

**Hygiene Practices in Urban Restaurants: Investigating Possibilities of
Introducing HACCP Systems in Thika Town**

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H60/7473/02

**A Thesis Submitted to the 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

September, 2010

DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

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DEDICATION

To my wife, Hellen Muinde for assisting me in the whole process of writing this work and building a strong foundation for my studies since I joined Kenyatta University.

ACKNOWLEDGEMENTS

This work would not have been possible without the guidance of my supervisors: Dr. George Omolo Rombo and Dr. Ciira Kiiyukia. They have been very helpful in ensuring the timely completion of the study. I wish to thank my employer JKUAT, through the Chief Catering Manager, who gave me a flexible arrangement to combine work and studies without raising any objection.

I would also like to thank the Chief Technician, Food Science Department, JKUAT who assisted me in the laboratory work. Appreciation goes to the Chief Public Health Officer, Thika Municipality, for his moral and logistical support. Mr. A. D. Bojana and Mrs. Muoki deserve special gratitude for editing the final work.

Thanks to my family members who played an indispensable role in ensuring the success of this study. They all understood especially during the days when I could not attend to their needs. The criticisms, comments and advice from other members of staff in the Catering Department are highly appreciated.

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ABBREVIATIONS AND ACRONYMS

BPw:	Buffered Peptone Water
CCP:	Critical Control Point
CL:	Critical Limit
Codex:	Codex Alimentarius
FAO:	Food and Agriculture Organization
FSIS:	Food Safety Inspection Service
GHP:	Good Hygiene Practices
GMPs:	Good Manufacturing Practices
GoK:	Government of Kenya
HACCP:	Hazard Analysis Critical Control Point
ICD:	International Commission on Diseases
IFT:	International Food Trade
ITROMID:	Institute of Tropical Medicine and Infectious Diseases
MPN:	Most Probable Number
NGO:	Non-Governmental Organization
NPLHS:	National Public Laboratories Health Services
QC/A:	Quality Control/Assurance
SSOP:	Sanitation Standards Operation Procedures
WHO:	World Health Organization

ABSTRACT

The restaurant food sector has experienced significant growth in the past few decades due to population growth and rapid urbanization. Despite the economic benefits of the sector, it has been recognized as a potential hazard to public health when food is not well-prepared. The purpose of this study was to examine hygiene practices and the possibilities of introducing food safety assurance systems based on scientific methods to enhance food safety in urban restaurants. Whereas the science of sanitation has changed in a global context, very little has changed in sanitary and food safety practices in developing countries like Kenya. The need for the study arose from lack of evidence on the food hygiene and manufacturing practices, food microbial contamination levels and the possibility of introducing HACCP as a quality assurance system in urban restaurants. The study adopted a descriptive survey and experimental design. Systematic random sampling was used. Data for the study was obtained from a random sample of 137 restaurants out of the representative total of 298 formal restaurants in Thika town. Data collected were analyzed using descriptive and inferential statistics and the results presented in pie charts, tables, graphs and percentages. SPSS and One-way analysis of variance at 95% level of confidence interval was used. A survey questionnaire was used to collect data on food hygiene standards and opinion of the staff on the desirability of introducing a HACCP system in (30) thirty restaurants. The *Staphylococcus aureus*, Aerobic plate counts and *Escherichia coli* microbial levels were established in various foods, water and other surfaces. Total plate counts (TPC) was below 10^5 CFU/g in all the seventeen (17) samples. The mean total plate count was high in nyama choma, work surfaces and passion juice while the lowest was in chips, plates and fruit salad. 63% of the business operators had some knowledge on food quality, only 8% apply these controls in the kitchens. Independent variables used included age, literacy level, marital status, sex and designation of the respondent. Dependent variables included knowledge on HACCP, principles of HACCP application and the effects of these principles in the overall management of the restaurants. The study also indicated that, there is no significant relationship between customer turnover and HACCP implementation at $p \leq 0.05$ confidence level. The study recommends that there is need to educate the management of the restaurants on HACCP implementation. The findings suggest that restaurants in Thika town do not adequately follow safe food hygiene and manufacturing practices or processes. This was so significant from the levels of bacterial food counts in most samples. However, the staff surveyed acknowledged that food contained bacteria that can present microbial hazard if poorly handled in the kitchen. They did not apply any good quality control strategy and therefore not sure of the food safety standards. Application of food safety control measures in the entire food processing cycle to ensure quality control had significant relationship between maintenance of general hygiene standards and HACCP awareness in the restaurants. In conclusion, there is need to establish and implement HACCP system to prevent probable food poisoning outbreaks and the restaurants can easily adapt the strategy only if law enforcers could put proper measures in place. Further research could open ways on how best the system can be applied, reinforced and be sustained in the urban restaurants and other food establishments to enhance food safety and protect consumers from food related health hazards.

CHAPTER ONE

INTRODUCTION

1.0 Background Information

Food safety plays a significant role in the economic and health development of Nations by safe guarding the nation's health, enhancing tourism and international trade, the production, distribution and consumption of safe food (WHO, 2000). Despite the importance of food safety, there seem to be few quality control systems to guard against food-related illnesses, in developing countries, some of which may be fatal while others can lead to expensive medical care. The magnitude of food borne diseases is illustrated by various statistics (Snyder, 1992). Illnesses from food related diseases outnumber illness from all other environmental factors combined. Over 66% of food-borne illnesses are caused by bacterial pathogens (Byran, 1992).

Worldwide, the incidences of diarrhoeal diseases alone have been estimated to be 400 million cases per year, which indicates a serious underlying food safety problem (Byran, 1992). The direct cost of foodborne illness outbreak can approximate \$75,000 per food service establishment and these can include investigation clean- up, restaffing, restocking, product loss, settlements and increased regulatory sanctions(Hannington, 1992) In Kenya, incidences of food borne illnesses reported from 1997 to 2003 were 1,492,690 cases that caused 604 deaths (GoK, 2005). In the year 2004, there were 11,849 reported cases. In Thika District Hospital, diarrhoea, intestinal worms and typhoid are among the top ten leading causes of hospitalization (GoK, 2005).

While these statistics point to the possible hazards of poor food safety guidelines, research shows that the food safety regulations and risk management measures in developing countries are not well-implemented (Dhamija, 1979). Dhamija attributes this to lack of understanding of the regulations and measures for the food industry by consumers and other stakeholders in the society.

FAO/WHO (2002) main objective is to ensure nutritional and safe food for all people at all times for productive and healthy life. Food service operators have a major responsibility since their actions can affect the health of many people. Food-borne diseases are major public health problem estimated to affect up to 10% or more of the population in the industrialised countries (WHO, 2005). Food and water-borne diseases in the developing countries are prevalent and epidemiological examinations have indicated large proportions of food-borne diseases which result from poor food sanitation and unhygienic handling of foods in restaurants and other eating outlets (Antoria, 2002).

Urban populations in Kenya comprise some 20% of people concentrated in six rapidly expanding cities and large towns (Gok, 1999). Nearly 50% of the Kenya urban populations live in unplanned low quality settlements having no access to infrastructure and other service. In developing countries, it has been suggested that lack of knowledge and skills on the good manufacturing practices (GMPs), have contributed to poor hygienic practices in food service establishments. The paucity of the studies on food safety among academics, in food science, has led to health administrative departments taking the evaluation of food safety and hygienic practices of food establishments (WHO/GoK, 1999). These reports show that about 80% of all diseases and more than 1/3 of all deaths in developing countries are caused by contaminated food and water (WHO, 2004). This study attempted to establish whether the scenario is the same in Thika District.

HACCP has been endorsed by the National Academy of Sciences, the Codex Alimentarius Commission which is an international food standard setting organization, and the National Advisory Committee on microbiological criteria for foods (ICMSF, 1980). It is the best system available for designing programmes to assist food firms in producing foods that are safe to consume (Food Codex, 1995). The biggest advantage of HACCP over the other systems is that it pre-empts all the activities in the food process thus reducing risks in food-borne diseases. According to Taber (1993), the hazard of any material is determined by chemical, physical and biological properties.

Processing and preparing can be a risky business and precautions must be implemented to prevent problems and to correct them if they do occur. HACCP, a system for ensuring

food safety, was developed in 1971 in a cooperative effort by the United States Army Natick Laboratories, the National Aeronautics and Space Administration and the Pillsbury Company (Pierson & Corlett, 1992). The system is endorsed as an effective and rational means of assuring food safety from harvest to consumption. Preventing problems from occurring is the basis of the HACCP system. It is termed superior to all the conventional food microbiological quality control procedures in the market because it only addresses significant food safety hazards. Nairobi Airport Services, which serves international airlines on the ground and in the air in Kenya, operates an HACCP system (Personal Observation, 2008).

The system employs several principles to meet the stated goals. These principles include hazard analysis, CCP identification, establishing critical limits, monitoring procedures, corrective actions, verification procedures and record keeping and documentation. When organizing and setting up HACCP programme, each step is important and necessary for the assurance of a safe, high quality finished product(s) (Rosander, 1990). Estimates of the present value of 20 years of HACCP-program benefits reported range from \$1.9 to \$171.8 billion in 1995 dollars. These are costs saving benefits (Crutchfield et al. (1997).

The HACCP system must be developed by each food establishment and tailored to its individual product, processing and distribution conditions (WHO, 2005). The Codex Alimentarius Commission (1995a, b) and its subsidiary bodies have discussed the need for a code of hygiene practices for street foods and restaurants. The Ministry of Health and major local authorities have put very few policies in place to ensure that the risk of disease communication is contained and food safety is enhanced (FAO, 2005). For instance, they have tended to rely on legislation that seeks to provide a framework for food safety inspection which, unlike a HACCP system, is not proactive and preventive. The Foods, Drugs and Chemical Substance Act, cap 242 of Kenya, may not provide an adequate supervisory framework for food establishments that clearly need to improve on their efforts to enhance product quality (GoK, 2004)

This may be as a result of inadequate food safety inspections and controls by the government agencies and lack of awareness and participation by stakeholders such as

consumers, NGO's, print and electronic media publications that would otherwise facilitate the understanding of food safety. The importance of investigating the possibility of introducing a HACCP system of monitoring and evaluating food safety, in urban restaurants, is clear from their role in the food chain in large urban populations.

Reports from Thika Municipal council office indicate that there are about 298 formal eateries in Thika Town, which offer meals to urban dwellers (Gok, 2005). They recommend that food establishments embrace safe food chains so that the outbreak of food-borne diseases or illnesses may not be transmitted within the town or to the rural areas where most of the workers live. This suggests that there is need to explore the possibility of restaurants embracing food safety systems, based on the HACCP principles that have been successfully applied in food service operations and are universally accepted by government agencies, trade associations and the food industry around the world. HACCP system is proactive and it can predict possibility of food poisoning or contamination. It has food safety control system that has simple control features which ensure immediate corrective action, is cost-effective and can be applied to all food operations.

Byran (1992) emphasizes that food safety concerns are magnified when an outlet prepares foods from raw materials and points out that foods mostly involved in the outbreaks of diseases include milk and milk products, vegetables, salads and puddings, meat and meat products among others. Perhaps the introduction of a HACCP system could improve and reduce the incidence of food poisoning in urban restaurants. It can also aid inspection by regulatory authorities and promote international trade by increasing confidence in food safety. It provides a more specific and critical approach to the control of microbiological hazards in foods than that provided by traditional inspection and quality control approaches (Amref, 1982).

1.1 Statement of the Problem

The significant role of food safety in the economic and health development of the nation, in enhancing tourism, national and international trade is acknowledged (FAO/WHO, 2001). While food safety systems based on HACCP principles have been successfully

applied in food service operations and have been universally accepted by government agencies, trade associations and the food industry around the world, little is known of the hygiene practices of urban restaurants in Thika town and their readiness to introduce HACCP systems.

Studies on food safety have tended to focus on regulations and measures required to develop and enforce the food safety regulations, education and technical sophistication to be applied by food processors for HACCP to be accomplished (Corlett, 1998). This may suggest a need for a study to determine if urban restaurants are ready to introduce a HACCP system of food safety assurance. The need to investigate the possibility of introducing a HACCP system, for restaurants, aroused from the fact that a HACCP system must be developed by each sector, such as urban food establishments and tailored to their individual products, processing and distribution conditions.

For a HACCP programme to be successful, management must be committed to the systems which indicate an awareness of the benefits and costs of the system which includes education and training of the employees. The current study provides insight into the possibility of Thika urban restaurants succeeding in implementing a HACCP system of food safety assurance.

1.2 Purpose of the Study

The purpose of this study was to establish the food safety measures and hygiene practices of urban restaurants. It also investigated the desirability and preparedness of restaurants in the implementation of HACCP systems for maintaining the highest possible food safety standards.

1.3 Objectives of the Study

General Objective

To improve the safety of food consumed in restaurants in Thika town using HACCP systems.

Specific Objectives

1. To determine the microbial load of foods consumed in restaurants in Thika town

2. To examine food safety control measures applied in restaurants in Thika town.
3. To establish the viability of implementing a HACCP system as a strategy for quality control in the restaurants in Thika town.
4. Determine awareness of SSOP by restaurant workers.

1.4 Research Questions

The following research questions guided the study

1. What are the microbial loads of foods consumed in restaurants in Thika town?
2. What are the food safety control measures applied in restaurants in Thika town?
3. Is there a prospect of implementing a HACCP system as a strategy for quality control in the restaurants in Thika town?
4. Is there an awareness of sanitation standard operations procedures by restaurant workers?

1.5 Assumptions of the Study

For the purpose of this study, the following assumptions have been made;

1. Restaurants apply the same food safety control measures.
2. Respondents were willing, able and free to provide honest and unbiased responses.

1.6 Significance of the Study

The results will be of importance to several parties. First, the management of urban restaurants will find the information on the analysis of the manufacturing practices such as food preparation, production and service useful in identifying the critical stages of contamination that require systematic control.

Health regulatory authorities and the urban council will have the information to establish policies for implementing good manufacturing and hygiene practices and a HACCP system of quality control. In particular, the feasibility of a HACCP system may be an indication of the possibility of enforcing laws relating to it being mandatory. The public health offices can also find the results useful in conducting training on HACCP for urban restaurant owners, employees and their suppliers.

Further, policy-makers will also be able to identify factors that influence slow application of HACCP in the restaurants and also the main resource groups that are required to disseminate the information in form of training, legal application and research study to the consumer at a time when demands for food safety are increasing and confidence in services of restaurants falling.

To the researchers in food safety, the study could shed more light on the viability of a HACCP system and point at the future direction of inquiry in the discipline. Its exploratory nature will provide a basis for further research aimed at isolating the causality between the various variables considered in the study. For instance, future studies may aim to look at the nature of relationship between the level of microbial contamination and food safety practices of urban restaurants.

1.7 Scope and Limitations of the Study

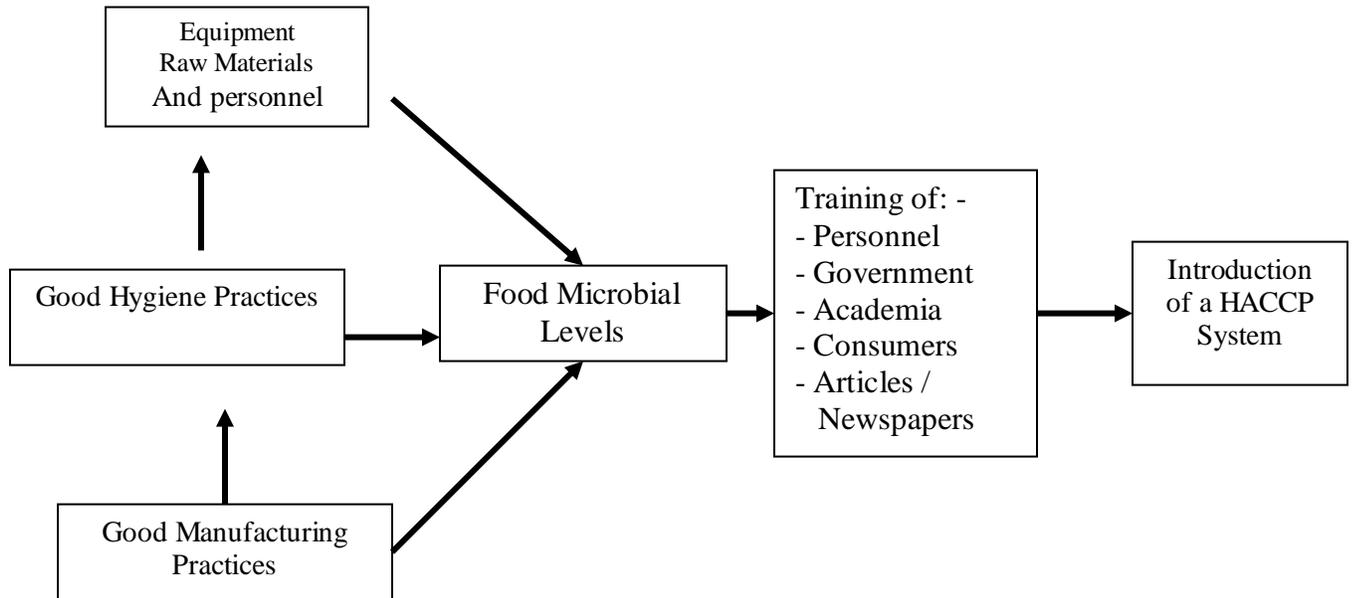
The findings of this study need to be interpreted in light of the certain methodological and conceptual limitations. The scope of the study was limited to urban restaurants and its findings may not wholly explain the hygiene practices of rural restaurants.

Further, the findings are based on the use of descriptive statistics and may be different if a more analytical technique is used to examine the food safety measures and possibility of introducing a HACCP system.

Samples on raw, cooked and non-cooked foods had enough reagents as required by the study. Also, poor record keeping in the council's office led to having incorrect total number of formal restaurants in the town. To counter this limitation; the researcher did a physical count since he is conversant with the town where he leaves and correlated with the councils offices records. No major discrepancies were reported.

