TO DETERMINE HYGIENE AND MICROBIAL CONTAMINATION OF
MINIMALLY PROCESSED FRUITS AS STREET FOODS IN CENTRAL
WARD, NAIROBI COUNTY

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF PUBLIC HEALTH
(EPIDEMIOLGY AND DISEASE CONTROL) IN THE SCHOOL OF
HEALTH SCIENCES OF KENYATTA UNIVERSITY.

DECEMBER 2016
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 God Almighty, for enabling me to finish this thesis.
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ABBREVIATIONS AND ACRONYMS

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<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>ACC/TPC</td>
<td>Aerobic colony count/Total plate count</td>
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<tr>
<td>CBD</td>
<td>Central Business District</td>
</tr>
<tr>
<td>CDC</td>
<td>Centre for Disease Control and prevention</td>
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<td>EU</td>
<td>European Commission</td>
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<td>GAP</td>
<td>Good agricultural practices</td>
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<td>GMP</td>
<td>Good manufacturing practices</td>
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<tr>
<td>IEC</td>
<td>Information education communication</td>
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<td>KEBS</td>
<td>Kenya Bureau of Standards</td>
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<td>MOH</td>
<td>Ministry of Health</td>
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<td>NCC</td>
<td>Nairobi City Council</td>
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<tr>
<td>NSSF</td>
<td>National Social Security Fund</td>
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<tr>
<td>NACOSTI</td>
<td>National Commission for Science Technology and Innovation</td>
</tr>
<tr>
<td>PCA</td>
<td>Plate count agar</td>
</tr>
<tr>
<td>PDA</td>
<td>Potato dextrose agar</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>VRBA</td>
<td>Violet Red Blue Agar</td>
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<td>WHO</td>
<td>World Health Organization</td>
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OPERATIONAL DEFINITION OF TERMS

**Food safety:** Assurance that food will not cause harm to the consumer when it is prepared and eaten according to its intended use (FAO/WHO, 2009).

**Food borne diseases:** Diseases spread through consumption of contaminated food sometimes resulting in appreciable morbidity and occasional mortality.

**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.

**Hygiene:** A continuous process of ensuring that cleanliness is observed and maintained to the required standards.

**Homogenate:** a homogenized sample mixed so well that removing some of the sample does not alter the overall make-up of the sample remaining. In this study each fruit category per cluster was homogenized.

**Indicator organisms:** Organisms detected using rapid, non-specific tests to give presumptive evidence for the presence of pathogens. After a positive presumptive test has been obtained, the presence of pathogenic microorganisms can be confirmed using specific detection techniques.

**Minimally processed fruits:** Those fruits that have undergone only a few unit operations such as washing, peeling, cutting, in preparation for consumption.

**Nutrient agar:** A widely used general medium containing beef extract and peptone and is suitable for counting microorganisms that grow in food. It uses the assumption that all living (viable) cells in the sample will be able to grow and manifest their presence after cultivation in the suitable medium for growth.
“Ready-to-eat” Status of the food being ready for immediate consumption at the point of sale. It could be raw or cooked, hot or chilled, and can be consumed without further heat-treatment including re-heating.

Street foods or street-vended foods: Foods and beverages prepared and /or sold by vendors in the streets and other public places for immediate consumption or consumption at a later time without further processing or preparation. This definition includes fresh fruits which are sold outside authorized markets for immediate consumption. (FAO/WHO 2009).
ABSTRACT

Despite numerous benefits of minimally processed fruits vended as street foods, it has been recognized that they can be a source of foodborne illnesses that can majorly result from poor hygiene practices and unsanitary conditions at fruit vending points. The main objective of the study was to assess the hygiene status and microbial contamination in fruit vending businesses in Nairobi central ward. The study was cross sectional with analytical component and through purposive sampling, 223 willing street food vendors from 7 clusters in the Central ward were selected for the study. Fifty two fruit samples of four fruit categories sold by different vendors in each cluster were pooled and homogenized, and a serving of each fruit typed weighed and analyzed in duplicate in the laboratory. The data collection tools utilized included a structured questionnaire and an observation checklist which were prepared using codex food hygiene and safety principles. Data collected was analyzed using SPSS version 21, Genstat 13th edition and Excel spreadsheet. Chi-square, and Kruskal Wallis tests were used to establish relationship between dependent and independent variables. All the significant tests for the hypothesis were at 95% confidence level (p<0.05). Food hygiene knowledge and hygiene practice levels were ranked according to Bloom cut off points on calculated scores, where scores were converted to 100%. Based on the sum scores, Food hygiene knowledge and practice was classified as good (>80%); average (60-80%) and poor (0-59%). Food hygiene knowledge and practices were significantly different in the clusters (p>0.05) with vendors in City market and CBD having the highest Food Hygiene Knowledge score while vendors in Uhuru Park and OTC having the highest Food Hygiene Practice score. Hygiene status was not significantly associated (p>0.05) with either food hygiene knowledge or practice. Time period of experience was found to be significantly associated with hygiene status (p>0.05). The major sanitary deficiencies that were identified included no drying racks for cleaned utensils, (55%) lack of uniforms, (54%) vendors wearing jewelry (74%) while working, lack of training, (83%) lack of medical certificates (73%) and cracks and crevices on work surfaces (87%), presence of garbage and waste near stalls, (68%) uncovered dustbins, (95%) and presence of houseflies (25%). Expressed in log\textsubscript{10} colony forming units/gram, high bacterial load counts, highest mean (log\textsubscript{10} 5.32cfu/g) were seen in fruit salad samples. High coliform load counts mean (log\textsubscript{10} 0.08) were seen in all the fruit samples indicating contamination with fecal matter, while high mold and yeast counts were found in fruit salad and pineapple samples. The null hypothesis was accepted. Compared to other similar studies, low levels of hygiene knowledge and practice were reported. The government should formulate a policy on ready-to-eat food vending as part of street food policy.
CHAPTER ONE: INTRODUCTION

1.0 Background information

Fruits are an extraordinary dietary source of micronutrients and fiber for humans and are thus vital for health and wellbeing. Almost 90% of vitamin C originates in fruits (Simitu, 2011). Well balanced diets, rich in fruits are especially valuable for their ability to prevent vitamin C and vitamin A deficiencies and are also reported to reduce the risk of several diseases plus their consumption has become a global priority (McCarthy & Matthews, 1994; Simitu, 2011).

There is an increasing demand for ready-to-eat fresh-cut fruits, which is causing an expansion of the market for minimally processed products, rising over the last years mainly due to the paucity of time, and increasing demand for low-caloric food products with fresh-like characteristics. The practical advantages and convenience they provide to consumers is undoubtedly favorable because they are easily accessible, convenient and most importantly cheaper than whole fruits. (Simitu, 2011) However, because of the specific forms in which they are prepared, they are highly perishable and are associated with new food safety problems both epidemiologically and microbiologically (Artés, Gómez, & Artés-Hernández, 2007; Eni et al., 2010).

In the developing countries, it is considered that the burden of food- borne illness is worse than in the developed countries, as a result of inadequate food safety programs or absence of an organized institutional body for vended street foods (Abeditan, 2011). However, there is little available data, to show the actual magnitude in general, leave alone in relation to minimally processed fruits alone. Many cases of illness go unreported and unrecognized yet these types of illnesses are a significant
contributor to the burden of disease in less developed countries. This therefore highlights the need of applying good hygiene practices from farm to fork to prevent contamination and/or bacterial growth, and ensure compliance with appropriate food safety guidelines and regulations (Sherrae & Neela, 2015). Much research work and surveillance of food borne diseases has been done in Kenya but, the incidences of food borne diseases associated with fruit are not easy to estimate as most of the illnesses are lumped together when recording, as diarrhoeal diseases, which suggest underlying problems in food safety. (Kariuki, 2012; Gizaw et al., 2014).

Street food vending is common in the Central ward of Nairobi County, and fruits are sold either by mobile vendors who hawk them around especially when there is traffic or in offices, or by stationary vendors who are set up in various such strategic places such as stalls, market places and public bus stations. These products are primarily offered as convenience items for those individuals who do not wish to be bothered by or have no time for preparation. They are also sold for immediate consumption, especially during lunchtime. Nairobi Central ward is a location that is convenient and desirable for most fruit vendors because there is enough foot traffic for the vendors to make sufficient sales, and if they were to sell outside the central ward the sales would not be as good (Kamunyori, 2007).

While it is expected that minimally processed fruits sold as street food contribute immensely to the nutritional needs of consumers, it is not easy to ascertain their safety from contaminants especially by microorganisms (Mwangi, 2002; Gitahi., 2012). Experts say fruits are reservoirs of disease causing germs. In recent years, there has been an increase in the number of reported cases of foodborne illnesses linked to fresh fruits (Mc Carthy & Matthews 1994; Madueke et al., 2014).
The fresh nature of these products, coupled with the mild handling and processing techniques, and the storage conditions have presented microorganisms with the potential to grow and multiply and in turn increasing chances of foodborne outbreaks associated with consumption of ready to eat foods (Francis, Thomas, & O’beirne, 1999). Pathogens may also invade the interior surfaces of sliced fruit during washing, peeling, trimming, handling and packaging (Abadias et al, 2008).

Vendors for minimally processed fruits just like all food handlers, have the primary responsibility to guarantee that fruits served are hygienic and safe for consumption. But intentional or inadvertent contamination of fruits puts the consumer at the risk of suffering foodborne illnesses (Monica, 2011). It is against this background that the study was carried out to address the various aspects of hygienic practices like preparation skills, handling, storage, place of preparation, storage of leftovers, and also to establish the microbial load of these minimally processed fruits.

1.1 Problem statement

The increase in consumer needs for fresh products with subsequent increase in street vending of minimally processed fruits is increasingly offering challenges to both health of consumers and local authorities as there is no proper control in this informal sector. Poor hygiene practices therefore, coupled with low standards of environmental and personal hygiene, improper handling of food, improper storage occur with street foods raising health concerns such as foodborne illnesses (Kariuki, 2012).

In Nairobi Central Ward the street food industry plays an important role where it feeds millions of people daily with a wide variety of foods that are relatively cheap and easily accessible. In the markets and bus stations, a wide variety of fruits that offer cheap snacks are sold. Due to increased demand for resources coupled the
unlimited and unregulated growth, there has been a severe strain on city resources such as water, sewage systems, and interference with city plans through congestion and littering. Street food vendors are usually unlicensed blocking vehicle and pedestrian traffic (Muinde & Kuria, 2005; Monica, 2011). This raises concern with respect to their potential for serious food poisoning outbreaks and exposure of the sliced fruits to flies, dust and other disease causing agents.

Few studies have been done in this context and especially in determining the hygiene and safety of minimally processed ready-to-eat fruits in Nairobi central ward which also hosts the CBD.

1.2 Justification

Fruits are increasingly becoming important dietaries in Kenya, and are assumed to be safe and healthier for consumption because they are mildly handled. In Nairobi, they are found to be sold in many areas where people operate like in the markets, stalls and side-roads. However, the hygienic preparation and microbial contamination of these products are not well established.

The need for this study arose from lack of information on fruit microbial contamination levels, and food hygiene practices. There is also general lack of knowledge about the microbiological status or the precise epidemiological significance of minimally processed fruits, and therefore was necessary to carry out research in order to highlight the health implications of consuming such ready-to-eat fruits, and recommend any necessary interventions that could be adopted by the relevant bodies or authorities in improvement of hygiene of street vended fruits.
1.3 Research questions

1. What is the food hygiene knowledge and hygiene practices of the fruit vendors?
2. What are the hygienic conditions of the fruit preparation and vending environment?
3. What is the microbial status of minimally processed fruits?

1.4 Hypothesis

Minimally processed fruits sold as street foods are not prepared and vended under hygienic conditions and therefore are a threat of microbial contamination.

1.5 Main objective

To assess the hygiene and status of microbial contamination, of minimally processed fruits sold as street foods in Nairobi.

1.6 Specific objectives

1. To establish food hygiene knowledge and practices of the fruit vendors
2. To determine the hygiene conditions of the fruit preparation and vending environment
3. To determine the microbial status of minimally processed fruits.

1.7 Conceptual framework

Figure 1.1 is a model that elaborates on factors that can affect hygiene and safety of fruits in public places and inter relates the major variables involved in this study. The dependent variable is fruit safety and quality while the independent variables are environmental factors such as hygiene and physical condition of the fruit vending.
environment; personal factors such as fruit hygiene knowledge and practice; and physiological factors such as microbial contamination.

Food safety is the assurance that food will not cause harm to the consumer when it is prepared and eaten according to its intended use (WHO/FAO 2012). Food borne illnesses that occur can therefore be as a result of microbial contamination during harvesting, transporting, packaging or distribution and also as a result of poor handling by the workers, or use of dirty equipment. Fruits can easily be contaminated either by the host who in this case could be the food handler or the consumer; microorganisms from production to consumption and the environment which includes factors such as temperature, humidity, air pollution, water etc.

