: Hazard Analysis Critical Control Point

ICMSF: International Commission on Microbiological Specifications for Foods

KAM: Kenya Association of Manufacturers

KARI: Kenya Agricultural Research Institute

KEBS: Kenya Bureau of Standards

KOFA: Kenya Organic Farmers Association

MOH: Ministry of Health

NACMCF: National Advisory Committee on Microbiological Criteria for Foods

NASA: National Aeronautics and Space Administration

POA: Plan of Action

SGS: Société Générale De Surveillance

UK: United Kingdom

USA: United States of America

WHO: World Health Organization

FIFO: First in First Out

OPERATIONAL DEFINITION OF TERMS

Critical control point (CCP): It is an operation that can implement controls and is required to bring down potential risks to food to at an agreed level.

Control point: any point where physical, chemical, or biological variables can be manipulated.

The critical limit: Point that a chemical, physical, biological agent should be managed to avoid, remove, or decrease the agent to an acceptable standard.

Fine dining hotel is a type of hotel that offers a fancy setting and service with unique and expensive menu options and accommodation.

Food: Any element purposed for intake by human-being, whether semi-processed, processed, or raw (Codex Alimentarius 1995)

Food Handler: Anybody who handles food, whether it's packaged or unpackaged, or the utensils, equipment, or materials utilized in the service or preparation of food.

Food-borne Hazards: Harmful contaminants that are either biological, chemical, or physical in nature.

Food-borne Diseases: Physicochemical or biological factors in food that are the root cause of many food-borne illnesses.

Food Hygiene: all that should be in place at each phase of the food chain for food safety and appropriateness to be guaranteed.

Food Safety: certainty that when food is produced and ingested according to its desired use, it would not affect the consumer.

Food safety management system: a procedural strategy of regulating hazards associated to food safety in a food premise procedure to facilitate the safety of foods.

Hazard: Food containing biological, chemical, or physical agents harmful to one's health.

HACCP: A system for establishing, examining, and controlling food safety hazards.

Personal Hygiene: procedures like washing hands regularly using water and soap and keeping clean clothing and the rest of one's body on a regular basis are examples of individual protective measures that help keep people healthy and help limit the spread of infectious diseases, especially those that are spread through direct contact.

Table of Contents

DECLARATION i

Plagiarism Declaration Form for Students ii

DECLARATION ii

Dedication iii

Acknowledgements iv

LIST OF ABBREVIATIONS AND ACRONYMS v

OPERATIONAL DEFINITION OF TERMS vi

Table of Contents vii

List of Tables xiii

List of Figures xiv

General Abstract xv

CHAPTER ONE: INTRODUCTION 1

1.1 Background of the Study 1

1.2. Statement of the Problem 2

1.3. Justification of the Study 3

1.4. Aims and Purpose of the Study 3

1.4.1. Aim of the Study 3

1.4.2. Purpose of the Study 3

1.5. Objectives of the Study 4

1.5.1 General Objective 4

1.5.2 Specific Objectives 4

1.6 Research Hypothesis 4

1.7. Assumptions of the Study 4

1.8 Limitations of the Study 4

1.9. Risks and Potential Adverse Effects of the Study 5

1.10 Scope and Delimitation of the Study 5
CHAPTER TWO: LITERATURE REVIEW 6
2.0 Introduction .....**Error! Bookmark not defined.**
2.1 General Overview of Hospitality Sector 6
2.2 History and General Overview of Compliance to Food Safety Management systems and Hygiene Requirements 6
2.3 Hygiene Requirements for Hotels 7
2.3.1 Use of Disposable Gloves 7
2.4. Food Borne Diseases 7
2.5. Food safety in comparison to food spoilage 9
2.6 Microbial Quality of Food 9
2.6.1 *Staphylococcus aureus* 11
2.6.2 *Escherichia coli* 12
2.7 Food Standards Applied in Nairobi 13
2.8 Hazard Analysis and Critical Control Point (HCCP) 13
2.8.1 The Origin of HACCP 13
2.8.2. HACCP Formation and Acceptance 14
2.8.3. The use of HACCP by Government institutions 16
2.8.4. The Seven Principles of Hazard Analysis Critical Control Point (HACCP) 17
2.8.5 Food Handler's Knowledge on Hazard Analysis Critical Control Point (HACCP) 18
2.9. Kenya Bureau of Standard (KEBS) 18
2.10. County Government Permits 18
2.11. Food Contamination 19
2.12 Food Safety Knowledge 19
2.13. Food hygiene handler's practices 20

2.14 Training 21
2.15. Confidence in the Safety of Food Served by Hotels 21
2.16 Food safety management in Kenya 22
2.17 Review on research methodologies 22
2.18 Gaps in knowledge 23
2.19 Theoretical and conceptual framework 23
CHAPTER THREE: 25
ASSESMENT OF SOCIO-DEMOGRAPHIC CHARACTERISTICS OF FOOD HANDLERS AND COMPLIANCE TO FOOD SAFETY MANAGEMENT SYSTEMS AND HYGIENE REQUIREMENTS IN FINE DINING HOTELS IN NAIROBI COUNTY 25
3.1 Abstract 25
3.2. Introduction 26
3.3. Materials and Methods 27
3.3.1 Study Site 27
3.3.2 Research Design 28
3.3.3 Study Population 28
3.3.4 Sample Size 28
3.3.5 Sampling Procedure 29
3.3.6 Data Collection 29
3.3.7 Data Analysis 29
3.4 Results 30
3.5 Discussion 32
3.5.1 Knowledge on Food management System 32
3.5.2 Importance of Food Hygiene Training 33
3.5. 3 Understanding Food Hygiene Measures 33

3.5.4 Age, Job Position, Years of Service and Education Level of Food Handlers 34
3.6. Conclusion 34
3.7 Recommendations .....**Error! Bookmark not defined.**
CHAPTER 4: 35
ASSESSMENT OF THE LEVEL OF KNOWLEDGE ON HACCP AND PRACTICES IN PREPARING FRUIT AND VEGETABLE DISHES AMONGST FOOD HANDLERS IN FINE DINING HOTELS IN NAIROBI COUNTY 35
4.1. Abstract 35
4.2 Introduction 36
4.3. Materials and Methods 36
4.3.1 Study Site 36
4.3.2 Research Design 36
4.3.3 Study Setting 36
4.3.4 Study Population 37
4.3.5 Sample Size 37
4.3.6 Sampling Procedure 37
4.3.7 Data Collection 37
4.3.8 Data Analysis 37
4.4 Results 38
4.4.1 Knowledge on HACCP 38
4.4.2 The Inferential Analysis 39
4.5 Discussion 40
4.5.1 Awareness of HACCP System among Food Handlers 40
4.5.2 Food Hygiene Practices among Food Handlers 40
4.5.3 Methods used to Hold Cooked Food 41
4.6 Conclusion 41

4.7 Recommendations .....**Error! Bookmark not defined.**
CHAPTER FIVE: 42
MICROBIAL SAFETY OF FRUITS AND VEGETABLE SALADS IN FINE DINING HOTELS IN NAIROBI COUNTY 42
5.1 Abstract 42
5.2 Introduction 42
5.3 Materials and Methods 44
5.3.1 Study Site 44
5.3.2 Research Design 44
5.3.3 Study Setting 45
5.3.4 Study Population 45
5.3.5 Sample Size 45
5.3.6 Sampling procedure 45
5.3.7 Data collection 45
5.3.8 Analytical Methods 45
5.4 Data Analysis 47
5.5 Results 47
5.5.1 Microbial load isolated from fruits samples 47
5.5.2 Microbial quantity isolated from vegetable samples 48
5.5.3 Microbial quality of fruits and vegetables 50
5.6.2 Microbes isolated from vegetable samples 53
5.7 Conclusion 54
5.8 Recommendations .....**Error! Bookmark not defined.**
CHAPTER SIX: 56
GENERAL DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS 56
6.1 Discussions 56

6.2 Conclusions 58

6.3 Recommendations 59

REFERENCES 60

Appendix A: Data collection tools 76

APPENDIX B: FOOD HANDLERS QUESTIONNAIRE 77

PART 1 DEMOGRAPHIC INFORMATION 77

APPENDIX C: FOOD AND BEVERAGE MANAGER QUESTIONNAIRE 87

2. PRACTICES 88

Appendix D: PARTICIPANT CONSENT FORM 89

Appendix E: HOTEL RATINGS IN NAIROBI (WESTLANDS AND CENTRAL BUSINESS DISTRICT) 91

Appendix F: The Descriptive Analysis on HACCP 92

List of Tables

Table 2.1: National Public Health Laboratories, (Gok,2005) 8

Table 3.1: Summary of findings on socio-demographic characteristics of respondents. 30

Table 3.2: HACCP training by duration of service in the industry..... 31

Table 3.3: Knowledge on HACCP system by year of service and gender..... 31

Table 4.1: Association between knowledge on HACCP among hotel personnel 39

Table 5.1: Microbial load isolated from fruit salad..... 48

Table 5.2: Microbial load isolated from vegetable salad 50

Table 5.3: Microbiological criteria for fruits and vegetables (Log10)..... 51

List of Figures

Figure 2.1: Projected risk of food related illness..... 9

Figure 2.2: Impact of different temperature on food products..... 11

Figure 2.3: The major events that led to the formation of HACCP 15

Figure 2.4: Food safety management system deployment timeline 16

Figure 2.5: Hotel staff get professional training in catering (Lin & Hsu, 2017)..... 21

Figure 2.6: Conceptual framework..... 24

Figure 3.1: Map of Nairobi County..... 28

Figure 4.1: Knowledge on HACCP..... 38

Figure 5.1: Distribution of microbial organisms: (A) E. coli (B) Staphylococcus aureus, (C) Total viable count..... 51

General Abstract

Workers in the food industry perform a key role in preventing food poisoning and ensuring food safety at every phase of the food chain. This research was set out to examine compliance to food safety management systems with regard to fruits and vegetable salads in fine dining hotels in Nairobi County. A cross sectional approach was used to assess food handlers' HACCP knowledge and practice via semi structured questionnaires with a sample of 201 respondents selected at random. Salad samples consisting of mixed fruits and vegetables were also collected from the hotels for microbiological quality investigation using serial dilutions. The survey data was subjected to quantitative analysis using SPSS with results presented in the form of mean ranks for constant variables and frequencies and percentages for categorical groups. Testing for correlations or the Chi-squared test of independence between categorical variables was performed. The bulk of the respondents in this survey were between the ages of 31 and 40, with more males than females working as food handlers (59% and 41% respectively). The majority (96%) of respondents reported to be acquainted with the HACCP (Hazard Analysis and Critical Control Point) system. Additionally, most food handlers had college or university education ($P>0.05$), notwithstanding with a positive correlation (r=0.170) between age and fulfilling food safety management system and hygiene guidelines. A significant relationship was further established between HACCP knowledge, and conformity with food safety management systems & hygiene regulations ($P<0.05$). The hotel staff's adherence with food safety management systems and hygiene requirements increased with their level of education (r=0.034). Bacterial *E. coli* and *S. aureus* were discovered in the fruit samples tested for microbiological analysis (53.55%, and 52.4% respectively). Albeit the amount of contamination varied depending on the source of the samples. The research concludes that the level of education, job position, years of expertise, and the overall standard of the hotel in which food handlers operate all have a role in their degree of compliance to food safety management systems and cleaning standards. Whereas the microbial counts varied, fruits and vegetables from different hotels, of diverse quality, tested positive for microbial contamination. Therefore, in order to prevent foodborne infections, it is suggested that food workers get appropriate training on food hygiene, safety, and HACCP.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

The welfare of people and economies worldwide depends on safeguarding their health via the production of healthy food. People frequently report nausea, vomiting, diarrhea, and stomach pain after consuming tainted food (Murungi *et al.,* 2021). These symptoms are brought about by the ingestion of harmful chemicals and heavy metals, as well as bacteria, viruses, fungus, parasites, and other microbes. Most scientists believe that germs are the primary cause of food poisoning. Besides *Salmonella and E. coli, Shigella spp., E. coli, Bacillus cereus*, and *Escherichia coli* are other potential contributors of food poisoning. Food contamination may be caused by a variety of organisms, not only *Salmonella and Campylobacter* (Bunei *et al.,* 2021). As per the World Health Organization, yearly, food-borne illnesses kill 4.2 million people. Children under the age of five years are estimated to account for one-third of all victims of food-borne related mortality. In 2008, the World Health Organization indicated that diarrheal diseases were responsible for 550 million diseases and 230,000 fatalities worldwide each year (Kinyingi, 2020) with consumption of tainted food being the leading cause of diarrhea illness. Contaminated food and water are a key challenge in Kenya since it is responsible for an estimated 70% of cases of diarrhea.

Workers in the food industry have a key role to play in preventing the spread of illness at each phase of the food chain, from production, its distribution, to final human ingestion. All workers in the food business should have a basic understanding of how to prevent and manage food poisoning (Githigia *et al.,* 2021). This is why it is so crucial to clean your hands well prior, and after handling food to avoid spreading germs. Mwangi *et al.* (2018) found that almost all incidents of food poisoning may be attributed to carelessness on the part of food sector personnel. Cross-contamination between raw and processed foods may occur when personnel in the food business fail to properly prepare and store food. Workers in the food service industry who have been ill can still transfer germs even after they are fully recovered from their symptoms.

Diseases transmitted by contaminated food have been linked to things like reheated chicken, unclean storage conditions, and carelessness in the kitchen. The spread of disease and damage caused by tainted food may be prevented by adhering to proper food handling procedures. According to studies by Enz (2014), sanitizing and properly handling food is necessary for averting the propagation of bacteria and illnesses. Despite

the importance placed on food safety in the restaurant business, many establishments serving local cuisine do not adhere to basic sanitation standards.

Systematized approaches to ensuring that the food produced and distributed to customers is free of harmful contaminants are known as food safety management systems (FSMS) (Wandolo & Mutisya, 2018). The foundation of the FSMS is a series of risk analyses and critical control points. The Codex Alimentarius Commission (CAC), an organization whose mission is to guarantee the safety of the globe's food distribution, has officially recognized the HACCP system. HACCP greatly decreases the possibility of customers becoming sick as a consequence of taking contaminated food by keeping a close eye on the whole food process.

Hazard Analysis and Critical Control Point (HACCP) is one such food safety system that must be in place to guarantee that no contamination occurs in the food supply chain between the farm and the table. If HACCP is applied by food manufacturers, it may help decrease the incidence of food-related illness. The initial documented usage of the method was in 1971 in the United States (Mugure, 2021). The purpose of these rules is to provide a reliable procedure for detecting and eliminating potential hazards throughout the process of food production. Hazard analysis, critical control point (CCP) identification, critical limit (CL) setting, process monitoring, corrective action (CA) creation, system performance assessment, and documentation strategy development are all part of the HACCP methodology.

1.2. Statement of the Problem

Customers at Fine Dining Hotels often represent a varied cross-section of society, with various cultural, ethnic, and socioeconomic dining tastes. . Reports of pathogenic contamination of fruits and vegetables has been a public health concern in the recent past with microbial assessments showing high levels of contamination of mangoes, kales, and tomatoes with anaerobic bacteria (Kunyanga *et al*., 2018). Some of these contaminants include *Staphylococcus aureus, Klebsiella spp*, Actinomycetes, and *Escherichia coli*. Implementation of food safety standards at all stages of the food value chain is important to meeting microbial safety demands Food poisoning occurs in food businesses often, indicating either that these platforms, and consumers are unaware of the procedures involved or that they are not adhering to them (Dione *et al.,* 2021).

Although several studies in Kenya have shown that food workers are aware of food safety and personal cleanliness, WHO states that in most cases, documented food-borne

infections originate from foodservice outlets, when food handlers participate in unsanitary and poor food preparation methods.

According to the Fact Sheet (2017) published by the World Health Organization, food-borne disease outbreaks have a significant economic and social effect on both individuals and healthcare systems. The expense of treatment, together with the opportunity cost of diminished yield, may add up quickly. In order to prevent hotels and restaurants from endangering their customers' health, FAO and WHO suggest a series of legislative, and regulatory measures. Coupled with the lack of a functional monitoring framework to oversee implementation of FSMS in fine dining restaurants, and policies governing food safety, the risk of food-borne illnesses increase with the ever-rising number of hotels in Nairobi city.

1.3. Justification of the Study

The prevalence of FBD may be reduced by investigating the hotels' adherence to hygiene standards and food safety management programs. The findings of this research will be used by policymakers, and other stakeholders to draft more stringent regulations for food establishments nationwide (Obino, 2021) as well as aiding the Ministry of Public Health and Sanitation's Department of Public Health (DPH). The study's findings will also assist top-tier hotels, as they recognized that it is their job to protect public health via their operations. Restaurants will be able to attract and retain more consumers as a result of deeper understanding of the elements influencing their purchase choices. Information from the current findings will allow food safety experts, and the relevant institutions to explain how various hotel suppliers are engaged in the implementation of food safety policies, while continuously following up on new food safety trends in the hotel industry.

1.4. Aims and Purpose of the Study

1.4.1. Aim of the Study

To contribute towards creating awareness on safety of foods from fine dining hotels in Nairobi County, Kenya.

1.4.2. Purpose of the Study

To come up with data that policymakers and other stakeholders will use to formulate policies and guidelines required to prevent food contamination or food-borne illness outbreaks.

1.5. Objectives of the Study

1.5.1 General Objective

To assess compliance to food safety management systems for fruits and vegetable salads in fine dining hotels in Nairobi County, Kenya.

1.5.2 Specific Objectives

i. To evaluate the socio-demographic features of food handlers in fine dining hotels in Nairobi County with respect to compliance with food safety management systems and cleanliness regulation standards.
ii. To evaluate the level of knowledge on HACCP and practices in preparing fruit and vegetable salads amongst food handlers in fine dining hotels in Nairobi County.
iii. To evaluate microbial safety of fruits and vegetable salads in fine dining hotels in Nairobi County.

1.6 Research Hypothesis

i. There is no association between the sociodemographic characteristics of food handlers in fine dining hotels to their level of compliance to food safety management systems, and cleanliness regulation standards.
ii. A good percentage of food handlers in fine dining hotels do not have knowledge of HACCP, and practices in preparing fruit and vegetable salads.
iii. There are no TVC, *Staphylococcus aureus*, and *E. coli* in fruit and vegetable salads at the serving level.

1.7. Assumptions of the Study

In order to carry out my research, I expect that the hotels I have picked will cooperate and that I will be able to get permission from the appropriate authorities. All the hotels in the study are also considered to have food safety management systems and hygiene in place.

1.8 Limitations of the Study

Due to the recent movement in people's eating patterns toward fruits and vegetables since they are perceived as healthy, the key disadvantage of this study is that it solely analyzed fruit and vegetable meals in the chosen hotels. The findings of this study do not provide any confidence that the food served at these restaurants is safe to consume, even

if they comply with food safety management systems and sanitary criteria. One potential problem with this study is that participants may lie on the questionnaires.

1.9. Risks and Potential Adverse Effects of the Study

The study participants may be subjected to relatively long durations of questioning that may be inconvenient to their working hours. Additionally, information shared in the course of this research may be subjective, involving giving hygienic information about their workstation, leading to possible termination of their jobs by their employers.

1.10 Scope and Delimitation of the Study

Requests for the relevant permission from authorities in the food businesses were made prior to the survey. Moreover, time-factor was taken into consideration before the assumption of the research to prevent clashing schedules with the study respondents.

CHAPTER TWO: LITERATURE REVIEW

2.1 General Overview of Hospitality Sector

Each high-end restaurant in Nairobi is distinct, yet they all have a few commonalities. Every Fine-Dining Hotel strives to provide an extraordinary dining experience via meticulous attention to detail, flawless execution, and top-notch service. While Nairobi's Fine Dining Hotels have grown into a diverse array of cuisines and themes, many components of the high-end experience remain the same (Oyoo, 2016). The Fine Dining experience is all about the finer details. Music, lighting, and artwork on the walls are only the beginning. Many high-end restaurants in Nairobi are going so far as to create their own stoneware to match the look and taste of their meals.

In Nairobi's Fine Dining Hotels, guests spend a lot more than just the cuisine. Guests look for something completely different. Holding chairs for ladies, guiding guests to the toilet, crumbs between courses and changing linen napkins are all common services of Fine Dining Hotels in Nairobi Silverware and wine glasses are never reused, and new wine is always served in a fresh glass. Everything must be in order at all times in Fine Dining Hotels.

2.2 History and General Overview of Compliance to Food Safety Management systems and Hygiene Requirements

Following the 1993 *Escherichia coli* eruption at Jack-in-the-Box, the USA began looking for a regulatory food safety structure that would be more efficient than before (Paldino & Herath, 2020). In the United Kingdom there was eruption of Bovine Spongiform Encephalopathy epidemic (BSE) during the same period which weakened public confidence in Western Europe’s FSMS. As a consequence, there has been a growing interest in the HACCP method execution in the world. Whilst HACCP principles were formulated several decades earlier, in the 1990s there were seven principles developed by the NACMCF, which were largely adapted by Codex Alimentarius, that concentrated on implementing the method across developed production systems. The number of government and private organizations that need HACCP enforcement increased during this time.

HACCP was projected to minimize food related disease by twenty percent in the US alone during the first seven years of its introduction (King *et al*., 2017). For the purpose of enhancing customer confidence in systems of food safety management, many retailers of food and food service purchasers created additional unique demands suppliers had to

comply with in selling their goods during the HACCP adoption procedure (Jaffee *et al*., 2018). This led to the development, in the first instance in Europe and then implemented in the USA and worldwide, of the Global Food Safety Program structure for the assessment of further voluntary management requirements of food safety in response to desired approaches to reducing foodborne diseases, minimizing redundancies and helping us to achieve global continuity in food safety (Pearson *et al*., 2019). Even if advanced economies now largely follow the fundamental HACCP standards on safety of food, concepts such as traceability, food robbery susceptibility and deliberate adulteration have recently been discussed to progressively improve the safety of food (Prinsen *et al.,* 2020). Developing countries, on the other hand, tend to have varying degrees of success in integrating existing food safety systems and many still suffer from high foodborne disease rates (Li & Guldenmund, 2018). The HACCP framework at its most basic level is an early detection approach to protecting food products. This device can prevent biological, physical and chemical hazards, minimize or eliminate them (Kotsanopoulos & Arvanitoyannis, 2017). In addition to hazard control, the framework requires document management to demonstrate compliance with HACCP.

2.3 Hygiene Requirements for Hotels

2.3.1 Use of Disposable Gloves

For those handling food, particularly raw foods, disposable gloves are recommended. However, since wearing gloves enabled bacteria to accumulate up on top of the gloves and on the hands, handwashing is essential afterward to prevent food contamination (Nyalo, 2020). When using disposable gloves, the following precautions and procedures must be followed:

Wash hands thoroughly in between transitions and the point where gloves are discarded, and gloves should be adjusted on a regular basis. Besides, gloves are supposed to be disposed after conducting non-food-associated tasks like closing or opening doors by use of hands and ensuring bins are emptied. Moreover, appropriate sanitary services must be provided, including warm running water and soap for washing hands. Hand sanitizers should be available, but not as a substitute for handwashing.

