SAFETY AND QUALITY OF FRESH FRUIT JUICES SOLD BY STREET VENDORS IN NYERI COUNTY

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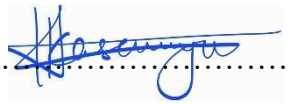
Signature:  Date: …20th November, 2023…….

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ABBREVIATIONS AND ACRONYMS

FAO - Food and Agriculture Organization

FDA - Food and Drug Administration

GHPs - Good Hygienic Practices

GMPs - Good Manufacturing Practices

HUS- Hemolytic-uremic syndrome

ISO - International Organization for Standardization

KENAS- Kenya National Accreditation Service

KEPHIS- Kenya Plant Health Inspectorate Service

KNBS- Kenya National Bureau of Statistics

LSD- Least Significant Difference

MRLs - Maximum residue limits

PRPs- Prerequisite Programs

WHO - World Health Organization

OPERATIONAL DEFINITION OF TERMS

Food borne hazard	A biological, chemical, or physical substance that might have the ability to have a negative impact on health
Fruit juice	Liquid made from the edible portion of healthy, fully ripe, and fresh fruit
Maximum residue limit	The maximum amount of pesticide residues (given as mg/kg) that the Codex Alimentarius advises are legally permissible in food products and animal feeds
Morphology	Study of the proportions and relationships between the pieces that make up animals, plants, and microbes. The phrase describes the basic biological features of a plant or animal's component arrangement and structure.
Pasteurised fruit juices	Juices that have been subjected to high temperatures for a short time to kill any bacteria or other microorganisms that may be present
Pesticide	Any substance that can be administered to animals to control ecto-parasites or that is intended to prevent, destroy, attract, repel, or control any pest, including unwanted species of plants or animals, during the production, storage, distribution, and processing of food, agricultural commodities, or animal feeds.
Pesticide residues	Any specific chemicals originating from the usage of a pesticide in food, agricultural products, or animal feed
Street food	Foods that are ready to eat cooked and/or sold by hawkers or vendors, especially in public areas like streets
Unpasteurized fruit juice	Juices that have been freshly squeezed and have not been heated

ABSTRACT

Street vending of foods is on the rise because consumers are increasingly looking for cheap and convenient alternatives to mainstream foods. As such, fruit juices have become one of the major street foods vended as they have proportional amounts of vitamins, minerals, and phytochemicals essential for human health. Even if this may be the case, the safety of the juices sold on the street cannot be guaranteed since this area is still uncontrolled and many of the sellers give little to no thought to the security and quality of the products they sell. Therefore, the objective of this study was to evaluate the street vendors' knowledge of food safety and hygiene standards, as well as the microbiological and chemical safety and the quality of the juices they offered to consumers. The study was carried out in Nyeri County using a cross-sectional design with both descriptive and analytical components. Exhaustive sampling was done for both the street vendors of fresh fruit juice and the fruit juice samples. Data was collected through face-to-face interviews as well as by observations of general hygiene and cleanliness. Twenty samples of fruit juice were collected for laboratory analyses using simple random sampling. Survey data was analyzed using the Statistical Package for Social Sciences (SPSS) software version 20. Descriptive statistics such as means and frequencies were used to present the findings. Correlation and regression analysis were also used to determine the relationship between various parameters. Analyses of variance were performed using the Genstat statistical software version 15 to determine the differences amongst the microbial organisms isolated and vitamin C levels analyzed on different juices collected from various sites. Differences were significant at $p \leq 0.05$ and were compared using the Fisher's protected LSD test.

According to the findings, most of the vendors (75%) were women and mostly belonged to the 31–40 age group. More than half (55%) of them had attained secondary education, which was a normal level of education dispersed throughout the factors. Only 7.5% of the respondents

were widowed, compared to 70% of the respondents who were married. Most respondents (95%) had not had a food handlers' medical check-up during the previous six months, and the majority of respondents (87.5%) had not received any training on food safety and hygiene procedures. All respondents concurred that they cleansed their hands with soap and water before handling fruits and fruit juices. Half (52%) of the respondents also agreed that having the fruit juices unrefrigerated for the whole day was unsafe, however, 45% of the respondents thought it would be safe at the end of the day. The participants in the survey handled garbage by emptying and cleaning their trash cans at the end of each workday. Every respondent agreed that vendors should only purchase fruits from reliable sources and that the water used to wash fruits should be clean because the water used to make fruit juice can be a contaminating factor. Majority of the respondents (87.5%) ensured their environment is free from sources of contamination, such as flies, stagnant water, and while 72.5% agreed that surfaces from which the fruit juices were made were free of personal effects such as bags and phones. All of the respondents also made sure that the processing area had enough lighting so that any physical dangers that might get into the fruit juices can be seen. The vendors' understanding of hygienic procedures was above average; a bigger proportion (73.6%) had strong hygiene knowledge, 23.8% had acceptable knowledge, and only 2.6% had poor food hygiene knowledge. An analysis of correlations revealed that training in food safety and hygiene measures was substantially connected with medical examination (r- 0.675, $p < .01$). More than half (60%) of the fruit juice samples tested contained *Staphylococcus aureus* from mango, passion, pineapple and tree tomato, *E. coli* was detected in 20% of the fruit juice samples from mango, pineapple, pawpaw and watermelon from Karatina and *Salmonella* was only detected in 5% of the samples from pineapple fruit juice collected from Gatitu trading center. According to the KEBS standards for fruit juices and nectars, KS EAS 948:2019, *E. coli* should not be detected in fruits juices meant for direct human consumption. Although not explicitly highlighted in the KEBS