Food environment would affect the safety and quality of the fruits if there is unhygienic knowledge, attitude and awareness of hygiene, availability of sanitary conditions and harvesting and post-harvesting are some of the factors that determine whether fruits will be safe for consumption or not. These interactions are shown in figure 1.1
Independent variables:  

**ENVIRONMENTAL FACTORS:**

Hygiene status and physical conditions of the fruit vending environment
Availability of sanitary conditions
Harvest and postharvest handling of fruits

**PERSONAL FACTORS**

Knowledge and awareness of hygiene and safety of fruit vendors
Practices of food safety by fruit vendors including proper fruit handling
Personal hygiene

**PHYSIOLOGICAL FACTORS**

Proper handling and storage to prevent deterioration and microbial contamination

Figure 1.1: Factors that affect hygiene and safety of foods in public places

Source: Modified from Codex Principles on Food hygiene
CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction
This chapter reviewed literature related to food safety and hygiene standards in public areas, with status of microbial contamination of fruits being given the prime consideration. The chapter therefore highlighted theoretical content necessary to understand the research project.

2.1 Minimally processed fruits
Minimally processed fruits are fruits that have undergone minimal operations such as washing, slicing, peeling and deseeding, usually for immediate consumption. They are a subsector of the food industry especially in Kenya with a potential for growth. They are also highly perishable, as a large portion of their surface area lacks the epidermis which acts as a protective barrier to damage of the fruit such that if any mechanical injury was to occur, it would set off a complex series of events in loss of quality of the fruit (Artes et al., 2007; Gitahi, 2012). To minimize the perishability of these freshly cut products, strict control procedures such as temperature, atmosphere, relative humidity and sanitation must be adhered to (Monica, 2011). In general, less contamination has been reported on fruits than on vegetables, partly due to the lower pH of most fruits (Monica, 2011). Some outbreaks have suggested that fresh cut fruits such as melons can be a source of Salmonella, and yeasts are also very common on raw fruits and vegetables with populations ranging from $10^2$ to $10^6$ colony forming units per gram (Gitahi, 2012).

2.2 Minimally processed fruits as street foods
Street foods are prepared ready-to-eat food items retailed by vendors and they are usually sold from pushcarts or baskets or stalls or shops, are centrally processed and
provide employment and income to a large population especially in Kenya especially in urban setting actually because of road congestion in the evening which in turn provides a conducive environment for fruits vendors to sell their products from one vehicle to another (Monica, 2011). Most street food vendors plan food preparation in such a way that the prepared or semi-prepared food items are consumed within the day, however, there are leftovers which vendors are encouraged to discard, especially the minimally processed fruits (Sherrae & Neela, 2015).

The World Health Organization, (2012) survey recognizes that street food have social economic advantages and have experienced fast growth rate which is significant over the past few decades. This is mainly because of rapid population growth and urbanization. Fruit vending is a way of providing income to low income people and assures business to those vendors who could otherwise be jobless. As stated by (WHO/FAO, 2012), food vending is important in that it is inexpensive, very convenient, source of nutrition to the poor both in urban and rural areas, and a major source of income. The street vended fruits however pose a major problem to public health. Poor infrastructure and poor services such as poor water supply, inability to control venders due to high mobility and their temporary manner, poor resources for laboratory and inspection services, lack of knowledge of microbial, and basic food safety and poor public awareness of contamination of street foods also contribute to the risk factors that pose risks to public health (FAO/WHO, 2009).

In many developing countries, street food or ready-to-eat food vendors are an important component of the food supply chain, street food satisfies a vital need of the urban population as it is priced in a reasonable way and conveniently available. Part of the global populace entirely depend on it for survival (Kisembi, 2013). The role of
street foods in the provision of nutritional requirements for the urban population, has received little official attention and more notice has been paid to the latent dangers that arise from consumption of street foods rather than to any benefits they may offer. Ready-to-eat fruit salads and fruits are usually considered safe to eat by consumers and their consumption in Kenya has increased both in quantity and variety over the years. Ready-to-eat foods as defined by the (EU, 2005), means food intended by the producer or manufacture for direct human consumption without the need for cooking or other processing effective to eliminate or reduce to an acceptable level microorganisms of concern.

Fruits are important sources of vitamins, minerals, dietary fiber and anti-oxidants. They can be consumed raw and fresh, fully nourishing the body with all the vitamins from the fruits. Their increased consumption, especially in Nairobi central ward, has made food safety checks a necessity (Kader, 2008).

Fruit vendors also, once they receive the fruits, should be in a position to process them in sanitary conditions so as not to enhance potential for contamination by microbiological pathogens, which may adhere to the surface of the fruit or penetrate the fruit surface and multiply within the tissue especially, during washing, peeling, slicing, trimming, packaging, handling or selling. Food surfaces may also act as reservoirs for microbial contamination (Buck, Walcott & Beuchat, 2003; Gitahi, 2012).

2.3 Hygiene status of minimally processed fruits

Minimally processed fruits have a high potential for growth both in Kenya and around the globe. The production and consumption of fruits has become a thriving business internationally, consequently, it has grown into an all year round available
commodity, emphasizing the urgent need for both international and national application of good hygienic standards (Mekonnen, 2011). The practical advantages and convenience these foods provide to consumers is indisputably favorable, but due to the specific ways in which they are prepared, they are also extremely perishable. To reduce perishability, strict control procedures on hygiene have to be followed and elaborated to avoid quality loss and to assure food safety to consumers (Buck et al., 2003; WHO/FAO, 2012).

Sanitation issues for any food item being produced or utilized consists of four components which include quality of the raw food, personal hygiene of the personnel handling the food, the sanitation of the environment where the food is being prepared and served, as well as of the equipment being used. A default in the hygiene and sanitation standards of any of these components can result in food contamination and subsequently food poisoning (Abeditan, 2011).

Surfaces and equipment used for fruit preparation should be easy to clean and preferably made or covered with impervious material. Preparation should not be carried out on or near the ground. Utensils and other containers such as bowls and jugs should allow for easy cleaning, and should not be used for other purposes other than preparation, processing or keeping minimally processed fruits, and should be free from contamination of the environment (Mekonnen, 2011). For instance, bowls and dishes should be stored upside down or covered as this discourages accumulation of foreign matter, dust and dirt. Chopping boards and utensils should be made using non-toxic or unhazardous material such as: lead, copper or cadmium, and their state should be maintained so as to reduce the likelihood of contamination and cross contamination (WHO/FAO, 2012).
Food handlers are tasked with a vital role of guaranteeing food safety throughout the chain of food from production to consumption, and any disregard or mishandling of hygienic measures on their part may enable pathogenic bacteria to come into contact with the food item and in some cases survive and multiply in large numbers so as to cause illness to the consumer (Madueke et al., 2014).

There is a noticeable increase of food vendors in Kenya including fruit vendors who sell fruits along the streets of Nairobi, in bus stations, markets and even in busy streets when there is traffic. This may have been instigated by the rapidly growing and changing demands of food alongside the need to diversify or have more sources of income in the face of declining incomes (Muinde & Kuria, 2005). Street foods are majorly prepared in the stalls which are within five to ten metres radius of dusty roads and footpaths (Gitahi, 2012). Some of the disadvantages of the street food industry usually listed in technical publications, for instance, are that street foods in general are thought to be a source of microbiological and chemical contamination and that they also undergo unhygienic or improper food preparation and/or handling practices, for example, fruit salads are held in open bowls (Gitahi, 2012; Kisembi, 2013). Studies have also shown that most food borne illnesses are attributed to food contamination through unhygienic food handling practices, infected food handlers, limited access to safe water or garbage disposal facilities, and lack of appropriate knowledge on food borne illnesses by food handlers (Monica, 2011).

According to (Muinde & Kuria, 2005), majority of the fruit vendors prepare their fruits either at their stalls or homes which are situated by roadside and this is one of
the major causes of contamination because structures are not well protected from the
dust. Majority of stalls are mainly made of wood and polythene bags and others
consider vending using small cartons (Muinde & Kuria 2005). Others prepare fruit
salad in the same stalls that are located by the roadside, making the fruits prone to
contamination. Most of these fruit vendors prepare fruits in unhygienic conditions as
there is accumulation of garbage and waste close to their stalls (Muinde & Kuria,
2005). Studies also reveal that hygiene when handling street fruits is relatively poor
mainly because of water insufficiency, subsequently, fruits are not thoroughly washed
while others, are not washed at all (Madueke et al., 2014). A separate study by
Muinde & Kuria in 2005 indicated that fruits were not kept under cool temperature,
personal hygiene of fruit vendors was not upheld, and there was generally no use of
aprons or uniforms.

The general code of hygienic practices for fresh fruits and vegetables has been
elaborated by the Codex Alimentarius Committee on food hygiene (Francis et al.,
1999). The codes were initiated in response to the growing concerns about fresh fruits
and vegetables as a source of food borne pathogens. They address Good Agricultural
Practices (GAPs) and Good Manufacturing Practices (GMPs) that will help control
microbial, chemical and physical hazards at all stages of the production of fresh fruits
from primary production to packing and sale. Important areas for microbial safety
have been highlighted to include environmental hygiene, hygienic production, (water,
soil, agricultural chemicals, biological control, indoor facilities, handling, storage,
transport, cleaning, maintenance, sanitation) and personal hygiene. Good agricultural
practices and Good hygienic practices are the basis for safe production and utilization
of fresh produce (Buck et al., 2003). Much of the microbial contamination could be
from soil or organisms originating directly from animals. Microbial load can however
be reduced by washing which will remove dirt from the surfaces of the fresh produce keeping the microbial load low. (Roy, 2014). In order to ensure safety of street foods various departments of health care in Kenya should develop codes of practice and sanitary requirement for street food stalls and vendors. There is need for emphasis on the proper construction of food stalls, protection of foods and beverages from contamination, sanitation of the food stalls and training of the food handlers on personal hygiene and sanitary food preparation (Monica, 2011; Gitahi, 2012).

2.4 Food hygiene Knowledge and Practice of the Vendors

Food safety is a major concern with street foods, and studies are carried out all over the world as a way of improving food safety to all food handlers. Data shows that people who work in the industries and other institution are more likely to get food safety training as compared to street food vendors and are also more likely to be well educated (Monica, 2011). A study conducted in Accra, Ghana established that 94% of street vendors were women who had minimal or no education at all (Monica, 2011). The main aim of the training is to minimize food poisoning and improve the food safety among all food handlers, although studies have shown that improper food handling has in the past increased with increase in the number of fruit vendors trained, suggesting that such training made little to no difference in proper handling of fruits and food, therefore there was no reason of introducing the training (Kassa et al, 2010).

Food safety courses and training can be used to curb the foodborne diseases among food and fruit vendors by learning various sustainable and proper methods they can employ in order to maintain a hygienic environment (Walker et al., 2003; Gitahi, 2012). A survey of hygiene and sanitary practices of street food vendors in the central
state of Northern Nigeria indicated that most fruit and food vendors have undergone training but less than half made use of the knowledge taught (Nurudeen et al, 2014). Physical factors such as equipment used, furniture used in the vending area and the environment itself, coupled with poor hygiene practices during production and washing of fruits with contaminated water are all sources of contamination. Personal grooming, washing of hands and medical check-up are important preventive measures of contamination (Monica, 2011). Food preparation premises should be purposely built in areas that are free from dust or smoke, flies, away from heaps of garbage, should not be congested, and the surfaces should be made of material that is easy to clean and free from cracks or crevices so that microorganisms cannot easily grow and multiply. (Monica, 2011; WHO/FAO, 2012).

2.5 Microbial Contamination of Minimally Processed Fruits
Minimally processed fresh (MPF) fruits and vegetables are good media for growth of microorganisms. They have been involved in outbreaks because of the consumption of products contaminated by pathogens. They are also sensitive to various spoilage microorganisms such as pectinolytic bacteria, saprophytic Gram-negative bacteria, lactic acid bacteria, and yeasts (Abiadas et al., 2008). The causal agents of microbiological spoilage in fruits and derivatives can be bacteria, as well as yeasts and molds (Brackett, 1994; Gitahi, 2012; Monica, 2011). Because of their high acidity, most fruits do not encourage growth of spore forming bacteria, but encourage growth of yeasts and molds. However, there are some fruits including papaya, watermelon, avocado and sweet melon, whose acidity is low enough to encourage growth of the bacteria. The growth of these bacteria in the fruits and products poses a risk of food borne illnesses, such as that from E.Coli, shigelloses, and others. Yeasts will
mainly cause fermentation of the fruit products, giving them an alcoholic taste, while some of the moulds when they grow could produce harmful mycotoxins (Wiley, 1994; Artes et al 2007).