1.8 Conceptual Framework

This study was guided by a conceptual framework that inter-relates the major variables involved in this study. The conceptual framework is as shown in figure 1.1 below.



**Figure 1.1: Improvement of food hygiene practices through HACCP system
Adapted: Pierson and Corllet (1992)**

The model above shows that the food microbial levels is determined by good hygienic practices, good manufacturing practices and equipment, raw materials and personnel involved. The researcher adopted the Pierson and Corllet model since it correlates with the study in terms of the HACCP system. The process reflected in the conceptual framework, shows how GMPs can be used in the food establishments to enhance food safety and speed up the process of implementing HACCP systems thus reducing disease outbreaks associated with food and waterborne disease causes, therefore, protecting the public from these diseases. Maria, (1995) suggested that education and technical sophistication must be applied by food processors for the system to be accomplished.

In the United States, food-borne diseases caused 76 million illnesses, 325,000 hospitalizations and 5,000 deaths (CDC, 2002). A survey done, also showed that 13% of restaurants implement the food code for cooking temperatures of beef, fish and chicken at 160°C and pork at 180°C. In Washington, 4 people died and 700 became ill after eating at a chain of quick-service restaurants due to *E-coli* in uncooked hamburger (CDC, 2002). The scenario can replicate in Kenya.

1.9 Operational Terms

Control: To manage the conditions of an operation to maintain compliance with established criteria or the state where correct procedures, criteria are being followed.

Critical control point: A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Good hygiene practices: All practices regarding the conditions and measures necessary to ensure the safety and suitability of food at all stages of food chain.

Githeri: A traditional food of maize and beans boiled together by the Kikuyu tribe in Kenya.

HACCP: Hazard Analyses Critical Control Point, a system approach to the identification, evaluation and control of food safety hazards.

Hazard: A biological, chemical, or physical agent that is reasonably likely to cause illness or injury when used in the manner and quantity proposed.

Food-service establishment: Establishments for the preparation and serving of meals and other edible products to clients/customers.

Hazard analysis: The process of collecting and evaluating information on hazards associated with food under consideration to decide which are significant to affect food safety.

Restaurant: Food establishment that has been registered under category C of Food Drugs and Chemical Substances Act Cap 254 laws of Kenya.

Risk: A function of the likelihood and severity of an adverse health effect on the consumer as a result of exposure to a hazard.

Sanitation: As applied to food industry, it is the creation and maintenance of hygienic and healthful conditions/environment.

Severity: The seriousness of the effect(s) of a hazard.

Prerequisite programs: Procedures, including GMPs that address operational conditions providing the foundation for the HACCP system.

Food safety – Assurance of food products against hazard, which may expose the consumer to a health problem when used in the manner and quantity proposed.

Analyze hazards – Potential hazards associated with food and measures to control those hazards are identified. The hazards could be biological, such as a microbe or chemical such as toxin or physical such as ground glass or metal fragments.

Identify critical control points – These are points in a food production from its raw material state through processing and dispatch to consumption by the customer at which the potential hazard can be controlled or eliminated as in cooking, cooling, packaging and metal detection.

Establish preventive measures with critical limits for each control point – For cooked food, this will include setting the minimum cooking temperature and time required to ensure the elimination of any harmful microbes.

Establish procedures to monitor the critical control points - This will include determining how and by whom cooking time and temperature should be monitored.

Establish corrective actions to be taken when monitoring shows that a critical parameter has not been met – This could be reprocessing or disposing of food if the minimum cooking temperature is not met.

Establish procedures to verify that the system is working properly – testing time and temperature recording devices to verify that a cooking unit is working properly.

Establish effective record keeping documenting the HACCP system – this includes records of hazards and their control methods, the monitoring of safety requirements and action taken to correct potential problems.

HACCP looks at the flow of food through the restaurant, from the time it is delivered to the time it is served to the customer. This can be ascertained to the restaurant as follows:

The Delivery – all the deliveries should be in good condition. Frozen foods must be received frozen (-18°C). Produce should be 4.4°C and dry goods intact. Check dates of expiry and refuse any products that do not meet these standards.

The Storage of products – Rotate, remember FIFO rule. Refrigerated products should be stored below 4.4°C and frozen foods must be stored at -18°C with enough room for circulation.

Food Preparation – Use clean and sanitized equipment and utensils. Thaw all frozen foods in the refrigerator and keep them cold until you work with them. All hot foods should be prepared quickly and should reach the right temperature (73.9°C) and be held at (60.8°C.) Never mix old products with new. Proper hygiene habits are a must for all staff with proper hand washing. Prepare only the food you plan to use in one day and date all the food prepared.

Serving customers – All employees must have high personal hygiene habits because they can transmit diseases/illness, (Weber, 1994). They must have clean hands, hair in place, clean uniform and thoroughly trained in proper hand washing techniques.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter involves a review of literature related to food safety and hygiene standards in food establishments and the possibilities of implementing HACCP as a control system. Among the top ten causes of outpatient morbidity in Thika District Hospital, intestinal worms and diarrhoeal diseases cover 6.4% and 5.0% respectively (GoK,2005), therefore, efforts should be made to bring the morbidity to a manageable level.

2.2 Global Perspective on Food Safety

The food safety development (FSD) strives to reduce the serious negative impact of food-borne diseases worldwide (Gessner & Beller, 1994). Food and waterborne diarrhoeal diseases are leading causes of illness and death in less developed countries, responsible for affecting 1.8 million people annually. Recent trends in global food production, processing, distribution and preparation are creating an increasing demand for food safety research in order to ensure a safer global food supply. WHO works closely with FAO (2002) to address food safety issues along the entire food production chain by the use of HACCP system. These methods provide efficient, science-based tools to improve food safety, thereby benefiting both public health and economic development.

To improve food safety and strengthen consumer confidence, concerns over safety and quality for governments, food producers, industrial traders and consumer are increasing. The burden of food-borne diseases is significant in all parts of the world. In the European region, some food safety and quality problems have endangered consumer health. Food can be contaminated by water used as an ingredient (Ilboudo & Traoré, 2005).

2.3 Consumer Information and Demand

The implementation of food safety principles should be confined not only to developed countries but also to developing countries because this is a clear indication of factors of development allowing the destructive eventualities of potential health incidents, which

can be avoided (WHO, 2005). Consumers who are well-informed will be able to fight for their rights and ensure that they are provided with safe and good quality products and services.

Countries without effective food control systems cannot ensure safe foods, although the range of foods eaten may affect our individual health in the long term, food safety discussions usually focus on the more immediate effects that arise from consuming foods contaminated with some undesirable biological or chemical agents. Food quality control is the science, which deals with the basic standards of food safety maintenance to be accepted by the human race (FAO / WHO, 2002). In Kenya, there is Food, Drugs and Chemical Substances Act CAP 254 of 1992 and Public Health Act CAP 242 of 1986 of the Laws of Kenya which deals with public protection on food safety and sanitation (Gok, 2005).

The importance of food technologies in the prevention of diseases and health remains unrecognized in public health establishments and they are thought to be causes of food-borne diseases (WHO, 2005). The role of food technologies in the life and health of people is wide and very important in improving the nutritional quality of food ensuring safety and preventing food-borne diseases. They reduce losses due to spoilage and contamination and therefore prevent malnutrition and starvation. There are socio-economic implications which facilitate and promote trade in food, provide employment, women facilitation in family's food preparation thus fully participating in social life. They also increase the customers' pleasure and provide a greater choice of products.

2.4 Public Health Aspects

Food safety is a priority for consumers and customers as they want safe health food, which keeps them strong and healthy (Hayer, 1994). Major case for food contamination with pathogens is unsanitary practices during product handling, processing and distribution. Food poisoning agents (infection and intoxication), that are associated with foods include *Escherichia coli*, *Salmonella spp*, *Vibrio cholera*, *Staphylococcus aureus*, *Bacillus cereus*, *Listeria monocytogenes* and *Clostridium perfringens* (Socckett, 1991).

Staphylococcus aureus is a human associated bacterium isolated from the human skin and nasal membrane and its presence in food indicates lapse in the maintenance of personal hygiene (Adesiyun, 1984).

Salmonellosis is one of the major food-borne health hazards and is associated with animal food such as poultry, meat, milk, eggs and fish (Garner & Nunn, 1995). They produce enzymes that degrade carbohydrates, fats and proteins thus resulting in softening and flavor deterioration of foods (Maff, 1995). Under favorable conditions during harvesting, processing and storage of food commodities, moulds produce toxic metabolites called mycotoxins which are a concern to global food safety because of their effects on human health. Most mycotoxins are heat stable and capable of producing diseases of acute or chronic nature when ingested with food. They can affect organs like the liver, the kidney and nervous systems, endocrine and immune systems. Uses of an integrated management system of risks that reflects the HACCP concepts and emphasizes on good manufacturing practices have been recommended (Kapperud, 1995).

New challenges to Kenya food supply have prompted public health authorities to consider adopting a HACCP- based food safety system on a wider basis, because of the increasing number of new food pathogens (WHO, 2005). HACCP focuses on identifying and preventing hazards from contaminating food, is based on sound science, permits more efficient and effective government oversight, places responsibility on the food manufacturer or distributor, helps food establishments compete more effectively in the world market and reduces barriers to international trade (ICMSF, 1980).

2.5 Food Safety versus Food Spoilage

Spoilage is any change in the food that causes the development of undesirable flavors, textures and appearances. Examples of spoilage include soft rot in potatoes which is a biological change, rancidity in oils a sign of chemical change and crushing of food during shipping which is a physical change (Thorner, 1983). There are two types of food borne illnesses, intoxication and infection. An illness caused by consuming harmful (toxic)

chemical is intoxication while that caused by microorganisms invading the body is an infection (Desenclos, 1996).

Bacillus cereus food poisoning was associated with rice at a day care centre in Virginia (Khdor, 1993) while in Quatemala transmission of a newly introduced epidemic strain by street vendors caused infection (Koo, 1996). This can also happen in Kenya and therefore necessary measures have to be taken to avoid this happening to safe guard the public from food poisoning.

Outbreaks of food borne illnesses in Kenya as reported by National Public Health Laboratories in Nairobi between 1990 to 2004 were as shown in (Table 2.1). These were just the reported cases against those affected who never went to the hospital for treatment. The types of bacteria shown are the most common causes of food poisoning in Kenya. Total outbreaks and the cases reported caused some death and therefore to avoid these deaths, the Ministry of Health should introduce polices and guidelines which should guard the public from mass food poisoning from public food service establishments.

Table 2.1: NPHL, (GoK, 2005)

Type of bacteria	Outbreaks	Cases	Death
<i>Bacillus cereus</i>	16	261	0
<i>Brucella spp</i>	2	38	1
<i>Clostridium botulinum*</i>	74	140	10
<i>Escherichia coli*</i>	7	640	4
<i>Salmonella spp*</i>	342	31245	39
<i>Staphylococcus aureus*</i>	47	3181	0
<i>Cholera*</i>	450	4568	2587

Note: * = most common causes of bacterial food poisoning

Source: NPHL (Gok, 2005).

Table 2.2: Incidences of food-borne illnesses in Kenya from 1997 - 2003

Year	1997	1998	1999	2000	2001	2002	2003
Cases	2,017	4,852	564	663,314	600,660	597,110	624,273
Deaths	133	390	43	14	12	8	4

Sources: Public Health Food Safety (GoK, 2005)

Note: Incidences of food poisoning in developing countries could be much higher than the reported cases due to poor infrastructure and lack of facilities (Ombui, Kagiko and Arimi, 2001).

A report workload for Thika District Hospital laboratory was as shown in the table below compared with Gatundu hospital and other rural health facilities (Table 2.3). This shows that Typhoid tests carried the greatest number, thus, showing that stringent food safety measures have to be put in place to avoid further outbreaks.

Table 2.3: Thika/Gatundu District Hospital

TEST	THIKA DISTRICT HOSP.	GATUNDU DISTRICT HOSP.
Stools cultured	157	46
Salmonellosis	1	6
Enter-pathogenic coli	34	25
Typhoid	4611	2330
Brucellosis	234	12

Source: (Gok, 2005)

Disadvantages of HACCP badly done could include lower quality products, less save products, low customer satisfaction, bad customer relationships, legal/civil/prosecution, loss of reputation and profit. Advantages of the system well done could be higher quality products, safer products, high customer satisfaction and relationship, focus of resources, premium prices and better margin (WHO, 2005).

In small business sector the barriers and challenges of implementing HACCP system is attributed to inadequate infrastructure and facilities, lack of expertise and information, psychological constraints, basic hygiene and human resource (ICMSF, 1980). Others could be perception and finance, legal and government commitment, business, customer and consumer awareness. Also lack of formal education, expertise, technical support and inadequate communication and training programs (Tartakow, 1981)

The toxin produced by one strain of *Clostridium botulinum* (type B) was so powerful that when a bite-size piece of beef containing it was diluted about 108 times, all the mice into which it was injected died. This indicates that if a human being had eaten a small amount of that meat, he would have died (Nickelson, 1990). Bacteria are killed by heat at a rate that is referred to as a logarithmic order of death. The *D*-value is defined as the time needed at a given temperature to destroy 90% of a microbial population. Each 90% reduction of bacteria at *D*-value of 2.5 minutes at 250°F (121°C) is described as a reduction of one “log cycle” (Vieira, 1999).

2.6 Effect of Temperature on Foods

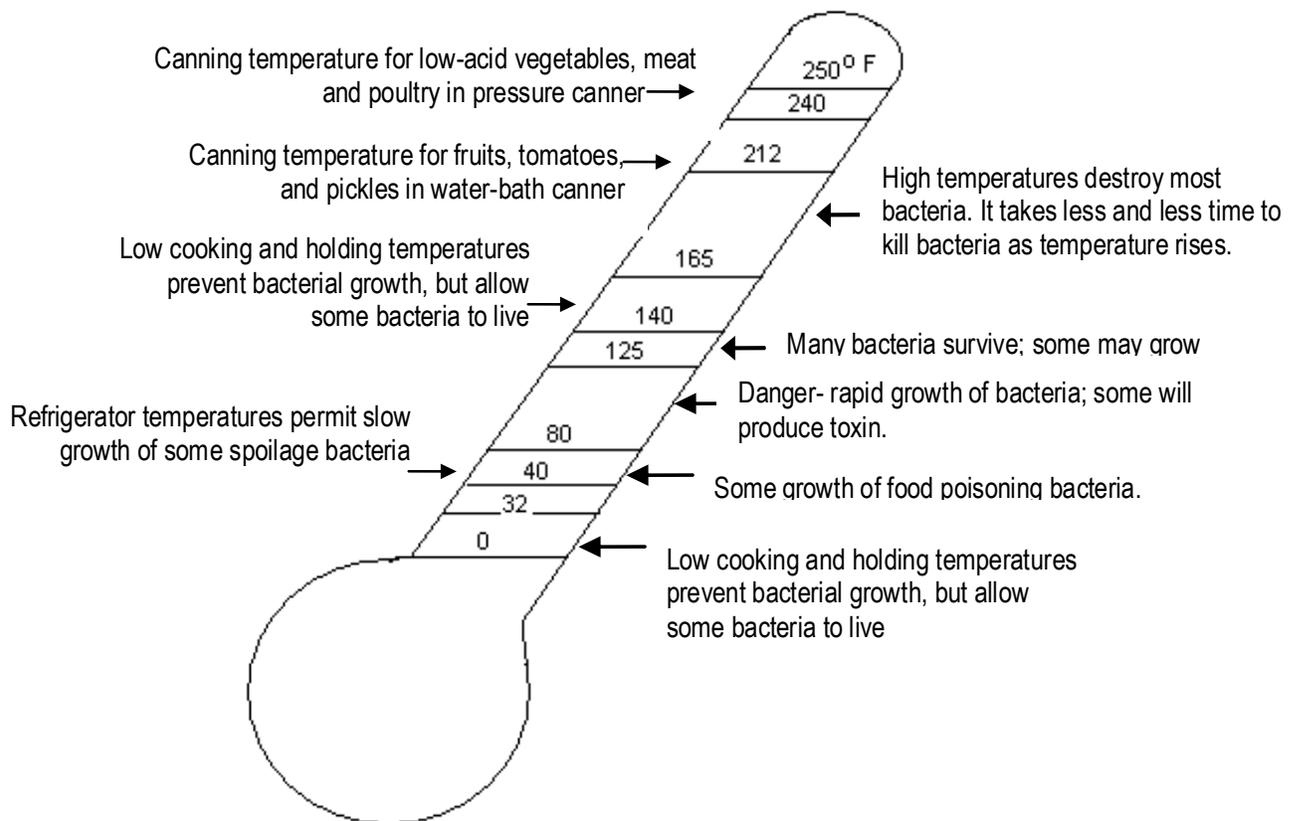


Figure 2.1: Temperature control on Foods

Source: Mildred, M. & Mary (1999)

See appendix 3,(a, b, c and d) for more details of food temperature control.

2.7 HACCP and Food Safety

This was developed to ensure the safety of food for United States astronauts nearly 30 years ago (Pierson & Corlet, 1992). It is now being used in the restaurants because these guidelines make good sense. When customers go into a restaurant, most of them are looking for a clean, safe place to eat. By applying the basic principles of HACCP to the restaurant business, you are making sure that you serve safe food to the customers (Ndungu, 2002).

2.8 Application of HACCP to Food Service and the Underlying Benefits

HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical and physical hazards from raw material production, procurement and handling, to processing, preparation, distribution and consumption of the finished product. A firm commitment to HACCP by top management provides company employees with a sense of the importance of producing safe food (WHO, 2002).