standard for fruit juices, detection of *Salmonella* and/or *S. aureus* in food is potentially hazardous and a cause for alarm. No pesticide residue levels were detected in all the samples. According to the study's findings, the majority of fruit juice street vendors are more knowledgeable about food safety. The study also indicates that the respondents can perform the necessary food safety practice but due to their negligence this causes microbiological contamination of fruit juices which is a public health concern. Therefore, County Public Health officials should pay close attention with a focus on improvement of practices, regulatory compliances and vendor training that are essential to ensure food safety of fruit juice vended in the streets.

CHAPTER ONE: INTRODUCTION

1.1 Background

According to FAO/WHO Codex Alimentarius Commission, “street-vended foods or street foods are ready to eat prepared and/or sold by vendors and hawkers especially in streets or other public places” (WHO, 2010). In ancient Greece, tiny fried fish were first sold on the streets, and this is where the history of street food began. It was also extensively consumed by ancient Rome's poor urban inhabitants who lacked access to kitchens. In ancient China, the privileged inhabitants would direct their servants to purchase food from the streets for them to consume (Kumar, 2015). Street food vending has since become globalized and can be found in most, if not all, countries in the world; although varying greatly between regions and cultures (Wanjek, 2005). In Kenya, the most common street foods include but are not limited to boiled eggs, cakes, *maandazis,* kebabs, French fries, African sausage (*mutura),* roasted maize, boiled maize, sausages, fruit salads and unpasteurized fruit juices, which will be the focus of this study.

Fruit juice is a liquid made from the edible component of a healthy, well matured, and fresh fruit. They are simply prepared by mechanically squeezing the fruit, blending using a fruit processor or extracted using water (Khan, Islam, Chowdhury, 2015). Fruit juices are famed for their nutritive value, vitamin and mineral content, as well as other naturally occurring phytochemicals that enhance general health and wellbeing (Ukwe *et al.,* 2011). Due to their ready consumption and affordable price, fruit juices are a popular beverage among the general public in many tropical developing countries around the world (Tambekar *et al.,* 2009). Due to their potential nutritional and health benefits as well as their accessibility, these juices are in high demand (Asha & Nithisha, 2014; Moussavi *et al.,* 2016).

As much as freshly squeezed juices are rich in essential vitamins and other phytochemicals, they may not always be safe because some may be contaminated with heavy loads of microbes

(Mihiretie & Desta, 2015) resulting from their handling and preparation, processing equipment and utensils, environmental exposure and the storage practices employed by the different street vendors (Kumari, 2008). Customers may experience drink deterioration or digestive problems as a result of microbial contamination in major juice elements such water, sugar, and natural fruit pulp (Andres, 2004).

Marras (2014) says that "despite knowledge of the risk factors, the actual harm of street food to consumers' health has yet to be fully established because of difficulties in tracking cases and the lack of disease-reporting systems; making follow-up studies to establish actual links between street food consumption and food-borne diseases nearly impossible."

1.2 Statement of the problem

Due to the unregulated and informal nature of the street vending business, there are not a lot of quality control measures in place and the most fundamental ones that deal with hygiene are often overlooked or out rightly ignored by the street vendors. The safety of their products is usually the last thing on their minds as most of them are focused on making a living. For the most part, consumers propagate the narrative that fresh juices are the healthier and safer options regardless of the hygienic conditions of where they are purchasing their drinks. A lot of factors can compromise the safety of the juices they consume.

According to WHO's first ever estimate report of 2015, "the burden of foodborne diseases caused by 31 agents—bacteria, viruses, parasites, toxins and chemicals—states that each year as many as 600 million, or almost 1 in 10 people in the world, fall ill after consuming contaminated food. Of these, 420 000 people die, including 125 000 children under the age of five years." Raw ingredients (fruits, water, sugar), processing equipment and utensils, personal cleanliness of food handlers, processing environment, and the occurrence of unsanitary conditions all add to the introduction of bacterial pathogens into fruit drinks made using these fruits (Andres, 2004).