Routine examination of foods for a range of pathogenic microorganisms is impractical. In order to assess the microbiological safety from foodborne pathogens, widespread use of groups or species which are easily enumerated and whose presence in foods indicates exposure to conditions that might introduce hazardous organisms and/or allow their growth, are used. These groups are referred to as indicator organisms which are generally used to assess food hygiene (Abadias et al., 2008). In this study, total count of bacteria, total count of coliforms and total count of yeast and molds were assessed. Ready-to-eat fruits have been implicated as vehicles for transmission of microorganisms even though the frequency of foodborne outbreaks associated with them is low compared to products of animal origin. Nonetheless, foodborne illnesses associated with minimally processed fruits appear to be on the increase in many countries either due to improved recognition or reporting, increased consumption changes in commodities or production practices or a combination of these factors (Monica, 2011). In Kenya, the monitoring of microbiological food safety and the prevention of foodborne disease are the responsibility of a number of interlinked public bodies for example KEBS, MOH, the food industry and other related organizations (EU, 2005).

Minimally processed fruits should have satisfactory levels of bacteria, yeasts and moulds of up to $10^4$. Levels of $10^5$ and $10^6$ in fruits represent a significant potential risk to health. $10^7$ is indicative of spoilage and $10^8$ is indicative of odour development (Mekonnen et al., 2011). The law also stipulates that there should be no coliforms (0 CFU/g) in fruits and vegetables, as they are indicative of faecal contamination.
World Health Organization with guidelines according to the Public health services guidelines in the United Kingdom, also states that bacterial load levels of $<10^4$ cfu/g is satisfactory, $10^4 < 10^5$ is acceptable, and $>10^5$ unsatisfactory (WHO/FAO, 2012).

Minimally processed street fruits in Nairobi are therefore likely to pose a public health risk, indicating the need to improve hygiene practices in preparation and handling of the street fruits to avoid contamination.

*Table 2.1: General microbiological profiles of harvested fruits and vegetables*

<table>
<thead>
<tr>
<th>Product</th>
<th>Microorganisms of contamination</th>
<th>Approximate quantitative range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits</td>
<td>Bacteria: the inherent low pH of most fruits favors a predominance by molds. However, gram negative bacterial species can be isolated.</td>
<td>Usually less than $10^4$ cfu/g (Splittstoesser, 1970)</td>
</tr>
<tr>
<td></td>
<td>Molds: common types include fusarium, alterania, rhizophus, phoma, trichodema etc</td>
<td>$10^3 - 10^4$ cfu/g (Webb and Mundt, 1978)</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Bacteria Moulds</td>
<td>$10^3-10^7$ cfu/g</td>
</tr>
</tbody>
</table>

*There is considerable variation in the numbers and types of microorganisms present on vegetables and fruits. The species, the amount of adhering dirt, soil, location, and presence or absence of physical damage would all be significant variables.*
2.5.1 Bacterial contamination of minimally processed fruits

Counts of viable bacteria are commonly based on the number of colonies that develop in nutrient agar plates which have been inoculated with known amounts of diluted foods and then incubated under prescribed environmental conditions. Only those bacteria, which will grow under the chosen environmental conditions, can be counted. Plate counts that apply to fresh foods such as fresh fruits, vegetables, fermented foods and foods incorporated in these such as sandwiches and filled rolls would be expected to have an inherent high plate count because of the normal microbial flora present. It should however not be more than 20-300 colonies/plate when counting (Artés et al., 2007; Mekonnen, 2011).

The presence of enteric bacteria, e.g., coliforms and *E.coli* have been widely accepted as indicators of fecal contamination and therefore the indicators of the possible presence of pathogens of enteric origin, e.g., *Salmonella*. Coliforms could also be indicators of microbial proliferation, inadequate processing or post process recontamination due to cross contamination by raw materials, dirty equipment or poor hygienic handling. A common practice (Madueke, 2014) is to use tests for coliforms for screening and if there is reason to determine the likelihood of fecal contamination, the coliforms or other *Enterobacteriaceae* are subjected to further tests to establish whether any of them are *E.coli*. Low numbers of coliforms are usually permitted in sensitive foods at numbers ranging from 1 to not exceeding 100/g or ml (Artés et al., 2007; Gitahi, 2012). As a means of assessing the adequacy of sanitation, the use of coliforms is recommended. (Gitahi, 2012) The total plate count is a general method commonly employed to judge the overall hygiene or sanitary quality of foods. (WHO/FAO, 2012)
2.5.2 Yeast and mould contamination of minimally processed fruits

Yeast and moulds outgrow bacteria in most acid foods such as fresh fruits and vegetables, and cause spoilage especially if these products have been improperly stored or handled. Additionally, there is also potential hazard from the production of mycotoxins by moulds. Humans should not consume foods that are visibly moldy and will therefore recognize spoilage when large numbers of yeast or visible moulds are present. The number of yeast colonies per counting plate should be lower (10-100 colonies/plate), while that for moulds should be less than 50 colonies/plate (Artés et al., 2007)
CHAPTER THREE: MATERIALS AND METHODS

3.0 Introduction

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

3.1 Research design

The study was cross sectional and analytical in design to investigate hygiene and safety of minimally processed fruits and laboratory analysis of the fruit samples to assess their microbial load.

3.2 Study variables

The dependent variable is hygiene and microbial contamination of minimally processed fruits, while the independent variables were the hygienic conditions of fruit environment and hygiene of fruit preparation surfaces; hygiene knowledge and practices; and socio demographic and economic characteristics of the vendors in the clusters.

3.3 Study Area

The study was conducted in the Central ward, Nairobi Metropolis. Nairobi Central Ward is in Starehe constituency. There are 6 wards in Starehe constituency, but central ward was purposively selected because it comprises City Square, Muthurwa and Nairobi Central Sub-Locations of Nairobi County It covers the CBD and its outskirts to include areas around Moi Avenue, NSSF grounds, Technical University of Kenya, St.Peter claviers, Khalsa racecourse and Muthurwa market. Starehe constituency is one of the seventeen constituencies in Nairobi County and consists of
Nairobi central ward is a convenient location for sale of fresh produce, and is a spatial location for fruit vendors who sell minimally processed fruits, as they can find a market for their goods often at a higher price than if they sold outside the central ward. This in turn increases their profits hence most street-traders have identified the area as their preferred location for economic activity.

3.4 Study population

The target population was all fruit vendors of minimally processed fruits. The study population were the fruit vendors identified who consented to be included in the study. The number found was assumed to be adequate to represent Nairobi central ward.

3.5 Sampling Techniques

Simple random sampling was used in the selection of study participants while proportionate sampling and random sampling was used for fruit samples. Out of the

Figure 3. 1: Nairobi Central Ward-Starehe Constituency

Source: Google maps 2015
323 street – fruit vendors in Nairobi Central Ward, 223 consented to be interviewed. In all the clusters, every third vendor was picked for observation because of homogeneity among the clusters, and proportionate sampling was also conducted to determine the number of fruit samples of specific fruits to be picked from each cluster for the laboratory analyses. This is illustrated in table 3.1

Table 3. 1: **Response rate of vendors and selection of fruit Samples**

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Total Vendors</th>
<th>No. Consented</th>
<th>Response Rate (%)</th>
<th>Observation Checklist</th>
<th>No. of Fruit Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>City market</td>
<td>65</td>
<td>49</td>
<td>100</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Muthurwa</td>
<td>43</td>
<td>28</td>
<td>100</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>OTC Bus stop</td>
<td>56</td>
<td>31</td>
<td>100</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Accra road</td>
<td>34</td>
<td>27</td>
<td>100</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Uhuru park</td>
<td>18</td>
<td>10</td>
<td>100</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Nyamakima</td>
<td>53</td>
<td>39</td>
<td>100</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>Mfangano St</td>
<td>54</td>
<td>39</td>
<td>100</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>323</strong></td>
<td><strong>223</strong></td>
<td><strong>100</strong></td>
<td><strong>76</strong></td>
<td><strong>52</strong></td>
</tr>
</tbody>
</table>

### 3.5.1 Sample size determination for fruits

For microbial analysis, the formula by Daniel 1999 was used. A pathogen rate of 20% from the fruit samples and a 5% significance level was assumed:

\[ n = \frac{NZ^2 p (1-p)}{d^2 (N-1)} + Z^2 p (1-p) \]

Where:

N= total no. of fruit vendors selling fruits in Nairobi central ward (323)

Z= 1.96 standard error from the mean

P=0.2 pathogenic rate

D=0.05 absolute precision

\[ n = \frac{323 \times 1.96 \times 1.96 \times 0.2 (1-0.2)}{0.05 (323-1)} + 1.962 \times 0.2 \times (1-0.2) \]

=52 selected minimally processed fruit samples.
An inventory was conducted to determine the number of fruits commonly sold singly and as salad mixture, and 4 fruits namely pineapple, pawpaw, watermelon and salad were found to be the most common. Proportionate sampling was conducted to determine the number of fruit samples to be collected from each cluster from vendors who specifically sell minimally processed fruits. For each identified cluster, the sample size for fruits collected was determined.

The 52 samples were proportionately and randomly selected from the clusters. Identical fruits sold by different vendors in each cluster were then pooled and homogenized. Samples for analysis were then picked from this pooled mixture and a serving of each fruit type was weighed and analyzed in duplicate in the laboratory.

### 3.5.2 Sample size determination for fruit vendors

All fruit vendors found to be selling minimally processed fruits for consumption in the identified clusters in Nairobi Central Ward and who consented were included in the study. Nairobi central ward was purposively identified for this study because it is a good location where vendors can find a market for their goods at a higher profit as compared to other areas. It is also a central location where most people work and are therefore able to purchase these goods especially during lunch time. The bus stations, and the markets in the central ward were purposively selected as most of the fruit businesses are found in the Central Business District, along the bus terminals on the street and in markets, and were divided into seven clusters as follows: Bus stations (Otc, Acrra, Uhuru park, Mfangano, Nyamakima), City market and CBD, and Muthurwa market.
3.6 Data collection tools

3.6.1 Questionnaire

The Questionnaire (prepared using codex food hygiene and safety principles) was first pre-tested using simple random sampling in homogenous non-participating areas of Nairobi such as Ngara market and Kenyatta National Hospital.

The Pre-tested questionnaires were then used to collect information on respondents’ socio demographic characteristics; food hygiene knowledge, and practices among the fruit vendors. In order to assess food hygiene knowledge levels, a total of 8 questions were prepared using the CODEX food hygiene and safety principles and score of 1 given for each correct response and 0 for each wrong response. The highest score possible was 16 while the minimum was 0. Questions on knowledge included activities on supplies receipt (3 points), knowledge on main way of dealing with already prepared leftovers (6 points), knowledge on main precaution to take in the entire fruit processing (1 point), knowledge on medical certification (1 point), training (1 point) knowledge on frequency of medical check-up (1 point) awareness of food safety standards and regulations (1 point), and source of knowledge (2 points). The scores were then converted to 100 points. Based on the sum scores level of knowledge was classified into poor level knowledge (Less than 59% (0-8points)), fair level knowledge (60-80% (9-13points)) and good level knowledge (80-100% (14-16points)), using Bloom’s cut off point.

Food hygiene practices were also assessed using 19 standardized yes/no questions that were prepared using the codex food hygiene and safety principles with 1 point for each correct response and 0 for each wrong response. The highest possible score was 19 points which were converted to 100% Food hygiene practice scores were rated as
either poor (<59% (0-11 points)), fair (60–80% (12-15 points)) or good (≥80% (15-19 points)) using the bloom cut off points.

3.6.2 Observation checklist

An observation checklist was also utilized to collect information on nonverbal occurrences on the hygienic practices and environmental conditions, including sanitary facilities, food handling practices and personal hygiene of the fruit vendors and to check on the status of equipment and utensils used for fruit preparation. The observation checklist was administered during and after the interview without the knowledge of the vendors. A total of ten hygiene condition parameters were assessed using the observation checklist, and a score of 1 was assigned for either presence of ideal hygiene condition or ‘yes’ while a score of 0 was assigned for ‘no’ or absence of ideal hygiene condition. The total score was converted to 100%. A score of < 59% (0-5 points) was classified as poor environmental hygiene conditions 60-80% (6-8) fair while a score above 80% (>8 points) was classified as good environmental hygiene conditions.

3.6.3 Laboratory analysis

Laboratory tests were conducted on fruit samples which were first collected from the seven clusters, aseptically in sterile cooler boxes and transferred to the laboratory for analysis within 3 hours. The four different types of fruit samples underwent microbial analysis for total yeast and mold count, total count of bacteria, and total coliforms. Standard enumeration techniques were used to determine the number of microorganisms in a sample and colonies were grouped using their cultural and morphological features.
3.6.3.1 Preparation of media

The media, PCA, VRBA and PDA were first sterilized by autoclaving for 15 minutes at $121^0\text{C}$, and VRBA underwent boiling thereafter so that solidification would not take place. The prepared media was then put in a water bath at 45-50$^0\text{C}$ in readiness for working.

3.6.3.2 Preparation of homogenate

The most commonly sold minimally processed fruits were collected in four categories (watermelon, pawpaw, pineapple and fruit salad), and 25 grams of each pooled and homogenized category of fruit sample per cluster was diluted in 225ml diluent consisting of distilled water and 0.85% sodium chloride, and homogenized again for 1 minute in a vortex mixture. This preparation was done for each and all the fruit samples.