The system is designed for use in all segments of the food industry from growing harvesting, processing, manufacturing, distributing and merchandising to preparing food for consumption. Prerequisites programmes like good manufacturing practices (GMPs) are essential foundations for the development and implementation of successful HACCP plans. Food safety systems based on the HACCP systems have been successfully applied in food processing plants, retail food stores and food service operations. It should be emphasized that HACCP is a preventive approach, and not reactive (WHO, 2002).

So as to verify that the procedures are being implemented, inspection schedules, review plans, records and sampling should be incorporated into the methods, procedures and tests of the whole preparation process. Todd (1996) estimated that 5% of all food-borne illnesses may be traced to abusive industrial practices. Ninety five percent are associated with abusive practices in food service, restaurants or home preparation of foods. HACCP

principles can be applied in food service establishments as implied by Bernard (2002), and can reduce the number of outbreaks of food-borne illness.

The first CCP of product is at the receiving area where those responsible must examine the condition of each item as it is unloaded, from known and approved suppliers who should have functional temperature indicators which should be checked to monitor abuse (Firestone, 1992). Food fried in badly abused oils may absorb the degraded fat, causing gastrointestinal distress. Complaints of this nature and studies on oil quality led to the development of regulations governing restaurants frying oils in developed countries like Europe (WHO, 2005).

(Flyers, 2008) says, the benefit underlying this system for all food sectors and consumers alike to the government include among others improved public health, more efficient and targeted food control, reduced public health costs, trade facilitation and increased confidence of the community in the food industry. To the industry, there will be increased consumer and government confidence, reduced legal and insurance costs, increased market access, reduction in production costs, improved staff-management commitment to the food safety and decreased business risks. To the consumer, there will be reduced risks of food-borne diseases, increased awareness of basic hygiene, increased confidence in the food supply chain and improved quality of life.

Some of the barriers to the implementation of the HACCP systems in food establishment are external conditions which increase the pressure on the strategies for its implementation like regulatory market forces, promotion by public health and food control authorities (WHO, 2002). Others could be internal factors like the level of knowledge or resources available and lack of government or industry support. Management should be committed to the system and need to change attitude and organizational culture towards the system approaches.

Adequate training is important for overcoming barriers related to human resources. This should include both employees and enforcement officials and should lead to behavioural changes, enhance competency along with assessment thereafter. The application of HACCP in restaurants should be mandatory (Stuart, 2002). This is to change the

traditional role of food safety agencies and food inspectors since the system is making headways in the food industries. Educating food handlers to adhere to good personal hygiene and proper handling of food is an essential component of National Food Safety Programme and especially handling of fish (Owaga, 2004).

Table 2.4: Some food-borne disease outbreaks in United States

Microbiological agent	Food implicated	Factors contributing to outbreak	Action taken	Reference
<i>Bacillus cereus</i>	Fried rice	Poor storage	Education	118(a)
<i>Cryptosporidium</i>	Apple cider	Insufficient washing	Guidelines on production	72(b)
<i>Escherichia coli</i> O157:H7	Hamburgers in fast-foods restaurants	Poor processing and cooking	Cooking temperature	47(c)
<i>Salmonella enterica</i> serotype <i>paratyphi</i> B	Goats-milk cheese	Poor Monitoring	Cheese production public education	64(d)
<i>Salmonella typhimurium</i>	Roast pork	Poor storage and reheating	Health education	113(e)
<i>Shigella sonnei</i>	Lettuce	Faecal contamination	Withdrawal public health	75(f)
<i>Vibrio cholerae</i>	Street foods	Food preparation	Licensing health education	135,136(g)

(a, b, c, d,e,f,g – As it appears in the original)

Source: Mildred & Mary (1999)

2.9 HACCP Study-Setting Priorities in the Restaurants

A complete HACCP study cannot be done for every type of restaurant in Thika town. If possible, epidemiological data should be used to set or establish priorities. Foods that are commonly implicated as sources of food-borne diseases should be given first priority; however, Kenya does not have food-borne surveillance programmes which could provide data (GoK, 2005). Therefore, priorities can be based on the following risk factors: Intrinsic properties of the foods involved, preparation and handling, volume of food prepared and susceptibility of consumers.

The HACCP system consists of seven principal activities which should be considered during the HACCP process but in implementing the process, each step should be applied in a manner consistent with the needs and resources of the restaurants. The steps in the HACCP process can be outlined as follows (WHO, 2005):

- a) Hazard analysis – This will consist of pre-visits to the restaurants, description of the products and their intended use, construct flow charts and on site confirmation and finally listing all potential hazards associated with each step.
- b) Determine Critical Control Points- This is the heart of the HACCP study and the success is on flexibility and common sense.
- c) Establish critical limits – Critical limits must be specified for each control measure, so as to monitor the CCPs. This will include characteristics like temperature, time, moisture level and parameters which are organoleptic such as visual and texture e.g. clear running of juices in meats and boiling of liquids which are an indication of thorough cooking.
- d) Establish monitoring procedures – Monitoring is the scheduled measurement or observation at a CCP of the compliance with the critical limits set out for each control measure. Physical, chemical and sensory monitoring methods are preferred because of their speed of response. To monitor the critical control point, make observations, use of senses to evaluate characteristics of foods or measure physical or chemical attributes of foods.
- e) Establish corrective action procedures – Each deviation has two types of action needed. Corrective actions are those that will bring the CCP back under control and

disposition actions are those actions to be taken with the food that has been produced in the time period when CCP was out of control. This might include increase cooking temperature, time, adjusting quantities of some ingredients, adjusting preparation or storage at a later stage, decreasing holding time, increasing holding temperature, reheating, re-washing and sanitizing, rejecting incoming goods and finally disposal of products. Disposition actions will require judgments based on the hazards and their assessed severity and risks.

- f) Establish verification procedures – This should be done by health personnel who are experienced in HACCP and knowledgeable about preparing the foods of concern.
- g) Establish documentation procedures – This calls for maintenance of log or record forms in which to put results of monitoring. This is essential for food processing operations and prudent in marketing of food service operations in the restaurants.

2.10 Chapter Summary

Since the publications of various editions, journals and articles on food safety and sanitation, the science of food safety has changed tremendously both internationally and locally. In the developed and developing countries, the barriers to consumer participation on food safety are far too many thus ranking Kenya to be number eight next to India and Nepal (WHO, 2002). Global trends in food chain have created an increasing demand for food safety research to ensure safe food supply. Consumers well-informed are able to fight for their rights and ensure that they are provided with good quality products and services.

Food service workers continue to violate the basic principles of food protection with the result that food-borne illness outbreaks have not substantially decreased in the developing countries. An outbreak of *E-coli* was associated with bloody diarrhea and hemolytic uremic syndrome from hamburger (Bell, 1994). To deal with the aspects of public health, use of integrated management system of risks that shows the HACCP concepts and emphasizes on GMPs have been recommended (FAO, 2002). Hotels, restaurants, cafes, kiosks and roadsides stands in the commercial sector will all need to be advised, trained and certified as compliant(WHO, 2005).

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This section gives a short description of the research design, target population and a sampling strategy which was used in the research. This was followed by an outline of instruments used, their validity and reliability, data collection procedure and analysis.

3.1 Research Design

The study used a cross-sectional descriptive survey to investigate food safety, hygiene standards and possible implementation of HACCP as a strategy for quality control in the restaurants. The design was an experimental method of analysis to determine microbiological quality of food served in restaurants and took a form of conclusive study which was based on laboratory and statistical methods.

3.2 Target Population

The target population comprised eating houses classified as restaurants which were grouped into two strata; classified hotels and formal restaurants. These were structured with a separate kitchen and dining place for serving meals within the town. For microbial testing, 30 restaurants were tested representing 10% of the whole population of 298 restaurants in the municipality.

3.3 Study area

Thika municipality has an approximate population of 200,000 people during daytime and 150,000 people at night. It has an approximate area of 93.5 km sq. (GoK, 2005). Thika Municipality is situated in the lower dry eastern part of Thika District. It neighbours Kakuzi division to the North, Gatundu and Gatanga divisions to the West, Ruiru division to the South and Machakos District to the East (GoK, 2005). It has district administrative

centres, small and large industrial plants which form the significant economic activities in the municipality.

The municipality has no farming activities except a wide range of manufacturing industries, commercial and residential centers. Thika Town is situated 45 kms North-East of Nairobi the capital city of Kenya. Its proximity to Nairobi has made a tremendous impact on the industrial development of the town. Among the many social economic activities, catering services is the second largest (GoK, 2005). The restaurants provide meals to the high number of workers and visitors who take their lunch and sometimes supper in town. This creates a public awareness on providing safe food to avoid food-borne disease outbreaks.

3.4 Sampling

Simple random sampling was done. Thika town was purposively identified for the study because of its credibility as rural-urban town. The respondents were selected by use of systematic probability sampling which has the advantage of easy sample selection and data collection. Therefore, the theorem used was $n_i = (N_i/N) n$ for $i = 1, 2, \dots, K$, where n is the total size of the sample (Walpole, 1990).

3.5 Sample Size

Convenient sampling was done also called haphazard, fortuitous or accidental where the researcher selected the required number of restaurants that were conveniently available and within the central business district in the municipality. Thika Municipality has a total of 298 formal restaurants (GoK, 2005). This was a descriptive and experimental study (Fowler, 1999); a total of 30 restaurants were used in the research. Therefore, 10% of 298 equal 29.8 which is approximately (30) thirty restaurants. Since the study population was less than ten thousands then the ten percent formula was applied (Mugenda & Mugenda, 2004).

3.6 Research Instruments

Questionnaire was open-ended and one set was administered to the restaurant owners/staff, customers and Public Health Officers. A checklist of facilities in the restaurants was also conducted. A working relationship with the respondents prior to conducting interviews was established by doing a prior visit. The researcher developed the questions in the instruments as guided by the research questions and literature review.

The questions were addressing the following research questions:

- What are the microbial loads of foods consumed in restaurants in Thika town?
- What is the food safety control measures applied in restaurants in Thika town?
- Is there a possibility of implementing a HACCP system as a strategy for quality control in the restaurants in Thika town?
- Is there an awareness of SSOP by restaurant workers?

An observation schedule was used to supplement data from questionnaires and interviews, which covered the receipt of food materials, storage, preparation, production and service. Since the research was to be experimental, laboratory and other bimetallic instruments were used.

3.7 Instrument Validity and Reliability

3.7.1 Validity

According to Paton (2002) validity is quality attributed to proposition or measures of the degree to which they conform to establish knowledge or truth. An attitude scale is considered valid, for example, to the degree to which its results conform to other measures of possession of the attitude. Validity therefore refers to the extent to which an instrument can measure what it ought to measure. It therefore refers to the extent to which an instrument asks the right questions in terms of accuracy. Mugenda and Mugenda (1999) define validity as the accuracy and meaningfulness of inferences which are based on research results.

The content validity of the instrument was determined in two ways. First, content validity of the instrument was determined through piloting, where the responses of the subjects were checked against the research objectives. This also gave a reason as to why content had to be used. For a research instrument to be considered valid, the content selected and included in the questionnaire must be relevant to the variable being investigated (Neuman, 2000).

The researcher then performed a pilot test outside the area of study but in restaurants using the HACCP system. Appropriate changes were made on the research instruments depending on the responses. Secondly, the researcher discussed the items in the instrument with the supervisors, lecturers from the department and colleagues. Advice given by these people helped the researcher determine the validity of the research instruments. The advice included suggestions, clarifications and other inputs. These suggestions were used in making necessary changes.

3.7.2 Reliability

Reliability is a measure of the degree to which a research instrument yields results after repeated trials (Mugenda and Mugenda, 1999). Reliability is a quality attributed to proposition or measures to the degree to which they produce consistent results. An attitude scale is considered reliable, for example, to the degree to which the same respondents, or very similar respondents, receive the same or very similar score upon repeated testing.

To establish the reliability of the questionnaire, pre- testing through piloting was done. The reliability of the items was based on estimates of the variability of staff responding to the items. The reliability coefficient was determined by test-retest technique. The instruments were then administered to the same subjects after an intervening period of one week. This technique was used because it determines the stability of the research instrument. Pearson's product moment's correlation (r) was used to determine the coefficient stability of the data collection instrument. Neuman (2000) say that Pearson's

Product moment coefficient of correlation is one of the best-known measures of association.

The reliability was calculated and was found to be 0.764 between the two tests. A reliability of at least 0.5 was considered high enough for the instrument to be used for the study, Patton (2002). Feedback obtained from the pilot study assisted the researcher in revising the questionnaire to ensure that it covered the objectives of the study. The main reason for piloting the questionnaire was to ensure as far as possible that the items would detect the kind of responses the researcher intends to get, that they are acceptable in terms of their content, and they adequately covered any aspect of the unit which the researcher particularly wished to explore. In a case where it was discovered that the items in the questionnaire were difficult for the respondents, they were rectified accordingly.

3.8 Data Collection Procedure

Field sampling was done in two categories upon receiving of food samples, storage, processing and service. The samples were transported in cool boxes to laboratories for testing and analyzing. Microbiologically, sensitive raw materials and ingredients were arranged as follows, beef stew, salads, cooked vegetables and water.

A food scored (+) if it had hazard characteristic and (-) if it didn't have or exhibit characteristic. The six characteristic ranking systems were applied for microbiological analysis only. The second step was to assign risk categories (0-VI) based on the food microbial sensitivity, its raw materials and ingredients.

Table 3.1: Hazard characteristics and risk category of samples

Food samples	Hazard characteristics		Risk category
	(+) <i>Has</i>	(-) <i>Hasn't</i>	
Beef Stew	+		VI
Cooked vegetable		-	V
Dinner plate		-	IV
Fruit salad	+		III
Githeri	+		II
Kachumbari	+		I
Personnel		-	0
Vegetable salad	+		VI
Water		-	I
Work place		-	V

3.9 Sampling Plan and Procedure

Among the 30 restaurants, the following formed the purposive sampling frame units of observation in the study: Restaurant proprietors – 07, managers- 06, cooks- 05, waiters- 05, storekeepers- 05 public health officers – 02.

As suggested by International Commission for the Microbiological Testing in Food Safety Management (Tavakoli, 2008), the procedures for microbial testing were carried out. Identified and collected representative sample of 250 gm of each sample was recorded and product temperature maintained to protect the samples from contamination or damage. Sealed samples to ensure integrity and submitted them to the laboratory in the original unopened containers. The decision criteria for microbial analysis were based on three four plan (n, c, m, M), Jay (1986).

Where n = number of sample units, c = maximum number, m = maximum level of bacteria, M = quantity to separate (marginal).

Table 3.2 – Class plan (n, c, m, M).

Product	test	class plan	n	c	m	Limit/gm M
Salads	APC	3	5	2	10^6	10^7
	Coliforms	3	5	2	4	400
	<i>S.aureus</i>	3	5	2	10^3	2×10^3
Vegetables	APC	3	5	3	10^5	10^6
	<i>E-coli</i>	3	5	2	10	10^2
Meat	APC	3	5	3	10^6	10^7
	<i>Salmonellae</i>	2	5	1	0	-

Source: Jay (1986)

3.10 Data Analysis

Use of descriptive statistics on the quantitative analysis was done. The use of means, standard deviation, frequency distribution and percentages was applied. The response from structured interviews was quantified and interpreted.

A. Aerobic/Total Plate Counts in (APC) Agar

Equipment and staff hands were swabbed using sterile swabs and the swabs taken to laboratory, transferred to a culture medium and the water was diluted in diluents to see if the colony forming units exceeds 3.0×10^5 micro organisms per gram or $TPC < 10^5$ CFU/g. The determination of total viable count was done by the aerobic plate count method using plate count agar (PCA). Aliquots of 0.1 ml of sample dilutions were spread onto pre-dried PCA agar using a sterile glass rod. The prepared dishes were then inverted and incubated at 37°C for 48 hr.

B. Total Coliforms and *Escherichia Coli* Counts in (VRBA) Medium

To estimate bacterial population, dilutions of a sample were placed in triplicate tubes containing a violet red bile agar (VRBA) liquid medium to see where growth would be present. This was to test if the MPN was to exceed 360 per gram and for *Ecoli* were greater than 50 per gram or *E – coli* < 10 in 25g. The enumeration of total coliforms was done by the pour plate method using violet red bile agar (VRBA). The media was mixed with 0.1 ml of the sample dilutions and allowed to set. Finally, an overlay was prepared using VRBA and incubated at 37°C for 24h.

C. *Staphylococcus aureus* Counts in (BP) Agar

Enumeration of *Staphylococcus aureus* was done according to Baird – Parker method. Aliquots of 0.1 ml of dilutions were spread onto the pre-dried Baird Parker Agar (BPA), supplemented with egg yolk tellurite emulsion and spread with a sterile glass rod. The plates were incubated at 37°C for 24h. Black and shiny colonies with a narrow white margin and surrounded by clear zones were considered as coagulase positive *Staphylococcus aureus*.

A report on investigation on the presence of coagulase positive staphylococcus(CPS) in foods products marketed in Italy and on food contact surface swabs sampled showed that a total of 11,384 samples examined 1971(17.3%) were found to contain CPS and the strains cause a variety of nosocomial infections(G.Mula,2005). In Nairobi, *Staphylococcus aureus* isolates from beef carcasses, minced beef and dressed chicken were assessed for production of enterotoxin A, B C and D using passive agglutination technique. The data showed that chickens and minced beef are potential sources of food poisoning staphylococci in Kenya (Ombui, Arimi and Kayihura, 1992).

D. Water (Most Probable Number)

This was done in triplicate and the media used was Lauryl Tryptose Broth (LTB), which is used for detection of coliform organisms in water. In the statistical analyses, all treatments were contacted in triplicates. The differences among them were measured by use of ANOVA while Duncan's multiple range tests was used to determine significant differences between means at probability of 5% ($p \leq 0.05$). Statistical Package for Social Sciences (SPSS) was also used. According to Kenya Bureau of Standards, specifications for drinking water should have the following standard as shown in the table below on method for microbiological contamination of water.