Non-potable water can also be a source of microbiological contaminants such as total coliforms, fecal coliforms, and fecal streptococci when it is used to wash fruits and prepare them afterwards (Tasmin, 2010). The fruits sourced by vendors can also come with pesticide residues from the farms which may find their way into the final product that is the unpasteurized fruit juice. Another point worth noting is that when vendors have no or little schooling, their knowledge and awareness about bio-medical guidelines for handling food safety may be limited (Marras, 2014). While numerous East African Standards contain hygienic criteria for food outlets, information on food contact surfaces, food surface contamination, and food handlers' hands is sparse (Kaddumukasa *et.al*, 2019).

1.3 Justification of the study

An increase in rural-urban migration over the past few decades has culminated into more street-vending businesses opening all over the world as people strive to make a living. Be as it may, products being sold through this avenue need to be analyzed for their safety so that consumers can be assured that the food they are paying for will not eventually cause them adverse health effects. Food safety and nutritional quality are frequently disputed topics (World Bank and IMF, 2012). According to the Center for Disease Control and Prevention (2009), outbreaks of 12.3% of all foodborne illnesses occurred between 1990 and 2007. Information on the occurrence of food-borne diseases connected to the foods sold on the street is occasionally lacking in nations where street food vending is common. On the other hand, microbial analyses of comparable meals in the United States, Asia, and Africa have shown an increase in bacterial illnesses in the food. Raw vegetables and unpasteurized fruit and vegetable juice consumption have both been connected to human disease outbreaks (Mihiretie & Desta, 2015).

The study is necessary because it will ascertain the quality, microbial safety, and chemical safety of fruit juices being sold in Nyeri county; ultimately providing empirical data that can be useful in the formulation of functional implementation systems to address the gaps

identified. The data from this study will be beneficial to the national government when it comes to formulating and passing legislations and statutes around street vending that will result in decreased number of foodborne illnesses, to the county governments when it comes to the enforcement and implementation of the policies, to the street vendors as they will learn about technological advancements that help their products have a longer shelf-life and what measures they need to put in place to operate their businesses within the confines of the law and to the consumers as they will be assured that the fruit juices they are consuming are of consistently good quality, safety and nutritional value.

1.4 Aim of the study

The aim of this study is to contribute towards the improvement of the safety and quality of street-vended fruit juices in Nyeri County.

1.5 Purpose of the study

The purpose of this study is to generate data that can be used by the Ministry of Health in the formulation of appropriate and relevant legislation and help with putting in place adequate surveillance and disease reporting systems that will help capture food borne diseases associated with the purchase of street-vended fruit juices.

1.6 Objectives of the study

1.6.1 General objective

To establish the determinants of the safety and quality of street-vended fruit juices sold in Nyeri.

1.6.2 Specific objectives

i) To establish street vendors' socio-demographic characteristics and fruit juice processing knowledge and practices in relation to hygiene and food safety in Nyeri County

ii) To determine levels of contamination with *E. coli, Salmonella* and *S. aureus* in the fruit juices marketed in Nyeri by street vendors.

iii) To establish the levels of pesticide residues and Vitamin C content in the vended fruit juices

1.7 Research hypotheses

i) The vendors socio-demographic characteristics, fruit juice processing knowledge and practices in relation to hygiene and food safety are positively associated with the quality and safety of street vended fruit juices.

ii) There is a strong correlation between microbial contamination of fruit juices and their safety for human consumption.

iii) Pesticide residues and Vitamin C content shows a positive association with the safety and quality of street vended fruit juices.

1.8 Limitations of the study

Self-evaluation of food safety practices due to self-reported bias.

Restricted interaction with the fruit juice street vendors due to the Covid-19 pandemic

1.9 Risks and potential adverse effects of the study

The outcomes and conclusions of this research could result in the closure of non-compliant enterprises and the loss of jobs.

CHAPTER TWO: LITERATURE REVIEW

2.1 History and general overview of juicing

The manufacture of fruit juices is as old as agriculture (Bates *et al*., 2001). According to the Dead Sea Scrolls, pomegranate and fig mash was used for "deep force and subtle form" before 150 B.C. This may be the earliest instance of man attempting to extract the vital juices from fruits and vegetables for therapeutic purposes (Crocker, 2013). Orange juice pasteurization began in 1910 as a result of an excess of oranges grown by Californian growers. At this time, refrigerators had not yet been invented so handling, storage and transportation of fresh juice was hardly an option. Pasteurization was employed to kill microorganisms present in the juice thus making them a lot easier to handle and also giving them a relatively longer shelf life. In the 1920s, Dr. Max Gerson developed his own fruit and vegetable diet that he used to treat a wide range of diseases. He even went as far as saying that this diet has cancer curing properties, claims which are yet to be substantiated as of now. By the 1930s, one Dr. Norman Walker had invented a juicer. The machine would grate, and squeeze fruits and vegetables and resultant pulp would be pressed using a hydraulic press in a linen bag. This invention was further improved on in the 1950s when the first masticating or grinding machine called Champion was rolled out into the market. This decade also saw the introduction of centrifugal juicers, commercial juicers and blenders (Wellpared, 2017).