3.6.3.3 Enumeration of total count of bacteria

Starting from $10^{-1}$ homogenate, decimal serial dilutions of $10^{-2}$ to $10^{-6}$ were prepared using sterile physiological salt solution. After the serial dilutions, duplicate pouring plates were prepared by pipetting 1ml dilution into each empty sterile petri dishes followed by approximately 20ml melted and till 45$^0\text{C}$ cooled plate count agar (PCA). The samples were then incubated upside down in an incubator at 35-37$^0\text{C}$ for 48 hours. All colonies on plates containing 30-300 colonies were counted using a colony counter and expressed as number of viable microorganisms per gram of original food sample. Average counts obtained from the selected dilution were multiplied with the dilution factor to obtain the number of colony forming units per gram of fruit. (Cfu/g)
3.6.3.4 Enumeration of total coliforms count

Using separate sterile pipettes, decimal dilutions of $10^1$ to $10^6$ from the fruit samples depending on their nature were prepared. 1ml of each dilution was pipetted into sterile duplicate petri dishes followed by approximately 20ml VRBA agar. After solidification, the petri dishes were incubated upside down at $35-37^0c$ for 24 hours and observed for characteristic violet red colonies surrounded by a dense violet precipitation of bile salts. Colonies 30-300 were counted, and average counts obtained from the selected dilution were multiplied with the dilution factor to obtain the number of colony forming units per gram of fruit.

3.6.3.5 Enumeration of total yeast and mold count

Decimal dilutions of the fruit sample were also prepared and 1ml of each dilution pipetted into duplicate petri dishes. Pour plates with 15-20mls potato dextrose agar were used and tartaric acid was also used to lower pH to 3.5 for cultivation of molds and yeasts. The petri dishes were incubated at $30^0c$ for 3-5 days and observed for overgrowth of mold colonies after 3 days incubation. The number of yeast colonies per counting plate should be lower (10-100 colonies /plate) since they are usually of a larger size, while molds should not contain more than 50 colonies per plate, depending on the nature of the sample. Average counts obtained from the selected dilution were multiplied with the dilution factor to obtain the number of colony forming units per gram of fruit.

3.7 Validity and reliability of instruments

Validity is the extent to which an instrument can measure what it claims to measure. To ensure validity therefore, the questionnaire was pre-tested using simple random
sampling in non-participating fruit street vendors in Nairobi’s Ngara and Kenyatta markets to ensure clarity of interpretation, accuracy and correct any errors which might appear when constructing the instrument

3.8 Logistical and ethical considerations
The research permit was obtained from the National Commission for Science, Technology and Innovation. (NACOSTI), and the Research Ethics review committee from Kenyatta University. Fruit vendors were asked to participate in the study voluntarily by seeking verbal consent

3.9 Data analysis
Data on hygiene and microbial status of minimally processed fruits was summarized using descriptive statistics such as frequencies and percentages and presented in graphs and tabular form. Chi-square analyses were used to examine possible associations between vendor demographics and hygiene status, Kruskal Wallis test was used to assess the difference in hygiene knowledge, hygiene conditions and hygiene practices between the clusters, while correlation analyses (spearman’s rho) was used to examine the relationship between microbial contamination and Hygiene status. Food hygiene knowledge, practices, and environmental conditions were prepared using CODEX principles of food hygiene, and categorized as either poor, fair or good (for general hygiene status, that is, practice + environmental conditions) and low, moderate or high (for food knowledge) using bloom cut off points. Statistical significance was set at p < 0.05. Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 21, and analysis of the lab samples was conducted using GenStat 13th edition and excel spreadsheet.
CHAPTER FOUR: RESULTS

4.0 Introduction

This chapter presents the results of the study in narratives, Tables and Figures. The results are presented in order of the specific objectives and relationships among the variables.

4.1 Socio demographic characteristics of the vendors

Table 4.1 shows the socio-demographic characteristics of fruit vendors with results indicating that the majority of the fruit vendors were males (54.3%). The age group that was most (43.0%) predominant among the fruit vendors ranged from 21 to 30 years with a mean age of 25 years. Majority of the participants had secondary school education (51.1%), and only 2 (0.8%) did not have formal education. Majority of the fruit vendors were married (57.0%); the household size for majority of the respondents (65.0%) was between 2-5 members and 58.3% had been in the fruit vending business for more than two years.
Table 4.1: Socio-demographic characteristics of fruit vendors

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Categories</th>
<th>Frequency (N = 223)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>121</td>
<td>54.3</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>102</td>
<td>45.7</td>
</tr>
<tr>
<td>Age</td>
<td>10-20</td>
<td>12</td>
<td>5.4</td>
</tr>
<tr>
<td></td>
<td>21-30</td>
<td>96</td>
<td>43.0</td>
</tr>
<tr>
<td></td>
<td>31-40</td>
<td>71</td>
<td>31.8</td>
</tr>
<tr>
<td></td>
<td>above 40</td>
<td>44</td>
<td>19.7</td>
</tr>
<tr>
<td>Level of education</td>
<td>Primary</td>
<td>65</td>
<td>29.1</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>114</td>
<td>51.1</td>
</tr>
<tr>
<td></td>
<td>Tertiary</td>
<td>42</td>
<td>18.8</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>2</td>
<td>0.9</td>
</tr>
<tr>
<td>Marital status</td>
<td>Single</td>
<td>81</td>
<td>36.3</td>
</tr>
<tr>
<td></td>
<td>Married</td>
<td>127</td>
<td>57.0</td>
</tr>
<tr>
<td></td>
<td>Divorced</td>
<td>6</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>Widowed</td>
<td>9</td>
<td>4.0</td>
</tr>
<tr>
<td>Household size</td>
<td>0-3 children</td>
<td>145</td>
<td>65.0</td>
</tr>
<tr>
<td></td>
<td>4-6 children</td>
<td>72</td>
<td>32.3</td>
</tr>
<tr>
<td></td>
<td>7 and above</td>
<td>6</td>
<td>2.7</td>
</tr>
<tr>
<td>Time period of experience in the business</td>
<td>&lt;6 months</td>
<td>16</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>6-12 months</td>
<td>27</td>
<td>12.1</td>
</tr>
<tr>
<td></td>
<td>1-2 years</td>
<td>50</td>
<td>22.4</td>
</tr>
<tr>
<td></td>
<td>&gt; 2 years</td>
<td>130</td>
<td>58.3</td>
</tr>
</tbody>
</table>

4.2 Food hygiene knowledge and practice among vendors

4.2.1 Food hygiene knowledge of vendors

Table 4.2 illustrates food hygiene knowledge variables of fruit vendors. Majority (76.6%) of the respondents had knowledge on sorting, washing and preparing their fruits when they received them while (33.6%) made juice out of already prepared leftovers. The main precaution (86.1%) taken by the respondents during the entire fruit preparation was to maintain general standards of hygiene (standards that generally minimize microbial contamination such as washing fruits and keeping work preparation surfaces clean). Only 16.6% of the respondents had been trained on food
hygiene and only 27.4% mentioned the knowledge on medical certificates. Most (40.4%) thought that they should go for medical check-up after every 6 months and majority (58.6%) were aware of food safety standards and regulations. Majority (82.5%) of the respondents acquired food hygiene knowledge via observation.

**Table 4.2: Food hygiene knowledge of vendors**

<table>
<thead>
<tr>
<th>Hygiene knowledge</th>
<th>Categories</th>
<th>Frequency (N = 223)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities on supplies receipt</td>
<td>Sort, wash and prepare</td>
<td>171</td>
<td>76.7</td>
</tr>
<tr>
<td></td>
<td>Preserve (in fridge)</td>
<td>4</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Wipe</td>
<td>43</td>
<td>19.3</td>
</tr>
<tr>
<td></td>
<td>Don’t do anything</td>
<td>5</td>
<td>2.2</td>
</tr>
<tr>
<td>Main way of dealing with already prepared leftovers</td>
<td>Use them for the next day</td>
<td>30</td>
<td>13.5</td>
</tr>
<tr>
<td></td>
<td>Consume</td>
<td>48</td>
<td>21.5</td>
</tr>
<tr>
<td></td>
<td>Throw away</td>
<td>11</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>Refrigerate</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Give away</td>
<td>16</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>Sell at throw away price</td>
<td>3</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Take to family</td>
<td>39</td>
<td>17.5</td>
</tr>
<tr>
<td></td>
<td>Make juice out of it</td>
<td>75</td>
<td>33.6</td>
</tr>
<tr>
<td>Main precaution taken in the entire fruit processing</td>
<td>Maintain general hygiene standards</td>
<td>192</td>
<td>86.1</td>
</tr>
<tr>
<td></td>
<td>Do nothing</td>
<td>7</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>Don’t know</td>
<td>24</td>
<td>10.8</td>
</tr>
<tr>
<td>Medical certification</td>
<td>Yes</td>
<td>61</td>
<td>27.4</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>162</td>
<td>72.6</td>
</tr>
<tr>
<td>Training on hygiene and food safety</td>
<td>Trained</td>
<td>37</td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td>Not trained</td>
<td>186</td>
<td>83.4</td>
</tr>
<tr>
<td>Frequency of medical check-up</td>
<td>Every 3 months</td>
<td>33</td>
<td>14.8</td>
</tr>
<tr>
<td></td>
<td>Every 6 months</td>
<td>90</td>
<td>40.4</td>
</tr>
<tr>
<td></td>
<td>Every 12 months</td>
<td>37</td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td>Don’t know</td>
<td>63</td>
<td>28.3</td>
</tr>
<tr>
<td>Awareness of food safety standards and regulations</td>
<td>Aware</td>
<td>130</td>
<td>58.6</td>
</tr>
<tr>
<td></td>
<td>Not aware</td>
<td>92</td>
<td>41.4</td>
</tr>
<tr>
<td>Source of knowledge</td>
<td>Training</td>
<td>36</td>
<td>16.1</td>
</tr>
<tr>
<td></td>
<td>Media</td>
<td>3</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Observation of others</td>
<td>184</td>
<td>82.5</td>
</tr>
</tbody>
</table>
4.2.1.1. Food hygiene knowledge score

Figure 4.1 shows the food hygiene knowledge scores among the fruit vendors.

A higher percentage of respondents (62.8%) had poor hygiene knowledge levels, 17% had fair food hygiene knowledge levels, while 20.2% had good food hygiene knowledge levels.

![Food hygiene knowledge](image)

**Figure 4.1: Food hygiene knowledge level scores**

Table 4.3 compares the food hygiene knowledge level scores among the clusters. Majority of vendors in City market and CBD had the highest food hygiene knowledge score while vendors in OTC had the least food hygiene knowledge score. There was significant association in food hygiene knowledge scores between the clusters (Kruskal Wallis test: $\chi^2 = 63.827$, df = 6, p < .001).

**Table 4.3: Food hygiene knowledge score by clusters**

<table>
<thead>
<tr>
<th>Clusters</th>
<th>Food hygiene knowledge score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
</tr>
<tr>
<td>City market and CBD</td>
<td>85.7</td>
</tr>
<tr>
<td>Muthurwa market and stage</td>
<td>50.0</td>
</tr>
<tr>
<td>OTC</td>
<td>28.6</td>
</tr>
<tr>
<td>Accra road</td>
<td>57.1</td>
</tr>
<tr>
<td>Uhuru park</td>
<td>57.1</td>
</tr>
<tr>
<td>Nyamakima</td>
<td>57.1</td>
</tr>
<tr>
<td>Mfangano street</td>
<td>57.1</td>
</tr>
</tbody>
</table>
4.2.2. Food hygiene practice of vendors