Table 3.3: Microbiological limits for containerized mineral water

Substance	Limit	Method of test
Total viable count (at 37°C), per ml, max.	20 Shall be absent	KS 05-220 *
Coliforms in 250 ml	“	“
<i>E. coli</i> in 250 ml	“	“
<i>Staphylococcus aureus</i> in 250 ml	“	“
Iron-sulphite-reducing anaerobes in 50 ml	“	“
<i>Pseudomonas aeruginosa</i> fluorescence in 250 ml	“	“
<i>Streptococcus faecalis</i> in 250 ml	“	“
<i>Shigella</i> in 250 ml	“	“
<i>Salmonella</i> in 250 ml	“	“

3.11 Ethical Consideration

An introduction letter from the Director of Board of Postgraduate Studies to the Ministry of Education enabled the researcher to obtain a research permit. Work plan, budget and confidentiality of responses were considered.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Introduction

Safety control measures on hygiene and food safety greatly contribute to the prevention and control of food-borne diseases if widely accepted and correctly implemented. This research reported the findings of a survey which assessed food business operator's knowledge of, attitudes to and opinions about the safety controls and regulations which are in place in Thika. It also investigated measures taken to enhance food safety and reduce incidence of food-borne diseases by looking at the most common food poisoning bacteria.

4.1 Demographic Data

The demographic data and understanding of quality control strategy in food establishment of the respondents were gathered and the mean and percentages values tabulated to determine how informed they were on the issue of quality control and hygiene standards.

Sex distribution

Staff working in these restaurants were mostly male (65%) as compared to female (35%) as shown in figure 4.1. This shows that most Restaurants prefer engaging male staff in their operations. This could be because men are more flexible and can handle more labour intensive duties than women.

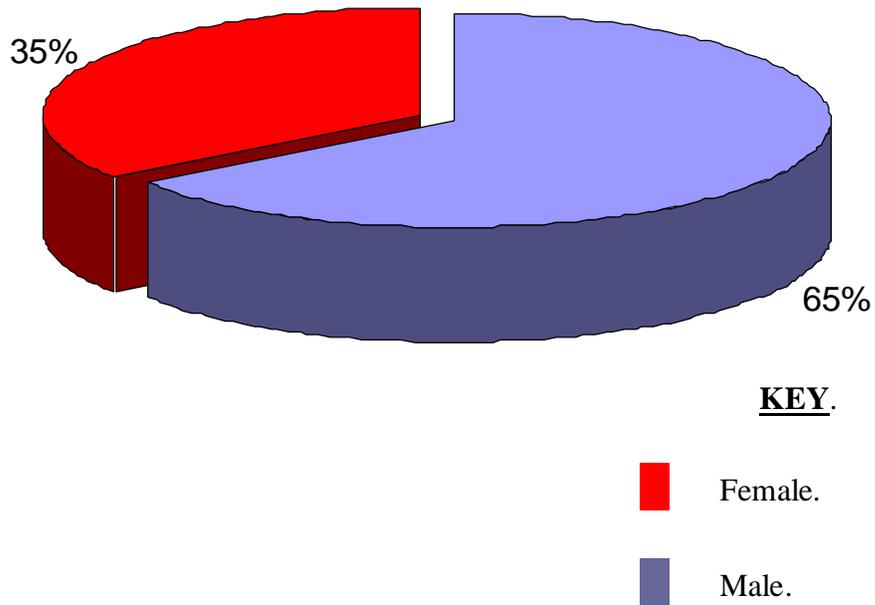


Figure 4.1: Sex distribution of the workers

Most restaurants had more male than female staff workers and after a serious enquiry from the management; the reason was that male workers are flexible to work with than female workers. They also do not have complicated social living style compared to women.

Education

The data confirmed as in figure 4.2 most restaurants workers, managers and owners are trained in catering management, 44% had college education. Those with secondary level were 22 % while those with post-secondary education were 26%. This shows that the level of formal education is relatively high among the staff in the restaurants in Thika town.

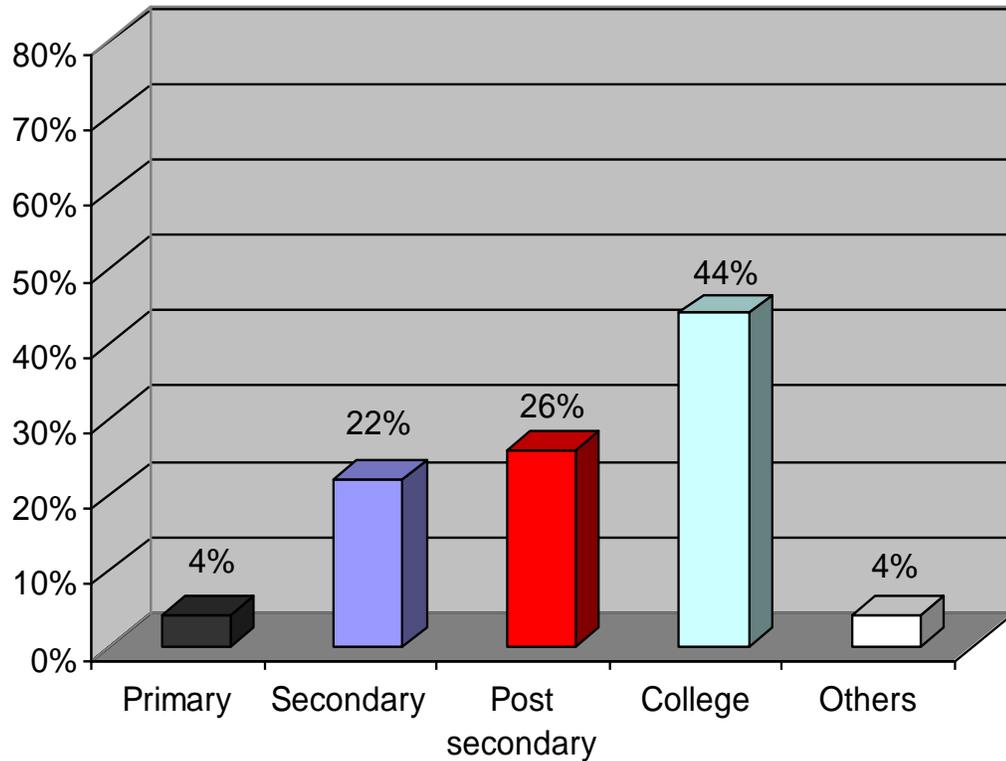


Figure 4.2: Education level of respondents

The analysis here indicates that 44% of the workers respondents had training up to college level indicating that they are trained to handle food and therefore most likely aware of the HACCP system. At the end of the discussion, a hypothesis is tested on whether awareness of the SSOP system by workers affects microbial loads of foods consumed in restaurants.

New employee training is very important when beginning work. This is helpful to acquaint them with all aspects of the operations. The quality assurance program should provide for instructing staff about the units operations, products and good hygiene practices.

Instructions should include basic information that any new staff should know about food handling and cleanliness. To ensure success, employee should be educated, trained, and retrained in the use of HACCP. An effective approach for the implementation of the

system consists of management education, operations steps, employee motivation and involvement.

Training

As shown in figure 4.3, 60% of staff who work in these restaurants do not have basic formal training relevant to food production or catering and therefore they have relative experience in the industry while 40% are trained in catering. This can contribute to the slow understanding and implementation of scientific and hygiene standards in the restaurants. When staffs are properly trained and well-experienced, they become flexible to change and therefore become so easy to adapt to any change in a production and service systems.

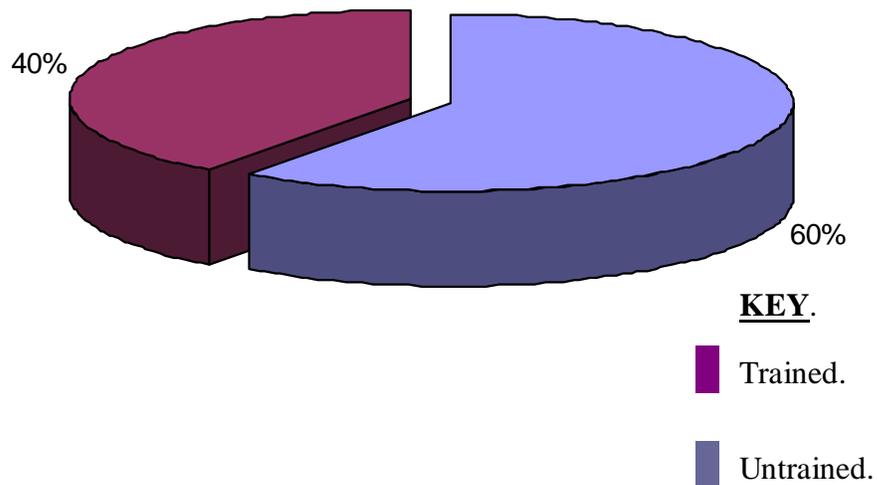


Figure 4.3: Training in catering (formal) of restaurant workers

The fact that most of the workers respondents were untrained could explain the high rates of microbial loads of foods since it means they are not aware of the different ways they are supposed to handle food to avoid contamination.

Designation

Majority of the respondents as shown in figure 4.4, were either managers or owners of the restaurants, with managers being 37% and owners 30% respectively. Others are employed to work in the restaurants. Most restaurants have managers who are employed while some are managed by the owners. Head cooks cover 26% and general cooks are only 8% as designated in their work stations.

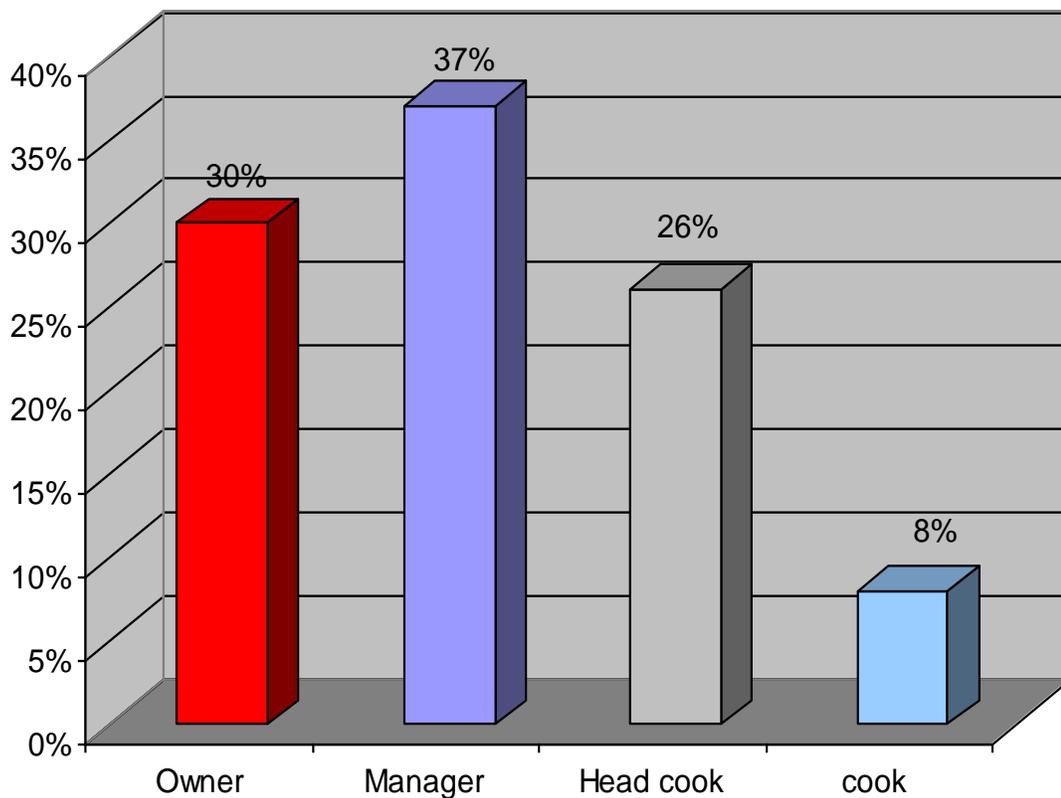


Figure 4.4: Designation of staff in the restaurants

4.2 Food Safety Control Measures

The study was conducted, using the structured interview method and microbial level on foods served in the restaurants was done. Thirty (30) food business operators in Thika Municipality were interviewed by means of a questionnaire. The results were 22 (74%) of these restaurants were 'ready to eat' establishments and 8 (26%) were to prepare and wait restaurants.

The study established that 19(63%) of the business operators have knowledge on quality control measures for food establishments. Only 3 (8%) apply these controls in the kitchen, while 29 (86%) indicated that the food contains ingredients that may present microbiological hazards if poorly handled. The findings of the study suggested the need to establish implementation of HACCP system as strategy for quality control in the restaurants. This is to enhance food safety and includes better use of resources and more timely response to problems.

Knowledge on HACCP application is low 9 (30%) in the restaurants in Thika Municipality probably due to lack of enforcement from the relevant authorities. There is lack of credible source of information and standards with only 12 (40%) of some establishments trying to adapt a safety standards not associated with HACCP. This fairly low knowledge is similar to what other studies in Europe had found.

Weighing and sorting of food materials in most restaurants was used as a critical point which covered a total of 80%. This is similar to other studies in Nairobi, which found that food materials collected from the farmers needed adequate sorting before preparation for the public consumption. Preservation of food perishables was used as a critical point by 15% of the restaurants. This is due to the low amount of raw foods purchased because of inadequate storage facilities and financial constraints. A similar study done in Geneva found that financial constraints, human resources and inadequate facilities were the main barriers in the application of HACCP system (FAO, 2002). Most restaurants stored their dry foods very well because these foods can stay longer without spoilage. A study in

Kenya showed that some dry maize stored in poor conditions resulted in the outbreak of aflatoxin which caused food poisoning (Gok, 2005).

Proper food storage was fairly practiced in most restaurants (70%) in high temperatures after cooking then holding. This was due to the high level of literacy with the customer demands for hot food. A study in China (2005) showed that most people served in some restaurants were served with cold foods which led to food poisoning. General hygiene standards was not well-observed and a similar study done in Kenya, showed that 70% of food outlets were below the deserved hygiene standards yet they were operational. HACCP is more superior to all the conventional quality control procedures as it focuses on identifying and preventing hazards from contaminating food, sound science based, permits efficient and effective government oversight, ensures food safety on manufacturer/distributor, world market competition and reduces barriers to international trade. The main purpose of this study was to investigate hygiene practices in urban restaurants

Level of understanding on Quality control Strategy

Staff interviewed knew of some quality control strategy (37%) as shown in Figure 4.5, but with no specification of any application while 63% had no understanding of any quality control therefore, this shows that there is need for the staff to be taught on specific methods of food safety and hygiene standards.

Quality is the composite of characteristics that differentiate individual units and have significance in determining the degree of acceptability of that unit by the user and the compound characteristics of quality are both measurable and controllable. A complete sanitation program should consist HACCP system which can be incorporated in a quality assurance program because it applies to a zero defects concept to food production.

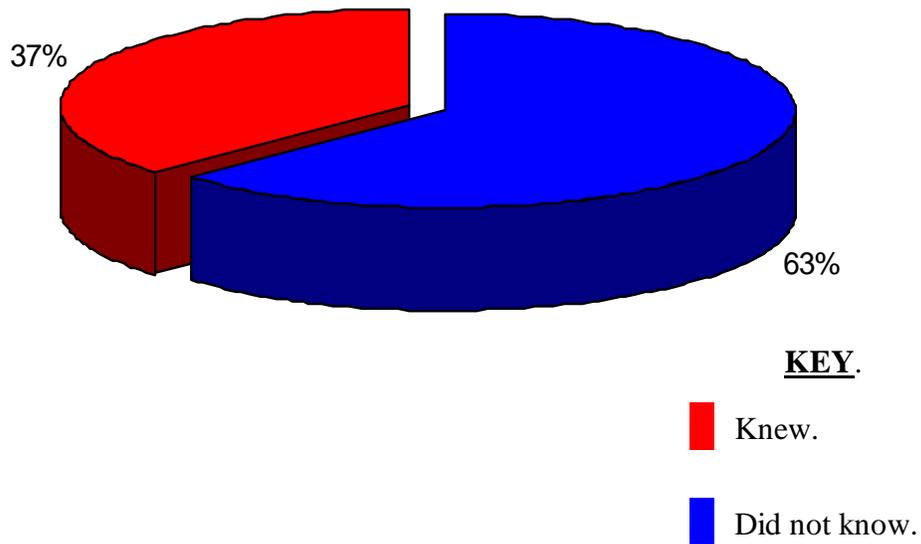


Figure 4.5: Understanding of quality control strategy by the restaurants staff

Methods of food storage

This was fairly applied in most restaurants as shown in figure 4.6, only 10% were leaving the food not covered or well-stored thus no precaution observed. Restaurants storing food in high temperatures were 60% while those in cold temperatures were 30%.

All foods should be well stored accordingly to avoid contamination which can occur from the soil, sewage, live animals, external surfaces and internal organs of meat animals. Storage facilities should provide adequate space with appropriate control and protection against contamination which can be reduced by having organised storage layouts with appropriate stock rotation.