2.4. Food Borne Diseases

Acute diseases caused by food have a brief incubation time, manifest themselves via gastrointestinal signs such diarrhea, vomiting, and abdominal cramps, and are triggered by the most recent ingestion of hazardous food. Sometimes issues with the digestive system might be linked to neurological and other symptoms. Bacteria, viruses, fungi,

chemicals, heavy metals, poisonous plants, and animals are only some of the aetiological agents that have been linked to the onset of many illnesses (Oka, 2011). Bacteria are the leading cause of food poisoning. Multiple species of bacteria, including *Salmonella*, *Bacillus cereus*, *Staphylococcus aureus*, *Clostridium botulinum*, *Clostridium pefringens*, *Escherichia coli*, and *Shigella*, are at play (Ndaramu, 2020). Outbreaks have been established from diverse areas of the globe, indicating that these diseases are still a concern (Chlebicz & Śliżewska, 2018). Several other food poisoning agents have gained little coverage, despite frequent media accounts of foodborne illness or deaths as a result of eating tainted foods. Raw vegetables and fruits are susceptible to viruses and bacteria that cause conditions such as gastroenteritis, and hepatitis A. This is attributed to the microorganisms' long survival time (Seymour & Appleton, 2001). Meat that has not been inspected and certain food crops like cassava. This suggests the existence of a public health threat that requires to be examined (Tack *et al*., 2019). Aflatoxin contamination of cereals, pulses, nuts, and other foods is a significant source of mycotoxin food poisoning in Kenya. There exist records of deaths related to the ingestion of infected cereals containing high concentrations of aflatoxin B and B1. Aflatoxin B, B1, GI, and G were found in high concentrations in cereals, pulses, and nuts purposed for human intake (Marder *et al*., 2019). This research looked into the frequency of foodborne illness in Kenya, as well as the attempts made to combat them.

Table 2.1 shows the types of bacteria, outbreak, cases, and death as reported by the National Public Health Laboratories.

Table 2.1: National Public Health Laboratories, (Gok,2005)

Type of bacteria	**Outbreak**	**Cases**	**Death**
Bacillus cereus	16	261	0
Brucella spp	2	38	1
*Clostridium botulinum**	74	140	10
*Escherichia coli**	7	640	4
*Salmonella spp**	342	31245	39
*Staphylococcus aureus**	47	3,181	0
*Cholera**	450	4,568	258

Note: * = highly usual causes of bacterial food poisoning Source: National Public Health Laboratories (Gok, 2005).

Figure 2.1 shows the projected risks of foodborne related illness in Sub Saharan Africa as reported by Disability adjusted life years (DALYs) and it shows that diarrheal disease

agents such *Escherichia coli* are the most by 71%. Helminths come in second, preceded by intrusive infectious disease agents, and then chemicals and poisons, which make up just 2%.

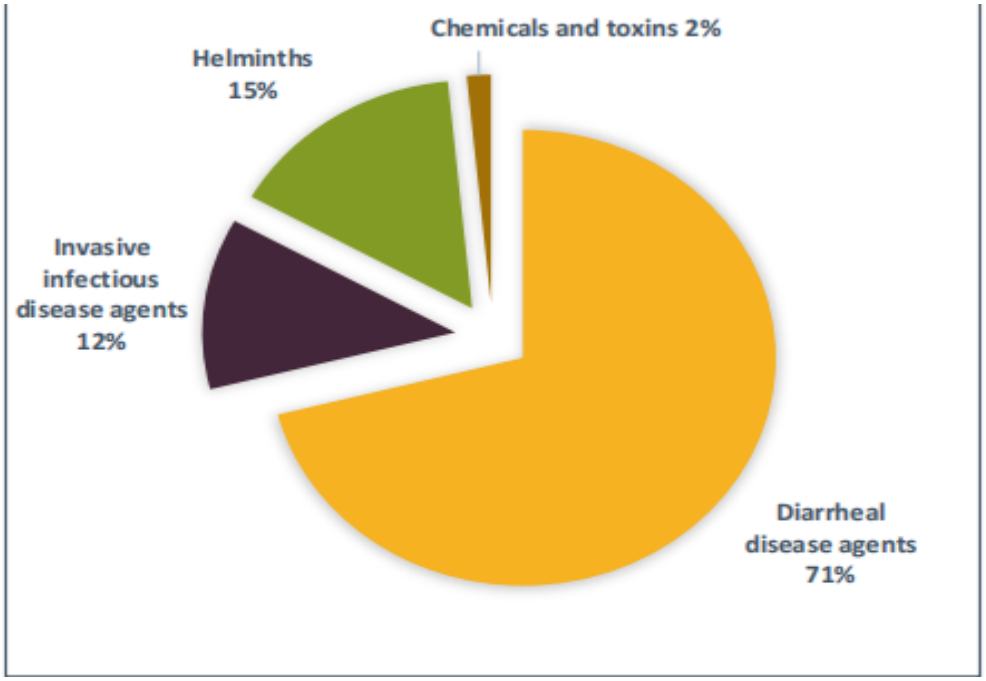


Figure 2.1: Projected risk of food related illness: Source: Rawat, 2015.

2.5. Food safety in comparison to food spoilage

When food spoils, its flavor, texture, and appearance change in ways that are no longer acceptable or safe for people to consume. Foods can become spoilt by microorganisms such as bacteria and physical damage due to insects (Rawat, 2015). There are two categories of foodborne illnesses i.e., food intoxication and foodborne infection (Choyam *et al.*, 2019). Food intoxication results due to consumption of food that contains preformed exotoxins (enterotoxins) for example the *staphylococcal* food poisoning (Nguyen *et al*., 2019). Illnesses caused by ingesting foods and water tainted with enteropathogenic bacteria are known as foodborne infections (Odeyemi *et al.*, 2020).

2.6 Microbial Quality of Food

To keep food safe for customers, microbiological quality control measures are required at every stage of the food manufacturing process. It is very uncommon for traditional microbiological procedures in food to include enrichment and isolation on solid medium, followed by biochemical or serological identification (Dinges *et al.*, 2020). As

a result, they are tedious, time-consuming, and in some cases, unreliable. Since foodborne pathogen monitoring, characterization and counting have become more crucial in the food business, it is essential to create and optimize new alternatives for these tasks in food microbiology. Temperature monitoring, visual examination, and supplier selection are all ways to ensure the raw material's microbiological integrity. Figure 2.2 shows the impact of different temperatures on food products.

2.6.1 Microbial quality of fruits and vegetables

While fruits and vegetables are a good source of essential nutrients, they are susceptible to harboring harmful micro-organisms. The exposure of fruits, and vegetables to microbial contaminants is associated with their exposure to dust, soil, water, and handling practices during harvesting (Eni *et al.*, 2010). Most of these produces are in plenty especially during the rainy seasons, calling for the need of measures to protect their microbial as well as their nutritional quality. Reports of pathogenic contamination of fruits and vegetables has been a public health concern in the recent past with microbial assessments showing high levels of contamination of mangoes, kales, and tomatoes with anaerobic bacteria (Kunyanga *et al*., 2018). Some of these contaminants include *Staphylococcus aureus*, *Klebsiella spp*, Actinomycetes, and *Escherichia coli*. Implementation of food safety standards at all stages of the food value chain is important to meeting microbial safety demands. Corrective measures need to be put in place from good agricultural practices, cascaded up to the food supply chain.

Fruits and vegetables consumed raw have an instant impact on their health. Salads from the cold section of hotels, and restaurants are commonly served in both formal, and informal food service sectors. Research has shown significant bacteriological potency of these salads which are commonly referred to as *Kachumbari* (Mbae *et al.*, 2018). Proper washing of fruits, and vegetables combined with investment in knowledge intensity of food service personnel on sanitary practices. In addition, to help public health officials execute food safety measures, a study of the Hazard Analysis and Critical Control Points Principles is necessary to pinpoint the source of microbial contamination in the salads.

Impact of different Temperature on Foods Products

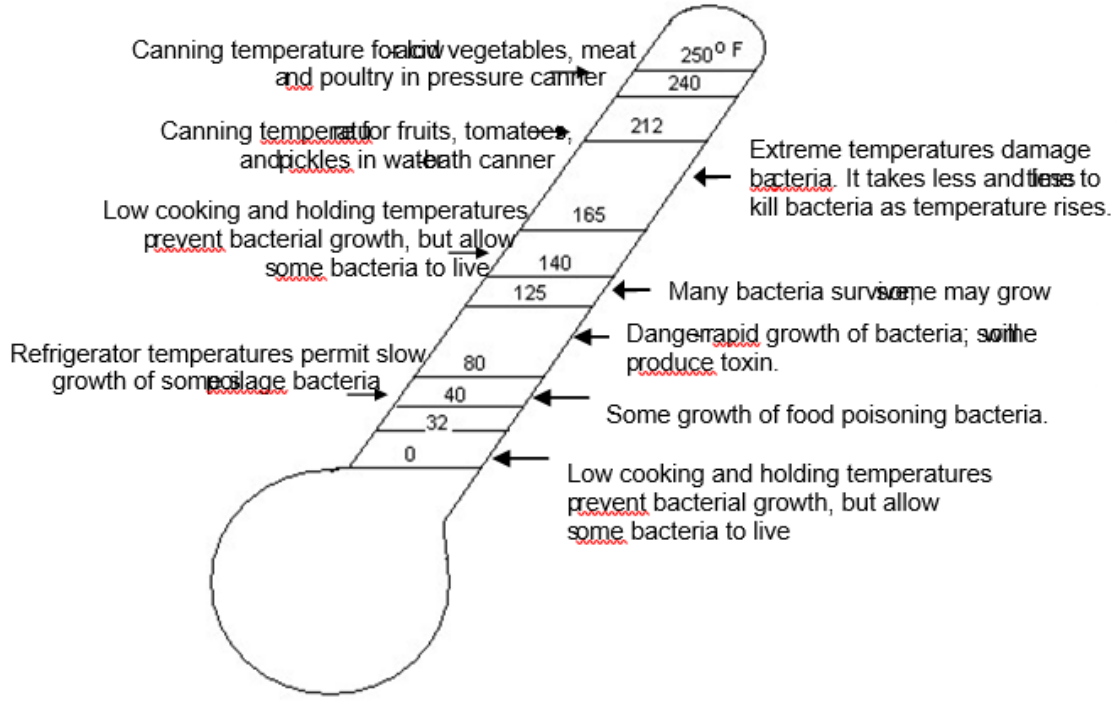


Figure 2.2: Impact of different temperature on food products

Source: Mildred, M. & Mary (2019)

2.6.1 Staphylococcus aureus

In terms of bacterial classification, *Staphylococcus aureus* belongs to the Gram-positive, cocci-forming group. Food poisoning is often brought on by this common food contamination. Possibly, it can generate heat-resistant enterotoxins (Bergdoll, 2017). Since the pathogen may develop biofilms, it is more difficult to completely remove it from a polluted environment. Despite cooking at temperatures as high as 121 degrees Fahrenheit, *Staphylococcus aureus* enterotoxins are responsible for the vast majority of instances of *staphylococcal* food poisoning (Foster & Geoghegan, 2015). The failure to keep food at an appropriate temperature [140°F (60°C)] or below [40°F (4°C)] is the leading cause of food poisoning.

Nausea, vomiting, retching, stomach cramps, and diarrhea are all symptoms of staph food poisoning (Moreillon *et al.*, 2018). Dehydration, headaches, muscular cramps, and alterations in blood pressure and pulse rate may develop in more severe instances. Symptoms usually appear soon (Taylor & Unakal, 2021). The severity of your symptoms will be proportional to your susceptibility to the poison, the quantity of the toxin you ingested, and the state of your health. The average duration of this ailment is

two days. Extreme situations, however, may need even more time than three days for full recovery.

2.6.2 Escherichia coli

It is a Gram-negative, facultative anaerobe that has a rod form. As it turns out, several varieties of *E. coli* may be consumed without fear. Shiga toxin-producing *E. coli* (STEC) is one *E. coli* strain that may result in a life-threatening food poisoning. Diseases may be transmitted to people by the use of potentially poisonous foods such as meat that has not been cooked properly, unpasteurized milk, and raw vegetables and sprouts (Kaper et al., 2019). Because of their similarity to *Shigella dysenteriae* toxins, STEC toxins are frequently referred to as "Shika-toxins." While 37 degrees centigrade is best for the growth of STEC, the temperature range in which it may thrive is 7 to 50 degrees centigrade (Meng *et al.,* 2020). For development to occur, STEC needs a food with a pH of 4.4 and a water concentration of 0.95 or below. Evidence suggests that STEC may be killed by heating food to a temperature of 70 degrees Celsius or above. STEC serotypes other than *E. coli* O157:H7 have been associated with many incidents and epidemics.

Among the most typical signs of a STEC infection are abdominal discomfort and bloody stool. Vomiting and a high temperature may also occur. The average incubation period is 3–4 days (Gomes *et al.,* 2016), however it may be as short as a couple of hours or as lengthy as a few weeks. Rarely, especially in the young and the elderly, this infection may cause a disease known as haemolytic uraemic syndrome (HUS), which often resolves on its own within 10 days. Acute renal failure, hemolytic anemia, and thrombocytopenia are the hallmarks of Hemolytic uremic syndrome.

Those infected with STEC have a 10% chance of developing HUS, with a 3-5% mortality risk. Children less than five years old who have acute renal failure have HUS more often than any other known cause (Wang *et al.,* 2020). Half of individuals who survive HUS acquire mild to severe chronic renal sequelae, and around a quarter of those with HUS may experience neurological disorders (such as seizures, strokes, and comas).

Bacteria are established in air, water, soil and food. Some of the requirements for the growth of bacteria are moisture, food, time and favourable temperature which enables them to grow to a point the cause illness. The danger zones are between 40^0F and 140^0F where they grow rapidly.

2.7 Food Standards Applied in Kenya

According to (Murungi *et al.*, 2021), food requirements in Kenya are either mandatory or optional. Governments set mandatory regulations in the form of legislation that constitute technical criteria like labelling, certification, and testing. Non-compliance liability regulations are used to enforce them. FAO or WHO have a comprehensive account of the different government departments and the regulations they are responsible for enforcing (Grace *et al.,* 2020). Voluntary standards are developed by formal structured approaches by key supply chain stakeholders (Birgen *et al*., 2020). FPEAK, KOFA, KAM, and AFIPEK are only a few of the norms observed by associations. Voluntary requirements are not legally binding, although some have become de-facto obligatory guidelines (Kinuthia *et al*., 2021). When producers want to succeed in foreign markets, they need them (Odhiambo *et al*., 2017). Compliance with guidelines like Tesco Nature's Option and BRC Global becomes a requirement for an extended supplier-consumer association (Murungi *et al*., 2021). Individual, global, national, and multilateral standards are all types of standards

Kenyan organizations conform to private requirements that are voluntary. They come from the associations' targeted international markets (Carron *et al*., 2018). In Kenya, Bureau SGS and Veritas are allowed to conduct BRC audits and certification (Patel & Chadhuri, 2019). National guidelines are derived from state bodies and, like national standards, are obligatory (KINYUA, 2020). Non-compliance with them has resulted in trade restrictions/barriers. Multilateral standards are optional, but they serve as a guide for national standards (Wambui *et al*., 2019). The applicable Codex and other international standards, like HACCP, are given priority in formulating national standards in order to provide a forum for implementing national standards or adapting them to the national food safety situation (Kiilholma, 2017).

2.8 Hazard Analysis and Critical Control Point (HCCP)

2.8.1 The Origin of HACCP

The US military, US National Aeronautics and Space Administration (NASA), and the Pillsbury Organization were the first to use HACCP in the late 1950s and prior 1960s (Al-Busaidi *et al.,* 2017). Their partnership sought to devise a plan to provide a secure food supply to the space program. HACCP was used to avoid unnecessary food safety risks. The Pillsbury Organization was the first to apply the HACCP method to the manufacture of consumer foods (Hou *et al.,* 2018). The Codex committee's proposal that

HACCP be used to resolve food safety brought HACCP global recognition. The HACCP framework and precursor programs are a preventive strategy to hazard detection and control that uses precautionary measures at all stages of development to avert hazards from entering the food chain.

2.8.2. HACCP Formation and Acceptance

HACCP is associated with food safety. It is a structured and preventive strategy recognized globally that outlines biological, chemical and physical hazards through prevention and anticipation instead of end-product testing and inspection (Normamatovich *et al*., 2021). HACCP's system of food safety management developed from two main innovations. W.E Deming was linked to the first advancement. Deming, whose model on quality management are largely considered a significant element in transforming Japanese food product quality around the 1950s (Suherman *et al.*, 2021). The scientist and others created systems for Total Quality Management, emphasizing on a complete production system strategy that could increase quality while still reducing costs.

The other big advancement was on the HACCP principle itself. During the 1960s, the Pillsbury Organization, the U.S. Army and the U.S. NASA spearheaded the implementation of the HACCP principle as a seamless integration to produce food that is safe for U.S. space program (DeBeer *et al*., 2021). NASA required a "zero defects" policy to ensure consumer safety when astronauts eat in space (Weinroth *et al*., 2018). Therefore, Pillsbury implemented and embraced HACCP as the framework that could offer maximum protection while cutting down on final product testing and inspection. HACCP stressed process management upstream in the manufacturing system by using operator regulation and constant monitoring procedures at critical control points (OZTURKOGLU-BUDAK, 2017). Pillsbury publicly introduced the HACCP concept at a 1971 food convention. The U.S. FDA organization concluded the utilization of HACCP concepts in promulgating canned food standards in 1974 (DeBeer *et al*., 2017). Other significant food manufacturers embraced the HACCP method in the early 1980s.

The important occurrences that contributed to the development of HACCP concepts in a timeline are shown in Figure 2.3 the Total Quality Management (TQM) was the predecessor of quality management prior to the HACCP System development and adaptation (Trienekens & Zuurbier, 2018). Edward Deming was the first person to develop the TQM scheme based on the constant improvement principle (Hammoudi *et*

al., 2019). NASA's Flight Food Safety team was led by Dr. Paul Lachance, while the Pillsbury team was led by Dr. Howard Bauman. The strategy to lessen the likelihood of food poisoning could have been implemented even if the original HACCP plan had only incorporated three of the seven guidelines that we now know. While working on the HACCP system for the space program, Pillsbury began using it in its own food safety processes (Otsuki *et al.,* 2021). In the spring of 1971, the first National Conference on Food Safety was convened, and it was then that HACCP was first introduced to the food industry. The following year, Pillsbury started delivering HACCP training to drug and food regulators and encompassed HACCP into the laws governing the use of low-acid cannabis.

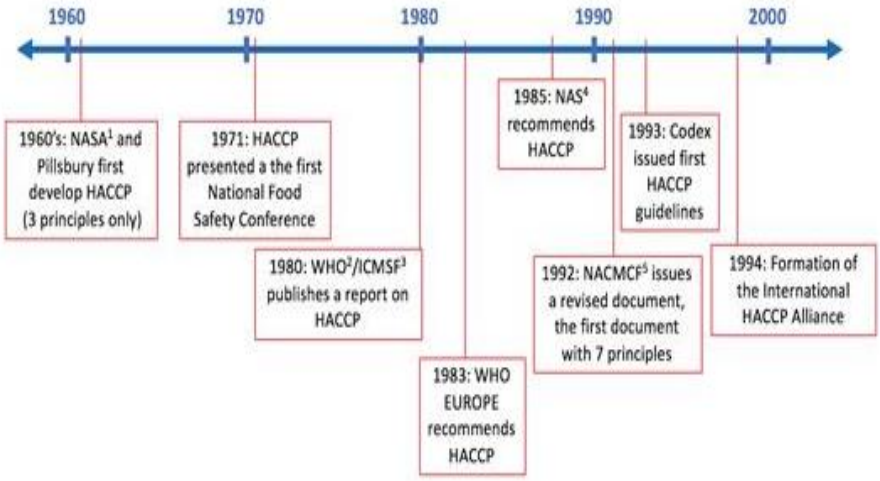


Figure 2.3: The major events that led to the formation of HACCP

Source: (Trienekens & Zuurbier, 2018)

The first official endorsement of HACCP came from WHO Europe in 1983, after research conducted by WHO and ICMSF in 1980 (Asfaw *et al.,* 2009). In 1985, the National Academy of Sciences found that HACCP was better to another common norm of randomized food testing as a technique to guarantee the hygiene of meals. The NACMCF, created in response to the conclusions of the 1985 study, has subsequently developed a variety of instructional and enforcement tools aimed to further encourage HACCP being adopted (Jongwanich, 2019). The seven underlying concepts of HACCP were initially revealed in a 1992 evaluation of this NACMCF study. Specific instructions for the Implementation of the Critical Control Point System for Hazard Analysis were accepted by the Codex Alimentarius Commission in 1993, reflecting the general acceptance of HACCP at that point. Figure 2.4 depicts the evolution of food safety management systems.

#

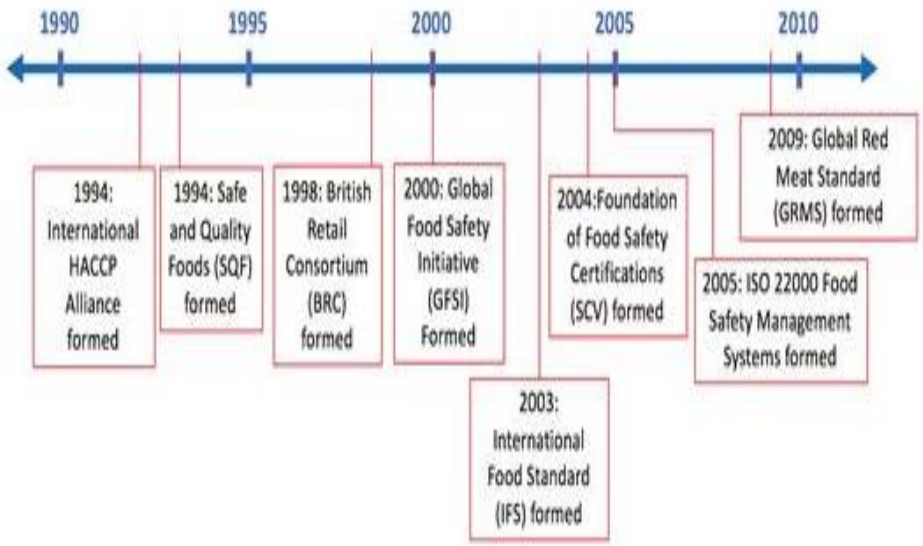


Figure 2.4: Food safety management system deployment timeline

Source: Henson & Jaffee, 2016

By analyzing, monitoring, and defining hazards, HACCP is often used as a method to avoid and not depend on final testing. HACCP, which is science-based and highly comprehensive, describes the threats and control steps. HACCP is made up of prerequisite programs and values, and it has identified GMP as a critical framework for a successful HACCP implementation (Henson & Jaffee, 2016). Food processing facilities that use the HACCP method must first incorporate the prerequisite programs, also known as GMP/Point of Focus POA, and then apply the seven HACCP principles. The GMPs / POA type requisite HACCP programs in a functioning HACCP framework for safety considerations that are not part of HACCP, such as unacceptable non-hazardous and poor sanitation. GMPs refer to the whole process. The HACCP strategy is derived from the utilization of HACCP concepts to particular steps in the process of manufacturing (Swinnen & Vandemoortele, 2019). To effectively sustain the HACCP after implementation, continuous improvement is needed. The HACCP practices for each CCP must be followed in conformity with the plan of HACCP. To develop and manage the structure, a HACCP group and a director should be named.