Table 4.4 shows the food hygiene practices of fruit vendors. Results indicate that 90% of the vendors had dustbins present in their stalls but only 4% of those vendors covered them as a form of practice, and 38% of those dustbins were overfilled at the time of visit. Waste water and refuse were also not disposed of properly (waste water and dirt near the stalls) by about 40% of the stalls. Work surfaces were generally clean (wiped, no visible dirt) in 67% of the stalls visited and 82% of the vendors washed their fruits before minimal processing with 85% of them using cold water for washing. It was observed that of the fruit vendors, 52.6% did not wash their hands before or after fruit preparation; 53.9% were not using aprons or uniforms, and 73.7% wore jewellery. Approximately 40% handled money while serving fruits while 81.6% were not handling fruits with bare hands and had short and clean nails. Up to 97% of the utensils utilized were in good working condition and about 44% of the vendors had drying racks for the utensils after washing. The basin used for washing utensils was also used for fruit preparation in 29% of the stalls, and only 13% of the preparation surfaces were free from cracks and crevices. However, 90% of the prepared fruits were handled properly, stored and covered.
<table>
<thead>
<tr>
<th>Food hygiene practices</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of garbage receptacles/ dustbins</td>
<td>Yes</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>8</td>
</tr>
<tr>
<td>Dustbin covered</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>65</td>
</tr>
<tr>
<td>Waste water and refuse disposed of properly (no waste water or refuse near stalls)</td>
<td>Yes</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>30</td>
</tr>
<tr>
<td>Preparation surfaces (wiped, no visible dirt)</td>
<td>Clean</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Dirty</td>
<td>25</td>
</tr>
<tr>
<td>Vendors wash fruits before minimal processing</td>
<td>Yes</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>13</td>
</tr>
<tr>
<td>Dustbin overfilled at the time of visit</td>
<td>Yes</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>43</td>
</tr>
<tr>
<td>Wash their hands before or after fruit preparation</td>
<td>Yes</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>40</td>
</tr>
<tr>
<td>Use of aprons/uniforms</td>
<td>Yes</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>41</td>
</tr>
<tr>
<td>Handle fruits with bare hands</td>
<td>Yes</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>62</td>
</tr>
<tr>
<td>Handle money while serving fruits</td>
<td>Yes</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>45</td>
</tr>
<tr>
<td>Short nails and clean hands</td>
<td>Yes</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>14</td>
</tr>
<tr>
<td>Vendor wearing jewellery</td>
<td>Yes</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>20</td>
</tr>
<tr>
<td>Modes of cleaning utensils</td>
<td>Cold water</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>No cleaning</td>
<td>11</td>
</tr>
<tr>
<td>Utensils in good working condition</td>
<td>Yes</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>2</td>
</tr>
<tr>
<td>Basin for washing utensils also used for food preparation</td>
<td>Yes</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>54</td>
</tr>
<tr>
<td>Cleanliness of the basin and its surrounding area</td>
<td>Kept</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Not kept</td>
<td>29</td>
</tr>
<tr>
<td>Preparation surfaces free from cracks and crevices</td>
<td>Yes</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>66</td>
</tr>
<tr>
<td>Drying racks for cleaned utensils</td>
<td>Yes</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>42</td>
</tr>
<tr>
<td>Prepared fruits handled properly</td>
<td>Yes</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>7</td>
</tr>
</tbody>
</table>
4.2.2.1 Food hygiene practice score

Figure 4.2 shows Food hygiene practice scores among vendors. It was established that 1.3% had good food hygiene practice while 98.7% had poor food hygiene practice. None of the vendors had what could be described as good hygienic practices.

![Hygiene practice level](image)

Figure 4.2: Food hygiene practice score

Table 4.5 illustrates how comparisons were made among clusters on food hygiene practice scores. Vendors in OTC, Mfangano Street and Uhuru Park had the highest food hygiene practice score while vendors in Muthurwa market had the least food hygiene practice score. There was significant difference in food hygiene knowledge scores between the clusters (Kruskal Wallis test: $\chi^2 = 39.327$, df = 6, $p < .001$)

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Food hygiene practice score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
</tr>
<tr>
<td>City market</td>
<td>44.4</td>
</tr>
<tr>
<td>Muthurwa market and stage</td>
<td>27.8</td>
</tr>
<tr>
<td>OTC</td>
<td>50.0</td>
</tr>
<tr>
<td>Accra road</td>
<td>33.3</td>
</tr>
<tr>
<td>Uhuru park</td>
<td>50.0</td>
</tr>
<tr>
<td>Nyamakima</td>
<td>38.9</td>
</tr>
<tr>
<td>Mfangano street</td>
<td>50.0</td>
</tr>
</tbody>
</table>

Table 4.5: Food hygiene practice score by Clusters
4.3  Hygiene conditions of the vending environment

4.3.1  General profile of street fruit vending place

Table 4.6 summarizes the general profile of the street fruit vending place. The study established that the main means of vending was stalls, (52.6%); carts recorded 38.2% while 9.2% of the vendors utilized a wheelbarrow as their means of vending. In regard to the general status of the vending place, majority (78.9%) recorded fair condition, 14.5% were in poor condition and 6.6% of the vending place were in good condition. This means that one out of seven fruit vending place in Nairobi central ward were in poor condition.

Most (55.3%) of the vending places were made of iron sheets, while only 3.9% were made of sacs, and while most (94.7%) of the fruit vending places had building structures that were washable and working surfaces that were cleanable, the environmental surrounding was not very clean as 68% of the stalls had garbage and waste from city council near them.
Table 4.6: General profile of street fruit vending place

<table>
<thead>
<tr>
<th>General profile</th>
<th>Frequency (N = 76)</th>
<th>Percent %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means of Vending</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cart</td>
<td>29</td>
<td>38.2</td>
</tr>
<tr>
<td>Wheelbarrow</td>
<td>7</td>
<td>9.2</td>
</tr>
<tr>
<td>Stall</td>
<td>40</td>
<td>52.6</td>
</tr>
<tr>
<td>Status of vending place</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good condition</td>
<td>5</td>
<td>6.6</td>
</tr>
<tr>
<td>Average condition</td>
<td>60</td>
<td>78.9</td>
</tr>
<tr>
<td>Bad condition</td>
<td>11</td>
<td>14.5</td>
</tr>
<tr>
<td>Nature of construction material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td>31</td>
<td>40.8</td>
</tr>
<tr>
<td>Iron Sheets</td>
<td>42</td>
<td>55.3</td>
</tr>
<tr>
<td>Sacs</td>
<td>3</td>
<td>3.9</td>
</tr>
<tr>
<td>Building structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>washable and working surfaces cleanable</td>
<td>Yes</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>4</td>
</tr>
<tr>
<td>Environmental surrounding of the street-fruit vendors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garbage and waste near stalls</td>
<td>52</td>
<td>68.4</td>
</tr>
<tr>
<td>Garbage and waste far from stalls</td>
<td>24</td>
<td>31.6</td>
</tr>
</tbody>
</table>

4.3.2 Hygiene of the vending environment

Table 4.7 shows the hygiene conditions of the vending environment where, it was observed that most (75%) of the street fruit vending places had no houseflies and other pests present in stalls and 89% of the street fruit places had adequate water supply for washing fruits, also noting that water was available in 93% of the stalls. Availability of drainage system was only observed in 30% of the vending places visited.
Table 4.7: Hygiene of the vending environment

<table>
<thead>
<tr>
<th>Hygiene of the vending environment</th>
<th>Frequency (N = 76)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Houseflies and other pests present in stalls</td>
<td>Yes 19</td>
<td>25.0</td>
</tr>
<tr>
<td>No 57</td>
<td>75.0</td>
<td></td>
</tr>
<tr>
<td>Availability of water for washing fruits</td>
<td>Yes 71</td>
<td>93.4</td>
</tr>
<tr>
<td>No 5</td>
<td>6.6</td>
<td></td>
</tr>
<tr>
<td>Adequacy of water for washing fruits</td>
<td>Yes 68</td>
<td>89.5</td>
</tr>
<tr>
<td>No 8</td>
<td>10.5</td>
<td></td>
</tr>
<tr>
<td>Presence of drainage</td>
<td>Yes 23</td>
<td>30.3</td>
</tr>
<tr>
<td>No 53</td>
<td>69.7</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.3 shows the hygiene condition of the vending environment scores among fruit vendors.

Slightly more than half (57.9%) of the vending environments were in a poor state, 34.2% had fair hygiene vending environment while 7.9% were categorized as having good environmental conditions

![Hygiene condition score](image)

Figure 4.3: Hygiene condition scores

Table 4.8 shows how the hygiene condition scores were then compared among clusters sampled. Vendors in city market had the highest hygiene condition score while vendors in Accra road had the least hygiene condition score. There was
significant difference in hygiene condition scores between the clusters (Kruskal Wallis test: $\chi^2 = 16.311$, df = 6, $p = .012$)

Table 4. 8: Hygiene condition score by clusters

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Hygiene condition score</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Mean</td>
</tr>
<tr>
<td>City market</td>
<td>71.4</td>
<td>68.7</td>
</tr>
<tr>
<td>Muthurwa market and stage</td>
<td>57.1</td>
<td>54.0</td>
</tr>
<tr>
<td>OTC</td>
<td>71.4</td>
<td>66.2</td>
</tr>
<tr>
<td>Accra road</td>
<td>57.1</td>
<td>52.4</td>
</tr>
<tr>
<td>Uhuru park</td>
<td>71.4</td>
<td>65.7</td>
</tr>
<tr>
<td>Nyamakima</td>
<td>57.1</td>
<td>53.8</td>
</tr>
<tr>
<td>Mfangano street</td>
<td>57.1</td>
<td>58.2</td>
</tr>
</tbody>
</table>

4.3.3 Hygiene status of fruit vendors

Figure 4.4 shows the difference in Hygiene status of fruit vendors among the clusters. The general hygiene status of vendors was determined by combining the hygiene condition variables and hygiene practice scores. From the graph, Nyamakima market had the least hygiene status score (median = 41.25%) while Uhuru Park had the highest hygiene status score (median = 60.70%). There was significant difference in hygiene status scores between the clusters (Kruskal Wallis: $\chi^2 = 31.05$, df = 6, $p < .001$)
Figure 4.4: Hygiene status scores by Clusters

4.4 Microbial status of minimally processed fruits.

4.4.1 Total count of bacteria

Table 4.9 shows the mean differences in clusters, of samples tested for bacteria. Watermelon samples yielded the highest bacterial load levels (mean $\log_{10} 6.88 \text{ cfu/g}$) followed with fruit salad samples from Nyamakima cluster having the highest mean of $\log_{10} 5.32 \text{ cfu/g}$, and City market and CBD $\log_{10} 5.19 \text{ cfu/g}$. Other clusters that had higher bacterial loads in fruit salad samples included Uhuru Park, Muthurwa, and Mfangano. The bacterial load in all clusters were the same for all fruit samples except for watermelon samples where there was a difference in the clusters. Watermelon samples in Muthurwa cluster had highest bacterial load levels of $\log_{10} 6.8 \text{ cfu/g}$, followed by City market and Mfangano. Pineapple and Pawpaw samples were at satisfactory levels (below $10^4$) except for pawpaw samples found in Muthurwa market ($\log_{10} 4.64 \text{ cfu/g}$).
Table 4.9: Bacterial load (Mean log10 CFU/g +/- SD) of specific fruits by cluster

<table>
<thead>
<tr>
<th>Clusters</th>
<th>Fruit Salad</th>
<th>Water Melon</th>
<th>Pawpaw</th>
<th>Pineapple</th>
</tr>
</thead>
<tbody>
<tr>
<td>City market</td>
<td>5.19&lt;sub&gt;a&lt;/sub&gt; ± 0.15</td>
<td>4.52&lt;sub&gt;a&lt;/sub&gt; ± 1.26</td>
<td>0.00&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
<td>0.00&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
</tr>
<tr>
<td>Muthurwa</td>
<td>4.86&lt;sub&gt;a&lt;/sub&gt; ± 0.92</td>
<td>6.88&lt;sub&gt;b&lt;/sub&gt; ± 0.53</td>
<td>4.64&lt;sub&gt;a&lt;/sub&gt; ± 0.50</td>
<td>3.20&lt;sub&gt;a&lt;/sub&gt; ± 0.47</td>
</tr>
<tr>
<td>OTC</td>
<td>3.97&lt;sub&gt;a&lt;/sub&gt; ± 0.29</td>
<td>3.01&lt;sub&gt;a&lt;/sub&gt; ± 0.48</td>
<td>3.82&lt;sub&gt;a&lt;/sub&gt; ± 0.46</td>
<td>2.35&lt;sub&gt;a&lt;/sub&gt; ± 2.35</td>
</tr>
<tr>
<td>Uhuru park</td>
<td>4.41&lt;sub&gt;a&lt;/sub&gt; ± 0.23</td>
<td>1.76&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
<td>2.06&lt;sub&gt;a&lt;/sub&gt; ± 2.06</td>
<td>0.00&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
</tr>
<tr>
<td>Accra road</td>
<td>3.44&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
<td>1.41&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
<td>1.69&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
<td>0.00&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
</tr>
<tr>
<td>Mfangano</td>
<td>4.75&lt;sub&gt;a&lt;/sub&gt; ± 0.41</td>
<td>4.25&lt;sub&gt;a&lt;/sub&gt; ± 1.20</td>
<td>0.00&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
<td>2.60&lt;sub&gt;a&lt;/sub&gt; ± 0.01</td>
</tr>
<tr>
<td>Nyamakima</td>
<td>5.32&lt;sub&gt;a&lt;/sub&gt; ± 1.28</td>
<td>3.55&lt;sub&gt;a&lt;/sub&gt; ± 0.06</td>
<td>1.69&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
<td>1.95&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
</tr>
</tbody>
</table>

* Values with same subscript in each column are not significantly different (p>0.05).