As time has gone by, juices have become more and more popular because of the fame surrounding its nutritional and health benefits. More and more businesses have dedicated their enterprises solely to the sale of juices because this industry has become an economic powerhouse. For a lot of countries, fruits are readily available and in surplus; leading to the cropping up of street vendors who help in the utilization of the fruit and also make a living off of the trade. However, due to the uncontrolled nature of the street food industry, more research

is being done on the safety and quality of the food and juices that are consumed due to concerns about their safety.

2.2 Fruit morphology and composition

Fruit morphology is the study of the dimensions, shapes, and structures of fruits as well as the interactions between each of their individual elements (Bates *et al*., 2001).

2.2.1 Nutritional value of fruits

Nutrients are the substances from food assuring a normal deployment of the biological processes from the human body and participate in the metabolic processes (Birthare, 2018). Table 2.1 below shows the nutritional content of some commonly juiced fruits.

Table 2. 1**:** Nutritional content of some commonly juiced fruits

Fruit species	**Fiber (mg/g)**	**Vit A (IU/g)**	**Vit C (µg/g)**	**Vit E (µg/g)**	**Vit B1 (µg/g)**	**Vit B2 (µg/g)**	**Calcium (µg/g)**	**Iron (µg/g)**	**Potassium (mg/g)**
Apple	24-27	0.53	46-58	1.81	0.14	0.14	72	1.45	1.15
Avocado	50-62	6.21	71-173	20-27	1.07	1.07	107	10.71	6.43
Banana	24-26	0.81	87-93	1.02	0.42	1.02	59	3.39	3.69
Lemon	28	0.29	529-534	1.55	0.34	0.17	259	5.17	1.38
Mango	18	38.94	278	11.21	0.61	0.55	103	1.21	1.56
Orange	24	2.05	533	1.83	0.84	0.38	397	0.76	1.81
Papaya	18	2.84	620	7.30	0.29	0.29	243	0.71	2.57
Pineapple	13	0.23	155-362	20.19	0.90	0.39	71	3.87	1.13
Watermelon	4-5	3.66	81-99	0.49	0.79	0.20	79	1.97	1.16

Source: (Dorais and Ehret, 2008)

Low fruit and vegetable consumption, according to FAO (2003), is a key contributor to micronutrient deficiencies, which have resulted in some of the most common and debilitating nutritional problems. These include birth abnormalities, impaired immune systems, mental and physical retardation, and even mortality. As a result, there has been a rise in global campaigns and targeted advertising aimed at raising consumer knowledge on the importance of vitamins and minerals in their diet, the majority of which may be derived from the consumption of fruits and vegetables.

Some of the health benefits of the fruits listed in table 1 are:

Citrus: Oranges, lemons, and limes are a few examples of fruits in this group. They have flavonoids, which are antioxidants that assist in scavenging free radicals, preventing heart disease, and enhancing blood circulation in the arteries. Vitamin C, which shields the body from free radicals, speeds up wound healing, and holds blood vessels, tendons, ligaments, and bone together, as well as folate and thiamine, three other essential nutrients for cell division and metabolism, are abundant in citrus fruits (Assaduzzaman & Asao, 2018).

Mango: Mangoes are abundant in fiber, which can help prevent constipation while also improving metabolism by improving vitamin absorption. Mangos are a good source of vitamin A, which protects DNA structure and supports eye health, as well as magnesium, an electrolyte that helps control blood pressure. Additionally, mangoes lessen the harm brought on by damaging radiation as well as cognitive loss associated with aging. Mangiferin, a mango component that promotes immune system function, helps to prevent several malignancies. Mangoes are beneficial to brain tissue healing because they lessen the effects of anxiety, depression, and insomnia. (Assaduzzaman &Asao, 2018).

Papaya: It is incredibly low in calories and cholesterol-free. It has a lot of phytonutrients, minerals, and vitamins in it. Papaya is high in Vitamin A, which is necessary for keeping

healthy mucosa and good vision. It also has a lot of B-complex vitamins (folate, B6, riboflavin, and thiamine), which are important for metabolism. (Rudrappa, 2017).