2.8.3. The use of HACCP by Government institutions

HACCP has been adopted by scientists, government regulators, and the food industry and has gained global approval. Following the introduction of the HACCP strategy, a number of countries implemented HACCP-based national food safety regulatory programs (Hoffmann *et al.*, 2019). In the early 1990s, for instance, the voluntary inspection of seafood in Canada and the United States was focused on HACCP. In 1995,

1996, and 2006, the United States established mandatory HACCP-based inspection systems for fish, meat and poultry, and processed juice, respectively. The European Commission's directive (93/43/EEC) allows food businesses to consider and monitor possible hazards using HACCP principles (Chen *et al*., 2018). The British Retail Consortium (BRC) has unique worldwide standard requirements for adding HACCP in enterprise FSMSs, which enacts required HACCP-based compliance in many other nations, notably owing to overseas commerce in food goods. As a consequence of HACCP's acceptance as a means of ensuring safe food in regional and worldwide commerce, HACCP plans are being adopted all over the globe in the food business.

2.8.4. The Seven Principles of Hazard Analysis Critical Control Point (HACCP)

The HACCP plan is centered on the seven principles used to control significant health and safety hazards. A critical control point is a phase, process or point where regulation can be utilized to avoid, eradicate, or minimize a food safety hazard to manageable levels (Ransinghe *et al*., 2019). Conducting an Analysis of Hazards is the first principle in the HACCP algorithm. This is put into practice by outlining the stages of development and identifying the locations where major risks are most probable to appear. The HACCP group would concentrate on hazards that the HACCP strategy should avoid, eliminate, or monitor. There is a reason to add or remove the threat, as well as potential control measures (Savov & Kouzmanov, 2019). After hazard analysis, the second step involves identifying Critical Control Points. The team of HACCP utilized a CCP tree of decision to assist define the procedure's key points of control. Multiple critical control points (CCPs) can be utilized to regulate numerous food safety hazards, or multiple CCPs can be utilized to regulate one hazard (Zhou *et al.*, 2021). The amount of CCPs needed is controlled by the number of processing phases and the level of food safety regulation needed.

Identifying the Critical Points precede taking note of the CCP**.** The lowest permissible concentration of a chemical, physical, or biological component that should be determined at a critical control point (CCP) in order to avoid an intolerable risk to food safety is known as a critical limit (CL) (Liu *et al.,* 2021). The HACCP group described the procedures of monitoring processes for determining the critical limit for each critical point (Jackowska-Tracz *et al.,* 2018). Protocols that are used for monitoring should specify how the metric were collected, when it was collected, who was be in charge of it, and how frequently it was collected during processing (Dzwolak, 2019). When a vital limit is exceeded, rectification measures must be implemented. The HACCP group

determined the precautions to be undertaken to avert possibly harmful food from getting into the food chain, as well as the procedures that were required to amend the situation (Guzewich, 2018). This occasionally entails identifying the challenges as well as the procedures undertaken to prevent them from recurring. The second last stage of HACCP is validation. Aside from testing, these tasks determine whether the plan of HACCP is correct and the device is functioning in line with the plan of HACCP (Kushwah & Kumar, 2017). The HACCP group can identify actions like instrument calibration, CCP auditing, prior shipment review, product testing and record review as verification actions. Maintaining detailed records that can be utilized to depict that food was processed in a safe manner is a significant component of the HACCP approach (Oo *et al.*, 2019). Information about the HACCP plan must also be included in the documents.

2.8.5 Food Handler's Knowledge on Hazard Analysis Critical Control Point (HACCP)

Following research that was carried out in Taiwan to examine the associations among food safety awareness in HACCP procedures among employees in the restaurants, the results indicated that the participants more knowledge in food poisoning is more than on the HACCP systems due to poor training on the system. It was found that this was attributed by government and need to improve on knowledge through training (Setiyadi *et al.*, 2020). The impacts of workers' behaviors on the HACCP system were also studied at Kenyan five- and four-star hotels in Nairobi County, with researchers finding a favorable correlation between workers' behavior and the HACCP system (Peninah et *al.*, 2020).

2.9. Kenya Bureau of Standard (KEBS)

KEBS provides audit and certification services to the food sector against a number of certification bodies, and it certifies food safety procedures against internationally and domestically accepted standards (Grace, 2017). KEBS certification services assist operators in demonstrating their dedication to food safety and quality, allowing them to reduce risk, monitor compliance, increase operational performance, and maintain long-term viability, allowing them to fulfill legal responsibilities, regulatory requirements, and take advantage of emerging and global markets (Kavunja, 2020).

2.10. County Government Permits

Before conducting business, the Nairobi County Government requires food vendors to obtain a Health Certificate and a Food Hygiene Certificate Permit (Kiambi *et al.*, 2020).

The emergence of the two certificates appeared to irritate traders because they were said to mean the same thing. The two licenses are required for businesses engaging with food production, distribution, or sale to guarantee the safety and well-being of both the individual handling the food and the atmosphere in which it is prepared, as well as to show that the food is fit for sale. Food safety management is governed by the Public Health Act, which includes legislation and supporting structures. The food hygiene license is given to establishments that are reviewed by County Health officials on a regular basis to guarantee that food handlers are disease-free, and it is valid for six months (Kinyanjui, 2018). The Hospitality business, which includes management, servers and housekeepers, kitchen staff and bartenders, marketing, and facility maintenance, includes food vendors and sellers. As a result, most enterprises in the hotel sector strive to stay relevant by ensuring that they offer quality services to its customers in Kenya, allowing them to retain existing customers and gain new customers from competitors. As a result, obtaining a Health Certificate showing that a person is in good health is important in order to minimize the difficulties faced when employed in the hospitality industry (Kang'ethe, 2021). Both the Food Hygiene Certificate and the Health Certificate are issued by the City Council, and both require applicants to demonstrate that they are free of communicable diseases before they are issued. This is done by testing their blood and stool for bacteria that could be spread through water or food.

2.11. Food Contamination

As per the World Health Organization (2018), contamination is "the existence or incidence of a food pollutant that makes food to be dangerous." The World Bank describes naturally occurring microbial organisms like *Salmonella*, *Listeria*, *Campylobacter*, or *E. coli* as contaminants which are dealt with by lawmakers (The World Bank, 2020); the World Bank also attributes the rise in foodborne illnesses caused by microbial pathogens to the greater availability of food in developing countries. Chemical, microbiological, and physical contaminants may contaminate food in unintended or intentional ways.

2.12 Food Safety Knowledge

Global food safety has been under increased scrutiny in recent years due to rising rates of food-borne diseases (Akabanda *et al.*, 2017). As a result, a comprehensive legal framework for food safety should be able to address food safety at every stage, from farming to eating, with an emphasis on prevention over assessment, collaborative

decisions with those who responded, and publisher assessment in light of growing public interest and stricter industry regulations (Marklinder *et al*., 2020).

According to research conducted by Seaman and Eves (2016), eighty percent of novice food managers surveyed said that neither they nor their superiors had undergone food hygiene training at the outset of their careers. Several variables were identified as contributors to the issue of inadequate knowledge capacity, as well as the expense of training courses, a lack of easily available food safety courses, particularly free meal safety courses, and the length of training offered to food producers (Hume, 2018).

In a bid to engage with the incidents of foodborne disease, food safety programs globally are provided to educate food service personnel in food safety issues and existing knowledge indicates that the restaurant management firms are more probable to recruit people educated in food safety (Hine *et al.,* 2020). Powell *et al.,* (2017) found that there existed no connection seen between depth of understanding of workers and the levels of hygiene in hotels. Nevertheless, (Cates *et al.,* 2019) noted that the existence of a qualified head chef protects the bulk of vital food breaches and thus it is vital to employ and train the supervisor to ensure a healthy foodstuff.

2.13. Food hygiene handler's practices

Research on the hygienic habits of those who work in the food industry has shown mixed results. Green and Carol (2018) highlighted the following factors: limited time; infrastructure work, materials, and materials; food security management and co-workers' focus; worker characteristics; the impact on those who are not preparing meals. According to Kibret and Bayeh (2019), food-borne illnesses are as a result insufficient infrastructure, a lack of understanding about cleanliness, and the procedures of food service establishments. Multiple color-coded cuts and distinct operating locations for different kinds of food that discourage cross-contamination are examples of structural environment, equipment, facilities, and supply of suitable resources that help prevent foodborne illness (Derso *et al.,* 2017). Staff experience, enthusiasm, age, clean-hand inclinations, client-service issues, and expectations for the positive impact of mutual care among food-handlers in reducing foodborne disease are all factors to consider (Mjoka & Selepe, 2017). Some workers are unable to use gloves because they are allergic to the materials used to make them. In addition, Abdi *et al.* (2020) observe that employees are more likely to follow safety measures if they are made aware of the possibility for adverse outcomes should they fail to do so. Restaurant procedures and

guidelines also contribute to safe food preparation. Some restaurants, for instance, require staff to keep detailed records of hand washing and food temperatures to guarantee that proper procedures are always followed. Some of the foodborne diseases by the food handlers include contamination especially amongst raw and cooked food products, improper cooking temperatures and use of contaminated utensils. Food handlers have also been identified as the potential vehicle for microorganisms like *Salmonella*, *Staphylococcus aureus* and *E. coli* (Al-Kandari *et al.*, 2019)

2.14 Training

Figure 2.5 shows that whereas 40% of the workforce in these organizations are certified in catering, 60% do not have formal schooling in food preparation or hospitality while having significant sector competence (Kapperud, 2021). This facilitated the gradual acceptance and implementation of scientific and sanitary procedures inside the hotel industry. Workers who have received enough education and training are better able to weather the inevitable shifts in the organization of production and delivery of services.

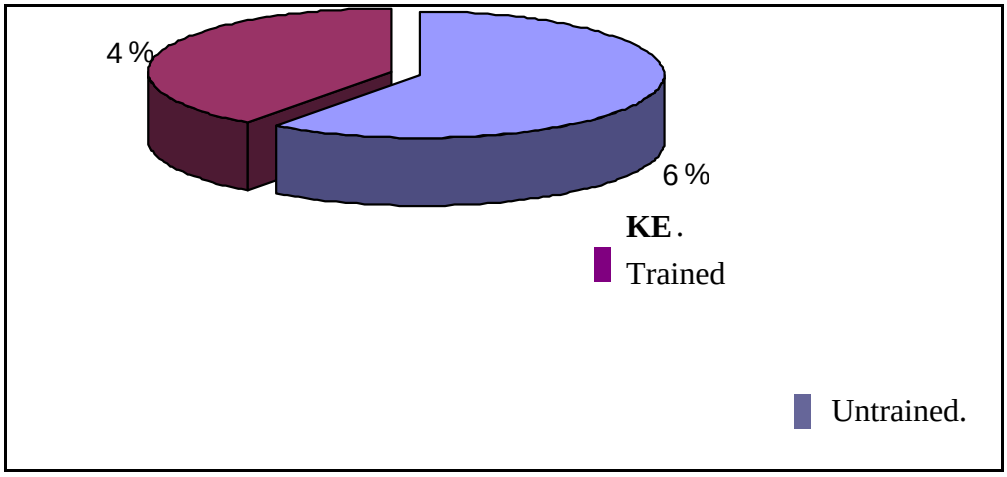


Figure 2.5: Hotel staff get professional training in catering (Lin & Hsu, 2017).

High microbial food loads may be a result of the fact that most of the workers have not had enough training, which indicates that they do not know how to properly handle food to avoid infection.

2.15. Confidence in the Safety of Food Served by Hotels

As per Usman, (2018) the perception of customers towards food overall safety has not attracted extensive interest; it focuses on the overall safety or threats of some product classes. Confidences on food safety reflect tacit conviction that ingestion of food items does not cause negative health impacts, and that is the average customer's assumption.

Bente (2019) figured out that customer preferences formed are generally disappointed, especially in the context of incidences of food safety. Given that it is challenging, if not unattainable, for clients to independently evaluate the safety and cleanliness of the food they consume at the recommended serving size, they largely depend on food network suppliers to supply nutritional alternatives. Consumers, therefore, are subject to a wide range of influences. It is also obvious that customers utilize their confidence in the salespeople, particularly those who are familiar to them, as a method for evaluating the safety of food. As a result, various players, like providers, manufacturers and servers, influence consumer confidence in food safety and health, with some having a more negative or positive effect on customers than others (Osagbemi, Abdullahi, & Aderibigbe, 2020). Customers' recollection of food safety implications and media attention serve a significant role in creating and weakening customer loyalty in such goods, as per Osagbemi, Abdullahi, & Aderibigbe, 2020. The presence of food safety concerns to customers depends on media coverage, which changes customer attitudes and behaviour. Customers tend to recall adverse news rather than positive news about those effects, thus reducing their confidence in the affected service operators. This often means lower orders and client support.

2.16 Food safety management in Kenya

Businesses in Kenya may apply for ISO 22000:2005 and FSSC 22000 certifications for food safety from the Kenya Bureau of Standards (KEBS). The country's food safety management is monitored by a number of different regulatory agencies. There is no comprehensive food safety policy in Kenya, and the restrictions that are in place are being poorly enforced (Moses, 2020), notwithstanding the severity of the problem. Several government agencies in Kenya ensure that food is safe for consumption, including the Kenya Bureau of Standards (KEBS), Kenya Agricultural Research Institute (KARI), Kenya Plant Health Inspectorate Services (KEPHIS), Department of Public Health (Department of Health), and Department of Weights and Measures (WMD) (Oloo J.E.O, 2015). The Minister of Public Health and Sanitation, via the Ministry of Public Health, is tasked with vetting food safety management firms to guarantee that they are doing their part to safeguard the public.

2.17 Review on research methodologies

In all the below methodologies 25 g of each sample of vegetable and fruit salad was weighed. In order to isolate *E. coli* 1ml of homogenate was pipetted and then dispensed in 9ml of sterile peptone water. Serial dilutions were also carried out. 0.1ml aliquot was

drawn and dispensed in a sterile petri dish and pour plated with violet red bile agar. Different red colonies were chosen with a wire loop and streaked to a methylene blue agar of eosin. Red metallic green sheen colonies were recorded as E. coli (Kibitok & Ndoku, 2016).

Staphylococcus aureus was isolated by 0.1ml BPW inoculated on Baird- Parker agar surfs, which included the emulsion of egg yolk tellurite and incubated for 24–48 hours at 37^0c. Standard colonies, i.e., black, convex and BP agar with or sans halo are counted and microscopically analyzed again. Colonies have also been tested and verified with the staphytect plus test for catalase reaction (Sospedra *et al*. 2013). Many researchers have often used cross-sectional studies design and still was utilized in this analysis.

2.18 Gaps in knowledge

Foodborne illnesses are still a major challenge in the world and especially in Kenya. There are many stakeholders who are in charge to ensure the safety of the public. There is therefore a necessity to examine training on food safety in the country. In addition, there is little investigation on the execution of the HACCP system in the catering sectors especially in small holding restaurants. This study set out to discover whether or not the best hotels in Kenya were adhering to HACCP and hygiene standards, how far the system had been put into effect, and what obstacles stood in the way of fully complying with it. Given the potential for contamination at any instance along the food chain, it is essential that food be handled correctly from farms to the dinner table. A large portion of the worldwide burden of disease, particularly in Africa, is caused by foodborne disease (FBD), which is spread primarily through contaminated fruits and vegetables. Both boosting the intake of fruits and vegetables and ensuring their safety are crucial for enhancing population health.

2.19 Theoretical and conceptual framework

A conceptual framework linking the study's main factors served as its inspiration. Figure 2.6 for a visual representation of the whole structure. The target group characteristics; external conditions (hand washing facilities, separate food storage, food preparation areas); and management factors (training, seminars, and food handler knowledge) all played a role in determining whether or not food handlers in these hotels complied with food safety management systems, as indicated by the model shown. Demographic characteristics including level of education, profession, and level of expertise determine the extent to which workers are susceptible to food safety hazards, and so are linked to

compliance with food safety management systems. Those in managerial roles are more likely to take part in food safety management systems, which in turn correlates with their likelihood of adhering to hygiene criteria and following food safety management system procedures. Various variables such as the kitchen's setting in terms of the division of food storage, areas to prepare food, hand washing facilities, equipment (gloves, thermometers, chopping board color, etc.), and so on could indicate the extent to which food handlers complied to food safety management systems and sanitation standards on the job. Meeting food safety requirements requires knowledge of food safety management systems and cleanliness criteria; older persons, with their more extensive life experience, are better able to do so than their younger counterparts.

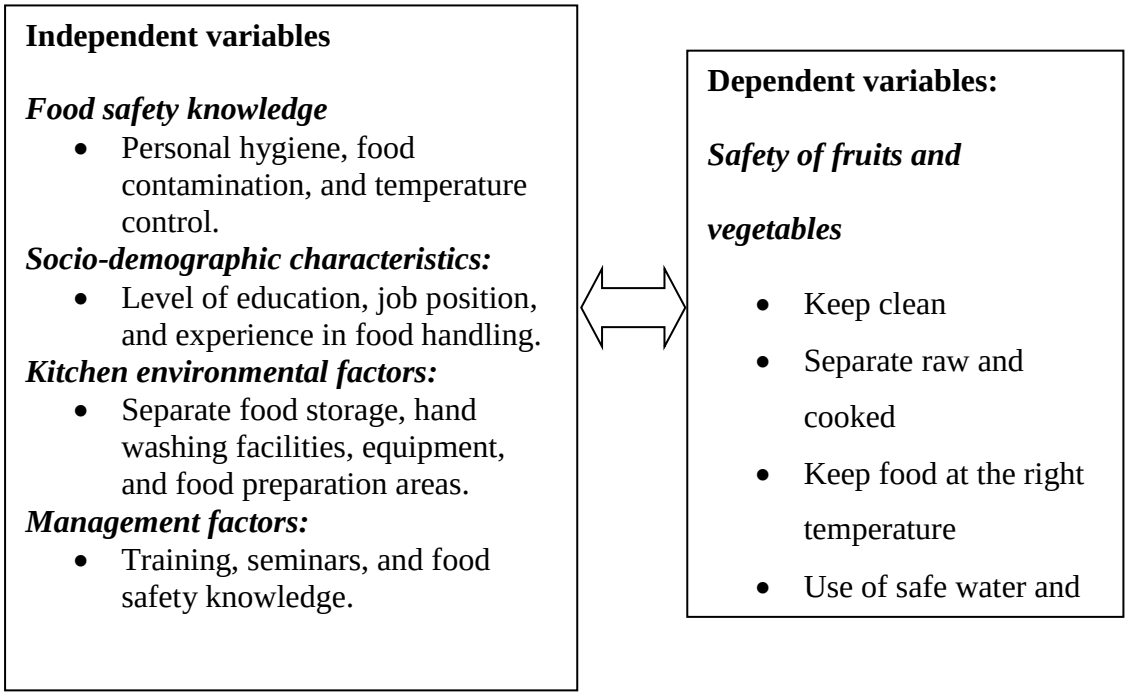


Figure 2.6: Conceptual framework

CHAPTER THREE: SOCIO-DEMOGRAPHIC CHARACTERISTICS OF FOOD HANDLERS AND COMPLIANCE TO FOOD SAFETY MANAGEMENT SYSTEMS AND HYGIENE REQUIREMENTS IN FINE DINING HOTELS IN NAIROBI COUNTY

Abstract

Workers in the fine dining hotels carry responsibility of protecting the health of their customers. The activities of obtaining, preparing, and consuming food are crucial to human survival. On the other hand, food-borne illnesses are a chronic and widespread concern that may have devastating effects. The study aimed at assessing the socio-demographic features of food handlers and their compliance with food safety management system in Nairobi County Kenya. A sample of 201 food handlers calculated using Cochran formula were interviewed at random using semi-structured questionnaires. The data gathered was entered into datasheets and examined through Statistical Package for the Social Sciences software to determine the effect of food handlers' socio-demographic factors on adherence to Food Safety Management System, and hygiene requirements. Male employees were the majority at 59% compared to their female counterparts who were 41%. In terms of job position, waitresses were predominant while chefs accounted for the category with the least participants (30.3%, and 9.9% respectively. Those who had served in their current role for less than one year were 24.12%, 1-2 years 17%, 3-5 years 24% and 5 years and above 47%. Additionally, most food handlers had college/university education (P>0.05), notwithstanding with a positive correlation (r=0.170) between age and fulfilling food safety management system and hygiene guidelines. The research concludes that, commitment to hygiene and safety of food is high in hotels with food handlers having satisfactory knowledge on food safety management systems, having served for relatively long tenures in the industry. Fine Dining Hotels have a responsibility to ensure that their staff has the necessary training to comply with all applicable regulations pertaining to the preparation, cooking, and food service.

3.2. Introduction

The term "food handler" refers to someone who takes part in the handling, processing, or production of food (Isara and Isah, 2019). Therefore, the individual hygiene and sanitation procedures of food handlers are vital in reducing the likelihood of contaminating food and, therefore, food poisoning. Workers who prepare and serve food have a duty to protect their own health, including by taking measures to avoid being sick while doing so (Khuluse, 2016). It is possible for food handlers to transfer harmful microbes like bacteria and viruses to their work surfaces and the meals they prepare. Following adequate hygiene standards when handling raw and prepared meals may help avoid contamination of food and poisoning (Ghartey, 2019).

A customer's ultimate decision on where to dine out may be influenced by a number of things. Many different opinions have been presented in articles exploring the question of what elements guests value most when selecting a restaurant. Fine dining hotel visitors' perceptions may be influenced by a number of factors, including the food's quality, the uniqueness of its flavors and compounds, the variety and attractiveness of the menu, and the availability of healthier menu options (Jang & Namkung, 2019). Diners' choices may be heavily influenced by the restaurant's ambiance, design, furniture, and other amenities (Yasami, 2018). Diners at upscale establishments, particularly those with lavish furnishings, may feel a sense of social superiority because of this (Akbar & Alaudeen, 2012).

Bisholo *et al.* (2018) found gaps in Africa's ability to monitor food-borne illness outbreaks. In highly populated areas like Nairobi City County, concerns about food safety have increased in the past few years. Food hygiene infractions are more common in ethnic food establishments than in non-ethnic restaurants, according to study by Ehiri (2012). A lack of food safety training among local food outlet owners was cited as a contributing factor to the observed disparities. Kabue (2015) found a robust positive correlation between cleanliness of the environment, personal cleanliness, kitchen hygiene, and trash disposal across the majority of restaurants in Nairobi City County. Individual food handler behavior significantly contributes to cross-contamination (Yeung & Morris, 2001). In the viewpoint of the customer, a possible danger to food safety. The United Kingdom's version of the foodie publication. This raises the issue of whether the hygiene of restaurant staff affects customers' dining preferences.