4.4.2 Total count of coliforms

Table 4.10 shows the total coliform load. The total coliform count for fruit salad in all clusters ranged from log<sub>10</sub> 0.72 cfu/g to log<sub>10</sub> 0.83 cfu/g with an average mean of log<sub>10</sub> 0.78 cfu/g. The rest of the fruit samples are also shown. All the fruit samples analyzed showed some level of contamination by coliforms as coliforms should be ideally absent in minimally processed fruits. (0.00 cfu/g)

Table 4.10: Coliform load (Mean log10 CFU/g +/- SD) of specific fruits by cluster

<table>
<thead>
<tr>
<th>Clusters</th>
<th>Fruit salad</th>
<th>Water melon</th>
<th>Pawpaw</th>
<th>Pineapple</th>
</tr>
</thead>
<tbody>
<tr>
<td>City market</td>
<td>0.79&lt;sub&gt;ab&lt;/sub&gt; ± 0.00</td>
<td>0.77&lt;sub&gt;b&lt;/sub&gt; ± 0.01</td>
<td>0.63&lt;sub&gt;a&lt;/sub&gt; ± 0.02</td>
<td>0.57&lt;sub&gt;a&lt;/sub&gt; ± 0.05</td>
</tr>
<tr>
<td>Muthurwa</td>
<td>0.77&lt;sub&gt;ab&lt;/sub&gt; ± 0.03</td>
<td>0.77&lt;sub&gt;b&lt;/sub&gt; ± 0.09</td>
<td>0.79&lt;sub&gt;ab&lt;/sub&gt; ± 0.06</td>
<td>0.80&lt;sub&gt;a&lt;/sub&gt; ± 0.07</td>
</tr>
<tr>
<td>OTC</td>
<td>0.72&lt;sub&gt;a&lt;/sub&gt; ± 0.06</td>
<td>0.53&lt;sub&gt;a&lt;/sub&gt; ± 0.04</td>
<td>0.76&lt;sub&gt;ab&lt;/sub&gt; ± 0.05</td>
<td>0.67&lt;sub&gt;a&lt;/sub&gt; ± 0.18</td>
</tr>
<tr>
<td>Uhuru park</td>
<td>0.73&lt;sub&gt;ab&lt;/sub&gt; ± 0.03</td>
<td>0.71&lt;sub&gt;ab&lt;/sub&gt; ± 0.10</td>
<td>0.69&lt;sub&gt;ab&lt;/sub&gt; ± 0.11</td>
<td>0.61&lt;sub&gt;a&lt;/sub&gt; ± 0.02</td>
</tr>
<tr>
<td>Accra road</td>
<td>0.83&lt;sub&gt;b&lt;/sub&gt; ± 0.00</td>
<td>0.75&lt;sub&gt;b&lt;/sub&gt; ± 0.02</td>
<td>0.87&lt;sub&gt;b&lt;/sub&gt; ± 0.00</td>
<td>0.80&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
</tr>
<tr>
<td>Mfangano</td>
<td>0.83&lt;sub&gt;ab&lt;/sub&gt; ± 0.01</td>
<td>0.82&lt;sub&gt;b&lt;/sub&gt; ± 0.01</td>
<td>0.62&lt;sub&gt;a&lt;/sub&gt; ± 0.00</td>
<td>0.80&lt;sub&gt;a&lt;/sub&gt; ± 0.01</td>
</tr>
<tr>
<td>Nyamakima</td>
<td>0.82&lt;sub&gt;ab&lt;/sub&gt; ± 0.03</td>
<td>0.66&lt;sub&gt;ab&lt;/sub&gt; ± 0.02</td>
<td>0.65&lt;sub&gt;a&lt;/sub&gt; ± 0.02</td>
<td>0.76&lt;sub&gt;a&lt;/sub&gt; ± 0.10</td>
</tr>
</tbody>
</table>

*Values with same subscript in each column are not significantly different (p>0.05).
4.4.3 Total count of mould and yeast

Table 4.11 summarizes the mean total mould and yeast count and their standard deviations for each cluster, which showed Nyamakima cluster having the highest mean (log$_{10}$ 4.6 cfu/g) for fruit salad, Muthurwa Market and stage having the highest mean of 4.0 cfu/g for watermelon samples, 3.9 cfu/g for pawpaw samples and 5.7 cfu/g for Pineapple samples. Unsatisfactory levels were seen in the pineapple samples from Muthurwa (5.6 cfu/g), and Mfangano (5.2 cfu/g) clusters while fruit salad samples were found to be at acceptable levels in Nyamakima cluster (4.6cfu/g) and not the satisfactory levels (< =4.0 cfu/g)

Table 4. 11: Mould and yeast load (Mean log10 CFU/g +/-SD) of specific fruits by cluster

<table>
<thead>
<tr>
<th>Clusters</th>
<th>Fruit salad</th>
<th>Water melon</th>
<th>Pawpaw</th>
<th>Pineapple</th>
</tr>
</thead>
<tbody>
<tr>
<td>City market</td>
<td>0.00$^a$ ± 0.00</td>
<td>0.00$^a$ ± 0.01</td>
<td>0.00$^a$ ± 0.00</td>
<td>2.74$^{ab}$ ± 0.03</td>
</tr>
<tr>
<td>Muthurwa</td>
<td>1.81$^a$ ± 1.81</td>
<td>4.00$^a$ ± 0.18</td>
<td>3.93$^b$ ± 0.71</td>
<td>5.76$^b$ ± 0.68</td>
</tr>
<tr>
<td>OTC</td>
<td>3.60$^a$ ± 0.49</td>
<td>3.17$^a$ ± 0.07</td>
<td>0.00$^a$ ± 0.00</td>
<td>2.28$^{ab}$ ± 2.28</td>
</tr>
<tr>
<td>Uhuru park</td>
<td>3.17$^a$ ± 0.08</td>
<td>2.36$^a$ ± 2.36</td>
<td>1.92$^{ab}$ ± 1.92</td>
<td>0.00$^a$ ± 0.00</td>
</tr>
<tr>
<td>Accra road</td>
<td>2.70$^a$ ± 2.70</td>
<td>2.90$^a$ ± 0.21</td>
<td>1.48$^{ab}$ ± 1.48</td>
<td>4.76$^b$ ± 0.66</td>
</tr>
<tr>
<td>Mfangano</td>
<td>0.00$^a$ ± 0.00</td>
<td>0.00$^a$ ± 0.00</td>
<td>0.00$^a$ ± 0.00</td>
<td>5.20$^b$ ± 0.71</td>
</tr>
<tr>
<td>Nyamakima</td>
<td>4.61$^a$ ± 0.96</td>
<td>1.58$^a$ ± 1.58</td>
<td>0.00$^a$ ± 0.00</td>
<td>3.73$^b$ ± 0.01</td>
</tr>
</tbody>
</table>

*Values with same subscript in each column are not significantly different (p>0.05).

4.5 Statistical analysis

The study sought to establish relationships among the variables and to determine significant differences in the parameters. Descriptive statistical analyses were used for the computation of the frequencies for each category. Chi-square analyses were used to examine possible associations (P < 0.05) between vendor demographics and
hygiene status while correlation analyses (spearman’s rho) was used to examine the relationship between microbial contamination and Hygiene status. Kruskal-Wallis test was also utilized to determine the differences in Hygiene status, hygiene knowledge and practise of vendors in the various clusters.

4.5.1 Relationship between socio-demographic factors and hygiene status

Table 4.12 indicates the relationship between socio demographic factors and hygiene status of vendors. There was significant association between marital status and hygiene status (0.049) time period of experience in business and hygiene status (p-value =0.023)

Table 4.12: Relationship between socio-demographic factors and hygiene status

<table>
<thead>
<tr>
<th></th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Chi-square*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>%</td>
<td>Count</td>
<td>%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>32</td>
<td>56.1</td>
<td>12</td>
<td>63.2</td>
</tr>
<tr>
<td>Female</td>
<td>25</td>
<td>43.9</td>
<td>7</td>
<td>36.8</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-20</td>
<td>2</td>
<td>3.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>21-30</td>
<td>28</td>
<td>49.1</td>
<td>8</td>
<td>42.1</td>
</tr>
<tr>
<td>31-40</td>
<td>16</td>
<td>28.1</td>
<td>5</td>
<td>26.3</td>
</tr>
<tr>
<td>above 40</td>
<td>11</td>
<td>19.3</td>
<td>6</td>
<td>31.6</td>
</tr>
<tr>
<td>Level of education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>17</td>
<td>29.8</td>
<td>7</td>
<td>36.8</td>
</tr>
<tr>
<td>Secondary</td>
<td>26</td>
<td>45.6</td>
<td>9</td>
<td>47.4</td>
</tr>
<tr>
<td>Tertiary</td>
<td>13</td>
<td>22.8</td>
<td>3</td>
<td>15.8</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
<td>1.8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>22</td>
<td>38.6</td>
<td>3</td>
<td>15.8</td>
</tr>
<tr>
<td>Married</td>
<td>32</td>
<td>56.1</td>
<td>16</td>
<td>84.2</td>
</tr>
<tr>
<td>Widowed</td>
<td>3</td>
<td>5.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Household size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-3 children</td>
<td>40</td>
<td>70.2</td>
<td>13</td>
<td>68.4</td>
</tr>
<tr>
<td>4-6 children</td>
<td>15</td>
<td>26.3</td>
<td>6</td>
<td>31.6</td>
</tr>
<tr>
<td>7 and above</td>
<td>2</td>
<td>3.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Time period of experience in the business</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;6 months</td>
<td>2</td>
<td>3.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6-12 months</td>
<td>12</td>
<td>21.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1-2 years</td>
<td>10</td>
<td>17.5</td>
<td>6</td>
<td>31.6</td>
</tr>
<tr>
<td>&gt; 2 years</td>
<td>33</td>
<td>57.9</td>
<td>13</td>
<td>68.4</td>
</tr>
</tbody>
</table>

* Likelihood Ratio Chi-square: Since most of the cells have counts less than 5
4.5.2  Relationship between Food hygiene knowledge and hygiene Status.

Figure 4.5 shows the relationship between food hygiene knowledge and hygiene status by use of scatter plot and line of best fit. High hygiene status scores were associated with high food knowledge score as shown in the line of fit although there was no significant association between them. (Spearman Rho = 0.169, p-value = .144)

![Figure 4.5: Relationship between Hygiene Knowledge and hygiene status](image)

4.5.3  Relationship between Food hygiene Practice score and Hygiene knowledge

Figure 4.6 indicates the relationship between Food hygiene practice and Food hygiene knowledge among vendors by use of scatter plot and line of best fit. High food hygiene practice scores were associated with high food knowledge score as shown in
the line of fit although there was no significant association between food hygiene practice score and food hygiene knowledge (Spearman Rho = 0.012, p-value = .916)

![Graph showing the relationship between hygiene practice score and hygiene knowledge](image)

**Figure 4.6: Relationship between Hygiene practice and hygiene knowledge**

### 4.5.4 Relationship between microbial status and hygiene status

Table 4.13 shows the relationship between microbial contamination of fruits and hygiene status. In all the fruits, level of contamination was not significantly associated with the hygiene status score of the fruits. A negative correlation coefficient is an indication that a high hygiene score was associated with a low microbial contamination and a positive correlation coefficient is an indication of a high hygiene score was associated with high microbial contamination; however, none of these coefficients were significant.
Table 4.13: Relationship between microbial contamination and hygiene status

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Correlation* with hygiene status score</th>
<th>Bacteria</th>
<th>Coliform</th>
<th>Moulds &amp; Yeast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Correlation Coefficient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit salad</td>
<td>-0.214</td>
<td>-0.072</td>
<td>0.162</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.645</td>
<td>0.878</td>
<td>0.728</td>
</tr>
<tr>
<td>Watermelon</td>
<td>-0.286</td>
<td>-0.414</td>
<td>-0.162</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.535</td>
<td>0.355</td>
<td>0.728</td>
</tr>
<tr>
<td>Pawpaw</td>
<td>-0.291</td>
<td>-0.036</td>
<td>-0.709</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.527</td>
<td>0.939</td>
<td>0.074</td>
</tr>
<tr>
<td>Pineapple</td>
<td>-0.371</td>
<td>-0.408</td>
<td>-0.429</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.413</td>
<td>0.364</td>
<td>0.337</td>
</tr>
</tbody>
</table>

* Spearman correlation
CHAPTER FIVE: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

The main objective of the study was to assess the hygiene and status of microbial contamination, of minimally processed fruits sold as street foods in Nairobi central ward. This chapter discusses the results, makes conclusions and gives relevant recommendations.

5.1 Discussion

5.1.1 Socio demographic characteristics of the vendors

The study revealed that the number of male vendors was higher (54.3%) than that of their female counterparts. This is in agreement with a study conducted by (Muinde & Kuria 2005) in industrial area Kenya, who discovered that most of the food vendors were males as compared to females. The explanation to this finding could be due to the fact the present study dealt with specific food (fruits) which do not require a lot of preparation and not the general foods including cooked meals mostly served by women. The results were however found to differ with the findings by (Lues et al, 2006) who found, street food vending to be a common income generating venture particularly for women in developing countries. It also contradicts the findings of (Isaac et al, 2013) who found that all food vendors in educational institutions in Ghana were women.