Pineapples are high in calcium, potassium, carbohydrates, crude fiber, and vitamin C (ascorbic acid, an antioxidant that helps iron absorption in the body). It contains copper, which helps control blood pressure and heart rate. Malic acid, which helps maintain tooth health and boosts immunity, and vitamin C, which helps pregnant women avoid urinary tract infections, are both found in pineapple. In addition to being anti-inflammatory, pineapples aid in digestion. They contain a lot of manganese, which is a mineral required for the body's development of bone and connective tissue. Pineapple juice supports the recovery of the immune system and the growth of strong bones (Hossain, Akhtar & Anwar, 2015).

Bananas are a good source of potassium, which helps muscles perform properly and reduces muscle spasms. Bananas also contain Vitamin A, which supports healthy bones, teeth, and eyes; Vitamin C, which facilitates wound healing; Vitamin D, which facilitates calcium absorption; and Vitamin B6, which supports heart and brain function. (Kumar, Bhowmik, Duraivel &Umadevi, 2012).

Avocados are creamy and high in calories, with a high level of monounsaturated fats (oleic acid) and omega-6 polyunsaturated fats (linoleic acid). They are also high in dietary fiber (both soluble and insoluble fiber) and calories. They are high in tannins, which are anti-inflammatory, antioxidant, and anti-ulcer. Vitamins (A, E, K, folate, thiamine, niacin), minerals (iron, copper, magnesium, manganese), and potassium (which helps regulate heart rate and blood pressure) are also found in it. (Amao, 2018).

Apples have a high content of vitamins and minerals. These fruits can help you lose weight, improve your brain health, give antioxidants, lower your risk of metabolic syndrome, and even prevent some cancers. (Assaduzzaman *et.al*, 2018).

Watermelon: Watermelon is high in electrolytes and contains a lot of water. Vitamin A and lycopene, both potent antioxidants, are found in its nutritional composition. Vitamin B6, thiamine, manganese, and vitamin C all contribute to the scavenging of damaging oxygen-free radicals. (Rudrappa, 2017).

2.2.2 Degradation of Vitamin C

Vitamin C is a water-soluble molecule present in varying amounts in fruits, vegetables, and meat, according to Devaki and Raveendran (2017), and is a necessary ingredient for many metabolic functions in human bodies. Scurvy is a broad connective tissue weakening and capillary fragility caused by a Vitamin C deficiency. Vitamin C is necessary for the synthesis of protein that forms the skin, tendons, ligaments, and blood vessels, as well as for the maintenance and repair of cartilage, bones, teeth, and other connective tissues. It also helps the body absorb iron. According to Sapei and Hwa (2013), fruit juices' ascorbic acid is quickly oxidized and lost during storage. Light exposure, pH, soluble oxygen level, metal ions present, sugar present, processing conditions, and storage temperature are all elements that influence the oxidation process. L-ascorbic acid breakdown is accelerated by pH changes between 1.5 and 7.0. The most important element affecting L-ascorbic acid's stability is the storage temperature, which directly affects how quickly it degrades. Temperature also has an impact on the negative effects of factors like oxygen and pH. As a result, keeping fruit juices at low temperatures is essential to retarding the degradation of L-ascorbic acid (Roig *et al*, 2009).

2.3 Food safety knowledge and hygienic practices of street vendors

In the food industry, it is the responsibility of food handlers to make sure that the food being provided is safe to consume. Intentional or accidental contamination of such food places puts customers at risk of developing foodborne illnesses (Annor and Baiden, 2011). Over the past ten years, several studies conducted in Ghana have emphasized the lack of hygiene knowledge and practices among street vendors, with personal cleanliness being the least observed among

those with lower levels of education (Acheampong, 2005; King *et al*, 1998; Nuer, 2001). Muinde and Kuria (2005) conducted research in Nairobi and discovered that street food vendors had received no professional food preparation training and had made no attempt to obtain it. They also noticed that the vendors had poor personal cleanliness, which is crucial because human beings are the most common source of food contamination, according to Marriot (2006). Figure 2.1 below shows the street food production chain.