Food handlers ought to constantly change into clean clothes before handling food, as well as after using the restroom, handling unclean objects, coming into close proximity to animals or raw food, or working with toxic or hazardous substances (Chukwuocha *et al.,* 2019). You may use your fingernails, hair, or skin to cover cuts if there is no danger of infection. It is not only impolite, but also potentially dangerous to your health, to grin and chew gum while handling food. Keeping neat compounds, discarding liquid and solid debris correctly, and keeping food in containers that are clean are all part of practicing good environmental hygiene (Meyer *et al.,* 2013). The goal of this part is to examine the workforce composition, sanitation practices, and FSM compliance of Nairobi's five-star hotels serving upscale cuisine.

3.3. Materials and Methods

3.3.1 Study Site

The setting for the research was Nairobi County areas in CBD and Westlands due to the presence of majority of the city's fine dining hotels (Figure 3.1). The study included top rated hotels five-to-two-star hotels in Nairobi County targeting the Westlands (Kitisuru, Mountain view, Parklands/Highridge and Karura) and Central Business District (CBD) areas.

The region around Nairobi County was analyzed. Nairobi is the 47th and last county of Kenya. Nairobi has an area of 269 square kilometers and is on the eastern border of the Rift valley. The majority of Kenyans find employment in Nairobi County since it serves as the country's commercial hub and is home to several offices. In addition to its convenient location, the presence of both wealthy and impoverished residents in Nairobi County makes it a great environment for my research. The fact that the majority of the world's finest hotels can be found in Nairobi is also a major draw. Seventeen parliamentary districts may also be found in Nairobi. There are around 4.3 million people living in Nairobi County as of the 2019 census.

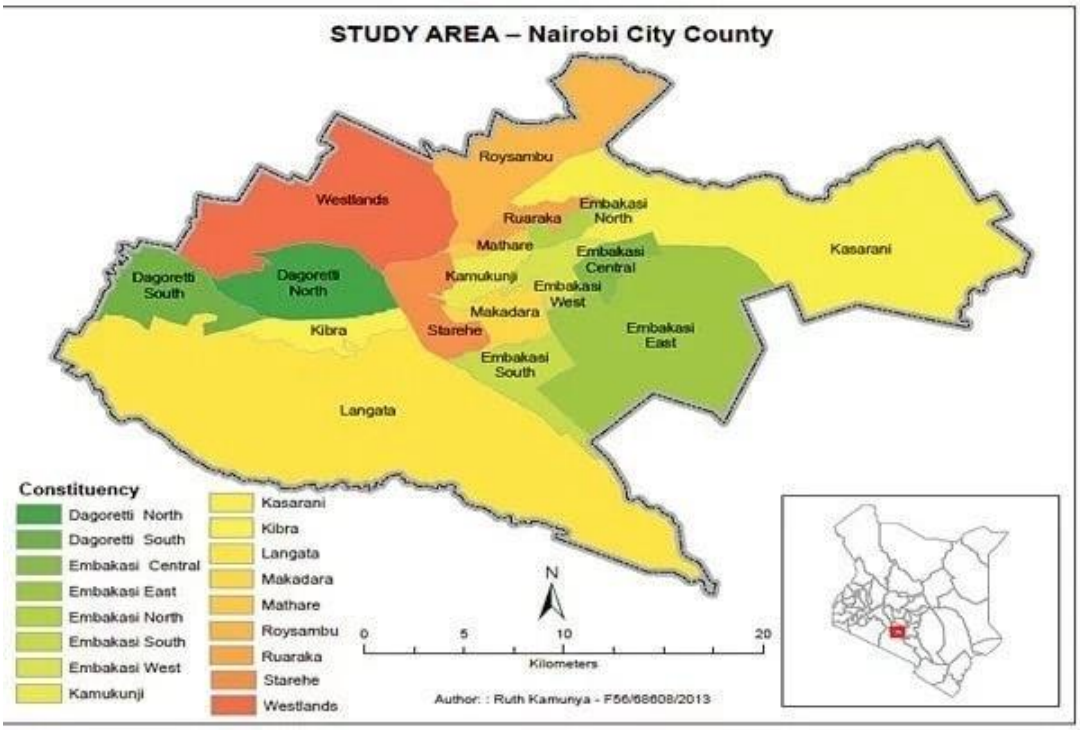


Figure 3.1: Map of Nairobi County

Source: https://www.tuko.co.ke/261934-constituencies-nairobi-county-their-mps.html

3.3.2 Research Design

Information on a sample population is gathered at a specific moment in time in a cross-sectional study (Busk, 2015). This research method was a good match for our study because of its ability to estimate the sample size we would need to answer our research questions concerning the demographics of upscale hotels and how they comply with food safety management systems and sanitary regulations.

3.3.3 Study Population

Hotels in the Westlands (Kitisuru, Mountain view, Parklands/Highridge, and Karura), and the Central business District (CBD) of Nairobi County were included in the research with an estimated target population of 1218 served per hotel daily (Coker *et al*., 2018). According to the December reports from the Tourism Regulatory Authority, there were an all-inclusive of 30 registered hotels in these locations; nevertheless, only 15 participated in this research due to either voluntary exclusion or closure.

3.3.4 Sample Size

Westlands (Kitisuru, Mountain view, Parklands/Highridge, and Karura) and the Central Business District (CBD) in Nairobi were surveyed to determine the number of food handlers and fine dining hotels in the region. The Cochran's Formula was used to estimate the sample size as follows;

$\eta_o = Z^2pq \div e^2$

Where;

e= estimated level of precision

p= estimated proportion of population

q=1-p

Therefore $\eta_o = 1.96^2 * 0.5 * 0.5 * \div 0.5^2 = 385$

Since the population is less than 10,000, we further modify it using the formula;

$$n = \frac{n_o}{1 + \frac{(n_o - 1)}{N}}$$

We get; 385/ (1+(384/500)) ≈ 201

3.3.5 Sampling Procedure

The research employed a comprehensive sample of all 15 hotels. Respondents were selected using a mixture of stratified and targeted sampling methods. There were four groups of those who responded: chefs, cooks, kitchen stewards, and waiters. The targeted groups were interviewed with survey questions (Appendix B) because of the relevance of food safety management systems and sanitary needs to their everyday operations.

3.3.6 Data Collection

Data was gathered by surveying those who worked directly with the cuisine (cooks, chefs, waiters, and kitchen stewards) using pre-designed questions. Gender, age, job title, duration of employment, years of experience in the hotel and the food service business, degree of education, and FSMS training were all recorded.

3.3.7 Data Analysis

Questionnaires, interviews, observations, and secondary resources were used to compile the qualitative data. The author of the research created a network diagram showing the interrelationships of several data sets. This information was utilized to populate the code's item variables. The coded data was entered into Excel and then exported to the Social Sciences Statistical Program (SPSS) for analysis of the demographics of food handlers and their compliance with food safety management systems and sanitary needs in high-end hotels. The p value for statistical significance was set at 0.05. Consequently,

the 95% confidence interval was used to establish upper and lower boundaries, leading to rejection whenever the estimated survey results sat outside the interval.

3.4 Results

3.4.1 Demographic characteristics

Tables, graphs, and charts are utilized to display the answers from the respondents' socioeconomic and demographic data in this part. The demographics are broken down by sex, age, job status, years at the hotel, years in the food service industry, years at the present position, and level of schooling. There were 118 (59%) males and 83 females (41%). This indicates that there are more male food handlers compared to females in this study.

Table 3.1 depicts that most of the food handlers 99 (49.3 %) were aged between 31-40 years, 51 (25.4%) were aged between 18-30, 46 (22.9 %) were aged between 41-50 while the remaining (2.4%) was distributed 51 to 60 years and above. A further 61 (30.3%) of the food handlers are waiters or waitresses, 60 (29.9%) are cooks, 60 (29.9%) are kitchen stewards while the rest 20 (9.9%) are the chef in various hotels in this study. Table 3.2 shows the personnel trained on HACCP by number of years served.

Table 3.1: Summary of findings on socio-demographic characteristics of respondents

Demographic variable	**Category**	**Frequency (n)**	**Percentage (%)**	**P-value**
	18-30	51	25.4	
	31-40	99	49.3	
	41-50	46	22.9	
Age Bracket	51-60	5	2.4	0.170
	Chef	20	9.9	
	Cook	60	29.9	
	Kitchen Steward	60	29.9	
Job Position	Waiter/Waitress	61	30.3	0.267
	Casual	8	4	
	Contract	44	21.9	
Terms of Service	Permanent	149	74.1	0.034
Level of	College/University	166	82.6	
education	Completed Primary	3	1.5	

Completed Secondary	32	15.9	0.452

Table 3.2: HACCP training by duration of service in the industry

	Between 1-2 years	**Between 2-5 years**	**Less than 1 year**	**More than 5 years**	**Grand Total**
Have never received training on HACCP	24%	10%	44%	5%	13%
Have received training on HACCP	76%	90%	56%	95%	87%
Grand total	**100%**	**100%**	**100%**	**100%**	**100%**

Most food handlers (88) have worked in the hospitality industry for at least five years, whereas another 54 have worked there for one to two years, 50 for three to five years, and the other 9 have worked there for a period of below a year. 94 (47%) of the food handlers had five and above years of service in the food service industry, 48 (24%) have 3 to 5 years, 35 (17%) have 1 to 2 years and the remaining 24 (12%) are food handlers with less than a year in the food service industry. 149 (74.1%) of workers in the hotel sector in this study are employed permanently 44 (21.9%) are employed on contract, while the rest 8 (4.0%) are casual employees. 166 (82.6%) of workers in the hotel sector in this study are College or university graduates, 32 (15.9%) had completed secondary school education while 3 (1.5%) had completed primary school education. This indicates that the majority of hotels are employing people who have acquired skills and training from schools. Table 3.3 shows the interaction between service factors.

Table 3.3: Knowledge on HACCP system by year of service and gender

	Between 1-2 years	**Between 2-5 years**	**Less than 1 year**	**More than 5 years**	**Association between factors (r)**	**Grand Total**
Female	65%	50%	55%	25%	0.267	41%
Male	35%	50%	45%	75%	0.349	59%
Grand total	**100%**	**100%**	**100%**	**100%**		**100%**

3.4.2 Associations between the socio-demographic characteristics and compliance to food safety management systems & sanitary needs

Although there was a positive association between age and both food safety management system compliance and hygiene standards (r=0.170), this was not statistically significant (p=0.056>0.05). Given that the p-value is less than the significance threshold (P=0.000<0.05), the positive association between job position and adherence to food safety management systems and hygiene regulations (r 0.267) is statistically significant. Years of service were positively correlated with meeting food safety management system and hygiene criteria (r=0.034); nonetheless, this was not statistically significant (p=0.17 >0.05). There was a statistically significant (P=0.000< 0.05) positive correlation between the hotel's compliance with food safety management systems and sanitation laws and the total number of years the personnel had worked in the foodservice industry (r = 0.349). Although there exists a positive association between terms of service and adherence to food safety management systems and sanitary regulations (r = 0.097), this was not statistically significant (p = 0.634 >0.05). The positive correlation between educational level and compliance with food safety management systems and sanitary requirements in this hotel (r = 0.452) is statistically significant (P=0.000< 0.05).

3.5 Discussion

3.5.1 Knowledge on Food management System

The socio-demographic composition of the study components was characterized by more males than females (59%, and 41% respectively) showing the male dominance in the job occupation. With three times the number of men than women who have over three years' experience in the hospitality industry, it is an indicator that gender plays a key role in the advancement of the industry. Food handlers had a limited understanding of the potential dangers at each level of the food chain, with only storage and the consumption of leftovers being identified as especially high-risk. Less frequent instances of food contamination were seen across the board, from procurement through preservation to pre-preparation to cooking to serving to reusing remaining portions. Fawzi and Mona (2019) found that higher levels of food safety awareness were linked to dining out and lower levels were linked to personal hygiene, which is in keeping with the outcomes of the present research. Because of the existing food safety programs'

overemphasis on obtaining a certificate rather than teaching practical hygiene skills, this result is likely the result of insufficient training (MacAuslan, 2018).

Those who work with perishable foods should be aware of the temperature range that poses a health risk. According to the results of this probe, the respondent has enough understood of thermostatic control. According to research by Panchal *et al., (*2014), just a minority of those working in the food service industry are aware of the dangers associated with temperatures in the range where bacteria thrive. A small percentage of managers in the food service business have professional training in the management side of food safety, which may explain why these outcomes are seen (Egan *et al.,* 2016). As a consequence, these managers are less likely to recognize potential threats to the health and safety of their employees and less likely to instruct them on how to prevent them.

3.5.2 Importance of Food Hygiene Training

The research found that hotel kitchen staff received food safety management training either at first orientation or via separate arrangements. Most inexperienced food handlers in a poll by Seaman & Eve (2019) reported their managers had not addressed or provided them with food safety training. The food workers were not well prepared for their roles in food safety management, despite the trainings. It was made obvious in the interview that not all employees were chosen for training, and that orientation comprised of briefings at the start every shift. One responder said that retraining employees on food safety was unnecessary since it was presumed, they already knew the material. This example shows that managers were reluctant to teach their staff on food safety because of the high turnover rate and the scarcity of free training resources. Hume (2015) explains that this reluctance to train stems from factors including the expense involved, the scarcity of relevant training options, and the length of time it would take to properly educate the workforce that handles the food.

3.5. 3 Understanding Food Hygiene Measures

The results revealed that a large proportion of managers (86.70 percent) have a solid understanding of food hygiene and safety procedures. There was no question in anyone's mind that the restaurant's management had taken every precaution to ensure that the food they provided was both safe and sanitary. According to research conducted by Zain and Naing (2012), the vast majority (83.3%) of managers and food handlers are aware of and follow procedures for maintaining proper food sanitation and preventing the propagation of food-borne illnesses.

3.5.4 Age, job position, years of service, and education level of food handlers

The survey found that men make up an overwhelming majority of those employed in the food industry. The typical age range of hotel workers in Nairobi is 30-60. These findings are congruent with those reported by Coker *et al.*, (2018) well as data from KNBS, (2023) which reported more men than women in active labor force. The research also shows that most hotel food is handled by chefs, head cooks, and head stewards. According to this survey, most hotel workers who handle food have at least a bachelor's degree. Employees in the food business can benefit from further education in food safety management systems and sanitary practices. Factors such as employment status, length of time in the foodservice industry, and level of education were shown to have a substantial impact on the degree to which high-end hotels adhered to food safety management systems and sanitary needs (Food Forum, Food and Nutrition Board ISBN:, 2001).

3.6. Conclusions and recommendations

The socio-demographic characteristics of hotel, and restaurant personnel influences the implementation of FSMS, and hygiene requirements in one way or another. This is with regard to the years of service, sex, and age bracket. Furthermore, fine dining hotel employees' adherence to food safety management systems, and cleanliness criteria is significantly correlated with their degree of education, and work position the food business, and hotel. Therefore, well-educated employees at hotels are more likely to follow all policies and procedures when it comes to the preparation, cooking, and serving of meals. Those who work with food on a regular basis have a natural knack for it and can manage it with ease and efficiency because of their years of practice.

Irrespective of their position in the hotel, all employees who handle food should undergo regular periodic training on food safety management systems and cleanliness regulations.

CHAPTER FOUR: LEVEL OF KNOWLEDGE ON HACCP AND PRACTICES IN PREPARING FRUIT AND VEGETABLE DISHES AMONGST FOOD HANDLERS IN FINE DINING HOTELS

Abstract

The safety of food served in fine dining hotels is subject to preparation, and handling procedures. HACCP systems are becoming more common in Nairobi's fine dining establishments, although the vendors' expertise and practices in this area remain crucial in maintaining the safety of the food served. To guarantee that all food handlers are adhering to safe practices, there is need for strengthening HACCP systems by investing in evidence-informed legislation. The study aimed to assess the level of knowledge on HACCP in preparing fruits and vegetable dishes amongst food handlers in Nairobi County through an interview using a semi structured questionnaire. 201 food handlers were involved in the study which was determined using Cochran formula. The p-value for the connection between HACCP knowledge and practices in making fruit and vegetable meals in conformity with food safety management systems & hygiene regulations is less than the threshold of significance (P=0.000< 0.05), indicating a positive correlation (r=0.586) between the two. Also, among those who were knowledgeable about HACCP were 72% for males and 71.1% for females. Average knowledge for males was 25.4% and 27.7% for females. Poor knowledge for males was 2.5% and 1.2% for females. When it comes to HACCP and other industry best practices, suppliers working in Nairobi's fine dining hotels are well-versed. However, knowledge alone cannot entirely measure the level of implementation of safety, and hygiene standards. It is therefore important that people all around the country who work with food (such as restaurant workers, owners, and supervisors) have access to the same training materials. Posters, the media, and communications strategies should be used to raise awareness of the hazards of food poisoning and the procedures hotels must take to limit those risks among employees who come into contact with food.

4.2 Introduction

Unhygienic food handling has been identified as the core cause of the current worldwide epidemics of foodborne disease. Restaurant workers, school cafeteria workers, and staff at nursing homes, among other establishments, have been seen using discarded chicken and storing food in unhygienic conditions (Rabbi & Dey, 2013). Indigenous foods may pose health hazards since both vendors and consumers are unaware of the potential problems associated with eating them, as shown by research by (Ratnapradipa *et al.,* 2010). Costs associated with food-borne illness are significant and should not be minimized. These costs include but are not limited to medical care, lost wages, the emotional toll on people affected, and financial losses for companies and the public health system.

There are not enough checks and balances in place to guarantee that food is secure to eat, as seen by the rise in incidents of food poisoning. According to Redmond and Griffith (2015), controlling the propagation of food-borne diseases is dependent on maintaining high standards of both sanitation and food management. HACCP is difficult to adopt in a variety of situations, including fast-paced white-linen businesses that don't employ frozen or packaged items (Katie *et al.,* 2009). It is also aggravating since there is no foolproof method to tell whether a dish contains transgenic components. Finally, there are some upscale restaurants that continue to compromise their customers' health by failing to adequately address issues of food safety.

4.3. Materials and Methods

4.3.1 Study Site

The research was undertaken at Fine Dining Hotels in Westlands and CBD of Nairobi County Kenya as detailed in part 3.3.1.

4.3.2 Research Design

Cross-sectional research, information on a group of people is gathered all at once. This study's approach was ideal for estimating the size of the study's target population—here, food handlers at five-star hotels—as well as the participants' levels of HACCP knowledge and their practices while preparing fruit and vegetable-based dishes (Spector, 2019).

4.3.3 Study Setting

The central business district (CBD) and Westlands neighborhoods of Nairobi County served as the study's location. According to 3.3.3, the survey covered only the best 5- to 2-star hotels in Nairobi County.

4.3.4 Study Population

The research population was top rated hotels five-to-two-star hotels in Nairobi County targeting Westlands (Kitisuru, Mountain view, Parklands/ Highridge and Karura) and Central business District (CBD) areas. The total number of registered hotels in these areas as per the report from Tourism Regulatory Authority is 30 however only 15 were involved in this study as others declined and others were closed.

4.3.5 Sample Size

Westlands (Kitisuru, Mountain view, Parklands/Highridge, and Karura) and the Central Business District (CBD) of Nairobi were surveyed, and a total of 201 food handlers and 15 Fine Dining Hotels were found. The sample size calculation was done according to section 3.3.5.

4.3.6 Sampling Procedure

The research employed a comprehensive sample of all 15 hotels. Respondents were selected using a mixture of stratified and purposive sampling methods. There were four groups of those who responded: chefs, cooks, kitchen stewards, and waiters. Since making fruit and vegetable dishes is a regular component of the work of food handlers at luxury hotels, questionnaires were given to all of the aforementioned groups on purpose for the study (Appendix B).

4.3.7 Data Collection

Information on food handlers' HACCP knowledge and their methods for preparing fruit and vegetable meals at five-star hotels was gathered via observation of activities, and the use of a semi-structured questionnaires to chefs, cooks, kitchen stewards, and waiters/waitresses.

4.3.8 Data Analysis

The qualitative data was collected using questionnaires, interviews, observations, and secondary sources. The study's author mapped out connections between different types of data. The data from this was used to generate the item variables in the code. After the data was coded, it was imported into Excel and imported into the Social Sciences Statistical Program (SPSS) for a comprehensive variables analysis of food handlers' understanding of HACCP and their practices in preparing fruit and vegetable meals at high-end hotels (Garner & Nunn, 2015). Statistical significance was described as a p-value less than 0.05. (Gessner, 2014). Therefore, the upper and lower bounds were measured using the 95% confidence interval, which resulted in disapproval if the calculated survey findings fell outside of the interval.

4.4 Results

4.4.1 Knowledge on HACCP

Figure 4.1 shows the proportion of males and females food handlers based on their knowledge on HACCP and practices in preparing fruit and vegetable dishes in compliance with food safety management systems and hygiene requirements. The results indicates that 72% of males are highly knowledgeable about HACCP as compare to females with 71.1%. 25.4% of males have average knowledge on HACCP as compared to females with 27.7%. only a minimum percentage of 2.5% males and 1.2% females of respondents have poor knowledge on HACCP.

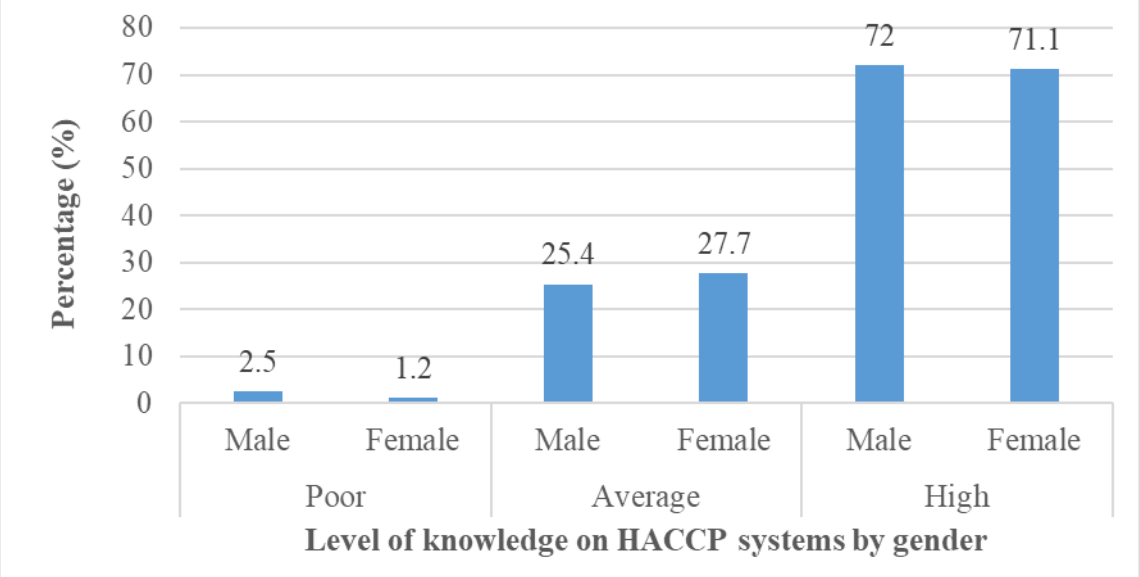


Figure 4.1: Knowledge on HACCP

As can be seen in Table 4.1, more than 85% of respondents concurred with each of these study claims. Only 35.8% of respondents agreed that food analysis should be performed on the final product, whereas 64.2% disagreed. Participants agreed (85.1%) that it was important to identify steps in the process where chemical, physical and biological contaminants could be introduced and come up with control measures which are very crucial in achieving food safety. Consumption of foods contaminated with food borne hazards can lead to adverse health effects (100%). 81.6% of the participants agreed that HACCP is important in achieving food safety.