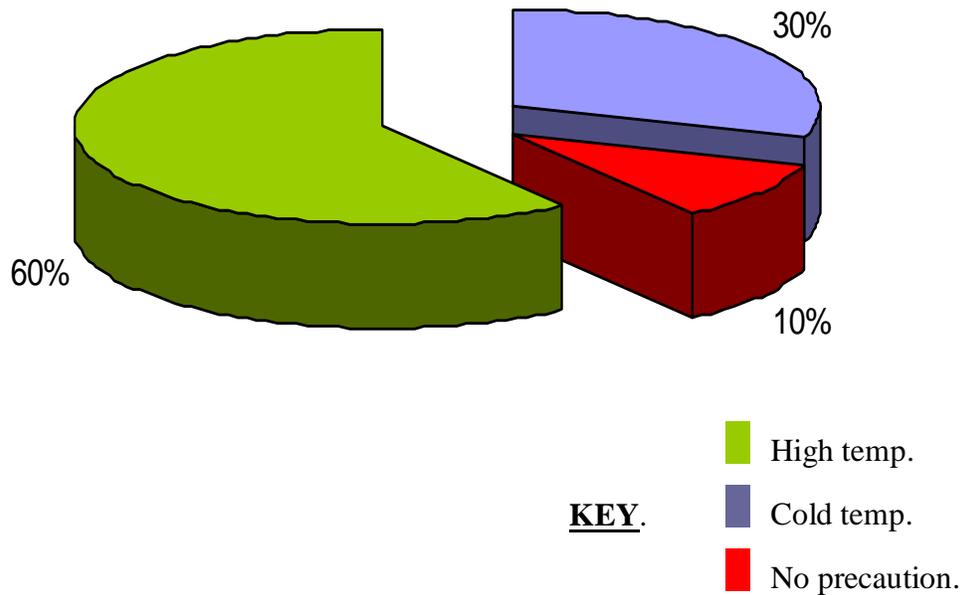


Figure 4.6: Methods of food storage in the restaurants

The analysis implies that there is a high chance of microbial loads of foods increasing since 10% of the respondents said that they do not take any precaution while preserving their food.

Source of information for quality control

The public health office in the municipality disseminates information on quality control but with no specifics on the best way to improve food safety standards. The majority of the respondents were aware of the quality control strategy for food establishment and knew of it from the public health staff as shown in Figure 4.7. This shows that there is need for the Public Health Authorities to emphasize on hygiene standards and have

frequent sensitization programmes on the same and use of more technical scientific methods of food safety approach.

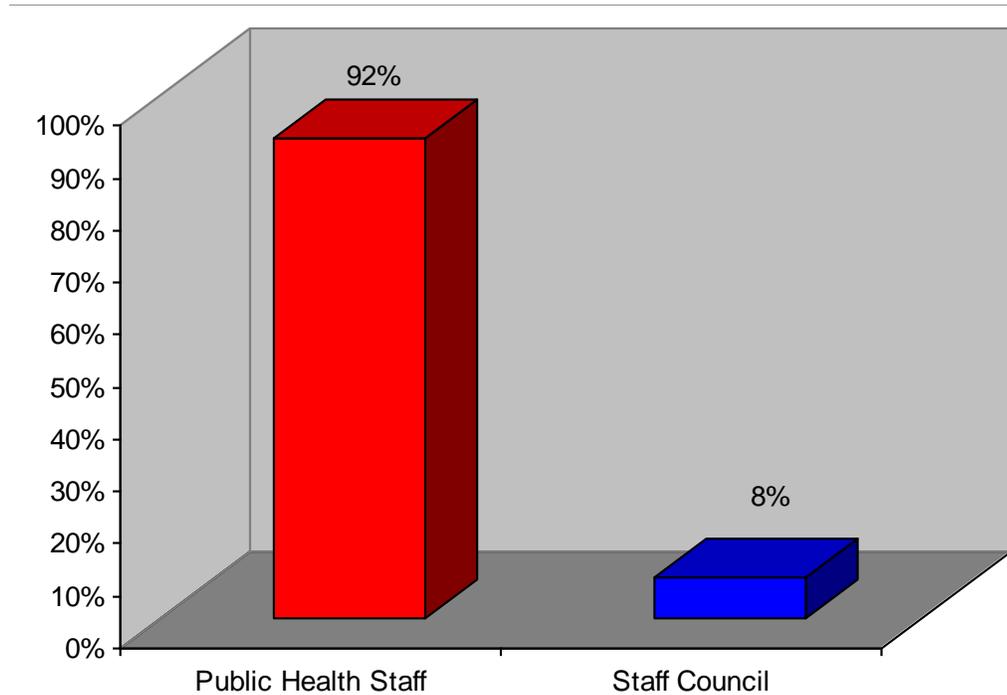


Figure 4.7: Source of information for quality control

Application of quality control strategy

Most of the restaurants apply quality control strategy at the receiving area where sorting and weighing were used as critical point (92%). Cooking was also used as a CCP but with no specific monitoring of time and temperatures (8%) as shown in figure 4.8. The quality control strategy is frequently applied while receiving the food stuff according to the respondents where they check the weight, quality in terms freshness, cleanliness and also quantity according to the specifications given on the purchase order. Hot food should be kept hot while cold food should be under refrigeration.

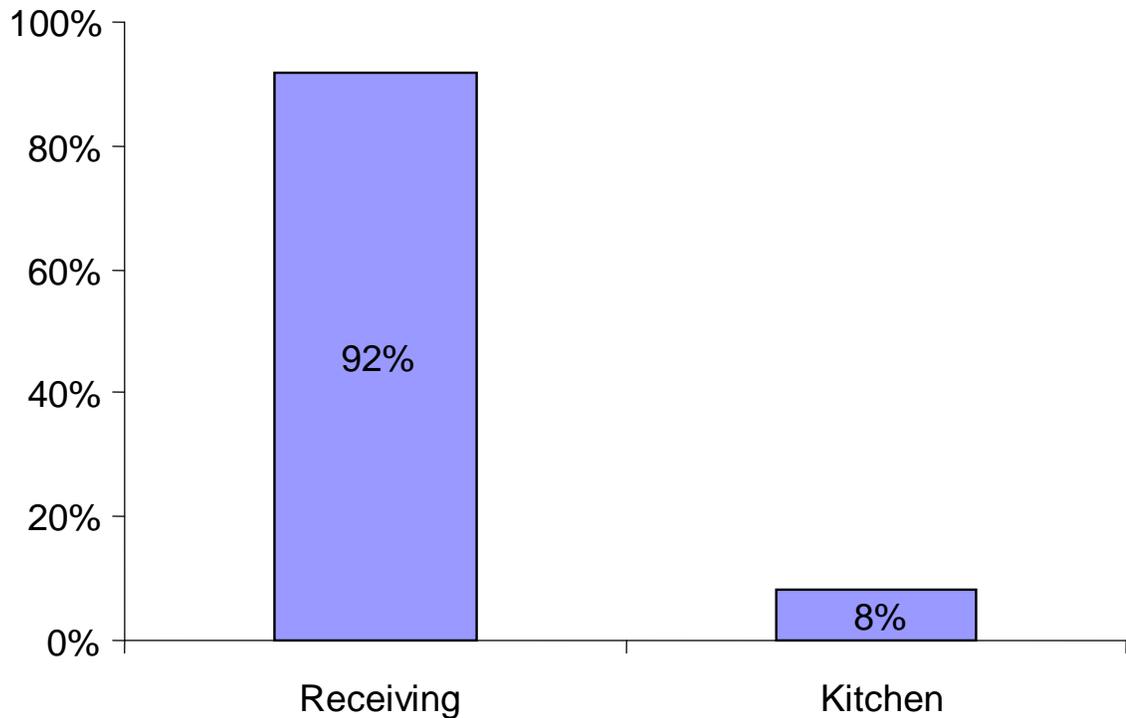


Figure 4.8: Application of quality control strategy in the restaurants

Type of food establishment(Restaurants)

Food prepared ready to eat is most common in the restaurants (74%) while a small number (26%) is prepared as you wait, see figure 4.9. This shows that there is need to enhance food safety in these premises for better health. Most restaurants prepare table de' hotel menus which need holding before service and therefore temperature (hot or cold) control is very important. Ala'carte menus are served hot because the customer waits for the meals to be prepared after making the order.

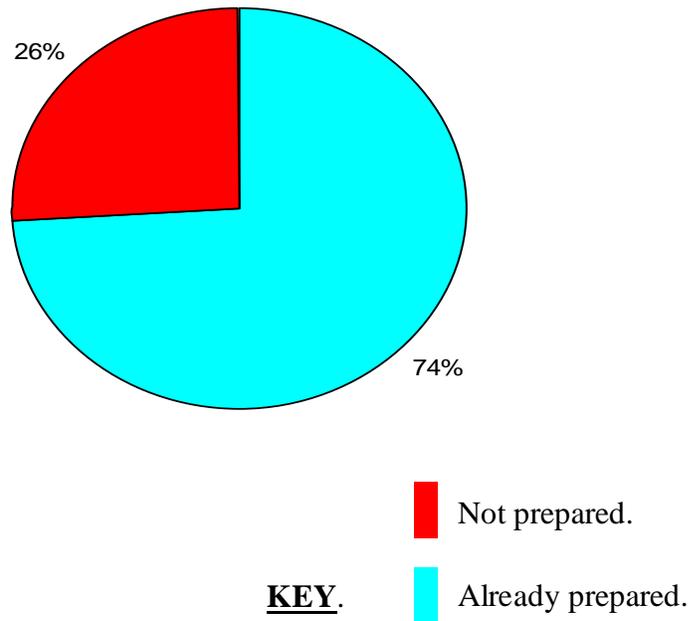


Figure 4.9: Type of food establishment(Restaurants)

Preservation methods

Most restaurants used refrigeration as a means of food preservation. Dry storage for non-perishables and freezing was done as a means of food storage covering 15% of all the restaurants for dry foods storage and 15% of the restaurants for freezing respectively, Refrigeration was done 70% of the restaurants (Figure 4.10.) This indicates a sign of some critical control points used in the systems. Perishables should be received at 40⁰F and stored in the same state under refrigeration if not to be used immediately. Dry foods should be stored at 50⁰F or more. Food should be cooked at a temperature of 165⁰F if it is meat and serve at a temperature above 70⁰F. For freezing it should be between 0⁰F and -18⁰F.

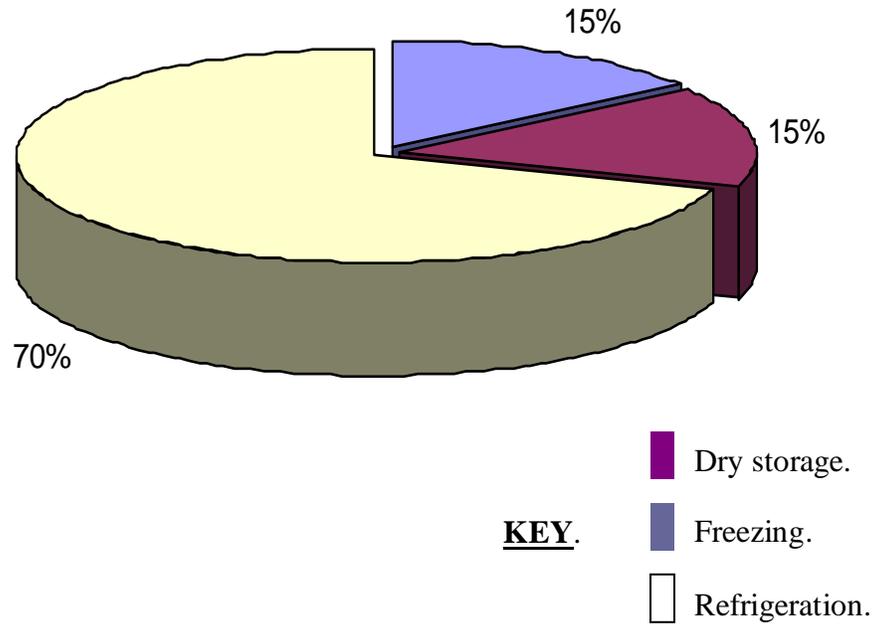


Figure 4.10: Preservation methods of food in the restaurants

The food preservation methods used in the restaurants vary depending with kind of facilities available. They store dry foods in well ventilated rooms with normal room temperature while other perishable foods are stored in cold rooms.

Receiving of perishables (meats, milk and vegetables)

The total respondents received food materials in bulk (20%), while 80% received in small quantities from the suppliers as shown in Figure 4.11. This shows that most of the restaurants do not have adequate storage facilities.

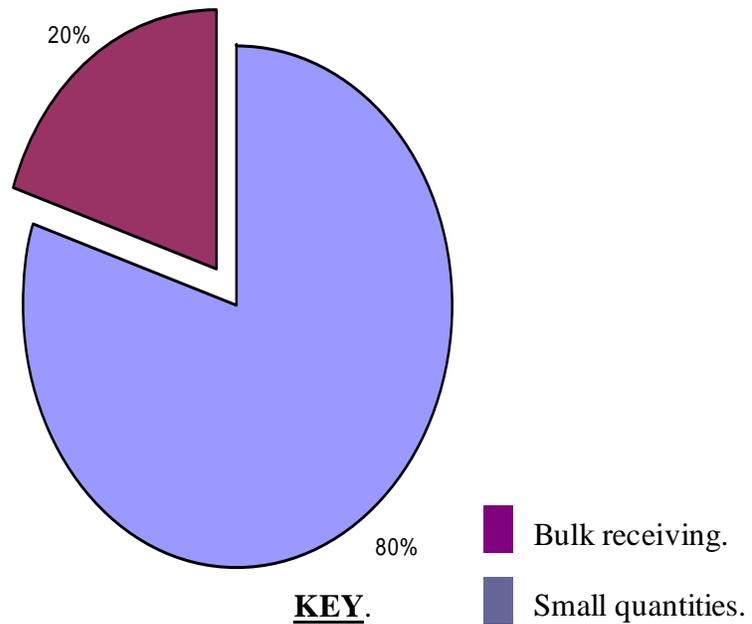


Figure 4.11: Receiving of perishables foods

Most perishable foods received for food production depend with the menu available and these are meats, poultry, fish and fruits, and all types of vegetables.

Receiving of both perishables and non-perishables(dry foods)

Most of the restaurants which received perishables (meats, vegetables and milk) from the supplier/market were (92%) and those who received non-perishable (dry foods) materials were (8%) as shown in Figure 4.12. Therefore, there is a lot of quality control system used here because the food store-staff check the details of the material specifications on quality and quantity.

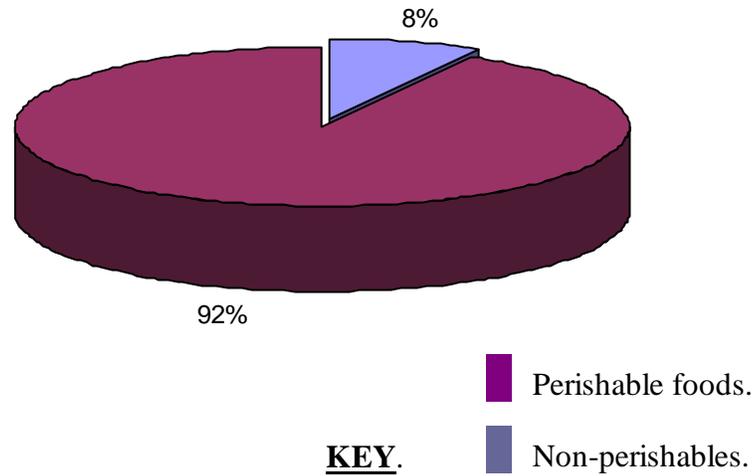


Figure 4.12: Receiving of perishables and non-perishables in the Restaurants from the Suppliers

Meat and poultry contamination can occur during slaughter, processing, distribution, and foodservice cycle because they are handled frequently often as many as 18 – 20 times. Anything contacting these perishables can serve as a contamination source and the risks of this condition occurring rises the more they handled. If the handling is careless and ineffective, the microbes win.

On environmental hygiene, 77% of the operators had clean compounds, liquid and solid waste was well collected. Smoking in both kitchen and dining rooms was silent but somehow allowed in the premises. Staff grooming was good and they had proper uniform as required by the public health law. Crockery, utensils and some equipment were dirty(12%) and (18%) clean. All the restaurants had health and safety licence for the year 2005 as required by the Public Health Act(GoK,2005). Food stores and cold rooms were dirty in 23% and clean in 72% of the restaurants. Hand wash basins was available in most

premises and therefore quite conscious of customer care, personal hygiene and food safety measures (Table 3.4).

Table 3.4 Environmental Hygiene

Observation (n=30)	Status	%
Compound	Clean = 23	77
	Dirty = 7	23
Liquid waste	Well collected = 27	90
	Not well collected = 3	10
Solid waste	Well collected = 19	63
	Not well collected = 11	37
Smoking in the kitchen	Allowed/silent = 25	83
	Prohibited = 5	17
Smoking in the restaurant	Allowed/silent = 28	93
	Prohibited = 2	7
Grooming of staff	Good = 27	90
	Bad = 3	10
Crockery and Utensils	Dirty = 12	40
	Clean = 18	60
Hot water – non cooking	Available = 12	40
	Not available = 18	60
Health & safety license (2005)	Issued = 30	100
	Not issued = 0	0
Food stores and cold rooms	Dirty = 7	23
	Clean = 23	72
Hand wash basins	Available = 29	97
	Not available = 1	13
Customer flow level	Many = 22	73
	Few = 8	27

4.3 Inferential Analysis

Mean, range values and standard deviations, frequency distribution and percentages of the data were calculated. The Aerobic bacteria, *Staphylococcus aureus* and *E.coli* counts of the sample foods were also analyzed by a 't' test using the SPSS to determine significant levels in the food samples. Level $p \leq 0.05$ was considered significant.

(i) Microbial load of food sampled from restaurants in Thika town:

Microbial tests were conducted from a total of 17 samples, cooked (Table 4.1), non-cooked (Table 4.2) and raw foods (Table 4.3). The Aerobic/Total plate counts (APC), total coliforms and *Escherichia coli* counts and *Staphylococcus aureus* counts yielded bacterial load levels which showed that all samples were microbiologically contaminated though at very low levels.

(ii) Total coliforms and *Escherichia coli* counts

Total coliform counts ranged from 1.5×10^2 CFU/g to 8.9×10^3 CFU/g with the highest mean of 9.7×10^3 CFU/gm (Table 4.1). The counts of *E.coli* were also available ranging from 1.6×10^1 CFU/g to 9.2×10^2 CFU/g with the highest mean of 8.2×10^3 CFU/gm. According to International Commission for the Microbiology Specification of Foods/ICMSF (2002), the presence of coliforms and *E.coli* organisms in foods indicate direct or indirect contamination of the materials with faecal matter and possible presence of other potential enteric pathogens. All the samples in the study showed coliforms and *E.coli* counts which could be a reflection of the inadequate hygiene and sanitary standards prevailing at different stages of food production process.