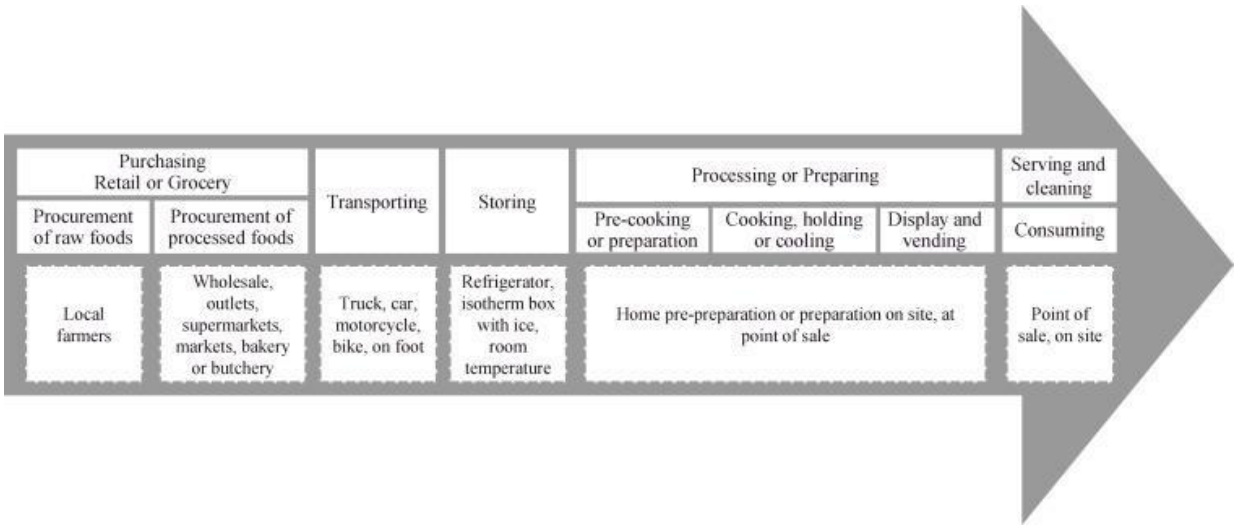

Figure 2. 1**:** The chain of street food production (Cortese *et al*., 2016)

Many nations lack comprehensive laws governing the safety of street food. Given the massive number of street food vendors and the fact that some sellers are difficult, if not impossible, to monitor because of their movement, implementation of such limitations is a major problem (FAO, 2002). Many of the hygiene practices that street vendors are supposed to adhere to are from some of the prerequisite programs (PRPs), GMPs and GHPs that are fundamental in the setting up and implementation of food safety management systems. Some of these include but are not limited to personnel hygiene and wearing of personal protective equipment (PPEs), waste disposal, pest control, prevention of cross-contamination, care of preparation equipment or utensils and storage of prepared foods.

2.3.1 Pest Control

Pests like mice, cockroaches, flying insects, and others pose a serious risk to the sanitation and safety of food because they can harbor a wide range of pathogenic bacteria that can cause outbreaks of foodborne illnesses (Fredericks and Mannes, 2016). According to Tambekar *et al.* (2009), an unhygienic environment attracts house flies and fruit flies which can act as sources of contamination. To avoid the spread of pests in food facilities, proper sanitation and hygiene practices should be used. This can be accomplished by maintaining a clean and well-maintained food preparation and vending area (FAO, 2009). Care should however, be taken to not use poisonous chemicals within the food preparation and vending sites so as to prevent unintentional transfer of the chemicals to the food. Non-toxic solutions like baits and/or insectocutors or insect zappers should be applied.

2.3.2 Waste Management

Inadequate refuse disposal facilities are a major cause of contamination of street vended foods (Kariuki *et al*., 2017) as waste can amass at the food vending sites leading to an increase in pest sightings which will consequently increase the risk of contamination of the food being vended (Khairuzzaman *et al*., 2014). Proper waste management and disposal methods are paramount in ensuring that cross contamination from waste and people handling waste is reduced to a near minimum (FAO, 2009). Waste receptacles should be emptied out on a daily basis or as soon as they are full to avoid attracting pests. Additionally, they should be constructed from a sturdy, cleanable material that is impervious.

2.3.3 Care of Utensils and Equipment

Khairuzzaman *et al*. (2014) found that recontamination of utensils usually happens after they have already been washed and are then stored on unclean surfaces or on cardboard boxes. Similar studies carried out also show that vendors do not replace water used for cleaning utensils as often as they should because of lack of water supply close to their businesses. In other instances, handwashing water has also been found to be used to wash utensils because of

lack of enough water to carry out all the required activities (Marutha *et al.*, 2020). The materials used to make utensils should be strong, simple to clean, and not encourage the growth of bacteria. The utensils should also be kept in a state of good repair as food safety requires adequate maintenance and storage of equipment and utensils used in food preparation and selling. When not in use, bowls and cups should be flipped upside down to avoid gathering dust and other foreign objects. After washing and rinsing in clean water, they should be dried on a high rack (FAO, 2009).

2.3.4 Personal Hygiene and Personal Protective Equipment

In a study conducted in Kampala, Uganda, coliforms and Staphylococcus aureus colonies were isolated from 86.7% of hand swab samples collected from street vendors (Kaddumukasa et al., 2019). Food handlers are crucial in preventing food contamination during preparation and distribution (Mjoka, 2017). Those who handle street food should dress neatly and avoid contact with the food. They should also wear a clean apron, preferably white or light in color, to allow dirt and stains to be seen easily and the apron to be cleaned (FAO, 2009). Food handlers should keep their hair covered, nails short and practice proper hand hygiene to prevent cross-contamination.