Table 4.1: Association between knowledge on HACCP among hotel personnel

Research statements	TRUE	%	FALSE	%	*P*-value
HACCP is important in achieving food safety	164	81.6%	37	18.4%	**0.000**
Food analysis should be at the final product	72	35.8%	129	64.2%	**0.000**
Checking of critical long the value chain	194	96.5%	7	4.5%	**0.000**
HACCP system can be of any food product	193	96.0%	8	4.0%	**0.000**
The safety of food relies mainly by the operations carried out by farmers, processors and producers	201	100.0%	0	0%	**0.000**
Consumption of foods contaminated with foodborne hazards can lead to adverse health effects	201	100.0%	0	0%	**0.000**
The HACCP system must be implemented in accordance with established protocols.	196	97.5%	5	2.5%	**0.000**
HACCP system is based on seven principles	189	94.0%	12	6.0%	**0.000**
HACCP system should always be reviewed in case there is change in production process	194	96.5%	7	3.7%	**0.000**
It is important to identify steps in the process where chemical, physical and biological contaminants could be introduced and come up with control measures	171	85.1%	30	14.9%	**0.000**

4.4.2 Inferential analysis, and Chi-square tests

The research assessed the connection between the dependent and independent variables by use of the Pearson correlation coefficient. There was a positive association (r=0.586) between HACCP understanding and procedures in preparing fruit and vegetable meals in accordance with food safety management systems & sanitary guidelines and a p-value of less than the significance level of (P=0.000 < 0.05). The hypothesis was examined via the utilization of Chi-Square values by the researcher. The researcher decided to reject the null hypothesis when the p-value was found to be lower than the threshold of significance (alpha = 0.05).

4.5 Discussion

4.5.1 Awareness of HACCP System among Food Handlers

Saadat *et al.,* (2020) reported that, for effective HACCP systems, urban enterprises, and industries must build a system adapted to their operations as a method of maintaining high levels of hygiene. According to the current research, high-risk food handlers struggled to define HACCP and its concepts. A lack of understanding among food handlers was an indicator that capitation of staff on HACCP is crucial for its effective implementation. More than half of the workers at fine dining hotels were knowledgeable on quality control strategies but had no idea of their implementation, with more than 50% others unaware of the quality control measures. These findings are in agreement with those of Das *et al*., (2019) which reported a lack of familiarity to quality control measures among meat handlers.

Training in the HACCP system was shown to be an efficient method for ensuring food safety. Sprenger (2017) emphasizes HACCP's usefulness as a food safety system due to its ability to be rapidly implemented on the manufacturing procedures of all foods, as well as its design to facilitate the flow of data for preventive and remedial interventions. Verification and documentation processes also guarantee worker security.

4.5.2 Food hygiene practices among food handlers

According to the data collected upon observation, the fine dining spaces in Nairobi County, Kenya, were quite clean. With smoking banned everywhere within the restaurant, including the kitchen and the dining room, each institution had a separate section set aside for smokers. These findings showed compliance with Public Health Act-required health and safety licenses at Fine Dining Hotels (OGWENO, 2015). This compliance was further seen in their attention to details with enough sinks and mirrors for hand washing, personnel who looked neat, and clean dishes as technically defined by Murimi & Waweru, (2020). Majority of workers in the food industry believed that washing hands before handling foods was crucial for maintaining food safety. Additionally, the biggest percentage of them agreed that it was critical to maintain the separation of raw, cooked, and food that is ready to consume for the sake of public health. This is a crucial practice to prevent cross-contamination (Li *et al.,* 2018). Cold storages such as refrigerators, and freezers which were found in these restaurants, and were important in preserving quality of raw fruits, and vegetables (Mujuka *et al*., 2020).

4.5.3 Methods used to hold cooked food

Observational findings from this research showed that the upscale eateries in Nairobi County, Kenya, were very clean. Majority of them excellent dining had clean grounds, with adequate capacity to collect both solid, and liquid waste which is an important factor in ensuring (Murimi & Waweru, 2020). Since smoking was prohibited in all areas of the establishment, including the kitchen and the dining room, designated smoking areas were provided. Fine Dining Hotels have never had a lapse in their Public Health Act-required health and safety permits (OGWENO, 2015). Ninety percent had adequate facilities for hand washing, including sinks and mirrors; ninety percent had presentable staff; sixty percent had clean plates (Murimi & Waweru, 2020). Majority of those polled in the food industry believed that it is crucial to clean their hands prior to handling food. They also agreed that it was important, from a public health perspective, to keep raw, cooked, and ready-to-eat foods separate. Dry storage was available at all of the establishments assessed, and played a key role in ensuring safety of food (Sarkar & Chakraborty, 2018).

4.6 Conclusion and recommendations

Preparing meals with a high proportion of fruits and vegetables has been linked with improved oversight of food safety and adherence to cleanliness requirements. Chefs at five-star establishments get HACCP training and comprehend how to correctly cook seasonal produce. Most personnel working with food at five-star hotels have at least a passing familiarity with HACCP. With results showing that the food handlers were knowledgeable on HACCP it is therefore recommended that there should be a regular inspection of these hotels by relevant authorities to ensure that the HACCP principle is being followed and its implementation. Furthermore, there should be continuous training for all food handlers on the HACCP concept by the management.

CHAPTER FIVE: MICROBIAL SAFETY OF FRUITS AND VEGETABLE SALADS IN FINE DINING HOTELS IN NAIROBI COUNTY

5.1 Abstract

While it is common knowledge that eating a diet high in vegetables and fruits is beneficial, the alarming increase in cases of food poisoning has made the issue of microbial contamination more pressing. The current research was carried out to assess the microbiological safety of fresh vegetables served at Nairobi's five-star hotels. Thirty samples of fruit, and vegetable salads were collected from restaurants in Westlands, and Nairobi CBD, and taken through microbiological analysis. The microbial assessment was carried out using Plate Count Agar (PDA), and colonies were enumerated using colony-forming units per milliliter. Bacteria were detected in all of the studied produce, albeit the level of contamination varied greatly with regard to the origin of the samples (P<0.05). *E. coli* was found in around 57.1% of samples from Nairobi CBD, whereas in Westlands, it was found in 50% of the samples. On average, *E. coli* levels in fruit samples varied between 0.05 to 0.87cfu ml^{-1}, with 42% of the samples contaminated with *S. aureus*. Vegetable samples showed a higher rate of contamination with *Escherichia coli* in the Nairobi CBD (42.8%) than in the Westland (37.5%) with an average count of 0.0 to 0.77 $cful^{-1}$. Furthermore, results showed that *S. aureus* was available in 42.8% of the contaminated samples from CBD and in over 62% of the samples from Westlands. It was therefore concluded that levels of contamination in fruit and vegetable salads obtained from different hotels were independent of the hotels' overall quality. Nevertheless, the bacterial counts were within reasonable bounds. In order to prevent foodborne infections, it is suggested that food workers get appropriate periodic training on food hygiene, safety, and HACCP guidelines, combined with periodic microbial monitoring of the food preparation environment.

5.2 Introduction

Fruit and vegetable intake is important for everyone's health as a whole, however microbial contamination of these foods is a growing problem that needs more attention. All around the globe, you may get fresh fruit and vegetable salads on hotel menus. Ababio and Lovatt (2014) said that fruits and vegetables are often offered alongside meals since they are sources of vitamins, minerals, and different nutrients necessary for optimal bodily functioning, and yet they only need minor washing and processing. On the other hand, pre-packaged fruit and vegetable salads are a leading cause of gastrointestinal disease and other forms of food poisoning (Abakari *et al.,* 2018). In fact, in the Ghanaian city of Kumasi, Feglo and Sakyi (2012) found a wide range of microbial loads in ready-to-eat meals, including *Staphylococcus aureus*, *Bacillus species*, *Klebsiella pneumoniae*, and *Escherichia coli*. Enteropathogenic bacteria such *Bacillus cereus*, *Escherichia coli*, *Staphylococcus aureus*, *Enterobacteriaceae*, and *Shigella sonnei* have been found in the majority of ready-to-eat meals, as described by Mensah et al. (2015). Commonly known causes of food-borne disease include bacteria including *Salmonella spp*., *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, and *Shigella spp* (Chiang *et al.,* 2016; Bonah, 2014). Food contamination is a leading cause of gastroenteritis epidemics in humans (Mohammad *et al.,* 2011).

More than 4.2 million individuals die annually from food-borne diseases, with bacteria being the main cause, as per the World Health Organization. One-third of all those killed by a food-borne illness were children under the age of five. The World Health Organization estimates that 550 million individuals have diarrhea each year, and 230,000 people die as a result (in 2018). Approximately 70% of cases of diarrhea in Kenya may be traced back to eating or drinking anything tainted.

Workers who prepare, serve, transport, and store food have a significant impact on whether or not customers become sick from eating it. Therefore, proper hand washing is crucial for preventing the transmission of illness and ensuring clean food preparation. Roughly 97% of all cases of food poisoning may be traced back to human error by food workers (Akabanda *et al.,* 2017; Mwangi *et al.,* 2018). Unsafe practices during food preparation and storage increase the risk of raw materials contaminating finished products. Workers in the food industry, whether or not they have had symptoms of gastrointestinal sickness, may be a source of organisms even after they have fully recovered. Therefore, it is essential that all workers in the food business be well-versed in food safety procedures and the causes of food-borne illnesses (Githigia *et al.,* 2021).

Recent cases of food-borne disease have been connected to a variety of factors, including filthy food storage, leftover chicken, and other instances of lax hygiene. Safe food handling procedures may reduce the risk of illness and harm from contaminated food. Both Abd Rahim (2018) and Kamboj *et al*. (2020) stress the importance of preventing sickness by maintaining sanitary conditions around food preparation and storage. While the issue of food safety is of paramount significance in the restaurant industry, many establishments serving traditional cuisine fall short on even the most basic sanitary standards. Customers at Fine Eating Hotels frequently represent a wide cross-section of society, with varying cultural, ethnic, and socioeconomic dining preferences. Since people have different preferences, the restaurants they pick reflect that. Customers assess a restaurant's cost to measure its quality, according to Sarkodie et al., (2022); Kafel and Sikora (2013), because they perceive a more expensive company offers better cuisine and delivers better service. Many restaurant decision factors are highly impacted by restaurant pricing. When picking where to dine, most people underestimate the necessity of cleanliness. Notwithstanding the efforts of various investigators, there is a lack of data on the microbiological safety and quality of fruits and vegetables offered in high-end hotels in Nairobi and Westland, Kenya. Consequently, the present study on the microbiological quality of vegetables and fruits is pertinent and offers data on the safety of taking ready-to-eat fruits and vegetables at these high-end establishments.

5.3 Materials and Methods

5.3.1 Study Site

The research was conducted in Westlands and CBD areas of Nairobi County as defined in part 3.3.1

5.3.2 Research Design

Data from the research population were gathered at a single time point for analysis using a cross-sectional methodology (Busk, 2015). Researchers were able to make educated guesses as to the magnitude of their anticipated outcome using this study's optimal methodology. Fruit and vegetable salad samples were collected for laboratory examination to establish the extent of microbial contamination.

5.3.3 Study Setting

All of the top-tier, two- to five-star hotels in Nairobi's CBD and Westlands neighborhoods served as research locations. The Food Microbiology Laboratory at the University of Nairobi analyzed the samples.

5.3.4 Study Population

Five- to two-star hotels in Nairobi County's Westlands (Kitisuru, Mountain view, Parklands/Highridge, and Karura) and CBD were the focus of the research. According to a December report from the Tourism Regulatory Authority, there were a total of 30 registered hotels in the research region; however, only 15 participated due to either voluntary exclusion or involuntary closure.

5.3.5 Sample Size

The hotels in the research locations exhaustively sampled. Eight hotels in Westlands and seven in the Central Business District were located. For scientific study, we gathered two 250-gram samples of fruit and vegetable salads.

5.3.6 Sampling procedure

A one-month study was done in August 2021, starting with the Central Business District and moving out to Westlands to sample fruit and vegetable salads served at fine dining establishments. It was done throughout the daylight, and samples were given out at the point of service. Each salad sample weighed 250 grams, and it came from upscale hotels. Following collection, each sample was assigned a unique identifier and sent to the lab for testing as quickly as possible (ideally, within 2 hours).

5.3.7 Data collection

Samples of fruit and vegetable salads were taken from high-end restaurants in the Central Business District and Westlands, and their microbiological safety was determined by rapid laboratory testing completed within 24 hours. Salads from high-end hotels were tested for microbiological contamination and their results were compared to industry regulations. Samples of salad were collected in sterile clear tins, transported in cooler boxes, labeled, processed in laboratory glassware, inoculated in petri dishes, cultured in an incubator, and counted using a colony counter.

5.3.8 Analytical Methods

5.3.8.1 Enumeration of Total Viable Counts

We used the standardized technique described in KS ISO 4833-1 to determine the total viable count in both fruit and vegetable salads. After weighing out 25 grams of the materials to be analyzed, we placed them in 225 milliliters of sterile diluent (Oxoid

Buffered Peptone Water) and gave them a gentle shake to produce primary dilution. Pipetting 1 ml of the first dilution into 9 ml of sterile diluent utilizing aseptic method yielded the first serial dilution. The sixth dilution consisted of adding 9 ml of diluent to 1 ml of the preceding dilution.

With a clean pipette, one milliliter of every dilution was then poured to well-labeled petri dishes in ascending order of concentration. Then, 15 ml of tempered Oxoid Standard Plate Count Agar in a VMB-6 water bath was put aseptically. After the media was added, the petri dish's contents were agitated for a total of 25 minutes utilizing 5 back-and-forth motions, 5 clockwise navigations, 5 anticlockwise motions, and 5 back-and-forth motions at right angles to the first set of motions. In a Memmert incubator at 370 degrees Celsius for 48 hours, the petri dishes were flipped once the contents had set.

Colony forming units per milliliter (cfu/ml) were determined after 48 hours in the incubator by counting colonies with a colony counter on standard plate count agar plates. The dilution factor was multiplied by the number of colonies on the selected plates to get the colony-forming units (CFUs), which ranged from 30 to 300.

5.3.8.2 Detection of *Escherichia coli* ISO 9308-1:2014

Samples of fruits and vegetables were examined for the availability of *Escherichia coli* utilizing Chromocult Agar. Carefully combining 25g of the materials under examination with 225ml of sterile diluent (Oxoid Buffered Peptone Water) yielded the major dilution used in the subsequent analysis. Pipetting 1 ml of the first dilution into 9 ml of sterilized diluent utilizing aseptic method yielded the first serial dilution. For the first three dilutions, 1 ml of the concentrated solution was added to 9 ml of diluent every time. A sterile pipette was used to deposit 1 ml of the sample dilutions over the surface of the chromocult agar. After spreading the inoculum throughout the agar plate utilizing a sterile glass spreader, we let the plate dry. *Escherichia coli* was detected by looking at the red colonies that form when the bacteria grow in an inverted culture at 370 degrees Celsius for 24 hours.

5.3.8.3 Enumeration of *Staphylococcus aureus* ISO 6888-1:2018

Confirmed presence of coagulase Each fruit and vegetable salad underwent Staphylococcus aureus testing using the internationally recognized KS ISO 6888-1 standard. For the primary dilution of each sample, 25 grams of the supplied sample was added to 225 milliliters of sterile diluent (Oxoid Buffered Peptone Water) and well mixed. Pipetting 1 ml of the first dilution into 9 ml of sterile diluent utilizing aseptic

method yielded the first serial dilution. One milliliter was added to nine milliliters of diluent up to the sixth dilution.

Each dilution was poured, one milliliter at a time, onto a sterile Baird Parker medium plate using a sterile pipette. After spreading the inoculum using a clean spreader, the plates were set aside to dry. After 48 hours of inversion and 370°C incubation, colonies were seen on the injected plates. First, colonies were located by looking for surrounding "hollow zones;" then, further tests, including coagulase and catalase analysis as well as sugar fermentation, were performed for confirmation. A colony in plasma was taken from the culture and incubated for 6 hours at 370c. Clotting was used as a laboratory technique to produce clots in the presence of positive samples.

5.4 Data Analysis

Colony-forming units per milliliter (cfu ml1) were used to determine bacterial concentrations, and these numbers were then log10 transformed. Genstat version 15 was used to do an ANOVA and determine significance ($P < 0.05$). The threshold for statistical significance according to Turkey's multiple comparison test was a P value of < 0.05.

5.5 Results

5.5.1 Microbial load isolated from fruits samples

TVC, *E. coli*, and *S. aureus* isolates showed statistically significant ($P < 0.05$) variation between hotels (Table 5.1). Every single sample of fruit had germs, albeit the amounts of contamination varied greatly depending on source. Fruit samples taken in the central business district of Nairobi had between 0.72 and 2.48 colony forming units per milliliter of liquid, while those taken in the hotels of Westland contained between 2.16 and 2.48 cfu ml-1 of germs. *E. coli* was found in around 57.1% of CBD samples and 50% of Westland samples. Samples of fruit included anything from 0.05 to 0.87 cfu ml-1 of *E. coli*. It seems that whereas 62.5% of the Westland samples were contaminated. with *S. aureus*, 42.8% of the CBD samples were infected with the bacteria. Detectable amounts of *S. aureus* contamination were from 0.29 and 0.78 cfu ml-1. The greatest levels of *E. coli* were found in fruit samples from Hotels H, F, and I in Nairobi's CBD, whereas the rest of the samples had almost any or no microbiological contaminants at all. Hotel-H (0.98 cfu ml-1) and Hotel-O (0.72 cfu ml-1) had the lowest TVC contamination levels. There were significantly more s*taphylococci* in Hotels A, B, D, E, and J than in any of the other hotels.

Table 5.1 shows Total bacterial counts, *E. coli* and *S. aureus* counts in fruit samples gathered from different hotels (Log_{10}).

Table 5.1: Microbial load isolated from fruit salad

Location	Hotels	Fruits		
		TVC	*E. coli*	*S. aureus*
Nairobi - CBD	Hotel-A	1.93^{e}	0.05^{c}	0.61^{a}
	Hotel-D	2.48^{a}	0.00^{c}	0.77^{a}
	Hotel-F	2.48^{a}	0.69^{a}	0.00^{d}
	Hotel-H	0.98^{f}	0.87^{a}	0.00^{d}
	Hotel-I	1.82^{e}	0.29^{b}	0.00^{d}
	Hotel-K	2.22^{c}	0.00^{c}	0.00^{d}
	Hotel-O	0.72^{g}	0.00^{c}	0.53^{b}
Westland	**Mean**	1.80	0.27	0.27
	Hotel-B	2.16^{cd}	0.00^{c}	0.58^{b}
	Hotel-C	2.25^{c}	0.00^{c}	0.29^{c}
	Hotel-E	2.45^{a}	0.00^{c}	0.78^{a}
	Hotel-G	2.16^{cd}	0.10^{c}	0.00^{d}
	Hotel-J	2.39^{ab}	0.00^{c}	0.60^{b}
	Hotel-L	2.27^{bc}	0.05^{c}	0.00^{d}
	Hotel-M	2.37^{ab}	0.05^{c}	0.48^{b}
	Hotel-N	2.48^{a}	0.00^{c}	0.00^{d}
Mean		2.33	0.03	0.34
LSD (P≤0.05)		0.066	0.108	0.08
P Value		<0.001	<0.001	<0.001
CV (%)		1.9	45.8	17.0

LSD stands for least significant difference, CV is for coefficient of variation, and signifies those letters in a similar row are not substantially not the same ($p \leq 0.05$).

5.5.2 Microbial quantity isolated from vegetable samples

The percentages of *S. aureus* and *E. coli*, as well as the total number of live bacteria, identified in vegetable samples are depicted in Table 5.2. All of the vegetable samples in the table had detectable levels of TVC contamination. Nevertheless, the total quantity of viable bacteria was not consistent across all sampled hotels. The bacterial count of vegetables collected in Nairobi's central business area ranged from 1.20 to 2.47 cfu ml-1. *E. coli* was identified in 42.8% of samples from the Nairobi CBD and 37.5% of

samples from the Westland area. There was a wide range (from 0.05 to 0.77) in the number of *E. coli* found in each milliliter of liquid tested. According to the data in the table, 42.8% of the CBD samples (3/7 vegetables) were tainted with *S. aureus*, while 62.9% of the Westland samples were tainted. Vegetable samples taken in Westland had significantly higher levels of *S. aureus* contamination compared to those taken in the Central Business District. *S. aureus* contamination was found at quantities ranging from 0.07 and 0.85 cfu ml-1. Hotels D and L had the lowest TVC counts, while hotels F, H, and I had the highest. Hotel-F and Hotel-G products from Nairobi's central business area (CBD) and Westland, respectively, had the highest incidence of E. coli. The remaining samples had very few bacteria if any at all. The greatest staphylococcal levels were found in samples from Hotels A, H, and O in the Central Business District and Hotel J in Westlands.

Table 5.2: Microbial load isolated from vegetable salad

Location	Hotels	Vegetables		
		TVC	*E. coli*	*S. aureus*
Nairobi - CBD	Hotel-A	2.25^{abc}	0.23^{cd}	0.75^{bc}
	Hotel-D	1.20^{f}	0.00^{ef}	0.00^{g}
	Hotel-F	2.47^{a}	0.56^{b}	0.00^{g}
	Hotel-H	2.47^{a}	0.25^{cd}	0.78^{ab}
	Hotel-I	2.47^{a}	0.00^{ef}	0.00^{g}
	Hotel-K	2.37^{ab}	0.00^{ef}	0.00^{g}
	Hotel-O	2.47^{a}	0.00^{ef}	1.08^{a}
Westland	**Mean**	2.24	0.14	0.37
	Hotel-B	2.47^{a}	0.00^{ef}	0.07^{fg}
	Hotel-C	2.25^{abc}	0.32^{c}	0.60^{cd}
	Hotel-E	2.13^{cd}	0.00^{ef}	0.00^{g}
	Hotel-G	1.92^{d}	0.77^{a}	0.00^{g}
	Hotel-J	2.45^{a}	0.00^{ef}	0.85^{ab}
	Hotel-L	1.20^{f}	0.00^{ef}	0.00^{g}
	Hotel-M	2.41^{a}	0.05^{ef}	0.23^{fg}
	Hotel-N	1.61e	0.00^{ef}	0.51^{de}
Mean		2.06	0.14	0.28
LSD (P≤0.05)		0.14	0.087	0.135
P Value		<0.001	<0.001	<0.001
CV (%)		3.8	36.3	24.8

LSD stands for least significant difference, CV is for coefficient of variation, and signifies those letters in the same row are not substantially different ($p \leq 0.05$).

5.5.3 Microbial quality of fruits and vegetables

Table 5.3 shows average counts of *E. coli* and *S. aureus* in produce are consistent with a level of microbiological quality that is considered good or even acceptable. Compared to fruit samples, vegetable samples were much more tainted. Because of TVC contamination, the microbiological quality of both vegetable and fruit samples was below standards.