(iii) *Staphylococcus aureus* counts

The coagulate positive *S. aureus* counts varied from 1.3×10^2 CFU/g to 6.3×10^3 CFU/g with the highest mean of 5.4×10^3 CFU/gm (Table 4.2). There was a significant ($p \leq 0.05$) relationship with hygiene standards compared with the food processes in the kitchens. The unhygienic habits of some of the personnel involved in the actual preparation may have led to contamination from the hands to the work-places or vice versa. All the samples revealed counts indicating that the products are capable of inducing outbreaks of staphylococcal food poisoning if poorly handled. The infectious dose capable of staphyloenterotoxins production has been reported as 10^6 CFU/g (CDC, 2002).

Water was a contributor to the highest number of counts in other foods because it had all the bacteria with a total mean of APC 4.7×10^3 CFU/ml. Sampled water was from the taps directly supplied and treated by the Municipal Council. The average counts for all the bacteria were relatively available though not very high to an alarming stage. This is an indication that hygiene practices in most of the restaurants in Thika town are not of high quality and therefore, there is need to enhance food safety standards by introducing more and better scientific food safety hygiene standards, thus HACCP application.

Table 4.1: Bacterial counts in the cooked food samples

Type of food	APC	<i>S.aureus</i>	<i>E.coli</i>
Beef stew			
Mean	4.2×10^3	2.4×10^2	5.7×10^2
Range	$1.5 \times 10^2 - 6.0 \times 10^3$	$3.1 \times 10^1 - 3.3 \times 10^2$	$3.8 \times 10^2 - 7.6 \times 10^3$
SD	0.5912	0.1210	0.3121
Cooked vegetable			
Mean	3.3×10^3	2.0×10^2	2.6×10^2
Range	$2.0 \times 10^3 - 5.3 \times 10^4$	$3.1 \times 10^2 - 3.7 \times 10^3$	$3.3 \times 10^2 - 4.0 \times 10^3$
SD	0.7630	0.8761	0.6612
Nyama choma			
Mean	5.8×10^2	4.5×10^2	2.6×10^3
Range	$4.5 \times 10^2 - 3.8 \times 10^3$	$6.3 \times 10^1 - 2.6 \times 10^4$	$1.6 \times 10^1 - 3.7 \times 10^3$
SD	0.6710	0.5511	0.5600
Chips			
Mean	3.0×10^3	4.1×10^3	4.3×10^3
Range	$1.8 \times 10^1 - 5.0 \times 10^3$	$2.0 \times 10^2 - 6.8 \times 10^3$	$2.3 \times 10^2 - 7.0 \times 10^3$
SD	0.7651	0.8981	0.7761
Bhajia			
Mean	4.0×10^2	4.6×10^2	4.5×10^2
Range	$1.7 \times 10^1 - 6.3 \times 10^3$	$2.0 \times 10^2 - 6.1 \times 10^3$	$9.2 \times 10^2 - 3.0 \times 10^3$
SD	0.875	0.8971	0.6765
Githeri			
Mean	4.2×10^3	3.5×10^2	3.2×10^2
Range	$3.8 \times 10^2 - 4.6 \times 10^3$	$1.5 \times 10^2 - 6.8 \times 10^3$	$3.6 \times 10^2 - 3.7 \times 10^3$
SD	0.8761	0.7631	0.553

The mean bacterial counts for Beef stew was lower than all other cooked food samples probably due to the fact that the stew was been taken when it was hot. Total plate count was also high in bhajia and githeri.

Table 4.2: Bacterial counts in the non-cooked food samples (CFU/gm)

Type of Sample	APC	<i>S.aureus</i>	<i>E.coli</i>
Personnel			
Mean	4.2×10^3	3.4×10^3	8.2×10^3
Range	$2.3 \times 10^3 - 6.7 \times 10^4$	$1.3 \times 10^2 - 5.2 \times 10^3$	$3.2 \times 10^2 - 15.0 \times 10^3$
SD	0.871	0.671	0.6512
Workplace			
Mean	9.7×10^3	3.8×10^2	7.6×10^2
Range	$5.3 \times 10^2 - 12.3 \times 10^4$	$2.3 \times 10^2 - 5.3 \times 10^3$	$6.7 \times 10^2 - 8.5 \times 10^3$
SD	0.7612	0.6070	0.8127
Water(ml)			
Mean	4.7×10^3	2.6×10^3	4.8×10^2
Range	$3.7 \times 10^2 - 5.7 \times 10^3$	$5.2 \times 10^2 - 3.0 \times 10^3$	$1.8 \times 10^2 - 7.9 \times 10^3$
SD	0.5051	0.6151	0.6055
Plate			
Mean	4.1×10^3	3.5×10^1	2.6×10^2
Range	$1.7 \times 10^2 - 6.6 \times 10^3$	$1.6 \times 10^1 - 6.0 \times 10^2$	$1.0^2 - 2.6 \times 10^3$
SD	0.6021	0.8021	0.5060

On the non-cooked samples, workplace had the highest bacterial counts and this could be because of staff not cleaning their work places after every task completed on food preparation and cooking.

Table 4.3: Bacterial counts in the raw food samples (CFU/gm)

Type of food	APC	<i>S.aureus</i>	<i>E.coli</i>
Kachumbari			
Mean	4.0x10 ⁴	4.5x10 ²	4.5x10 ³
Range	1.5x10 ³ -6.5x10 ⁴	4.6x10 ¹ -4.3x10 ²	2.6x10 ² -6.5x10 ³
SD	0.5005	0.6172	0.7112
Vegetable salad			
Mean	3.3x10 ⁴	3.4x10 ⁴	5.6x10 ³
Range	3.0x10 ³ -3.6x10 ⁴	1.5x10 ³ -5.2x10 ⁴	2.8x10 ² -7.6x10 ³
SD	0.7721	0.6991	0.9821
Fruit salad			
Mean	2.0x10 ³	2.2x10 ²	3.2x10 ²
Range	8.9x10 ² -4.0x10 ³	2.4x10 ¹ -4.8x10 ²	2.3x10 ² -3.1x10 ³
SD	0.7112	0.7721	0.9231
Passion juice(ml)			
Mean	2.2x10 ³	5.4x10 ²	3.7x10 ²
Range	1.2x10 ² -2.3x10 ³	2.6x10 ¹ -9.4x10 ³	1.8x10 ¹ -5.6x10 ³
SD	0.4451	0.5561	0.8732
Fresh meat			
Mean	5.2x10 ⁴	3.4x10 ³	4.6x10 ²
Range	2.5x10 ³ -5.4x10 ⁴	3.4x10 ² -7.3x10 ³	2.8x10 ¹ -6.3x10 ²
SD	0.3242	0.2343	0.9182
Coleslaw salad			
Mean	2.6x10 ⁴	3.5x10 ³	2.9x10 ²
Range	1.6x10 ³ -3.6x10 ⁴	3.8x10 ² -4.8x10 ³	2.2x10 ² -3.7x10 ³
SD	0.5423	0.5421	0.8723
Chef's salad			
Mean	3.1x10 ³	2.5x10 ³	4.5x10 ²
Range	2.1x10 ¹ -6.1x10 ³	1.5x10 ² -3.5x10 ³	2.8x10 ¹ -6.0x10 ²
SD	0.3425	0.6787	0.8001

The study revealed that the presence of certain levels of microbial contamination in foods and other surfaces in the kitchens could be attributed to poor hygiene. Microbial agents are the main cause of foodborne disease outbreaks associated with consumption of

contaminated foods. The low reporting of food poisonings and poor diagnosis and confirmation of the causative agent of the reported cases calls for improvement on reporting of the cases.

4.4 Test of Hypothesis

H0₁: There is no relationship between safety control measures applied and microbial loads of foods consumed in restaurants.

Table 4.4 Contingency table of safety control measures and Microbial loads of foods

		Microbial loads of foods		
		High	Low	Total
Safety control measures applied	Good	8	10	18
	Poor	9	3	12
	Total	17	13	30

5 % level of significance = $P < 0.05$

Chi-square critical value

$$\text{Where } \alpha = 0.05 \quad \& \quad n=30 \\ x^2_{\alpha} = 3.841$$

This is calculated through a table as shown (Patton, 2002).

Cell	O_i	λ_i	$O_i - \lambda_i$	$(O_i - \lambda_i)^2$	$\frac{(O_i - \lambda_i)^2}{\lambda_i}$
1, 1	8	10.2	- 2.2	4.84	0.47
1, 2	10	7.8	2.2	4.84	0.62
2, 1	9	6.8	2.2	4.84	0.71
2, 2	3	5.2	- 2.2	4.84	0.93

Chi-square computed

The sum of the last column gives $(x^2_c) = 2.73$

At the 95% confidence level and a degree of freedom of $= (2-1)(2-1) = 1$, $x^2_a=3.841$.

Since x^2_c is less than x^2_a , we accept the null hypothesis H_1 and conclude that there is no sufficient evidence to suggest there is a relationship between safety control measures applied and microbial loads of foods consumed in restaurants

It is therefore expected that there should be no significant linear relationship between safety control measures applied and microbial loads of foods consumed in restaurants.

H₀2: There is no relationship between awareness of SSOP by restaurant workers and microbial loads of foods consumed in restaurants

Table 4.5 Contingency table of awareness of SSOP and Microbial loads of foods

		Microbial loads of foods		
		High	Low	Total
Awareness of SSOP by restaurant workers	High	1	13	14
	Low	14	2	16
	Total	15	15	30

5 % level of significance = $P < 0.05$

Chi-square critical value

Where $a = 0.05$ & $n=30$
 $x^2_a=3.841$

This is calculated through a table as shown (Neuman, 2000).

Cell	O_i	λ_i	$O_i - \lambda_i$	$(O_i - \lambda_i)^2$	$\frac{(O_i - \lambda_i)^2}{\lambda_i}$
1, 1	1	7	- 6	36	5.14
1, 2	13	7	6	36	5.14
2, 1	14	8	6	36	4.5
2, 2	2	8	- 6	36	4.5

Chi-square computed

The sum of the last column gives $(x^2_c) = 19.28$

At the 95% confidence level and a degree of freedom of $= (2-1)(2-1) = 1$, $x^2_a=3.841$. Since x^2_c is more than x^2_a , we reject the null hypothesis H_0 and accept the alternate hypothesis and conclude that there is sufficient evidence to suggest that awareness of SSOP by workers influences microbial loads of foods consumed in restaurants.

It is therefore expected that there should be a significant linear relationship between awareness of SSOP by workers and microbial loads of foods consumed in restaurants. In order to establish the extent and direction of the relationship, the researcher conducted a regression analysis.

Table 4.6 Regression analysis of awareness of SSOP by workers against microbial loads of foods index

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.690	.353	.107	.1452

a) Predictors: (Constant), SSOPINDEX

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	.168	1	.168	7.964	.07
Residual	1.202	29	2.109E-02		
Total	1.370	30			

a) Predictors: (Constant), SSOPNDEX

b) Dependent Variable: MICRNDEX

Table 4.7 Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error			
(Constant)	.228	.094		2.429	.018
SSOPNDEX	.412	.146	.350	2.822	.007

a) Dependent Variable: MICRNDEX

The regression analysis shows a strong relationship $r=0.69$ and $r^2= 0.353$ which shows that 35.3% of the change/improvement in microbial loads of foods consumed in restaurants can be explained by the awareness of SSOP by restaurant workers. This relationship is not weak and can be used to explain/predict microbial loads of foods by studying the awareness of SSOP by workers.

Further on the beta coefficient of the resulting regression model $t=2.822$ indicates that the beta coefficient is significantly greater than 0, $p=0.007$ which is less than $p=0.05$ of the test statistic. This confirms that essentially there is a strong relationship between awareness of SSOP by workers and microbial loads of foods.

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.0 Discussion of Findings

All the restaurants had been issued with food trade licenses from the Municipal Public Health Authorities. Among all the managers interviewed, 30% knew HACCP as a strategy of quality control and it was the same population which was implementing the strategy at one point or the other in their establishments. Most restaurants sorted and weighed their raw food materials after reception. This attributed to 60% of the total restaurants which applied this as a critical control point. Similar studies by the Ministry of Health found that foods collected from the farmers can be contaminated.

On preservation of perishable foods, 75% of the restaurants applied it as a critical point. Proper food storage after preparation was fairly done and quite evident in most premises because this was stored in very high temperatures. This contradicts a study done in some cities in some developed countries, which found that most people who ate food prepared in the eating premises were served with cold foods which led to food poisoning. According to CDC reports food-borne diseases are among the most important health problems in both developed and developing countries. This study demonstrated that all samples had contamination load according to the total coliform count and the presence of other bacteria. Lengthy gaps between preparation and consumption of foodstuffs and lack of attention to the essential temperature required for cooking foods are among the most common causes of food contamination.

Maintenance of general hygiene standards in most premises was not well-observed similar to studies done in Nairobi, which showed that 70% of most restaurants were below the required hygiene standards. Most of the liquid and solid waste was fairly managed. Availability of hot water was lacking in some restaurants and therefore, cleaning of crockery and utensils was poorly done. Similar study was done in China

which showed that some customers had food poisoning after been served with poorly washed equipment in a restaurant (WHO, 2004).

According to the NPHL, meat grading standards is assumed that if CFU/g is above 2.1×10^6 , then it is unfit for human consumption. Good quality meat sold in Nairobi range in TPC and lies between $10^2 - 10^3$ CFU/g. Kenya Meat Commission is considered to be a preferred world class meat processor because they use HACCP system (ISO 22000:2008). Similar information was sourced from Kenya Bureau of Standards which has a standardized mark of quality of products. It is necessary to use HACCP system in restaurants for prevention of food-borne diseases. Cenci-Gonga (2005), determined the effect of implementation of HACCP on the microbiological quality of foods at a restaurant. In the study, 894 samples were examined and showed that the implementation of the HACCP system together with training in personnel hygiene lowered aerobic plate counts. Microbiological analyses of food samples resulted in aerobic plate counts from < 1.00 to 2.90 and from < 1.00 to $6.04 \log_{10}$ CFUg (-1). Total coliforms ranged from < 3 to 43 most probable number (MPN)g(-1) and from < 3 to $> 2,400$ MPN g(-1) for eggs and meat products.

Raw food materials consumed in Thika Town are sourced from various suppliers such as meat from slaughter houses, fish from Lake Victoria and Tana River, vegetables and fruits from the farms. The water in all the restaurants is supplied by the municipal council through ground piped water which sometimes can be contaminated due to sewerage pipe bursting in some occasions. It is recommended that any water for human consumption must not contain more than 3×10^1 CFU/ml and none should be of faecal contaminated.

5.1 Conclusions

Majority of the restaurant owners are not well or fully aware of HACCP system in formal set-ups. All foodservice owners did not have a HACCP program in place and many were unsure of what it was or how to apply the principles to their operation. There appeared to be challenges to implementing these programs and efforts need to be made to overcome

the challenges. There is little knowledge on HACCP as a strategy for quality control among the proprietors, managers and staff of the restaurants. This has made the food procedures and processes so routine that they do not document any fact on the food chain. The management of the restaurants does not observe adequate precautions in the entire food processing and therefore programs and materials related to HACCP need to be presented in a practical, realistic and step by step manner. A key focus area would be on motivating employees to follow standard operating procedures related to food safety.

Most of the food wastes in the restaurants are poorly managed, utensils and crockery badly cleaned, kitchen and dining floor not well-cleaned. Non-availability of hot water for customers to wash their hands was noted. Most customers are not keen on hygiene standards because this was quite evident in some restaurants where you could find many customers despite the premises being dirty. Just like street-vended foods may pose significant public health problems, restaurant foods can follow suit if poorly handled. One of the key findings of the WHO survey of street-vended foods was that infrastructure developments were relatively limited in relation to access to portable water, toilets, and refrigeration, washing and waste disposal facilities.

Food-borne diseases have been introduced as an imperative health problem in different countries. Food codex has classified meat and protein-rich foodstuffs and salads in high risk foods. The production of safe food products requires that the HACCP system be built upon a solid foundation of prerequisite programmes which most of the restaurants do not have. These prerequisite programmes have an impact upon the safety of food and are concerned with ensuring that the foods are wholesome and suitable for consumption. Many establishments which use HACCP system have preventive maintenance procedures for processing equipment to avoid unexpected equipment failure and loss of production. The application of HACCP is compatible with the implementation of quality management systems, such as the ISO 9000 series, and the system of choice in the management of food safety within such systems.

The ISO 9000 series welcomes the opportunity to collaborate in studies of restaurants foods and in the development of strategies and plans of action to improve urban

restaurants food safety. Feedback on the applicability of this study in improving restaurants food safety in specific urban centers is also encouraged. The microbial levels of foods served and work surfaces are available having microbial counts of not more than 10^5 CFU/g which is a dangerous zone for microbial growth, though some food control measures are applied in the restaurants. Thus, there is a significant relationship between hygiene standards and microbial contamination of foods consumed in the restaurants at $p \leq 0.05$ confidence level. A similar study done in Mombasa Island on street foods showed the same (Odundo, 2006).

5.2 Recommendations

HACCP is currently considered as the best system available for designing programmes to assist food firms in producing foods that are safe to consume. It is based on a common sense application of technical and scientific principles to the food production process from field to table and not a magic bullet that will cure all food safety problems because the natural world is always presenting us with new hazards. Managers, staff and other stakeholders need information to advocate for food safety issues and for decision-making in food safety control systems within food units.