The high demand for the minimally processed fruits has in turn attracted many new entrants into the business, most of which have been men (Haile Selassie et al., 2012). Various studies argue that rapidly growing and changing demands of food alongside
the need to diversify or have more sources of income in the face of declining incomes has contributed to the growth of street food business increasing the number of men (Madueke et al, 2014).

It was further established that most (42%) of the street food vendors were of middle age bracket. This agrees with the finding of (Musa and Akande 2003); (Isaac et al, 2013) who found a low level of involvement of under – aged food vendors in Nigeria and Ghana respectively. Study also conducted by (Franklyn et al., 2015) also established that street food vendors are majorly aged between 21-30 years.

Approximately 51% of the vendors had attained secondary level, while an insignificant 0.9% had no formal education qualification, indicating that almost all the fruit vendors in Nairobi central ward were literate. This is also in agreement with studies conducted in Tobago, West Indies by (Franklyn et al., 2015) who also found a majority of vendors having undergone secondary education. The education status may have been a means of exposure to basic proper hygienic practices. Additionally, this result shows that street food vending has attracted a substantial amount of college graduates, signifying the high levels of unemployment in the country. These results however disagree with studies conducted in Accra Ghana, which established that 94% of the vendors who were women had minimal or no education at all (Monica, 2011).

Majority (57%) of the street fruit vendors in Nairobi central ward were married and most of them also had a small household size. Research indicates that street food vending business is a key source of income to the vendors, since most have spouses and children that they support from the proceeds of the business (Franklyn et al, 2015).
Nearly 58% of the vendors had over two years’ experience in fruit vending business, while 7.2% had worked as fruit vendors in a span of less than six months, signifying that most of the fruit vendors in Nairobi Central Ward had been in the business for a while (probably because of customer-base development) since less than 10% reported an experience of less than six months. This corresponds well with the findings of (Abdalla et al., 2008; Franklyn et al., 2015), who established that majority of vendors had more than two years’ experience, and also that the food vending business in developing countries in rapidly expanding and serves as a form of employment for urban residents. Marital status and years of experience in business was found to be statistically associated with hygiene status which meant that the longer a person was in the trade the higher the chances of practicing proper hygiene standards, and most of those who vend have families, though the significance was very little. Level of education was not statistically associated with hygiene status probably because most of the vendors had attained secondary education which may have been a means of exposure to basic hygienic knowledge thus underscoring the importance of formal education prior to food vending. This does not agree with the results of (Isaac et al., 2013) who established that formal education had a significant relationship with hygiene status of food vendors.

### 5.1.2 Food hygiene knowledge of street fruit vendors

Approximately 86% of the vendors acknowledged that they were observing general hygiene standards, nearly 84% admitted that they had not received any training on hygiene and food safety, and 73% of the vendors stated that they did not have a valid medical certificate. Medical examination of food handlers, as per (FAO/WHO, 2012) is necessary if clinically or epidemiologically indicated. This finding is also in agreement with a study conducted by (Gitahi 2012) on street food vendors who also
found out that majority of respondents did not have medical certificates and had not undergone any food hygiene training. It is also in agreement with a study conducted by (Franklyn et al., 2015) who concluded that street food vendors urgently needed training and certification in food safety in order to avoid contamination when preparing and handling foods.

It was further established that almost two thirds of the respondents signified they did not know the frequency in which a food vendor should go for a medical examination and about 59% asserted they were aware of some food safety standards and regulations. This is in agreement with studies conducted in West Indies by (Franklyn et al., 2015) who asserted that food vendors were aware of basic food safety requirements even though it did not translate to food safety practices.

The study revealed that the relationship between food hygiene knowledge of fruit vendors and hygiene status was not statistically significant. This could be due to the fact that most (82.5%) of the fruit vendors acquired their source of knowledge mainly through observation which in turn could have translated to either poor or proper hygiene status, and probably because those who were inexperienced worked alongside the experienced therefore they observed what the others did hence, a street fruit vendor acquires the essential food hygiene knowledge in the course of the vending trade.

Food hygiene knowledge were also not significantly associated with food hygiene practice and this could also be attributed to the same reason of vendors mainly observing their counterparts and with time knowing what to do or how to go about the business in a hygienic manner. For example, results show that vendors in OTC had
the least food hygiene knowledge score but had high food hygiene practice scores. This is in agreement with a report by (Gizaw et al, 2014) who observed that most food handlers had superficial knowledge. It is also in agreement with studies done by (Margaret et al., 2013) who established that mean scores for food hygiene knowledge was better compared to the mean scores for food hygiene practice, meaning that knowledge in food hygiene did not necessarily translate to good food handling practices. There was significant differences on food knowledge in the clusters, and respondents who sold in the CBD and City market generally had better food hygiene knowledge than their counterparts in other areas. This could be perhaps speculated as the CBD being a central area.

5.1.3 Food hygiene practices of street fruit vendors

It was established that majority (95%) of the fruit vendors did not cover their dustbins while working, most (74%) wore jewellery while serving, nearly 90% of the preparation surfaces observed had cracks and crevices that could create a home for pests; and majority (54%) were not using aprons or uniforms. This is an indication of total disregard for food hygiene. This corresponds well with the findings of (Kariuki, 2012) who asserted that poor hygiene practices such as lack of protective attire while working, coupled with low standards of environmental and personal hygiene, improper handling of food, improper storage occur with street foods raising health concerns such as foodborne illnesses. It also agrees well with the findings of (Kisembi, 2013) who observed that street foods may undergo unhygienic or improper food preparation and/or handling practices. The studies are also in agreement with (Monica, 2011) who reported that 68% of street food handlers had not undergone any medical examination and 86% had not been trained on food safety.
However, approximately 82% of the vendors were not handling fruits with bare hands, and about 60% of the vendors did not handle money while serving fruits. This contradicts various studies (Muinde & Kuria 2005); (Monica, 2011); (Kisembi 2013); (Isaac et al, 2013); (Franklyn et al., 2015) which found out that street food vendors generally handle money while handling food without washing their hands. It was observed that the fruit vending stalls majorly had more than 2 fruit vendors, each with their own unique jobs. Nearly 82% of the fruit vendors had short nails and clean hands, a finding that agrees with (Franklyn et al, 2015) who also observed appropriate nails among the street food vendors. Most (67%) of the preparation surfaces were relatively clean via observation. Reports by various studies have indicated that working surfaces should be easy to clean as microorganisms can grow on surfaces and food particles. Cracks and crevices on poorly maintained working surfaces could also be a source of contamination and should therefore be well maintained. (Monica, 2011) Reports from literature also show that premises, equipment and work surfaces should be kept clean, regularly maintained and in good repair. Food preparation surfaces should be free from cracks and crevices as this can be a breeding ground for pests and a source of contamination (WHO/FAO, 2012)

There were significant differences in hygiene practice scores in the clusters, and it was noted that half (50%) of the respondents had fair hygienic practices, with Muthurwa market scoring the least in proper hygienic practices. This could probably be because poor personal hygiene of vendors was observed. A high food hygiene practice score was associated with a high food hygiene knowledge score, although studies have determined that knowledge does not necessarily translate to good hygienic practices (Mwangi, 2002) as was the case of City market and CBD. The
study however did not establish any significant differences between the hygienic practices of food handlers and food knowledge.

5.1.4 Hygiene conditions of the fruit preparation and vending environment

The study revealed that more than half of the street fruit vendors in Nairobi central wards utilized stalls for their fruit vending business, which were reasonably well built and washable. However, there is concern as the 5% of the vending places made of sacks can present serious food safety concern since dirt can be easily trapped by the sacks.

Even though water for washing fruits was adequate (90%) and available (93%) and there were no houseflies in majority (75%) of the stalls, the environmental surrounding was wanting as 68% of the vendors vended near garbage and waste near the stalls. This corresponds well with the findings of (Muinde & Kuria 2005); (Monica, 2011) who argued that unlimited and unregulated growth of street foods has been a severe strain on city resources such as water, sewage systems, and interference with city plans through congestion and littering. Study conducted by (Monica, 2011) showed that 72% of informal outlets had garbage heaps near their vending places. This raises concern with respect to their potential for serious food poisoning outbreaks and exposure of the sliced fruits to flies, dust and other disease causing agents. It is recommended that food should be adequately protected from airborne contaminants and pests in such a way as not to pose a threat to food safety (WHO/FAO, 2012).

The study established a statistically significant relationship between hygiene conditions of the vending environment and market cluster. Noticeably, vendors in Accra road, Muthurwa market, Mfangano Street and Nyamakima had the worst hygiene conditions and when the general Hygiene status was assessed, they were also
found to have the least hygiene status score, with the exception of Mfangano Street. This could be due to an observation that was made on the areas’ poor personal and unsanitary environmental conditions such as proximity to sewers and garbage dumps and pollution by passing vehicles as the areas also serve as bus stops for vehicles and the markets are approximately only 2metres from the main roads. Although it was also observed that vendors really try to keep their work areas clean.

Vendors selling minimally processed fruits like all food handlers, have a primary role to play in the food business and that is to guarantee that fruits served are hygienic and safe for consumption. Study by (Haile Selassie, 2011) mentions that conscious or unconscious unintended contamination of fruits places the consumer at risk of suffering from foodborne illnesses.

5.1.5 Microbial status of minimally processed fruits

From the findings, it was established that the level of bacteria was microbiologically high, with Fruit salad samples registering the highest mean of $\log_{10} 5.32$ cfu/g. Minimally processed fruits should have satisfactory levels of $\log_{10} 4.0$ cfu/g. Fruit salad samples had high bacterial load levels in Nyamakima, while watermelon, pawpaw and pineapple samples were highly contaminated in both Nyamakima and Muthurwa. However, there was no significant difference in the levels of contamination for all the fruit samples except for watermelon where significant differences were established. The WHO has set minimum standards for the recovery of microorganisms from foods of various origin. According to the Public health Services guidelines in the United Kingdom, $<10^4$ cfu/g is satisfactory, $10^4 < 10^5$ is acceptable, and $>10^5$ unsatisfactory. Some of the samples were found to be in the satisfactory grade, for instance all fruit samples in OTC tested for bacterial load were...
in the satisfactory grade. Several studies (Gitahi, 2012) on street vended foods have revealed high bacterial counts and high incidence of foodborne pathogens in foods.

In regard to total count of coliforms, it was established that all the fruit samples were contaminated since none of the samples registered 0.00 cfu/g as the lower range value expected for minimally processed fruits. Fruit salad and pawpaw samples had higher coliform loads in Acrra road (0.83 log_{10} and 0.87 log_{10} cfu/g respectively) and low coliform load in OTC in most of the samples. Watermelon samples were highly contaminated in Mfangano (0.82 log_{10} cfu/g) while Pineapple samples showed no difference in contamination in the clusters. The results are in agreement with a study carried out in a Bangkok project on street foods, where coliform bacteria were found in more than 50% of the food samples and also in Industrial area, Kenya where ready-to-eat foods were highly contaminated with coliform bacteria, with levels as high as 4.48 log_{10} cfu/g (Gitahi, 2012)

Total count of Mold and Yeast was also examined and pineapple samples in Muthurwa market (5.76 log_{10} cfu/g) were found to be more contaminated than the rest of the samples. There was no significant association between microbial contamination and hygiene status score.

This corresponds well with the findings of (Francis et al., 1999) who asserted that unhygienic practices of food vendors and unclean vending environment presented microorganisms with the potential to grow and multiply and in turn increasing chances of foodborne outbreaks associated with consumption of ready to eat foods.

The findings are also in agreement with (Abadias et al., 2008) who argued that pathogens may invade the interior surfaces of sliced fruit during washing, peeling,
trimming, handling and packaging if proper hygiene measures are not consistently observed.

5.2 Conclusions

The main socio demographic characteristic found to influence hygiene status was time period of experience in the business. This means that the more a person stayed in the business, the higher the likelihood of their improvement on hygiene status mainly because of exposure and observation.

The study showed that the food hygiene knowledge of the vendors was low, but those who had knowledge had good hygiene practices.

Hygiene condition of the vending environment was also found to be of poor standards and although fruit vendors tried to maintain proper standards of hygiene, some environmental factors such as poor structures, poor waste disposal systems, pollution by vehicles passing by and garbage dumps and litter near them could not be controlled.

Minimally processed fruits were not microbiologically safe either as levels of up to $10^5$ cfu/g were seen in the fruit samples. Various standards on food safety require that fruits be free from any contamination since they are minimally processed. Coliform counts in the fruits suggest contamination of the fruit samples by fecal material possibly from poor personal hygiene by vendors, water used for washing, the poor vending environment, or a combination of all these factors. Fruit salad samples were highly contaminated probably because of over handling, and pineapple and pawpaw samples were least contaminated. The null hypothesis was therefore accepted.
5.3 Recommendations

Vendor hygiene knowledge and practice can be increased by periodic hygiene training as an intervention. It should be promoted possibly through localized behavior change communication using IEC materials that can be understood, and education of the vendors about quality and hygienic vending of fruits by the public health ministry or other relevant government bodies.