Table 5.3: Microbiological criteria for fruits and vegetables (Log10)

Location	Microorganisms	Mean (cfu ml-1)		Interpretation of microbiological quality [a]
		Fruits	Vegetables	
Nairobi	TVC	1.80	2.33	Unacceptable [b]
	E. coli	0.27	0.03	Satisfactory
	S. aureus	0.27	0.34	Satisfactory
Westland	TVC	2.24	2.06	Unacceptable [b]
	E. coli	0.14	0.14	Satisfactory
	S. aureus	0.37	0.28	Satisfactory

a Gilbert *et al*., 2000. b Unfit for consumption

Figure 5.1 visually shows the distribution of E. coli, S. aureus and total viable counts through display of the quartiles and the averages. According to the figure the highest average population of *E. coli*, *S. aureus* and total viable counts was recorded from samples collected from CBD and lowest average population of these microbes was recorded from samples collected from Westlands Nairobi.

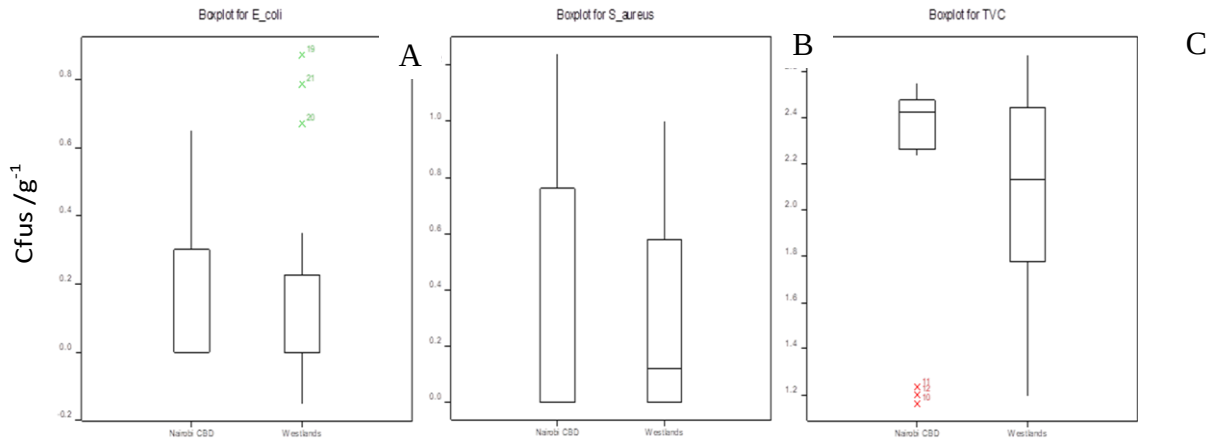


Figure 5.1: Distribution of microbial organisms: (A) E. coli (B) Staphylococcus aureus, (C) Total viable count

5.6 Discussion

5.6.1 Microbial contaminants in fruits

In the present experiment, microbial contamination of fruits and vegetables from a range of Nairobi hotels (2-5 stars) was detected. Pathogens like *Escherichia coli* and *Staphylococcus aureus* were among the microbes found in the polluted environment.

Isolated bacterial counts spanned from 0.72 to 2.48 CFU ml-1 on fruit samples collected in Nairobi's Central Business District and Westland, respectively. The bacterial counts in this research are similar to, but do not quite equal, the values reported by Uze et al. (2019), Bukar *et al.* (2015), and Eni *et al.* (2018). These findings corroborate the findings of Chuwku *et al.* (2016), who found that over 90% of the pre-cut fruits tested positive for the existence of bacteria that can cause sickness. The presence of microorganisms on fruit may provide insight on its storage conditions and handling history (Eni et al., 2018). However, Chukwu et al. (2016) hypothesized that the bacteria might have been introduced during production and distribution and could grow over time dependent on storage conditions (Abadias et al., 2018).

The levels of *Escherichia coli* and *Staphylococcus aureus* in fruit samples ranged from 0.05 to 0.87 cfu ml-1 and 0.29 to 0.78 cfu ml-1, respectively. The observed higher levels of *staphylococcal* counts (SCs) in fruit juices align with the findings of previous studies conducted by Rashed et al. (2013) and Ahmed et al. (2009), which were attributed to unhygienic preparation of food, especially fruit juices.

There was *E. coli* contamination discovered in 5.7 percent of CBD samples and 50% of Westland samples. In CBD, *S. aureus* was found in 42.8% of samples while in Westland, it was found in 62.5% of samples. Consistent with earlier studies that identified *E. coli, S. aureus,* or both from fresh produce (Kothe *et al.,* 2019; Al-Kharousi et al., 2016; Estrada et al., 2014; Eni et al., 2018; Harris et al., 2003), our findings support the safety of eating raw vegetables. *E. coli* O157:H7 was identified in a high percentage of fresh vegetable samples tested in Norway (Johansen et al., 2012). Independent Canadian study also discovered *E. coli* O157:H7 in a food sample (Johnston *et al.,* 2012). The authors state they saw proof that contamination affected every link in the value chain. Consequently, identifying these bacteria is essential for developing strategies to prevent and control their spread (Fan and Song, 2018). Pathogenic *Escherichia coli* and *Staphylococcus aureus* are a persistent threat to human health, and they can be lurking in your produce drawer.

The microbial count varied between hotel categories and geographical areas. Fruit samples gathered from hotels in Nairobi's central business district (CBD) exhibited elevated levels of *E. coli* and *staphylococci*; hotels H and O had the lowest TVC contamination, while hotels A, B, D, E, and J had the highest. Gomez-Govea et al. (2012) observed that the quantities of microorganisms were not impacted by the stores or locations from where the samples were obtained.

5.6.2 Microbes isolated from vegetable samples

There was TVC in every single sample of vegetables. Even still, the total number of viable bacteria was not a constant between hotels. Bacteria concentrations in Nairobi Central Business District fruit samples ranged from 1.20 to 2.47 cfu ml-1. From 0 to 0.77 *E. coli* were found per milliliter of fluids. Avazpour *et al. (*2013) also observed that these viruses were present in prepared salad vegetables offered at various restaurants in Ilam, Nepal, therefore our results are consistent with theirs. Orozco *et al.* (2017) also reported data on vegetable contamination, which they found included tomatoes. According to Herman *et al.* (2018) and Seow *et al. (*2012), *E. coli* O157:H7 is the highly isolated pathogenic bacterium from raw food. Many different types of food poisoning have been related to pathogens like *E. coli* O157:H7 and other microorganisms isolated from fresh vegetables. Raw vegetable eating has been connected to food poisoning (Seow *et al.,* 2012). Okoko *et al.* (2012), Luna-Guevara *et al.* (2019), Ganeshan and Neetoo (2014), and others have shown that enterobacteria may infect vegetables via irrigation water and handlers, posing a threat to public health. (2015). Produce like vegetables have a higher potential for contamination because of the frequent utilization of low-quality water in agriculture.

More than 62 percent of samples in Westland and 42.8% of samples in CBD showed signs of contamination with *S. aureus*, with contamination levels spanning from 0.07 to 0.85cfu ml-1. Anjay *et al.* (2016) reported that *S. aureus* was present in around 60% of commonly used salad vegetables and fruits, therefore our results are in line with their findings. Our results are similar with those of previous studies by El-Hadedy and El-Nour (2012), Razzaq *et al.* (2014), Anjay *et al.* (2016), and Saifullah *et al.* (2017), all of which noted contamination in vegetables and fruits. Saifullah et al. (2017) conducted further tests that confirmed *S. aureus* was present in the samples. *Staphylococcus aureus*, a major cause of food poisoning, has been found in many different foods, including raw vegetables (El-Hadedy and El-Nour, 2012). It is possible that it produces a broad range of toxins, which is what ultimately poisons people. While pathogen-free produce would be ideal, the *S. aureus* contamination level was below 4log10cfu/g, making the produce safe to consume. Since the study offered a good estimate of the contamination levels, it was concluded that the hotel food was probably safe to consume. If their numbers increase to a certain threshold, these bacteria may make plants toxic (Fernandez, 2018). The nutrients released by freshly cut produce are used by pathogens, creating ideal circumstances for the development and survival of these

pathogens, which has a negative effect on the quality of the bacteria present (Heaton and Jones, 2007). Saifullah *et al. (*2017) claim that irrigation water, harvest hygiene, and storage conditions all impact the quality of the microorganisms in fruits and vegetables. Khalil (2011) found that microbial contamination was aided by the fact that it was collected, stored, and transported in filthy settings. Several factors, some of which are connected to one another thus resulting with product contamination, impact the presence and spread of germs that cause food poisoning. The findings of a study comparing the hotels in terms of air pollution were inconsistent. Samples from hotels F, H, I, and J had high levels of TVC, whereas samples of vegetables from hotels F in Nairobi's central business district and G in Westland had high levels of *E. coli*. The greatest *staphylococcal* levels were discovered in hotels A, H, and O in the Central Business District and Hotel-J in Westland. Hygiene during handling and storage is likely to blame for the variable quantities of *S. aureus* seen in hotels.

The findings agree with the suggestions for enhancing the microbiological quality of fresh vegetables given by Gilbert et al. (2000). Total coliform (TC) < 104 cfu ml-1, faecal coliform (FC) < 102 cfu ml-1, and total viable count (TVC) < 102 cfu ml-1 are all considered to be within acceptable ranges by Gilbert et al. (2020). All of the selected products had total viable counts of bacteria (cfu ml-1) that were below the acceptable range for *E. coli* and *S. aureus*. The findings fall within the allowed limits of the International Commission on Microbiological Specifications for Foods (ICMSF) for mean aerobic counts of 0 to 103, bacterial counts of 104 to 105, and bacterial counts of more than 108. (ICMSF, 2016). This study suggests that the level of contamination as detected may be within safe parameters.

5.7 Conclusion and recommendations

Even though the hygiene quality of the hotels varied, this research found that the fruits and vegetables obtained from all of them were contaminated to some degree. The boundaries, however, fell within the realm of acceptability. Vegetables and fruits that haven't been heated provide a potential health risk because of the presence of *E. coli* and *S. aureus.* Bacterial contamination of fresh produce may vary greatly depending on the kind of produce, as well as on how the produce is prepared, handled, and stored. Therefore, more sanitary care must be taken with the produce from the farm to the table. A few of the food safety control steps that hotels may take to guarantee their guests eat

safe food include using safe agricultural techniques, safe manufacturing processes, safe hygiene standards, and establishing food safety management systems.

Even though the levels of contamination found in the fruit and vegetable salads served at these hotels were well within acceptable levels, it is still recommended that food handlers get regular training on food hygiene, safety, and standards in order to prevent the contamination of foods with the widespread microorganisms that can cause foodborne diseases. In addition, management has to make sure that the trainings are scheduled at times that are convenient for everyone who works with food.

CHAPTER SIX: GENERAL DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

6.1 Discussions

The majority of occurrences of illnesses that are thought to have been caused by food may be linked to carelessness or incorrect handling of food. As per the outcomes of this research, a big percentage of individuals have received training as food handlers. Ifeadike *et al.* (2020) came to similar conclusions; they discovered that 72.7 percent of the individuals who took part had attended secondary school or above, whereas 27.3 percent had only completed elementary school. The large percentage of individuals who took part in this survey had at least a bachelor's degree, which suggests that they have a solid education and are capable of performing the duties that are expected by the sector. This conclusion is in accordance with the outcomes of a study that was carried out by Moghnia *et al., (*2021), who discovered that people who dealt with food had extremely high levels of literacy. There is compelling evidence to imply that the majority of respondents were aware of control point HACCP and food handling regulations. Despite this, only two phases in the food flow were evaluated as being highly probable to lead to food contamination: storage and consumption of remaining food.

It has been shown that characteristics such as job title, length of service, and level of education have a major part in establishing whether or not high-end hotels' compliance with food safety management systems and cleanliness requirements. The findings suggest that Kenya's fine dining restaurants often maintain strong hygienic standards (Mekesha *et al.,* 2016). This is because appropriate personal cleanliness and food handling procedures are crucial in reducing the transfer of illnesses from food handlers to the customers. The results of this research are in accordance with the findings of Fawzi and Mona (2019), who demonstrated that the highest levels of food safety awareness were connected with dining out and the lowest levels were linked to personal hygiene. The findings of this study are compatible with those of Fawzi and Mona (2019). This is most likely the result of inadequate training brought on by the fact that the majority of today's food safety programs focus an excessive amount of stress on students' ability to do well on exams rather than on instructing them in the correct way to handle food (MacAuslan, 2013).

According to the findings of the study, these hotels adhered to the Public Health Act, which resulted in their having better levels of cleanliness. The majority of hotels complied with safe food holding standards since their customers had a high level of literacy on the proper way to store hot meals. However, research that was carried out in China found that restaurants that served regional delicacies did not adhere to the same standards of hygiene as more typical eating places (Watiki, 2014). According to Saadat *et al.'s* research from 2020, keeping the best possible levels of food hygiene requires having a HACCP system that is specifically designed to meet the requirements of the industry in question. This is particularly important for urban food enterprises. The lack of HACCP understanding among the workforce at these hotels demonstrates the evident need for HACCP and food system training at these establishments. According to Spencer (2017), the HACCP system is a quick and simple method that may be used to execute corrective and preventative actions on the manufacturing lines of any food product. As a consequence of this, it is of the utmost importance to initiate and develop HACCP system training as an efficient food hygiene program.

Samples of fresh fruit and vegetables from many five-star hotels in Nairobi were positive for *Escherichia coli* and *Staphylococcus aureus* in the present research. Despite not matching the levels noted by Uze *et al. (*2019), Bukar *et al.* (2015), and Eni *et al.* (2018), the bacterial counts in this research are similar to those discovered in prior studies. Experiments in which *E. coli*, *S. aureus*, or both were isolated from raw vegetables and fruits yielded similar findings (Kothe *et al.*, 2019; Al-Kharousi et *al.*, 2016; Estrada *et al.*, 2014). Many different types of food poisoning have been related to microorganisms like *E. coli* O157:H7 and other microorganisms kept away from fresh vegetables. Okoko *et al. (*2012), Luna-Guevara *et al.* (2019), and Ganeshan and Neetoo, 2019. (2015) show that the existence and incidence of *E. coli* in fruits and vegetables is an issue of public health because of enterobacteria contamination by means of irrigation water and food handlers (Lopez-Galvez *et al.*, 2014). Produce like vegetables have a higher potential for contamination because of the frequent utilization of low-quality water in agriculture.

Nonetheless, the p-value is too high to be regarded statistically significant (0.173 > 0.05), therefore the positive correlation between tenure and compliance with food safety management systems and hygiene laws (r = 0.034) is not. The vast majority of respondents (96%) were aware with the phrase "control point" HACCP, and over 70% believed that hotel fare was made strictly in line with HACCP principles. Of those who

work with food, just 46.34% can name HACCP as a quality regulation approach, whereas 53.66% had never heard of it. This demonstrates the need of developing a HACCP system that is adapted to the unique demands of each industry, and in particular urban food enterprises, to guarantee the greatest possible levels of food safety (Saadat *et al.,* 2020). When it comes to food safety, the HACCP system (Hazard Analysis and Critical Control Points) is paramount. Sprenger (2017) emphasizes that HACCP is an effective technique because it can be swiftly adopted on the production lines of all foods, and since the food safety system was built to allow the flow of information for preventative and remedial activities. The implementation of verification and documentation processes also ensures the safety of employees.

6.2 Conclusions

The findings of this study reveal that the education level, occupational status, number of years in the food business, and hotel where food handlers work all have a substantial impact on the likelihood that they will follow all applicable food safety management system and hygiene criteria. Staff that have received enough training are able to effectively and efficiently prepare, cook, and serve food by adhering to all applicable regulations. This research also found no correlation between food handlers' demographics (gender, age, length of service) and their adherence to fine dining hotels' food safety management systems or cleanliness regulations. Preparation guidelines for fresh produce have a close relationship to food safety management systems. Findings also suggest that these hotels employ staff versed in HACCP and the best methods for cooking meals including fresh produce. Even though the quality of the hotels varied, this research found that the fruits and vegetables obtained from all of them were contaminated to some degree. Yet the confines were tolerable. Vegetables and fruits that have been heated provide a potential health risk because of the presence of *E. coli* and *S. aureus*. Different types of produce, as well as how they are handled and stored, have varying degrees of bacterial contamination. Therefore, more sanitary care must be taken with the produce from the farm to the table. Excellent farming practices, good manufacturing methods, good hygiene standards, and the establishment of food management systems are all examples of food safety control measures that hotels may use to ensure they are providing their customers with safe food. Findings from this research may be used to push for HACCP trainings and other programs that teach people how to handle food safely and hygienically. Workers in the food industry have said that

they are unable to comply with food safety management systems because of the high volume of work and time constraints they face.

6.3 Recommendations

- Training in food hygiene and safety is essential for any business serving the public. Therefore, it is important to offer food handlers with the training and resources they need to address food safety and hygiene concerns within their sphere of influence.
- The hotels should ensure their staffs are well trained for them to be able to comply with all guidelines set when preparing, cooking, and serving food in their respective hotels. These trainings should be done on annual basis to ensure all employees clearly understand guidelines.
- The hoteliers should ensure that certifications are affordable for their employees and should focus on establishing proficiency in food hygiene rather than obtaining certificates.
- Campaigns to educate the public about food safety are needed. Posters, the media, and public relations campaigns may all play a role in informing those who work with food about the risks posed by pathogens like *Escherichia coli* and *Staphylococcus aureus*.
- To guarantee that rules regarding the use of HACCP systems and hygiene standards are being followed, the appropriate authorities should conduct regular inspections.

REFERENCES

Ababio, P. F., & Lovatt, P. (2015). A review on food safety and food hygiene studies in Ghana. Food Control, 47, 92-97.

Abadias M, Usall J, Anguera A, Solsona C, Viñas I (2018). Microbiological quality of fresh, minimally-processed fruit and vegetables, and sprouts from retail establishments. Int. J. Food Microbiol., 123: 121–129

Abadias M, Usall J, Anguera A, Solsona C, Viñas I (2008). Microbiological quality of fresh, minimally-processed fruit and vegetables, and sprouts from retail establishments. Int. J. Food Microbiol., 123: 121–129

Abakari, G., Cobbina, S. J., & Yeleliere, E. (2018). Microbial quality of ready-to-eat vegetable salads vended in the central business district of Tamale, Ghana. International Journal of Food Contamination, 5(1), 1-9.

Abd Rahim, S. I., Mansor, S. K. M., Yakob, M. A., & Ismail, N. (2018). Food safety, sanitation and personal hygiene in food handling: an overview from Islamic perspective. International Journal of Civil Engineering and Technology (IJCIET), 9(9), 1524-1530.

Adane, M., Teka, B., Gismu, Y., Halefom, G., & Ademe, M. (2018). Food hygiene and safety measures among food handlers in street food shops and food establishments of Dessie town, Ethiopia: A community-based cross-sectional study. PloS one, 13(5), e0196919.

Ahmad M.U.D., Sarwar A., Najeeb M.I., Nawaz M., Anjum A.A., Ali M.A., Mansur N. (2013). Assessment of microbial load of raw meat at abattoirs and retail outlets. Journal of Animal and Plant Science, 23:745–748.

Ahmed, M. S. U., Nasreen, T., Feroza, B., & Parveen, S. (2009). Microbiological quality of local market vended freshly squeezed fruit juices in Dhaka city, Bangladesh. Bangladesh Journal of Scientific and Industrial Research, 44(4), 421-424.

Akabanda, F., Hlortsi, E. H., & Owusu-Kwarteng, J. (2017). Food safety knowledge, attitudes and practices of institutional food-handlers in Ghana. BMC public health, 17(1), 1-9.

Akbar, Y.A.A. & Alaudeen, M.S.S. (2012). Determinant of factors that influence consumer in choosing normal full-service restaurants: Case in Seri Iskandar, Perak. South East Asian.Journal of Contemporary Business, Economics and Law, 1(4): 137-145.

Akonor, P. T., & Akonor, M. A. (2013). Food Safety Knowledge: The case of Domestic Food Handlers in Ghana 3(3), 99-110.

Al-Kharousi ZS, Guizani N, Al-Sadi AM, Al-Bulushi IM, Shaharoona B (2016). Hiding in fresh fruits and vegetables: opportunistic pathogens may cross geographical barriers. Int J Microbiol 2016: 14

Al-Busaidi, M. A., Jukes, D. J., & Bose, S. (2017). Hazard analysis and critical control point (HACCP) in seafood processing: An analysis of its application and use in regulation in the Sultanate of Oman. Food control, 73, 900-915.

Al-Kandari, D., Al-abdeen, J., & Sidhu, J. (2019). Food safety knowledge, attitudes and practices of food handlers in restaurants in Kuwait. *Food Control*, *103*(April), 103–110. https://doi.org/10.1016/j.foodcont.2019.03.040Al-Kandari, D., Al-abdeen, J., & Sidhu, J. (2019). Food safety knowledge, attitudes and practices of food handlers in restaurants in Kuwait. *Food Control*, *103*(April), 103–110. https://doi.org/10.1016/j.foodcont.2019.03.040

Angellillo, I. F., Viggiani, N. M. A., Rizzo, L., & Bianco, A. (2017). Food handlers and food-borne diseases: Knowledge, attitude and reported behavior in Italy. Journal of Food Protection 63(3), 381-385.

Anjay, P. Kaushik, S. Kumari., S. Kumari1 and N. Kumari. 2016. Occurrence of Staphylococcus aureus in Vegetables and Fruits Salad Food. J. Vet. Pub. Hlth, 14 (2): 89-91

APHA (American Public Health Association) (2008) Standard methods for the examination of water and wastewater (19th Edition). American Public Health Association (APHA), Washington, DC Microbiological Quality of selected street vended foods in Port Harcourt metropolis, Rivers State, Nigeria C

Asfaw, S., Mithöfer, D., & Waibel, H. (2009). EU food safety standards, pesticide use and farm-level productivity: The case of high-value crops in Kenya. Journal of Agricultural Economics, 60(3), 645-667.

Bello M., Lawan M.K., Kwaga J.K.P., Raji M.A. (2011). Assessment of carcass contamination with E. coli O157 before and after washing with water at abattoirs in Nigeria. International Journal of Food Microbiology, 150:184–186.

Bergdoll, M. S. (2017). Staphylococcus aureus. Journal of the Association of Official Analytical Chemists, 74(4), 706-710.

Bisholo, K. Z., Ghuman, S., & Haffejee, F. (2018). Food-borne disease prevalence in rural villages in the Eastern Cape, South Africa. African Journal of Primary Health Care and Family Medicine, 10(1), 1-5.

Bukar A, Uba A, Oyeyi TI (2015). Occurrence of some enteropathogenic bacteria in some minimally and fully processed ready - to - eat foods in Kano metropolis, Nigeria. Afr. J. Food Sci., 4(2): 32-36.

Bunei, E., Barclay, E., & Kotey, B. (2021). Routine activity theory and farm produce sale in Kenya: An analysis of non-compliance with agri-food safety laws. Crime Prevention and Community Safety, 23(4), 400-415.