Based on the findings of this study, responsibility for food safety lies within those that process the food, to ensure that the food they produce and serve or sell is well-received, stored and well prepared and satisfies the relevant requirement of food law. They should verify that such requirements are met and fulfilled because this will assist the authorities assigned the duties of advocating for HACCP implementation in the restaurants in introducing it and supervising the way the system is being operated.

The Ministry of Health through the public health authorities in the urban centre should educate adequately all restaurant owners, managers, staff, and other stakeholders on system implementation and more so the street vended foods which are a threat to the public because of the way they are prepared and served. The health authorities should also have a system of monitoring food-borne outbreaks associated with specific premises because as it is now, you cannot have specific data showing food poisoning attributed to homes, restaurants, hospitals, hotels, schools and others etc.

Proper training will ensure correct passage of information to the employees and customers and therefore increase participation on HACCP implementation which is an expensive exercise to begin with but a cost saving in the long run to the sector. The public health authorities should also take the challenge and not leave the catering colleges alone to be the only source of HACCP information. The public health authorities in urban restaurants should extend their periodical spot checks and random sampling together with the sensitization on food safety standards to the Staff and managers of the food establishments.

They should also do thorough checks on how food is received, stored, issued, prepared and served to the customers. The current spot checks they do now are low since the approach is reactive rather than preventive and therefore, less efficient. For a successful HACCP to be properly implemented, the restaurants management must be committed to the approach because this will indicate the awareness of the benefits and costs of HACCP. This will include education and training of employees where they must understand what HACCP is and then learn the skills necessary to make it function properly. Lack of training in basic food hygiene is a risk factor for food products being contaminated.

More research needs to be done by all stakeholders on how best HACCP can be fully applied in the restaurants in the urban restaurants and a fully trained, well-prepared team should be in place to initiate, conduct, monitor and evaluate the HACCP process in the restaurants. This can be done by applying some of the following suggestions:

(a) Display of notices

Every licensed food operator shall at all times display conspicuously his/her vendor's license and any other notices that are required by the relevant authorities to be displayed. Most restaurants had complied with this regulation from the Public Health Office.

(b) Consumer education

The relevant authority should inform consumers through posters, the media and publicity campaigns about hazards associated with street foods and the steps the authority requires restaurants to take to minimize those hazards. Consumers should also be informed of their responsibility in ensuring that they do not contaminate, dirtily or litter street food vending sites.

(c) Health status of food handlers

Any food handler who is suffering from jaundice, diarrhoea, vomiting, fever, sore throat with fever, discharge from ear, eye and nose, visibly infected skin lesions (boils, cuts, etc.) shall cease from handling food in any capacity and seek medical treatment.

Any food handler who has been identified as or is known to be or has previously been a carrier of food-borne disease organisms, shall not be involved in any food handling activity until certified by a Medical Officer of Health or any other medical practitioner as a non-carrier. Any vendor, helper or food handler shall be required to be immunized against food and water-borne disease such as typhoid, hepatitis A or any other food and water borne diseases as required by the relevant authority.

(d) Personal hygiene and behaviour

Every food handler, during the conduct of his business, shall observe the following: Wear an identification tag if issued and required by the relevant authority. Dress in clean and proper attire. Wash hands thoroughly with soap and clean water before and after handling food, after visiting the toilet, after handling unsanitary articles, touching animals, touching raw food, after handling toxic and dangerous materials as and when necessary.

Finger nails should be kept short and clean at all times. Hair should be kept clean and tidy and should be covered during operation. Non-infected cuts shall be completely protected by a waterproof dressing which is firmly secured and routinely changed. Shall not smoke or chew gum while preparing or serving food. Refrain from any unhygienic practices such as spitting and cleaning nose, ears or any other body orifice. Shall not sneeze or cough onto the food. The use of gloves is not recommended. No vendor is allowed to use the stall as a sleeping or dwelling place, or for any other personal activity.

(e) Training of food handlers

Every vendor, helper or food handler shall undergo a basic training in food hygiene prior to licensing and further training as required by the relevant authority. Training is to be conducted by the relevant authority or other institutions recognized or approved by the relevant authorities. Simple posters illustrating the "do's" and "don'ts" of food preparation and vending should be widely and prominently displayed in relevant places for the benefit of both food handlers and consumers.

(f) Sanitation

Water Supply: Restaurants should ensure sufficient supply of water at all times. Waste Water Disposal: Restaurants should have an efficient waste water disposal system which should be maintained in a good state of repair. The system should be large enough to carry peak loads and be provided with traps to ensure only liquid waste is discharged into the drain/sewer.

Solid Waste Disposal: Solid waste material should be handled in such a manner as to avoid contamination of food and/or portable water. Waste should be removed from the working area of the stall as often as necessary and at least daily. All solid waste should be properly disposed into suitable containers which are secured with tight fitting lids or placed in rubbish bins or central rubbish bins.

Immediately after disposal of the waste, receptacles used for storage and any equipment which has come into contact with the waste should be cleaned. The waste storage area should also be cleaned daily.

Cleaning: All working surfaces, table tops, floors and surrounding areas should be thoroughly cleaned at least daily.

Toilet facilities: Every restaurant should have access to facilities which are approved by the relevant authorities and kept at all times in a clean and operational condition.

(g) Appliances

The appliances should be kept clean. The equipment, including containers for storing drinking water, should be made of materials which do not transmit toxic substances, odour or taste, are not absorbent (unless its use is intended for that purpose and will not result in food contamination), are resistant to corrosion and capable of withstanding repeated cleaning and disinfection.

Every cutting surface used in the preparation of food should be free from cracks and crevices, with only reasonable wear and tear, and should be cleaned at least on the following occasions: Before and after daily operations; and especially after having put unclean material or food on it if the surface is subsequently to be used to cut street foods or foods to be consumed raw.

Cooked and uncooked food should be handled with separate utensils. Every restaurant should ensure that all defective, damaged, cracked, rusted, chipped and unsuitable appliances and crockery are removed from use and discarded.

All utensils should be regularly cleaned by thoroughly washing them in warm water containing adequate amount of soap or other suitable detergents and then either immersing them for half (1/2) a minute in boiling clean water and draining them or, for two (2) minutes in potable water at a temperature of not less than 77°C and draining them.

In the case where non-disposable crockery is used and water at 77°C or boiling temperatures is unavailable, potable water, wash soap or detergent and running water rinse is allowed. However, this method is not preferred. All appliances are to be maintained in good state of repair. Only containers made of food grade material, not previously used for non-food use, shall be used. Wash basins and sinks for cleaning utensils and washing hands should always be clean and maintained in a good state of repair. Towels used for wiping crockery should be clean, handled in a sanitary manner and only to be used for that purpose. Hand washing facilities such as hand wash basins, disposable towels and soap should be provided at all times.

(h) Food Preparation

Requirements for ingredients

Every restaurant should ensure the following: Supply of ingredients, including ice, must be from known and reliable sources. The food handling method employed should be such as to minimize the loss of nutrients. Freshness and wholesomeness of ingredients should be to maintain quality and safety of food. Transportation of ingredients should be made in a manner so as to prevent exposure to the environment, spoilage and contamination.

Cooking and handling

Soak and thoroughly wash fresh vegetables and fruit whether for cooking or consuming raw, with sufficient running potable water, to remove adhering surface contamination. Where appropriate, wash raw food before using in food preparation to reduce the risk of contamination. Never wash perishable raw food with other foods that will be consumed raw or in a semi-cooked state.

There should be an area for handling, storing, cleaning and preparing raw food ingredients, separate and apart from the cooked, street food display, handling and serving areas. Thawing: Frozen products, especially frozen vegetables, can be cooked without thawing. However, large pieces of meat or large poultry carcasses often need to be thawed before cooking.

When thawing is carried out as an operation separate from cooking, it should be performed only in: (a) A refrigerator or purpose-built thawing cabinet maintained at a temperature of 4°C; or (b) Running potable water maintained at a temperature not above 21°C for a period not exceeding 4 hours; or (c) A commercial microwave oven only when the food will be immediately transferred to conventional cooking units as part of a continuous cooking process or when the entire, uninterrupted cooking process takes place in the microwave oven.

Hazards associated with thawing include cross-contamination from drip and growth of micro-organisms on the outside before the inside has thawed. Thawed meat and poultry products should be checked frequently to make sure the thawing process is complete before further processing or the processing time should be increased to take into account the temperature of the meat.

The time and temperature of cooking should be sufficient to ensure the destruction of non-spore forming pathogenic micro-organisms. Water used for the purpose of drinking, preparation of hot or cold drinks and beverages should be of potable water quality, or of clean quality and boiled, or disinfected in any other way such as the use of an appropriate chemical agent. Ice should be made from potable water. Ice should be handled and stored so as to protect it from contamination. Containers used to transport or store ice should meet the requirements for water containers prescribed by Section 2.19. Food should not be re-heated more than once and only the portion of the food to be served should be re-heated. A temperature of at least 75°C should be reached in the centre of the food within one hour of removing the food from refrigeration. Lower temperatures may be used for reheating provided that the time/temperature combinations used are equivalent in terms of destruction of microorganisms to heating to a temperature of 75°C.

Serving food

Every restaurant should observe the following: Cooked foods should not be handled with bare hands. Clean tongs, forks, spoons or disposable gloves should be used when handling, serving or selling food. All crockery used should be clean and dry and not

handled by touching the food contact surfaces. Plates filled with food should not be stacked one on top of the other during display, storing or serving. Food grade packing materials should be used. Printed material should preferably never be used to serve food. Only food grade aluminium foil, waxed paper, food grade plastic and any other suitable material should be used for packing and serving food.

Never blow into plastic bags, wrappers or packages used for food. All beverages offered for sale should be dispensed only in their individual original sealed containers or from taps fitted to bulk containers and made of food grade plastic or other suitable material. Bulk containers should be covered with tight fitting lids. Cut fruit or other foods ordinarily consumed in the state in which they are sold may be set out in an enclosed display case, cabinet or similar type of protective device and should be displayed in a manner which will not affect the wholesomeness and cleanliness of such foods.

Food handlers should avoid handling money. If this is unavoidable, the food handler should wash his hands after handling money and before handling food again. Ready-to-eat foods intended for continuous serving should be protected from environmental contamination and kept at the following holding temperatures:

- (a) For food served hot..... 60°C or above;
- (b) For food served cold.....7°C or below;
- (c) For food served frozen...-18°C or below. A food warmer should be used to maintain continuous holding temperatures and should not be used for re-heating purposes.

Unsold food

All unsold cooked food and prepared beverages that cannot be properly preserved should be disposed off in a sanitary manner at the end of the day.

Food storage

The food should at all time be kept clean and free from contamination, and be adequately protected from pests, environmental contaminants and stored at proper temperatures

where appropriate. Readily perishable food should be placed or stacked so that it is not likely to be contaminated by contact with raw food, toxic materials or any other materials which may cause contamination. The bulk of readily perishable foods should be stored in clean containers placed in a clean ice box or refrigerator in which the food should not exceed a temperature of 10°C.

All dry ingredients should be stored and maintained in their original labelled commercial container or subsequent containers and should be properly labelled as to the content and designed to prevent moisture absorption. All non-perishable food should be stored in a clean, protected and closed container/cupboard to prevent cross contamination by pests. Once cleaned, the bulk of perishable raw food including wet cereals or pulses should be stored in clean separate containers preferably placed in a clean ice box, a refrigerator or a freezer to prevent spoilage.

Refrigerators and freezers should not be overloaded and their temperatures should be maintained at a maximum of 4°C and -18°C or below, respectively. All food stored in bulk should be stored in an orderly fashion and should be placed so as to facilitate ventilation, inspection and the detection of pests. All food should be stored and handled separately from toxic, poisonous, deleterious and injurious substances.

The principle "First in, first out" should be applied to stock rotation. Date marking on all food containers shall be checked before the food is used. Expired food shall not be sold or used in the preparation of food.

Customer facilities

Restaurants should have sufficient toilet facilities for each sex to accommodate the food handlers, their employees and clientele, conveniently located but separate and apart from food preparation, handling, storage, serving and selling areas to prevent contamination of the food. The toilet facilities should be approved and subject to all requirements for such facilities by the relevant authority. Among other requirements, the facilities should: (a) Have smooth walls of glazed tile to a height of at least two (2) meters; (b) Should be clean, free of bad odours and provided with a flushing system; (c) Be well lit, ventilated,

and routinely cleaned and sanitized and maintained in good working condition; (d) Include hand washing and drying facilities and properly supplied with soap and other needed supplies.

There is little knowledge on the applicability of HACCP as a strategy for quality control among the owners, staff and managers of these restaurants. This has made the sorting and weighing, cooking and proper food storage after preparation just as a routine operation. The management of these restaurants does not observe adequate precautions in the entire food processing. Most of the wastes in the restaurants are poorly attended and utensils not well cleaned and sanitized. The total number of customers in most restaurants in the town is not a measure of the HACCP implementation in the operations rather than a service provider within the town.

Restaurants food safety responsibility lies with those who process the food and therefore it is the duty of every one who is involved to ensure that the food produced is handled in a safe manner and satisfies the relevant requirements of food law. The Ministry of Health should adequately educate the restaurants managements on the implementation of HACCP. This will pass correct information to the staff and customers and therefore increase participation on the implementation of the quality strategy. Restaurants managements should take initiative and learn from the starred hotels which apply this system and implement in their premises. It important that where financial support is provided to restaurants for the purpose of facilitating HACCP implementation such as HACCP plan development or training, policy makers should ensure that appropriate support facilities are available.

5.3 Further Research

In line with the study findings; the study recommends the following areas for further research.

1. The study was confined to Thika Municipality alone. A similar study should be replicated to other municipalities not covered by this study since foodborne diseases occur worldwide and are 300-350 times more frequent than what is reported.
2. This study was on urban restaurants only. Another study needs to be carried out on rural restaurants to see whether the findings tally.
3. Pressure on HACCP implementation is necessary and national legislation should clearly be stated.
4. Systematic way of training for all stakeholders is very useful on how to create food safety awareness, hazard analysis, and integration of risk analysis into HACCP system.

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APPENDICES

APPENDIX 1: Respondents Questionnaire

Demographic data

1. Date of interview _____
2. Name of restaurant _____
3. Age of respondent (optional) _____
4. Sex **Male** **Female**
5. Marital status Married Single Separated
 Divorced Widow/Widower
6. Education level Primary Secondary
 Post secondary College
 Others, specify
7. What is your religion? Christian Muslim
 None Others
8. Designation of respondent in the restaurant?
 Owner Manager Head Cook
 Cook Other, specify

9. How long have you worked in the Restaurant?

One month Two months More than three

10. Have you worked in any other establishment?

Yes No

11. If yes, for how long? Less than a year One year More

12. Are you trained in catering? Yes No

Section 1(knowledge of quality control system)

1. Do you know of any quality control measure for food establishment?

a) Yes () b) No ()

2. If yes, which is the measure CMPs, GMPs or HACCP?

3. From where did you know of this strategy?

- a) Public health staff(s) { }
- b) Council staff(s) { }
- c) Customers { }
- d) Mass media { }
- e) WHO/FAO { }
- f) Can't remember { }

4. Where would you apply this quality control strategy in your food establishment?

- a) Receiving { }
- b) Storage { }
- c) Kitchen { }
- d) Others, specify { }

5. What type of food materials do you receive in your establishment?

- a) Perishables and non-Perishables { }
- b) Non perishables { }
- c) Perishables { }
- d) Don't know { }
- e) Others, specify { }

Section 2

Note:

For perishables, ask questions 6-12 and for non-perishables ask questions 13-19

6. In what quantities do you receive these foods?

- a) Bulk { }
- b) Kilograms { }
- c) Numbers { }
- d) Others, specify { }

7. How often do you receive your supplies?

- a) Daily { }
- b) Weekly { }
- c) Two weeks { }
- d) Others, specify { }

8. What do you do when you receive these foods?

- a) Weighing and sorting { }
- b) Preserving { }
- c) Straight cooking { }
- d) Don't do anything { }
- c) Others, specify { }

If (A) in question 6, move to question 9 and if (B) in question 6 move to question 11.

9. How do you preserve these foods?

- a) Store in refrigerator { }
- b) Store in Freezer { }
- c) Dry store { }

10. How do you ensure that the preservation methods are working?

- a) Observe chilling and freezing temperatures { }
- b) De-frosting and washing { }
- c) Nothing { }
- d) Others, specify { }

11. What other processes are involved in food preparation?

- a. Cooking { }
- b. Serving them raw { }
- c. Don't know { }
- d. Nothing done { }
- e. Others, specify { }

12. Is your establishment a “prepare as you wait or ready to eat” restaurant?

- a) Ready to eat { }
- b) Prepare as you wait { }
- c) Don't know { }
- d) Others, specify { }

Non-perishables

13. In what quantities do you receive these foods?

- a) Bulk { }
- b) Kilograms { }
- c) Don't know { }
- d) Others, specify { }

14. How often do you receive your supplies?

- e) Daily { }
- f) Weekly { }
- g) Fortnight { }
- h) Others, specify { }

15. What do you do when you receive these foods?

- a) Storing { }
- b) Sorting and Weighing { }
- c) Nothing { }
- d) Others, specify { }

If (A) in question 13 move to question 16 and if (B) in question 13, move to question 18

16. How do you preserve these foods?

- a) Store them in dry places { }
- b) Leave them intact { }
- c) Don't know what to do { }
- d) Others specify { }

17. How do you ensure that the preservation methods are working?

- a) Aeration of the store { }
- b) Store cleaning { }
- c) Nothing { }
- d) Don't know what to do { }
- e) Others specify { }

18. What other methods are involved in food preparation?

- a) Cooking { }
- b) Serving it raw { }
- c) Don't know { }
- d) Nothing done { }
- e) Others, specify { }

19. How do you keep food after preparation?

- a) Store it in high temperature { }
- b) Store it in cold temperature { }
- c) Nothing done { }
- d) Others, specify { }

20. Which precautions do you observe in the entire food processing?

- a) Maintain general hygiene standards { }
- b) Don't do anything { }
- c) Others specify { }

Section C

For establishment not related to H.A.C.C.P

1. Do you know of any quality control strategy for food establishment?

- a) Yes { }
- b) No { }

2. If no, how do you observe quality control in the food processing in your establishment?

- a) Set standards for particular points { }
- b) Ask health officers for instruction reports { }
- c) Don't do anything { }

3. Where are the quality controls set in your establishment?

- a) Receiving { }
- b) Storage { }
- c) Cooking { }
- d) Serving { }
- e) All of the above. { }

4. What type of food supplies do you receive?

- a) Perishable and non-perishable { }
- b) Non-perishable { }
- c) Don't know { }
- d) Others specify { }

Note:

For perishables ask question 5 – 11 and for non – perishables ask questions 12 – 18.