The government should formulate a policy on ready-to-eat food vending as part of street food policy in urban areas and routine inspections should be enhanced.

The government should formulate a policy on hand washing for street fruit vendors mainly because they rarely wash their hands.

5.3.1 Recommendation for further research:

Since the study focused on minimally processed fruits sold as street foods in Nairobi Central ward, it is suggested that the study be extended to other urban areas to assess whether different findings may be reached regarding hygiene and status of microbial contamination of minimally processed fruits sold as street foods in Nairobi.
References


Abeditan, O. E, (2011) Assessing Compliance with Food Hygiene Requirements among Urban and Sub-urban classified hotels In Bauchi State, Nigeria. Kenyatta University


USAID, (2012): Street Foods in Developing Countries: The Potential For micronutrient fortification;


WHO/FAO Joint organization (2012); Codex Alimentarius Commission on Food Hygiene;

Appendices

Appendix 1: Informed Consent
My name is Mercy Ndiege. I am a Masters student from Kenyatta University. I am conducting a research on hygiene and status of microbial contamination of fruits sold as street foods in Nairobi. The main objective is to assess if minimally processed fruits sold as street foods in Nairobi are hygienic and free from contamination. The information will be used by the Ministry of Public health and Sanitation to improve health and safety in all regions of Kenya.

This informed consent is for fruit vendors, both men and women who sell cut fruits in the Community, and who we are inviting to participate in research on Hygiene. Your participation is entirely voluntary. There may be some words that you do not understand; Please ask me to stop as we go through the information and I will take time to explain. If you have any questions you can ask me. Hygiene is one of the key areas that make a healthy community. We believe you can help us by telling us what you know about hygiene of cut fruits and local hygiene practices in general.

Procedures to be followed:

Care and Protection of research participants:

Participation in this study may either require that you fill out a questionnaire which will be provided or it can be read to you and you can say out loud the answer you want me to write down. If you do not wish to answer any of the questions included in the questionnaire, you may skip and move on to the next question. The information recorded is confidential and your name will not be included in the forms. Only a number will identify you and no one else except me and my research assistants will have access to the information.
In case of any uncomfortable questions, you have the right to refuse participation in this study. Please remember that participation in the study is voluntary. You may also ask questions related to the study anytime. You may refuse to respond to any questions and you may stop the interview at any time. You may also stop being in the study at any time without any consequences.

**Discomforts and risks:**

There is a risk that you may share some personal or confidential information by chance or that you may feel uncomfortable talking about some topics. However, we do not wish for this to happen. If this happens you may refuse to answer or skip these questions if you choose. You may also stop the interview at any time. The interview may take approximately 15-30 minutes of your time.

**Benefits**

There will be no direct benefit to you but your participation is likely to help us find out more about local hygiene practices and may also assist the Ministry learn how to improve hygiene status of street foods and health and safety conditions in our Communities and the country at large.

**Confidentiality of research participants:**

The interview will be conducted with confidentiality. Any information about you will have a number instead of your name and only the researchers will have this information. Nothing you tell us today will be shared with anybody outside the research team, and nothing will be attributed to your name. Your participation in this research is also entirely voluntary. It is your choice whether you participate or not, and the choice you make will not have a bearing on your job or any work-related
evaluations or reports. You may change your mind later and stop participating even if you had agreed earlier.

**Community considerations:**

The research being done may draw attention, and if you participate you may be asked questions by other people in the community. We will not be sharing information about you to anyone out of the research team. The information collected will be private even though the study is based on health of the public or community at large.

**Contact information:**

If you have any questions you may contact my Supervisors, Dr. Nyamari on 0722589335 or Professor Imungi on 0721468181 or the Kenyatta University Ethical review committee secretariat on kuerc@ku.ac.ke

**Participant’s statement:** The above information regarding my participation in the study is clear to me. I have been given a chance to ask questions and my questions have been answered to my satisfaction. My participation in this study is entirely voluntary. I understand that my records will be kept private and that I can leave the study at any time.

Name of participant
Signature Date

**Investigators statement:** I, the undersigned, have explained to the volunteer in a language he/she understands the procedures to be followed in the study

Name of Investigator
Signature Date
Appendix 2: Observation Checklist

**Fruit vendor no**

**Name of area**

### HYGIENIC CONDITION OF THE VENDING ENVIRONMENT

1. **Place of vending:**
   - a) cart______
   - b) wheelbarrow ____
   - c) stall_______
   - d) other (specify)

2. **Nature of construction material:**
   - a) polythene bag___
   - b) wood___
   - c) iron sheets___
   - d) other (specify)

3. **Status of vending place:**
   - a) good condition ______
   - b) average condition ______
   - c) bad condition

4. **Building structure washable and working surfaces cleanable:**
   - a) yes____
   - b) no____

5. **Environmental surrounding of the street-fruit vendors:**
   - a) garbage and waste near stalls ___
   - b) garbage and waste far from stalls/place of vending

6. **Presence of garbage receptacles/dustbins:**
   - a) yes_____
   - b) no____

7. **Dustbin covered:**
   - a) yes____
   - b) no ____

8. **Waste water and refuse disposed of properly (far away from the stalls):**
   - a) yes____
   - b) no____

9. **Houseflies and other pests present in stalls:**
   - a) yes______
   - b) no __________

10. **Preparation surfaces (properly wiped and no visible dirt):**
    - a) clean ______
    - b) dirty____

11. **Vendors wash fruits before minimal processing:**
    - a) yes_______
    - b) no____

12. **Availability of water for washing fruits:**
    - a) yes_______
    - b) no____

13. **Adequacy of water for washing fruits prior to preparation:**
    - a) yes______
    - b) no____

14. **Source of water:**
    - a) borehole___
    - b) rain____
    - c) river____
    - d) tap____

15. **Presence of drainage:**
    - a) yes__
    - b) no___

16. **Dustbin overfilled at the time of visit:**
    - a) yes__
    - b) no____

### PERSONAL HYGIENE OF VENDORS

1. **Wash their hands after fruit preparation:**
   - a) yes_____ b) no _____

2. **Use of aprons/ uniforms:**
   - a) yes_____ b) no____

3. **Handle fruits with bare hands:**
   - a) yes____ b) no____

4. **Handle money while serving the fruits:**
   - a) yes___ b) no____

5. **Short nails and clean hands:**
   - a) yes____ b) no____

6. **Vendor wearing jewellery:**
   - a) yes___ b) no____
7. Any visible boil cut or wound observed at time of visit: a) yes____ b) no____

PREPARATION AND SERVING UTENSILS:

1. Type of serving utensils: a) enamel___ b) plastic____ c) disposable polythene bags___ d) metal___

2. Modes of cleaning utensils: a) cold water____ b) cold soapy water____ c) hot water____ d) no cleaning

3. Utensils in good working condition: a) yes_____ b) no____

4. Basin for washing utensils also used for food preparation: a) yes____ b) no____

5. Cleanliness of the basin and its surrounding area: a) kept____ b) not kept____

6. Preparation surfaces free from cracks and crevices: a) yes_____ b) no____

7. Drying racks for cleaned utensils: a) yes___ b) no____

8. Prepared fruits handled properly or kept in sealed conditions to prevent insects and unhygienic environment: a) yes____ b) no____
Appendix 3: Questionnaire

SOCIO DEMOGRAPHICS:

1. Gender: a) male_____ b) female____

2. Age: a) 10-20_______ b) 20-30_______ c) 30-40_______ d) above 40_____

3. Level of education: a) primary____ b) secondary____ c) tertiary____ d) none____

4. Marital status: a) single_____ b) married____ c) divorced ____ d) widowed____

5. Household size: a) 0-3 children b) 4-6 c) 7 and above

6. Time period of experience in the business: a) >6months____ b) 6-12months___ c) 1-2years____ d) more than 2years_____

FOOD HYGIENE KNOWLEDGE:

7. What do you do when you receive your supplies: a) sort and prepare___ b) preserve____ c) wipe___ d) don’t do anything____ e) other(specify)____

8. How do you preserve leftovers from the previous day: use them for the next day___ a) consume___ b) throw away___ c) fridge d) other(specify)___

9. What precautions are needed in the entire fruit processing: a) maintain general hygiene standards___ b) do nothing____ c) don’t know____

10. Have you received any training on hygiene and food safety: a) yes b) no (if no skip to question 16)

11. If yes to question 14, where and when were you trained a) college institution b) university c) other specify

12. Has the training helped you to improve on food safety practices a) yes b) no

13. How often should you go for a medical checkup: a) every 3 months b) every 6 months c) every 12 months d) don’t know

14. Are you aware of any food safety standards and regulations: a) yes b) no
FOOD HYGIENE PRACTICES:

15. In what quantities do you buy your fruits: a) bulk____ b) kilograms____ c) numbers____ d) other (specify)

16. How often do you buy your supplies: a) daily___ b) weekly____ c) two weeks___ d) more than two weeks___

17. How do you store fruits at the point of sale: a) store in ambient temperature____ b) store in cold temperature___ c) nothing done____

18. Do you have a medical certificate a) yes b) no

19. How often do you wash your hands when handling fruits a) before cutting the fruits b) after cutting the fruits c) all the time d) other specify

20. If yes to question 20 which ones: specify

21. At what temperature should you store your fruits a) below 4 °C, b) 37°C c) 65 °C d) don’t know

22. How often are you visited by a Public health officer a) once per year b) every month c) never d) other specify
Appendix 4: KU Ethics Review Committee Approval

KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Email: chairman.kuerc@kun.ac.ke
secretary.kuerc@kun.ac.ke
ercu2008@gmail.com
Website: www.ku.ac.ke

P. O. Box 43844 - 00100 Nairobi
Tel: 8710901/12
Fax: 8711242/8711575

Our Ref: KU/R/COMM/51/566
Date: 6th October, 2014

Ndiege Mercy Adhiambo
Kenya University,
P.O Box 43844, Nairobi

RE APPLICATION NUMBER FKU/231/1 207- "HYGIENE AND STATUS OF MICROBIAL CONTAMINATION OF MINIMALLY PROCESSED FRUITS SOLD AS STREET FOODS IN NAIROBI CENTRAL WARD" - VERSION 2

1. IDENTIFICATION OF PROTOCOL
The application before the committee is with a research topic "Hygiene and status of microbial contamination of minimally processed fruits sold as street foods in Nairobi Central Ward" - Version 2 received on 6th October, 2014.

2. APPLICANT
Ndiege Mercy Adhiambo

3. STUDY SITE
Nairobi Central Ward, Kenya.

4. DECISION
The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines AND APPROVED that the research may proceed for a period of ONE year from 6th October, 2014.

5. ADVICE/CONDITIONS
i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.
ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur.
iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.
iv. Submit an electronic copy of the protocol to KUERC.

When replying, kindly quote the application number above.
If you accept the decision reached and advice and conditions given, please sign in the space provided below and return to KU-ERC a copy of the letter.

PROF. NICHOLAS K. GIKONYO
CHAIRMAN ETHICS REVIEW COMMITTEE

1........Ndiege...Mercy........accept the advice given and will fulfill the conditions therein.

Signature ____________________________ Dated this day of ___________ 2014.
cc. Vice-Chancellor
Director: Institute for Research Science and Technology
Appendix 5: NACOSTI Research Authorization

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349, 810571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

Ref: No.

NACOSTI/P/14/1408/2096

Mercy Adhiambo Ndige
Kenyatta University
P.O. Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on “Hygiene and status of microbial contamination of minimally processed fruits sold as street foods in Nairobi Central Ward” I am pleased to inform you that you have been authorized to undertake research in Nairobi County for a period ending 31st December, 2014.

You are advised to report to the County Commissioner and the County Director of Education, Nairobi County before embarking on the research project.

On completion of the research, you are expected to submit two hard copies and one soft copy in pdf of the research report/thesis to our office.

DR. S K LANGAT, OGW
FOR: SECRETARY/CEO

Copy to:

The County Commissioner
The County Director of Education
Nairobi County.
Appendix 6: NASCOSTI Research Clearance Permit

THIS IS TO CERTIFY THAT MISS MERCY ADHiambo Kodege of KENYA UNIVERSITY, 7053-400
NAIROBI has been permitted to conduct research in Nairobi Central.

On the topic: HYGIENE AND STATUS OF MICROBIAL CONTAMINATION OF MINIMALLY PROCESSED FRUITS SODA STREETS IN NAIROBI CENTRAL.

1. December, 2014

1. You must report to the County Commissioner and the County Education Officer of the area before starting your research. Failure to do that may lead to the cancellation of your permit.
2. Govt. Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant government ministries.
5. You are required to submit at least two (2) hard copies and one (1) soft copy of your final report.

The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice.

RESEARCH CLEARANCE PERMIT

CONNECTIONS: see back page.

Republic of Kenya

National Commission for Science, Technology and Innovation (NASCOSTI)