Busk, P. L. (2015). Cross-sectional design. Encyclopedia of statistics in Behavioral Science.

Coker, C., Greene, E., Shao, J., Enclave, D., Tula, R., Marg, R., Jones, L., Hameiri, S., Cansu, E. E., Initiative, R., Maritime, C., Road, S., Çelik, A., Yaman, H., Turan, S., Kara, A., Kara, F., Zhu, B., Qu, X., … Tang, S. (2018). No 主観的健康感を中心とした在宅高齢者における 健康関連指標に関する共分散構造分析Title. *Transcommunication*, *53*(1), 1–8. http://www.tfd.org.tw/opencms/english/about/background.html%0Ahttp://dx.doi.org/10.1016/j.cirp.2016.06.001%0Ahttp://dx.doi.org/10.1016/j.powtec.2016.12.055%0Ahttps://doi.org/10.1016/j.ijfatigue.2019.02.006%0Ahttps://doi.org/10.1016/j.matlet.2019.04.024%0A

Carron, M., Chang, Y. M., Momanyi, K., Akoko, J., Kiiru, J., Bettridge, J., ... & Häsler, B. (2018). Campylobacter, a zoonotic pathogen of global importance: Prevalence and risk factors in the fast-evolving chicken meat system of Nairobi, Kenya. PLoS neglected tropical diseases, 12(8), e0006658.

Chlebicz, A., & Śliżewska, K. (2018). Campylobacteriosis, salmonellosis, yersiniosis, and listeriosis as zoonotic foodborne diseases: a review. International journal of environmental research and public health, 15(5), 863.

Chiang, Y. C., Yang, C. Y., Li, C., Ho, Y. C., Lin, C. K., & Tsen, H. Y. (2016). Identification of Bacillus spp., Escherichia coli, Salmonella spp., Staphylococcus spp. and Vibrio spp. with 16S ribosomal DNA-based oligonucleotide array hybridization. International Journal of Food Microbiology, 107(2), 131-137.

Chen, C., Yang, J., & Findlay, C. (2008). Measuring the effect of food safety standards on China's agricultural exports. Review of World Economics, 144(1), 83-106.

Choyam, S., Srivastava, A. K., Shin, J. H., & Kammara, R. (2019). Ocins for food safety. Frontiers in microbiology, 10, 1736.

Chukwuocha, U.M.,, Dozie, I.N., Amadi, A.N., Nwankwo, B.O., Ukoga, C. N., Aguwa, O. C., Abanobi, O. C., &, Nwoke, E. A. (2019). The knowledge, attitude and practice of food handlers' in food sanitation in a metropolis in South Eastern Nigeria: East Africa Journal of Public Health, 6 (3): 240-243

Chukwu, C. O. C., Chukwu, I. D., Onyimba, I. A., Umoh, E. G., Olarubofin, F., & Olabode, A. O. (2016). Microbiological quality of pre-cut fruits on sale in retail outlets in Nigeria.

Das, A. K., Nanda, P. K., Das, A., & Biswas, S. (2019). Hazards and safety issues of meat and meat products. In *Food Safety and Human Health*. Elsevier Inc. https://doi.org/10.1016/B978-0-12-816333-7.00006-0

DeBeer, J., Bell, J. W., Nolte, F., Arcieri, J., & Correa, G. (2021). Histamine Limits by Country: A Survey and Review. Journal of Food Protection.

Demis, A. B., Alemnew, B., Gedefaw, G., & Diress, G. (2019). Prevalence and factors associated with intestinal parasitic infections among food handlers working at higher public University student's cafeterias and public food establishments in Ethiopia: a systematic review and meta-analysis.

Derso, T., Tariku, A., Ambaw, F., Alemenhew, M., Biks, G. A., & Nega, A. (2017). Socio-demographic factors and availability of piped fountains affect food hygiene practice of food handlers in Bahir Dar Town, northwest Ethiopia: a cross-sectional study. BMC research notes, 10(1), 1-7.

Dinges, M. M., Orwin, P. M., & Schlievert, P. M. (2020). Exotoxins of Staphylococcus aureus. Clinical microbiology reviews, 13(1), 16-34.

Dione, M. M., Diarra, S., Ilboudo, G., Konkobo-Yameogo, C., Lallogo, V. R., Roesel, K., ... & Knight-Jones, T. J. (2021). Value chain assessment of animal-source foods and vegetables in Ouagadougou, Burkina Faso–Considering food safety, quality, and hygiene perceptions and practices. ILRI Research Report.

Dzwolak, W. (2019). Assessment of HACCP plans in standardized food safety management systems–the case of small-sized Polish food businesses. Food Control, 106, 106716.

Draper, A. (1996). Street foods in developing countries: the potential for micronutrient fortification (pp. 3-4). John Snow, Incorporated, OMNI PROJECT.

Echols, M. (2001). Food safety and the WTO: the interplay of culture, science and technology. Kluwer Law International BV.

Egan, M.B., Raats, M.M., Grubb, S.M., Eves, A., Lumbers, M.L., Dean, M.S. & Adams, M.R. (2006). A Review of Food Safety and Food Hygiene Training Studies in the Commercial Sector. Food Control, 18, 1180-1190. Retrieved from: doi: 10.1016/j.foodcont.2006.0 8.001.

Ehiri JE, Morris GP (2017). Hygiene training and education of food handlers: does it work? Ecol. Food and Nutrition. 6, 341–345.

El-Hadedy, D. and El-Nour, S.A. 2012. Identification of *Staphylococcus aureus* and *Escherichia coli* isolated from Egyptian food by conventional and molecular methods. J. Genet. Eng. Biotechnol., 10: 129-135.

El-Hadedy, D., & El-Nour, S. A. (2012). Identification of Staphylococcus aureus and Escherichia coli isolated from Egyptian food by conventional and molecular methods. Journal of Genetic Engineering and Biotechnology, 10(1), 129-135.

Eni, A. O., Oluwawemitan, I. A., & Solomon, O. S. (2010). Microbial quality of fruits and vegetables sold in Sango. *African Journal of Food Science*, *4*(May), 291–296.

Enz, C. A. (2014). Issues of concern for restaurant owners and managers [Electronic version].

Estrada CS, Alcaráz LE, Satorres SE, Manfredi E, Velázquez LC (2014). Presence of enterotoxigenic Staphylococcus aureus in artisan fruit salads in the city of San Luis, Argentina. Braz J Microbiol 44: 1155-1161

Fan, L., & Song, J. (2018). Microbial quality assessment methods for fresh-cut fruits and vegetables. Stewart Postharvest Rev, 4(3), 1-9.

Fawzi, M., & Mona E. S. (2009). Food Safety Knowledge and Practices among Women Working in Alexandria University, Egypt. Egypt Public Health Asso,.84, 1-2.

Feglo P, Sakyi K. Bacterial contamination of street vending food in Kumasi, Ghana. Journal of medical and biochemical sciences. Food Control. 2012;1(1):1–8. 47: 92–97

Fernández E (2008). Microbiología e inocuidad de losalimentos. Universidad Autónoma de Querétaro. Querétaro, México: Segundaedición.

Foster, T. J., & Geoghegan, J. A. (2015). Staphylococcus aureus. Molecular Medical Microbiology, 655-674.

Forum, I. of M. (US) F. (2001). Food Safety Policy, Science, and Risk Assessment: Strengthening the Connection. In *Food Safety Policy, Science, and Risk*

Assessment: Strengthening the Connection: Workshop Proceedings. http://www.ncbi.nlm.nih.gov/pubmed/25057547

Garner C & Nunn, (1995): The Australian National Animal Health Information System Epidemiology. Sanitation of Animals, 27: 143–160.

Gathura, P. B., Obura, B., Muthuma, E., Mariach, N., Mkanga, B., Koigi, R., & Lolokote, S. (2020). Situational analysis of safety of animal-source foods, fruits and vegetables in Kenya.

Gessner B.D, Beller M., (2014): Protective effect of conventional cooking versus use of microwave ovens in an outbreak of salmonellosis. American Journal of Epidemiology, 1994, 139:903-909.

Githigia, S. M., Murungi, M. K., Muloi, D. M., Muinde, P., Akoko, J., Fèvre, E. M., ... & Alarcon, P. (2021). The Nairobi Pork Value Chain: Mapping and Assessment of Governance, Challenges, and Food Safety Issues.

GoK (2005): Ministry of Health Annual Medical Report (805).

Grace, D. (2017). Food safety in developing countries: research gaps and opportunities.

Grace, D., Alonso, S., Bett, B., Lindahl, J., Patel, E., Nguyen-Viet, H., ... & Dominguez-Salas, P. (2020). 9 Food Safety and Nutrition. The Impact of the International Livestock Research Institute, 338.

Guzewich, J. J. (2018). Practical procedures for using the hazard analysis critical control point (HACCP) approach in food service establishments by industry and regulatory agencies. In Food Protection Technology (pp. 91-100). CRC Press

Ghartey, A. F. (2019). Street–Vended Food: Risk Factors and Regulations' Enforcement in Selected Districts of Central Region, Ghana (Doctoral dissertation, University of Cape Coast).

Gilbert, R.J., de Louvois, J., Donovan, T., Little, C., Nye, K., Ribeiro, C.D., Richards, J., Roberts, D., Bolton, F.J. 2020. Guidelines for the microbiological quality of some ready-to-eat foods sampled at the point of sale. Communicable Disease and Public Health 3, 163–167.

Githigia, S. M., Murungi, M. K., Muloi, D. M., Muinde, P., Akoko, J., Fèvre, E. M., ... & Alarcon, P. (2021). The Nairobi Pork Value Chain: Mapping and Assessment of Governance, Challenges, and Food Safety Issues.

Gomes, T. A., Elias, W. P., Scaletsky, I. C., Guth, B. E., Rodrigues, J. F., Piazza, R. M., ... & Martinez, M. B. (2016). Diarrheagenic escherichia coli. brazilian journal of microbiology, 47, 3-30.

Harris LJ, Farber JN, Beuchat LR, Parish ME, Suslow TV, Garrett EH, Busta FF (2003) Outbreaks associated with fresh produce: incidence, growth, and survival of pathogens in fresh and fresh cut produce. Compr Rev Food Sci F 2: 78 – 141

Hume, S. (2005). Basics training. Restaurants and Institutions, 56, 85-86. Retrieved from EBSCOHOST database.

Jaja, I. F., Green, E., & Muchenje, V. (2018). Aerobic mesophilic, coliform, Escherichia coli, and Staphylococcus aureus counts of raw meat from the formal and informal meat sectors in South Africa. International Journal of Environmental Research and Public Health, 15(4), 819.

Jang, S. S., & Namkung, Y. (2009). Perceived quality, emotions, and behavioral intentions: Application of an extended Mehrabian–Russell model to restaurants. Journal of business research, 62(4), 451-460.

Johannessen, G. S., Loncarevic, S., & Kruse, H. (2002). Bacteriological analysis of fresh produce in Norway. International Journal of Food Microbiology, 77, 199e204.

Johnston LM, Jaykus L, Moll D, Martinez MC, Anciso J, Mora B and Moe CL. 2005. A field study of the microbiological quality of fresh produce. Journal of Food Protection, 68:840–1847.

Johnston, L. M., Jaykus, L.-A., Moll, D., Anciso, J., Mora, B., & Moe, C. L. (2006). A field study of the microbiological quality of fresh produce of domestic and Mexican origin. International Journal of Food Microbiology, 112, 83e95

Kafel, P., & Sikora, T. (2013). Food safety systems' functioning in polish networks of grocery stores. Management systems in production engineering.

Kafel P, Sikora T (2013). The usage of quality management methods and tools in food sector organizations. Food Science Technology Quality 1(86):204-216.

Kaper, J. B., Nataro, J. P., & Mobley, H. L. (2019). Pathogenic escherichia coli. Nature reviews microbiology, 2(2), 123-140.

Kamboj, S., Gupta, N., Bandral, J. D., Gandotra, G., & Anjum, N. (2020). Food safety and hygiene: a review. International Journal of Chemical Studies, 8(2), 358-368.

Katie, F. & Douglas, A. Powell. (2017). The use of restaurants' inspections disclosure system as a means of communicating food safety information. Journal of food service, 20 (6):287-297

Kibitok, S. K., & Ndoku, J. M. (2016). Journal of Food Safety and Hygiene Evaluation of microbial contamination of consumed fruits and vegetables salad (

Kachumbari) around Egerton University , Kenya. *Journal of Food Safety and Hygiene*, *2*(1), 3–6.

King, T., Cole, M., Farber, J. M., Eisenbrand, G., Zabaras, D., Fox, E. M., & Hill, J. P. (2017). Food safety for food security: Relationship between global megatrends and developments in food safety. Trends in Food Science & Technology, 68, 160-175.

Kivelä, T. (2009). The epidemiological challenge of the most frequent eye cancer: retinoblastoma, an issue of birth and death. British Journal of Ophthalmology, 93(9), 1129-1131.

Kinuthia, G. K., Ngure, V., & Kamau, L. (2021). Urban mosquitoes and filamentous green algae: their biomonitoring role in heavy metal pollution in open wastewater channels in Nairobi, Kenya.

Kinyanjui, C. N. (2018). Strategic Management Practices And Competitive Advantage Of International Hotels In Nairobi City, Kenya (Doctoral dissertation, University of Nairobi).

Kinyingi, J. W. (2020). Influence of Quality Catering Services on Food Safety in Children Day Care Centres, Nyeri Town Constituency, Nyeri Kenya (Doctoral dissertation, Karatina University).

Kisembi, R. M. (2010). Hygiene Practices in Urban Restaurants: Investigating Possibilities of Introducing HACCP Systems in Thika Town (Doctoral dissertation, School of Hospitality and Tourism Management in Partial Fulfilment of the Requirements for the Degree of Master of Science in Hospitality and Tourism Management, Kenyatta University,).

Khalil S (2011). Agricultural use of untreated urban wastewater in Pakistan. Asian Journal of Agriculture and Rural Development 1(1): 21.

Khuluse, D. S. (2016). Food hygiene and safety practices of food vendors at a University of Technology in Durban (Doctoral dissertation).

Kothe, C. I., Pessoa, J. P., Malheiros, P. S., & Tondo, E. C. (2019). Assessing the growth of *Staphylococcus aureus* and *Escherichia coli* on fruits and vegetables. The Journal of Infection in Developing Countries, 13(06), 480-486.

Kotsanopoulos, K. V., & Arvanitoyannis, I. S. (2017). The role of auditing, food safety, and food quality standards in the food industry: A review. Comprehensive reviews in food science and food safety, 16(5), 760-775.

Kushwah, A., & Kumar, R. (2017). HACCP–its need and practices. Acta Chemica Malaysia, 1(2), 01-05.

Kisembi, R. M. (2010). Hygiene Practices in Urban Restaurants: Investigating Possibilities of Introducing HACCP Systems in Thika Town (Doctoral dissertation, School of Hospitality and Tourism Management in Partial Fulfilment of the Requirements for the Degree of Master of Science in Hospitality and Tourism Management, Kenyatta University,).

Kotsanopoulos, K. V., & Arvanitoyannis, I. S. (2017). The role of auditing, food safety, and food quality standards in the food industry: A review. Comprehensive reviews in food science and food safety, 16(5), 760-775.

Khuluse, D. S. (2016). Food hygiene and safety practices of food vendors at a University of Technology in Durban (Doctoral dissertation).

Kushwah, A., & Kumar, R. (2017). HACCP–its need and practices. Acta Chemica Malaysia, 1(2), 01-05.

KNBS. (2023). Demographic and Health Survey 2022. *Demographic and Health Survey 2022*, 1–23.

Kunyanga, C. N., Amimo, J. O., Njue, L., Chemining'wa, G. N., Kunyanga, C., Amimo, J., Njue, L. K., & Chemining'wa, G. (2018). *Consumer Risk Exposure to Chemical and Microbial Hazards Through Consumption of Fruits and Vegetables in Kenya Metagenomic characterization of enteric bacterial pathogens and antimicrobial resistance genes detected from dairy cow feces and rumen fluid. View project Consumer Risk Exposure to Chemical and Microbial Hazards Through Consumption of Fruits and Vegetables in Kenya*. *78*(November). www.iiste.org

Li, Y., & Guldenmund, F. W. (2018). Safety management systems: A broad overview of the literature. Safety science, 103, 94-123.

Liu, F., Rhim, H., Park, K., Xu, J., & Lo, C. K. (2021). HACCP certification in food industry: Trade-offs in product safety and firm performance. International Journal of Production Economics, 231, 107838.

Li, M., Baker, C. A., Danyluk, M. D., Belanger, P., Boelaert, F., Cressey, P., Gheorghe, M., Polkinghorne, B., Toyofuku, H., & Havelaar, A. H. (2018). Identification of biological hazards in produce consumed in industrialized countries: A review. *Journal of Food Protection*, *81*(7), 1171–1186. https://doi.org/10.4315/0362-028X.JFP-17-465

MacAuslan, E. (2013). The Boss, the Owner, the Proprietor, the Food Hygiene Manager?" The Journal of the Royal Society for the Promotion of Health, 123, 229-232.

Marder, E. P., Griffin, P. M., Cieslak, P. R., Dunn, J., Hurd, S., Jervis, R., ... & Geissler, A. L. (2018). Preliminary incidence and trends of infections with pathogens transmitted commonly through food—foodborne diseases active surveillance network, 10 US Sites, 2006–2017. Morbidity and Mortality Weekly Report, 67(11), 324.

Mbae, K. M., Ndwiga, M. K., & Kiruki, F. G. (2018). Microbiological Quality of Kachumbari, a Raw Vegetable Salad Popularly Served Alongside Roast Meat in Kenya. *Journal of Food Quality*, *2018*. https://doi.org/10.1155/2018/8539029

Meyer, J., Strohbehn, C. H., Shelley, M., Arendt, S., Correia, P., Ungku Fatimah, U.Z., & Jin, J. (2013). Retail food service employees' perceptions of barriers and motivational factors that influence performance of safe food behavior. Journal of food protection (in review). Retrieved June 24, 2014 from

Meng, J., LeJeune, J. T., Zhao, T., & Doyle, M. P. (2020). Enterohemorrhagic Escherichia coli. Food microbiology: Fundamentals and frontiers, 287-309.

Mensah P, Manu DY, Darko KO, Ablordey A (2015). Streets foods in Accra, Ghana: how safe are they? Bull World Health Organization, (7):546–54.

Mjoka, J., & Selepe, M. (2017). Food hygiene practices and attitudes of the street food vendors at KwaDlangezwa, Northern KwaZulu Natal. African Journal of Hospitality, Tourism and Leisure, 6(3), 1-12.

Moghnia, O. H., Rotimi, V. O., Al-Sweih, N. A. (2021). Evaluating food safety compliance and hygiene practices of food handlers working in community and healthcare settings in Kuwait. International Journal of Environmental Research and Public Health, 18(4), 1586.

Mohammad, K., Noura, A. F., Basel, B., & Hassan, S. (2011). Food borne pathogen contamination in minimally processed vegetable salads in Riyadh, Saudi Arabia. Journal of Medicinal Plants Research, 5(3), 444-451

Moreillon, P., Que, Y., & Glauser, M. P. (2018). Staphylococcus aureus. Principles and practice of infectious disease. Elsevier-Churchill Livingstone, Philadelphia, PA, 2321-2351.

Murray PR, Baron EJ, Jorgensen JH, Pfaller MA, Yolken RH. Manual of clinical microbiology. 8th edition, American Society for Microbiology

Mugure, L. N. (2021). Enhancing Sustainable Business Practices in the Hotel Industry in Kenya: A Case Study of 5-Star Hotels (Doctoral dissertation, United States International University-Africa).

Mujuka, E., Mburu, J., Ogutu, A., & Ambuko, J. (2020). Returns to investment in postharvest loss reduction technologies among mango farmers in Embu County, Kenya. *Food and Energy Security*, *9*(1), 1–9. https://doi.org/10.1002/fes3.195

Muinde OK, Kuria E. (2005). Hygienic and sanitary practices of vendors of street foods in Nairobi, Kenya. African Journal of Food Agriculture Nutrition Development.5(1):1-14.

Murimi, M., & Waweru, G. (2020). Food Hygiene Knowledge, Attitudes and Practices amongst Food Handlers in Selected Hotels and Restaurants In Thika Town, Kenya.

Murungi, M. K., Muloi, D. M., Muinde, P., Githigia, S. M., Akoko, J. M., Fèvre, E. M., ... & Lopez, P. A. (2021). The Nairobi pork value chain: mapping and assessing governance, challenges, and food safety issues. Frontiers in Veterinary Science, 8, 60.

Msc, B. N. K. (2017). Influence of servicescape on customer satisfaction in restaurants within classified hotels in Nairobi County, Kenya (Doctoral dissertation, KENYATTA UNIVERSITY).

Mwangi, P., Wandolo, M., Maranga, V., & Mutisya-Mutungi, M. (2018). Evaluating the Food Handlers' Hygiene Practices as Determinants of Customer Choice at Selected African Indigenous Restaurants in Nairobi City County, Kenya.

Nataro, J. P., & Kaper, J. B. (1998). Diarrheagenic escherichia coli. Clinical microbiology reviews, 11(1), 142-201.

Nejadrezaei, N., & Ben-Othmen, M. A. (2020). Rural development as a key to achieve zero hunger in 2030. In Zero Hunger (pp. 723-733). Cham: Springer International Publishing.

Nguyen, L. H., Naficy, S., McConchie, R., Dehghani, F., & Chandrawati, R. (2019). Polydiacetylene-based sensors to detect food spoilage at low temperatures. Journal of Materials Chemistry C, 7(7), 1919-1926.

Obino, N. B. (2021). Factors influencing the increase of fast food outlets in the central business district of Nairobi, Kenya (Doctoral dissertation, Moi University).

Odeyemi, O. A., Alegbeleye, O. O., Strateva, M., & Stratev, D. (2020). Understanding spoilage microbial community and spoilage mechanisms in foods of animal origin. Comprehensive reviews in food science and food safety, 19(2), 311-331.

Obwanga, B., Mbauni, C., Mwangi, G. F., & Soma, K. (2020). Food system value-chain adaptability: Can new opportunities increase Kibera food security and food

safety? Linking aquaculture to urban food systems: Workshop Report-Discussing new opportunities with the aquaculture value-chains between Nyeri-Kibera. Wageningen Economic Research.

Odeyemi, O. A., Alegbeleye, O. O., Strateva, M., & Stratev, D. (2020). Understanding spoilage microbial community and spoilage mechanisms in foods of animal origin. Comprehensive reviews in food science and food safety, 19(2), 311-331.

OGWENO, C. (2015). COMPLIANCE WITH THE PROVISIONS OF SECTION 126 OF THE PUBLIC HEALTH ACT (CAP 242) BY PUBLIC FOOD PLACES IN BUNGOMA COUNTY, KENYA.

Oloo J.E.O. (2015). Food Safety and Quality Management in Kenya: An overview of the roles played by various stakeholders. *African Journal of Food Agriculture, Nutrition and Development*, *10*(11), 4379–4397.