5. In what quantities do you receive these foods?

- a) Bulk { }
- b) Few kilograms { }
- c) Don't know { }
- d) Others specify { }

6. How often do you receive your supplies?

- a) Daily { }
- b) Every third day { }
- c) Weekly { }
- d) Fortnight { }

7. What do you do when you receive these foods?

- a) Weighing and sorting { }
- b) Preservation { }
- c) Don't do anything { }
- d) Others specify { }

If (A) in question (5) move to question 8

If (B) in question (5) move to question 10

8. How do you preserve these foods?

- a) Store in Cold Environment { }
- b) Leave it intact { }
- c) Don't know what to do { }
- d) Others specify { }

9. How do you ensure that the preservation methods are working?

- a) De – freezing and washing { }
- b) Nothing { }
- c) Don't know what to do { }
- d) Others specify { }

10. What other processes are involved in food preparation?

- a) Cooking { }
- b) Serving them raw { }
- c) Don't know { }
- d) Nothing done { }
- e) Others specify { }

11. Is your establishment a “prepare as you wait or ready to eat” enterprise?

- a) Ready to eat { }
- b) Prepare as you wait { }
- c) Don't know { }
- d) Others specify { }

Non – perishable

12. In what quantities do you receive these foods?

- a) Bulk { }
- b) Few kilograms { }
- c) Don't know { }
- d) Others, specify { }

13. How often do you receive your supplies?

- a) Daily { }
- b) Every third day { }
- c) Weekly { }
- d) Fortnight { }
- e) Don't know { }

14. What do you do when you receive these goods?

- a) Storing { }
- b) Sorting and weighing { }
- c) Don't do anything { }
- d) Others specify { }

If (A) in question 12, move to question 15

If (B) in question 12, move to question 17

15. How do you preserve these foods?

- a) Store them in dry places { }
- b) Leave them intact { }
- c) Don't know what to do { }

16. How do you ensure that the preservation methods are working?

- a) Aeration of the store { }
- b) Store cleaning { }
- c) Nothing { }
- d) Don't know what to do { }

17. What other methods are involved in food preparation?

- a) Cooking { }
- b) Serving it raw { }
- c) Don't know { }
- d) Nothing done { }

18. How do you keep food after preparation?

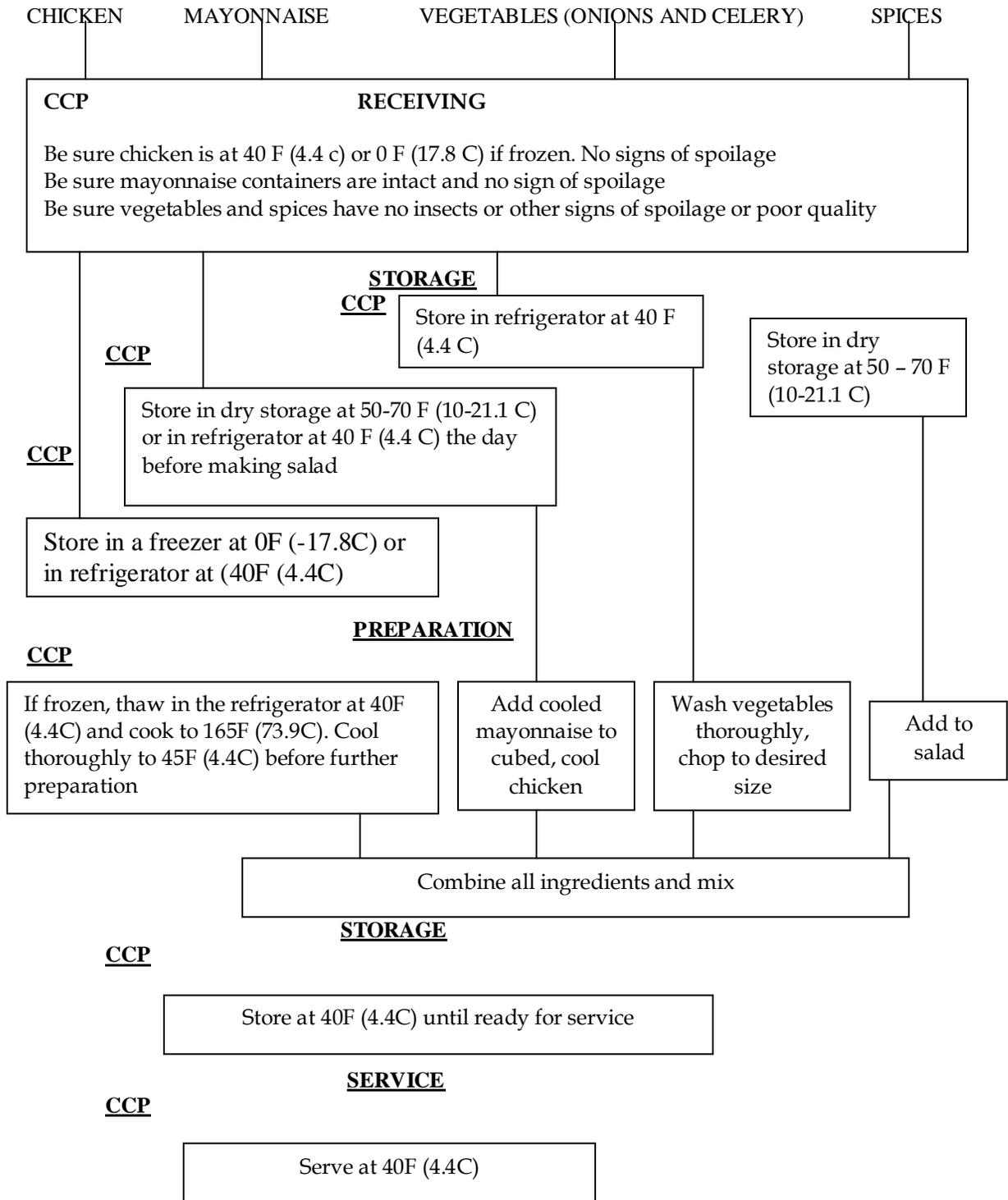
- a) Store it in high temperature { }
- b) Store it in cold temperature { }
- c) Nothing done { }
- d) Others specify { }

APPENDIX 3 (a): Temperature zones used for processing, holding, and preserving foods.

250.0	ZONE A FOR COMMERCIALY STERILIZING LOW ACID FOODS (Ph >4.5)	121.1
240.0	ZONE B FOR COMMERCIALY STERILIZING HIGH ACID FOODS (Ph <4.5)	115.6
212.0	ZONE C FOR MAKING MOST FOODS SAFE TO EAT	100.0
165.0	ZONE D FOR KEEPING HOT FOODS HOT	73.9
140.0		60.0
	DANGER ZONE FOR FOODS	
40.0		4.4
	ZONE E FOR KEEPING COLD FOODS COLD	
32.0		0.0
	ZONE F FOR KEEPING SOME FOODS IN SUPER CHILLED STATE FOR 2-3 WEEKS	
26.0		- 3.3
	ZONE G FOR STORING FOODS IN FROZEN STATE FOR 1-6 MONTHS	
0.0		- 17.8
	ZONE H FOR STORING FOODS IN FROZEN STATE FOR 6-24 MONTHS	
- 20.0		- 28.9
	ZONE I FOR STORING FOODS IN FROZEN STATE FOR MORE THAN 24 MONTHS	
- 40.0		- 40.0
	⁰ F	⁰ C

Source: Viera (1999)

APPENDIX (3b): Flow chart for chicken salad with CCPS



Check all lists to examine all CCP's are useful here. Employees doing the job may be very helpful in setting up the form to be used

APPENDIX (3b): Continued

Critical Control	Hazards	Standards	Corrective Action if Below Standard
<u>RECEIVING</u>			
Receiving raw Chicken	Contamination and spoilage	Accept at 40°F (4.4°C) — check with thermometer	Reject delivery
		Package intact	Reject delivery
		No off color, stickiness, etc	Reject delivery
Receiving vegetables	Contamination and spoilage	Package intact	Reject delivery
		No signs of insects or rodents	Reject delivery
		No cross-contamination from other foods on delivery vehicle	Reject delivery
Receiving spices	Contamination and spoilage	Package intact	Reject delivery
		No signs of insects or rodents	Reject delivery
		No cross-contamination from other foods on delivery vehicle	Reject delivery
		No moisture inside package	
Receiving mayonnaise	Contamination and spoilage	Package intact	Reject delivery
		No separation of product	Reject delivery

STORAGE

Storing raw chicken	Cross contamination of other foods Bacterial growth and spoilage	Store on lower shelf Chicken temp. must stay below 40° F (4.4° C)	Move to lower shelf away from other foods Discard if temperatures have been too high for too long(judgments must be made here by people responsible for quality, if any signs of poor quality exist, e.g., off odors or stickiness, discard.) If quality meets standards, use as soon as possible
		Label and date package. Use first in first out (FIFO) method of rotation	Discard product past rotation date
Storing vegetables	Cross-contamination from PHFs	Store above raw PHFs	Move to upper shelf if not damaged If damaged or spoiled, discard
		Label and date package. Use first in, first out (FIFO) method of rotation	Discard product past rotation date
Storing spices	Contamination and spoilage	No signs of insect or rodent infestation No moisture spoilage	Discard Discard Keep temperature between 50 and 70°F (10-15.6° C) and relative humidity at 50- 60%
Storing mayonnaise	Contamination and spoilage	No separation Package intact	Return to supplier Discard

Critical Control	Hazard	Standards	Corrective Action if Below Standard
<u>SERVICE</u>			
Serving salad	Contamination and spoilage	Servers must have clean hands and preferably gloves Temperature of salad must remain at 4Q-F (4.4~C) or below All plates, bowls, and other utensils silverware must be clean and sanitary	Clean hands and wear gloves Lower temperature Clean and sanitize properly Discard any food contacting unsanitary surfaces
<u>STORAGE</u>			
Storing prepared salad	Contamination and spoilage	Container must be covered properly and stored on upper shelves away from raw foods Temperature must remain at 40°F (4.4°-C) or lower	Cover and move to proper shelves Cool rapidly to proper temperature if food has not been in danger zone for too long (more than 2 hours)—good judgment needed here
<i>IF RESERVICE OF LEFTOVERS IS DONE, ALL STANDARDS DESCRIBED IN THE SERVICE SECTION MUST BE OBSERVED</i>			
<u>PREPARATION</u>			
Cooking chicken	Bacterial survival	Cook to 165 5F (73.9°C) check with thermometer	Continue cooking until proper temperatures met

Cooling chicken	Spoilage	Cool to 40 °CF (4.4°C) with 2-4 hours	Cut chicken to smaller pieces to quicken cooling
Cubing chicken	Contamination	Use clean, sanitary knives, cutting board, and containers. Avoid metal containers other than stainless steel for preparation and storage	Clean and sanitize all food contact surfaces
Cubing vegetables	Contamination	Use clean, sanitary knives, cutting board, and containers. Avoid metal containers other than stainless steel for preparation and storage	Clean and sanitize all food contact surfaces
Combining Ingredients (vegetables, spices, and mayonnaise)	Contamination	Use clean, sanitary knives, cutting board, and containers. Avoid metal containers other than stainless steel for preparation and storage	Clean and sanitize all food contact surfaces, wash hands
	Reaching spoilage temperatures in danger zone	Minimize time in danger zone,	Make smaller batches if necessary. Use cool mayonnaise [40°F (4.4°C)] Use cool stainless steel bowls and utensils.

Source: Vieira (1999)

Internal quality control to check temperatures, texture, colour, taste, absence of defects, or other quality and safety aspects. The Figure has a flow chart with CCPs, hazards, standards to be met, and corrective actions to be taken. This type of chart is very useful for both monitoring and verifying that the system is working. HACCP is widely accepted and recommended for all food production, handling, and distribution.

Appendix 3 (c) HACCP for Roasting Chicken

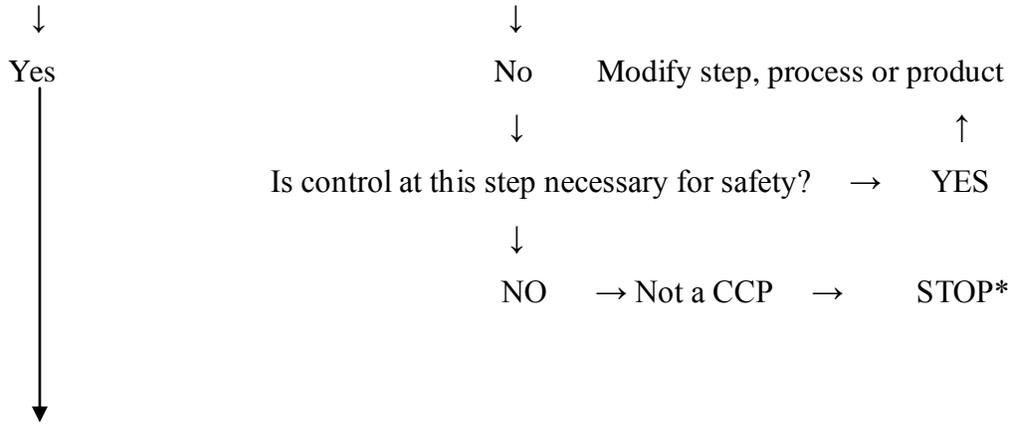
PROCESS	HAZARD	CRITICAL CONTROL POINT	STANDARD	MONITORING METHOD	ACTION TO TAKE IF STANDARD NOT MET.
Purchase chicken	Natural bacteria contamination	None by consumer			
Cold storage	Natural bacterial contamination	Refrigerator temperature Length of storage time	Refrigerator air temp. at $\leq 40^{\circ}\text{F}$ 2 days	Measure refrigerator air temp. Observation	Lower thermostat setting Discard
Remove chicken from storage	Natural bacterial contamination	Personal hygiene Sanitation of contact surfaces, including plates, utensils, sinks and counter tops	Thoroughly wash hands after contact with raw chicken Wash, rinse, and disinfect after contact with raw chicken	Observation Observation	Rewash Rewash and sanitize
Roast chicken	Natural bacteria contamination Contamination of chicken surfaces by food handlers Cooking process may not be sufficient to kill bacteria	Oven temp. Temp. of cooked chicken	Oven temp. conventional at $325 - 350^{\circ}\text{F}$ Internal temp at $180 - 185^{\circ}\text{F}$	Measure oven air temp. Measure internal temp.	Reset thermostat Continue cooking until reaches appropriate temp. if over cooked remove from the oven

Appendix 3 (d) Thawing Chicken before Roasting

Process	Hazard	Critical control point	Standard	Monitoring method	Action to take if standard not met
Freezer storage	Contaminating bacteria will survive	Freezer temp.	Freezer temp. $\leq 0^{\circ}$ F	Measure freezer air temp.	Reset thermostat
Thawing	<p>Insufficient thawing may lead to insufficient cooking pathogen survival</p> <p>Bacteria grow if portions are warm enough</p> <p>Drip from thawing chicken can contaminate surfaces and other foods</p>	<p>Thawing time temp.</p> <p>Thawing time temp.</p> <p>Sanitation of contact surfaces, including plates, utensils, sinks, counter tops</p>	<p>Allow 1 day in refrigerator to thaw 5lb chicken check for microwave standards</p> <p>Thaw in refrigerator</p> <p>Thaw in microwave oven</p> <p>Thaw under cool running water.</p> <p>Wash rinse and disinfect after contact with chicken or drip</p>	<p>Observation</p> <p>Measure refrigerator temp.</p> <p>Follow appliance instructions</p> <p>Observation</p>	<p>Continue until thawed</p> <p>Lower thermostat</p> <p>Reset water flow</p>
Remove chicken from thawing surface	Natural bacteria contamination	<p>Personal hygiene</p> <p>Sanitation of contact surfaces including plates, utensils, sinks, counter tops</p>	<p>Thoroughly wash hands after contact with raw chicken</p> <p>Wash, rinse and disinfect after contact with raw chicken</p>	<p>Observation</p> <p>Observation</p>	<p>Rewash</p> <p>Rewash and sanitize</p>

Appendix 4: A decision tree for CCP

Q1. Could preventive measure(s) exist for the identified hazard?



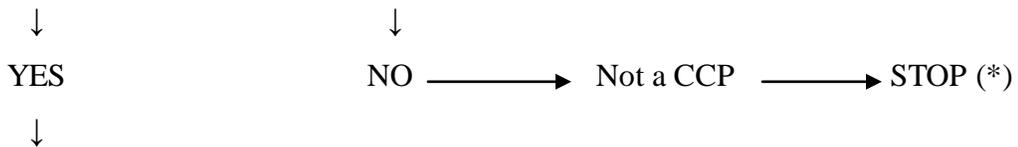
Q2. Is the step specifically designed to eliminate or reduce the likely

occurrence of a hazard to an acceptable level?



Q3. Could contamination with identified hazard(s) occur in excess of

acceptable level(s) or could these increases to unacceptable level(s)?



Q4. Will a subsequent step eliminate identified hazard(s) or reduce the likely occurrence

to an acceptable level?



*Proceed to next step in the described process