2.3.5 Managing unsold food and beverages

Unsold food and beverages that cannot be preserved properly at the end of the day should be thrown out, as they may constitute a health risk to customers. To avoid such losses, street food vendors should meticulously measure their output to ensure that there is no waste at the end of the day. However, there will be unsold output on occasion. When this happens, a vendor without a refrigerator (below 10°C) or similar equipment should be persuaded to discard the unsold item or give it to animals (FAO, 2009).

2.4 Pathogenic microorganisms associated with fresh fruit juices

2.4.1 Enterobacteriaceae

The large gram-negative family of enterobacteriaceae is a natural component of the gut flora and can be found in both the human and animal digestive tracts. *Klebsiella, Enterobacter, Escherichia coli, Salmonella*, *Citrobacter,* and *Shigella* are a few of the dangerous bacteria that belong to the enterobacteriaceae family (WHO, 2009). Fruit surfaces often retain bacteria during harvest and post-harvest processing, such as processing, storage, and transportation, and this microflora is present in fruit juices. Many organisms use them as a growth medium, including *Salmonella* and *E. coli* (Rathnayaka, 2013). Unpasteurized fruit juices have been implicated in numerous foodborne outbreaks brought on by various food-borne microbial diseases (Muinde & Kuria, 2005; Harris *et al*., 2003; Ghosh *et al*., 2007; Ingham *et al*., 2006; Raybaudi-Massilia, 2006). Juice pH, redox potential, water activity, nutrient availability, the presence of antimicrobial agents, and competing microorganisms are among the crucial elements that determine juice deterioration (Lawlor *et al*., 2009). This study will analyse *Salmonella, E. coli,* and *Staphylococcus aureus* contamination in fruit juices.

2.4.1.1 *Escherichia coli*

E. coli bacteria are typically present in the intestines of both humans and animals. A healthy human digestive system depends on the majority of E. coli strains. On the other hand, some E. coli can result in sickness outside of the digestive system or illness like diarrhea. E. coli that causes diarrhea can be spread by tainted food or water as well as through contact with people or animals. *E. coli* is a varied bacterial species with pathogenic strains classified into six pathotypes, one of which being E. coli O157:H7 (CDC, 2014).

***Escherichia coli* O157:H7:** This is an enterohemorrhagic bacterial strain that causes diarrhea, hemorrhagic colitis, and hemolyic-uremic syndrome (HUS) in people. Following consumption of infected, undercooked beverages and foods as well as fecal shedding from one person to another, transmission happens via the fecal-oral pathway. Shiga toxins have a significant role

in the emergence of a number of gastrointestinal conditions, including watery diarrhea, hemorrhagic colitis, and HUS (Ameer *et.al,* 2021). For isolation and detection of E. coli O157:H7, a specimen is inoculated into Sorbitol MacConkey agar and incubated for 18-24 hours at 35-37^{0}C (ISO 16649-1:2001).

2.4.1.2 *Salmonella*

Salmonella is a genus of rod-shaped, Gram-negative bacteria. They are generally motile, do not produce spores, and have peritrichous flagella (all around the body). The two types of Salmonella are Salmonella enterica and Salmonella bongori. Six subspecies of the original species, S. enterica, each have more than 2,600 serotypes (Fabrega & Vila, 2013). The antigens O (lipopolysaccharides) and H (flagellar) are used to further categorize the subspecies into serovars (Brenner et al., 2000). Humans infected with salmonella can develop invasive systemic typhoid fever or self-limiting gastroenteritis. Salmonella serovars are split into two categories since the infecting serovar has such a significant impact on how the disease manifests: Type I and Type II errors Salmonella (NTS) (Johnson, *et al*., 2018).

Typhoidal *Salmonella*: *Salmonella Typhi* and *Salmonella Paratyphi* A are the serovars that cause typhoid or enteric fever (Dougan & Baker, 2014). After ingesting food or drink tainted by an infected individual, *S. typhi* bypasses the intestinal epithelium and travels to the liver, spleen, bone marrow, and gallbladder. Common typhoid symptoms that manifest 7–14 days after consumption include fever, headache, muscle aches, stomach pain, and constipation or diarrhea. (Parry *et al*., 2002). The symptoms of *S. paratyphi* are comparable to those of *S.typhi*, however they are much milder (Dobinson *et al*., 2018).