Onah E (2014) "Heavy metal health risk assessment and microbial quality of locally milled ready-to-eat tomato in tamale, Ghana". A thesis submitted to the institute of distance learning, Kwame Nkrumah University of science and technology in partial fulfillment of the requirements for the award of Master of Science degree (M.Sc. food quality management). KNUST.

Oo, K. S., Than, S. S., & Oo, T. H. (2019). A Model HACCP Plan for Fish Seasoning Powder Production. American Journal of Food Science and Technology, 7(6), 200-204.

Owido, K. (2021). Influence of Organisational Factors on Strategic Positioning of Hotel Industry in Kenya: A Case of Five Star Hotels (Doctoral dissertation, United States International University-Africa)

Panchal, K.P., Carli, A., & Divorkin, M.S. (2012). Identifying Food Safety Knowledge Gaps Among Restaurant Food Handlers in Bilzano, Italy. Food Protection Trends, 1, 14-16.

Patel, R. B., & Chadhuri, J. (2019). Revisiting the Sphere Standards: comparing the revised Sphere Standards to living standards in three urban informal settlements in Nairobi, Kenya. Journal of International Humanitarian Action, 4(1), 1-10.

Pathare N.A., Asogan H., Tejani S., Al Mahruqi G., Al Fakhri S., Zafarulla R., Pathare A.V. (2016). Prevalence of methicillin resistant *Staphylococcus aureus* [MRSA] colonization or carriage among health-care workers. J. Infect. Public Health. 2016;9:571–576.

Peninah, C., Miricho, W., & Gesage, M. (2020). Effects of Employee Behavioral

Factors on HACCP System Practices in Four and Five Star Rated Hotels in Nairobi County, Kenya. *Journal of Tourism, Hospitality and Sports*, *48*. https://doi.org/10.7176/jths/48-05

Rabbi S. E, and Dey N. C.(2013). Exploring the gap between hand washing knowledge and practices in Bangladesh: A cross comparative study. Sectional BMC. Public Health. 213:89.

Ramsley, J. and Ingram, H. (2018). Developing Hospitality Properties and Facilities. (2nd ed).

Ransinghe, H. D. P., Joseph, R., Dharmarathna, E. K. G. P. U., Ranasinghe, M. K., & Abeyrathne, E. D. N. S. (2019). Identification of the Critical Control Points (CCPs) of a Commercially Established Pasteurized Milk Factory in Colombo.

Oxford. Elsevier Butterworth-Heinemann.

Ratnapradipa, D., Quilliam, D., Wier, L., & Rhodes, D. (2010). Food safety education: Child-to–Parent instruction in an immigrant population: Journal of Environmental Health. 73(6): 70-75.

Rawat, S. (2015). Food Spoilage: Microorganisms and their prevention. *Pelagia Research Library Asian Journal of Plant Science and Research*, *5*(4), 47–56. www.pelagiaresearchlibrary.com

Razzaq, R., Farzana, K., Mahmood, S., and Murtaza, G. 2014. Microbiological analysis of street vended vegetables in Multan city, Pakistan: A Public Health Concern. Pakistan J. Zool., 46: 1133-1138

Redmond, E. C., and Griffith, C. J. (2015). Consumer perceptions of food safety risk, control and responsibility. Appetite, 43(3): 309-313.

Saadat, A., Barman, S., & Shukla, L. I. (2020). Reduction of Food Wastage: Roles of Administrative Interventions and Cultural Ecosystem Services. Zero Hunger, 671-691.

Sarkodie, N. A., Commey, V., & Mohamed, B. (2022). Determinant factors of consumers' choice of formal full service restaurants in Ghana. Journal of Hospitality Management and Tourism, 13(2), 38-47.

Seaman, P., & Eves, A. (2009). Perceptions of Hygiene Training Amongst Food Handlers, Managers and Training Providers- a Qualitative Study. Food Control, 21(7), 1037-1041. Retrieved from: doi: 10.1016/j.foodcont.2009.12.024.

Setiyadi, K., Syah, T. Y. R., Pusaka, S., & Darmansyah, H. S. (2020). HACCP Plan Implementation for Food Safety for Startup Business: Fruit Combining.

Sarkar, T., & Chakraborty, R. (2018). Formulation, Physicochemical Analysis, Sustainable Packaging-Storage Provision, Environment Friendly Drying Techniques and Energy Consumption Characteristics of Mango Leather Production: A Review. *Asian Journal of Water, Environment and Pollution, 15*(3), 79–92. https://doi.org/10.3233/AJW-180046

Seymour, I. J., & Appleton, H. (2001). Foodborne viruses and fresh produce. *Journal of Applied Microbiology*, *91*(5), 759–773. https://doi.org/10.1046/j.1365-2672.2001.01427.x

Sospedra, I., Rubert, J., Soriano, J. M., & Mañes, J. (2013). Survey of microbial quality of plant-based foods served in restaurants. *Food Control*, *30*(2), 418–422. https://doi.org/10.1016/j.foodcont.2012.08.004

Spector, P. E. (2019). Do not cross me: Optimizing the use of cross-sectional designs. Journal of Business and Psychology, 34(2), 125-137.

Sprenger, G. A. (2017). From scratch to value: engineering Escherichia coli wild type cells to the production of L-phenylalanine and other fine chemicals derived from chorismate. Applied microbiology and biotechnology, 75(4), 739-749.

Suherman, S., Alhanif, M., Purwati, D., Hapsari, F. D., Dasilva, T., & Mohammed, O. A. (2021, February). A Comprehensive Review on Hazard Analysis and Critical Point (HACCP): A Case of Lumpia Semarang. In IOP Conference Series: Materials Science and Engineering (Vol. 1053, No. 1, p. 012080). IOP Publishing.

Strawn L.K., Fortes E.D., Bihn E.A., Nightingale K.K., Gröhn Y.T., Worobo R.W., Bergholz P.W. 2013. Landscape and meteorological factors affecting prevalence of three food-borne pathogens in fruit and vegetable farms. Appl. Environ. Microbiol, 79(2):588–600.

Sundus Saifullah, Ferhat Abbas, Abdul Samad, Muhammad Rizwan, Farah Sabeen Bugti, Saima, Roomeela, Mohammad Yousaf, Tworko Mykhaylo and Abdul Raziq. Staphylococcus aureus prevalence in the fresh salad and vegetables of the Quetta city. Pure and Applied Biology. http://dx.doi.org/10.19045/bspab.2018.70031

Tack, D. M., Marder, E. P., Griffin, P. M., Cieslak, P. R., Dunn, J., Hurd, S., ... & Geissler, A. L. (2019). Preliminary incidence and trends of infections with pathogens transmitted commonly through food—Foodborne Diseases Active Surveillance Network, 10 US Sites,

Taylor, T. A., & Unakal, C. G. (2021). Staphylococcus aureus. StatPearls [Internet].

2015–2018. Morbidity and Mortality Weekly Report, 68(16), 369.

Usman, E. (2018). Factors important for the selection of fast food restaurants: Anempirical study across three entries in Pakistan. British's Food Journal. 114(9): 1251-1264.

Uzeh RE, Alade FA, Bankole M (2019). The microbial quality of prepacked mixed vegetable salad in some retail outlets in Lagos, Nigeria. African Journal of Food Science, 3(9): 270-272

Wandolo, M. A., & Mutisya-Mutungi, M. (2018). Evaluating the Food Handlersâ€™ Hygiene Practices as Determinants of Customer Choice at Selected African Indigenous Restaurants in Nairobi City County, Kenya. Journal of Hospitality and Tourism Management, 1(1), 57-76.

Wang, P., Robert, L., Pelletier, J., Dang, W. L., Taddei, F., Wright, A., & Jun, S. (2020). Robust growth of Escherichia coli. Current biology, 20(12), 1099-1103.

Watiki, C. (2014). Service quality and customer satisfaction in hotels in Nairobi, Kenya (Doctoral dissertation, University of Nairobi).

Wambui, G. A., Judy, K., & Stephen, M. (2019). Offer quality affecting consumption of hospitality products and services in franchised restaurants in Nairobi Central Business district Kenya. Менаџмент у хотелијерству и туризму, 7(1).

Weinroth, M. D., Belk, A. D., & Belk, K. E. (2018). History, development, and current status of food safety systems worldwide. Animal Frontiers, 8(4), 9-15.

World Health Organization (2017). Fact sheet No 237. Food Safety and Foodborne Illness. Google internet, November 2008.

WHO (2017). Food Safety and Food-borne Illness. Fact Sheet 237

www. who.int/media centre/factsheets/fs237/en/www.who.int/entity/food-safety/public.

World Health Organization. (2008). WHO Initiative to Estimate the Global Burden of Food-borne Diseases. Increasing Impact Through Collaboration", Food-borne Disease Stakeholders Meeting. Geneva. Retrieved from http://www.who.int/foodsafety/foodborne_disease/FERG_Stakeholder_2008.pdf.

World Health Organization. 2022. Food safety. https://www.who.int/news-room/fact-sheets/detail/food-safety. Accessed on 22 October 2022

[Accessed 20/8/2014].

World Health Organization (2017). Fact sheet No 237. Food Safety and Foodborne Illness. Google internet, November, 2008.

Yen, E., Hoffman, V., Grace, D., & Karugia, J. (2018). Food safety in Kenya: Focus on fruits and vegetables. *Project Note*, *March*, 1–4. http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/132321

Yasami, M. E. H. R. I. (2018). Tourists' threat appraisal, coping appraisal and protection intention in using food safety cues in the choice of malaysian restaurantsr (Doctoral dissertation, Ph. D. thesis, Universiti Putra Malaysia, Faculty of economy and management, Kuala Lumpur).

Zain, M. M., & Naing, N. N. (2002). Sociodemographic characteristics of food handlers and their knowledge, attitude and practice towards food sanitation: a preliminary report. Southeast Asian journal of tropical medicine and public health, 33(2), 410-417.

Zhou, Y., Wang, Z., Jin, Y., & Fu, Z. H. (2021). Late acceptance-based heuristic algorithms for identifying critical nodes of weighted graphs. Knowledge-Based Systems, 211, 106562.

Zocchi, D. M., & Fontefrancesco, M. F. (2020). Traditional products and new developments in the restaurant sector in East Africa. The case study of Nakuru County, Kenya. Frontiers in Sustainable Food Systems, 239.

APPENDICES

Appendix A: Data collection tools

Overall Objective: To assess compliance to food safety management systems for fruits and vegetables in fine dining hotels in Nairobi County, Kenya

Data	**Instruments/ Equipment**	**Manufacturer-Name**	**Tool**	**Data recording space**
Specific Obj 1: To evaluate the socio-demographic features of food handlers in fine dining hotels in Nairobi County in terms of compliance with food safety management systems and cleanliness regulations.				
Level of education, gender, experience in food handling, age	Mobile phone	Oppo	Open data kit (ODK) questionnaire	online Database
Specific Obj 2: To evaluate the level of knowledge on HACCP and practices in preparing fruit and vegetable salads amongst food handlers in fine dining hotels in Nairobi County.				
Knowledge and practices	Mobile phone	Oppo	Open data kit (ODK)questionnaire	Online database
Specific Obj3 To evaluate microbial safety of fruits and vegetable salads in fine dining hotels in Nairobi County.				
TVC	Petri dish		Colony counter	Form
E. coli, staphylococcus aureus	Petri dish		Procedure	

APPENDIX B: FOOD HANDLERS QUESTIONNAIRE

You have been invited to participate to this study which aims to contribute towards the safety of foods from fine dining hotels in Nairobi County, Kenya.

Kindly answer all the questions and be assured that your responses will be treated with high level of confidentiality.

PART 1 DEMOGRAPHIC INFORMATION

Please tick appropriately in this section.

Date of Interview		Name of Interviewer	
Name of Hotel			
Sex:	1 – Male ☐ 2 – Female ☐		
Age	20-30 ☐ 30-40 ☐ 40-50 ☐ 50-60 ☐		
Job position	1- Chef ☐ 2- Cook ☐ 3- Kitchen steward ☐ 4- Waiter/waitress ☐		
Years of service in this hotel	1- Less than one year ☐ 2- Between 1-2 years ☐ 3- More than 5 years ☐		
Years of service in foodservice industry	1- Less than one year ☐ 2- Between 1-2 years ☐ 3- More than 5 years ☐		
Terms of service	1-Permanent ☐ 2-Contract ☐		

	3-Casual ☐
Education Level (Tick Correctly)	1 - College/University ☐ 2 - Completed Secondary ☐ 3 - Completed primary ☐ 4 - Dropped from primary ☐ 5 - In primary ☐ 6 - In secondary ☐ 7 - Literate e.g., Adult Education ☐ 8 – Illiterate ☐ 9 - Pre-primary ☐ 10 - Others (specify) ☐
Have you received training on FSMS?	1- Yes ☐ 2- No ☐
If yes when was the last training conducted?	1.Less than 12 months ago ☐ 2.One year ago ☐ 3. 2 years ago ☐ 4. More than 2 years ago ☐

PART 2: KNOWLEDGE ON HAZARD ANALYSIS CRITICAL CONTROL POINT (HACCP)

Tick appropriately

		TICK APPROPRIATELY	**REMARKS**
1	Have you ever heard of hazard analysis critical control point (HACCP)?	**YES** ☐ **NO** ☐	
2	Is HACCP system new in food industry?	**YES** ☐ **NO** ☐	
3	HACCP is important in	**TRUE** ☐	

	achieving food safety because it aims at identifying, assessing and controlling of hazards in food production process.	**FALSE** ☐	
4	Food analysis should always be done at the final product	**TRUE** ☐ **FALSE** ☐	
5	Checking of critical control point should be done along the value chain.	**TRUE** ☐ **FALSE** ☐	
6	Foods which are prepared by strictly following the principles of HACCP are known to be free of biological hazards.	**TRUE** ☐ **FALSE** ☐	
7	HACCP system can be applied to the production or processing of any food product.	**TRUE** ☐ **FALSE** ☐	
8	The safety of food relies mainly by the operations which are carried out by farmers, processors and producers.	**TRUE** ☐ **FALSE** ☐	
9	Consumption of foods contaminated with foodborne hazards can lead to adverse health	**TRUE** ☐ **FALSE** ☐	

	effects.		
10	In your own opinion can consumers as well apply HACCP at home?	**YES** ☐ **NO** ☐	
11	There are guidelines that must be followed for the implementation of HACCP system.	**TRUE** ☐ **FALSE** ☐	
12	HACCP system is based on seven principles. Mention them	**TRUE** ☐ **FALSE** ☐	
13	Is HACCP system a government agency?	**YES** ☐ **NO** ☐	
14	HACCP system should always be reviewed in case there is any change in production process.	**TRUE** ☐ **FALSE** ☐	
15	Is the system efficient in attaining food safety?	**YES** ☐ **NO** ☐	
16	Effective control of food through the use of HACCP can control *E. coli*.	**TRUE** ☐ **FALSE** ☐	
17	*Salmonella* causes salmonellosis and by effective use of HACCP the disease outbreak can be controlled.	**YES** ☐ **NO** ☐	

PART 3: FOOD SAFETY PRACTICES

In this section, please tick in the appropriately using a scale of 1-5 whether the following practices are being carried out: 1= strongly disagree 2= disagree 3= neutral 4= agree 5= strongly agree

	Food practice	**1**	**2**	**3**	**4**	**5**	**REMARKS**
1	Washing hands before handling foods is important in preventing food contamination.						
2	Separating raw, cooked and ready to eat foods is critical in preventing cross contamination of foods.						
3	Cooking food at safe temperature using a thermometer is essential to ensure that pathogens are killed.						
4	Keeping hot foods hot at temperature above 140 degrees Celsius will prevent growth of						

	microorganisms.						
5	Keeping cold foods cold at temperature below 40 degrees Celsius will not create an environment for growth of microorganisms.						
6	The level of microbial load of foods are checked at various critical control point.						
7	Washing of foods thoroughly with clean running water before preparation is essential in removing any contaminants from the food.						
8	Food handlers are usually exempted from work when they have been diagnosed with communicable or contagious						

	disease.						
9	Food handlers always wear recommended attire while at work like apron, gloves, hair net, face mask.						
10	Working surfaces are usually cleaned and sanitized before using it for another food.						
11	Foods that are prepared in this hotel are usually purchased from approved supplier.						
12	Foods in this hotel are stored using the FIFO method.						
13	Leftover foods are thoroughly reheated before serving to customers to ensure safety of the food.						
14	Foods are stored in closed						

	containers where no insect or animal can enter to prevent contamination.						
15	Analysis of microorganisms in foods at entry point is important.						

PART 4: FOOD SAFETY KNOWLEDGE

In this section, please tick where appropriate where double hand washing should be done.

Occasions for double hand washing	**TRUE**	**FALSE**	**REMARKS**
After handling waste			
After using the toilet			
Before preparing food			
After touching your hair			
After drinking or eating			
After handling cleaning chemicals			
After taking a break			
Switching from handling raw food to cooked foods			
After coughing, sneezing before			

handling food			

Please tick to indicate ways through which food contamination may take place.

Ways in which food contamination may occur	**TRUE**	**FALSE**	**REMARKS**
Through Improper food handling			
Food handlers			
Cross contamination			
Contaminated working surfaces			
Improper cooking temperatures			

Please tick the possible vehicles for food contamination.

Possible vehicles for food contamination	**TRUE**	**FALSE**	**REMARKS**
Food preparation surfaces			
Chopping boards			
Hands			
Flies			
Food handlers			
Food storage containers			
Knives			
utensils			

Rate on Likert scale of 1-4 the extent you feel the following stages of food production is critical in achieving food safety.

1= don't know 2= less likely 3= likely 4= very likely

Food flow	**1**	**2**	**3**	**4**

Purchasing				
Receiving				
Storing				
Preparation				
Serving				
Use of leftovers				

How long do they take to be examined medically in this hotel?

3 months ☐ 6 months ☐ 1 year ☐ don't know ☐

What temperatures do you consider to be danger zone?

-15 to -10^{0}c ☐

4.4 To 60^{0}c ☐

40- 140^{0}c ☐

Not sure ☐

PART 5: BARRIERS TO COMPLIANCE TO FSMS

In this section tick against which describes best your opinion towards barriers to compliance to FSMS and hygiene requirements in this hotel.

1= Disagree 2= Neutral 3= Agree

Perceived barrier	**1**	**2**	**3**
Lack of knowledge in system			
Lack of training			
Time pressure			
Lack of management support			
Too much work			
Poor working environment			
Lack of working equipment			
Lack of recognition			

APPENDIX C: FOOD AND BEVERAGE MANAGER QUESTIONNAIRE

1. KNOWLEDGE

	Tick appropriately		**REMARKS**
1	In your own view do you think foodborne disease is a problem in Kenya?	1.Yes ☐ 2.No ☐	
2	If yes, what do you think are the main causes of the diseases?	1 Contaminated food ☐ 2 Food handlers ☐ 3 Poor food hygiene ☐ 4 Food pathogens ☐ 5 Don't know ☐	
3	HACCP system has helped in achieving the safety of foods.	**TRUE** ☐ **FALSE** ☐	
4	What food types do you consider hazardous?	1 Baked food ☐ 2 Salads- fruit and vegetables ☐ 3 Raw and cooked meat ☐ 4 Sea foods ☐ 5 dairy products ☐	
5	What are the challenges you face in ensuring compliance to food safety management systems in this hotel?	1.Lack of training ☐ 2. Ignorance by employees ☐ 3. too much ☐	

		work 4 Time pressure☐	

2. PRACTICES

	Tick appropriately		**REMARKS**
1	What measures have you taken into consideration in this hotel to ensure food services by your employees achieve food safety?	1 Training☐ 2 Seminars☐ 3 Strict guidelines in food preparation ☐	
2	How do you ensure the internal temperature of the food is achieved?	1 Use of thermometers☐ 2 Just cooking thoroughly ☐ 3 Don't know ☐	
3	How do you cool foods before storage?	1 using ice ☐ 2 Leaving it in open air ☐ 3 Use of chillers ☐ 4 Covering the food half way☐	
4	How do employees in this hotel know the importance of ensuring food safety?	1 Understanding impact of unsafe foods ☐ 2 Being aware of foodborne diseases ☐ 3 It is one of the hotel policies ☐	

Appendix D: PARTICIPANT CONSENT FORM

Dear participant,

You are being kindly asked to help with a study titled "Compliance to food safety management systems for fruits and vegetable salads in fine dining hotels in Nairobi County, Kenya." The study's overarching goal is to help ensure that guests of Nairobi County's five-star hotels don't get sick from eating tainted food. To that end, it will collect data that policymakers and other interested parties can use to evaluate hotels' adherence to food safety management system and sanitation regulations.

In this research, you will be required to answer questions honestly; the information you submit will be kept in strict confidence. You are in no danger by taking part in this research, and you are free to leave at any time, nevertheless you are strongly urged to finish the survey.

Prior to the start of the research, the enumerator should be approached with any queries you may have about the information sheet. See the form below.

Your willingness to participate is highly appreciated.

Consent Form

Researcher (name): _____MERAB AWINO ANNETTE_____contact: ___0710919552_____

Title of project: COMPLIANCE TO FOOD SAFETY MANAGEMENT SYSTEMS FOR FRUITS AND VEGETABLE SALADS IN FINE DINING HOTELS IN NAIROBI COUNTY, KENYA

Kindly tick where appropriate:

1. I affirm that I read (or was read to) and comprehended the information sheet for the aforementioned research. I had the chance to analyze the facts, ask questions, and have those issues adequately addressed. ☐

2. I am aware that my involvement is entirely voluntary and that I am free to discontinue at any moment, for any reason, without affecting my legal rights.

3. I am aware that other researchers on the team may examine pertinent portions of the information and data I provided throughout the course of the research.

I authorize these persons to have access to these data.

4. I agree to participate in the research voluntarily and without any conditions.

Name of respondent: _____

Date: _____

Signature: _____ OR

Thumb Print

Appendix E: HOTEL RATINGS IN NAIROBI (WESTLANDS AND CENTRAL BUSINESS DISTRICT)

PUBLICATION OF CLASSIFIED ESTABLISHMENT BY TOURISM REGULATORY AUTHORITY DECEMBER 2020

Hotel	**Rating**
Intercontinental Nairobi	*****
The Sarova Stanley	*****
Tribe hotel	*****
Villa Rosa Kempinski	*****
Dusit D2	*****
Sankara Nairobi	*****
Fairmont the Norfolk	*****
Hilton Nairobi limited	****
Nairobi Safari club	****
Central Park hotel	****
Southern hotel	****
Pride inn Lantanna	****
Golden Tulip westlands	****
La masion	****
The clarion hotel	***
Marble Arch hotel	***
Best western plus meridian hotel	***
Pride inn Azure	***
Ibis westlands	***
After 40 Hotel	**
Kahama hotel	**

Appendix F: The Descriptive Analysis on HACCP

Research question	**YES**	**Percent**	**NO**	**Percent**
Have you ever heard of HACCP?	194	96.5	7	3.5
HACCP system is new in food industry	30	14.9	171	85.1
HACCP can be applied at home	115	57.2	86	42.8
HACCP is a government agency	156	77.6	45	22.4
HACCP system is efficient in achieving food safety	164	81.6	37	18.4
Food served in this hotel is strictly prepared following HACCP principles	139	69.2	62	30.8