Nontyphoidal *Salmonella*: These are common dietary pathogens that cause gastroenteritis, bacteraemia, and secondary infections (such as meningitis or acute arthritis) (Hohmann, 2001). Additionally, they are the leading cause of bacterial diarrhea in the globe, projected to result in 153 million cases of gastroenteritis and 57,000 fatalities annually. The most frequent clinical

symptom of nontyphoidal Salmonella infection is gastroenteritis, with an incubation period of 6 to 72 hours in most cases and up to 16 days in rare cases. Acute diarrhea, stomach discomfort, fever, and vomiting are all common symptoms. (CDC, 2020).

2.4.2 *Staphylococcus aureus*

Staphylococcus aureus is a Gram-positive, round-shaped bacterium that, under an electron microscope, resembles a cluster of grapes. They're commonly found on the skin and in the upper respiratory tract. They're also facultative anaerobes, which mean they can develop with or without oxygen (Masalha *et al*., 2001). Staphylococcus aureus produces a variety of toxins, including *Staphylococcus* enterotoxins, which are one of the most common causes of food poisoning. This usually happens after eating a variety of foods, especially those that have been contaminated with *S. aureus* due to inappropriate handling and subsequent storage at high temperatures. Nausea and violent vomiting, with or without diarrhea, are among the early symptoms. Usually, the sickness is self-limiting, and only very rarely does it become serious enough to necessitate hospitalization (Argudin *et al*., 2010).

The most common cause of food contamination is assumed to be food handlers who have enterotoxin-producing S. aureus in their nostrils or on their hands. This contamination can occur through contact with the food or by respiratory secretions. Estimates place the prevalence of S. aureus on human skin and mucosal membranes at 20–30% for persistent colonization and 60% for intermittent colonization (Kluytmans and Wertheim, 2005).

2.5 Pesticide residues

Pesticide is a chemical substance used to eliminate pests and control potentially dangerous organisms. They fall within the category of biocides. Even at extremely low concentrations, they have significant effects on human health and the environment. They exhibit significant resistance to chemical and biological degradation, high mobility in the environment, and a high propensity for bioaccumulation in human and animal tissues (Liu *et al*., 2009). Pesticides are

most commonly used as plant protection chemicals, which protect plants against harmful impacts such as weeds, fungi, and insects (Tiwari, 2016). According to Codex Alimentarius Commission, a pesticide means "any substance intended for preventing, destroying, attracting, repelling, or controlling any pest including unwanted species of plants or animals during the production, storage, transport, distribution, and processing of food, agricultural commodities, or animal feeds or which may be administered to animals for the control of ectoparasites."

Pesticides have made it possible for food producers and handlers to increase production volume, extend shelf life, and enhance the appearance of a variety of commonly farmed foods (Rissato *et al*., 2005). As a result, pesticide residues can be found in food, posing a possible health concern to consumers due to their toxicity at particular levels of exposure and concentration. Because of growing public concern about the health effects of pesticide residues in the diet, the maximum residue levels (MRL) and total daily consumption of pesticide residues in foodstuffs have been strictly regulated (Fernandes *et al.,* 2011) especially by Codex Alimentarius Commission; the standards body of FAO and WHO.

Pesticide use is strictly regulated globally. The European Union Commission and the European Food Standards Authority are the appropriate bodies in Europe; the Environmental Protection Agency and the Food and Drug Administration are the appropriate bodies in the United States; and the Codex Committee for Pesticide Residues and the WHO/FAO Joint Expert Meeting on Pesticide Residues are the relevant bodies for world-wide limits and WTO (World Trade Organization) purposes (AIJN, 2010). In Kenya, the bodies concerned are Kenya Bureau of Standards (KEBS) and Pest Control and Poisons Board (PCPB).

In 2008, Garcia-Reyes *et al*. carried out a reconnaissance study to check for the presence and occurrence of pesticide residues in fruit based soft drinks. They obtained 102 samples from 15 countries and applied liquid chromatography-electrospray time-of-flight mass spectrometry

(LC-TOF MS) in their screening, which they claim could trace up to 100 different pesticides in the products. They results showed that “the concentration levels detected were of the micrograms per liter level, low when considering the European maximum residue levels (MRLs) set for fruits but very high (i.e., 300 times) when considering the MRLs for drinking or bottled water” (Garcia-Reyes *et al*., 2008). These claims were however disputed by the British Soft Drink Association saying that pesticide levels are closely monitored and maintained at “very low levels” (Merrett, 2008).

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 Study design and setting

3.1.1 Study setting

The study was conducted in Nyeri County (County No. 19), which is 153 kilometers from Nairobi and is situated in the old Central Province. It is 2361 km2 in size, has a population of 759,164 (KNBS, 2019), and is headquartered in Nyeri town. A governor, a senator, eight members of parliament (MPs), and thirty members of the county assembly serve as the county's administrative leaders. Mount Kenya and Aberdare are strategically located to the east and west of the county, respectively, in the fertile and thickly inhabited highlands (Figure 3.1).

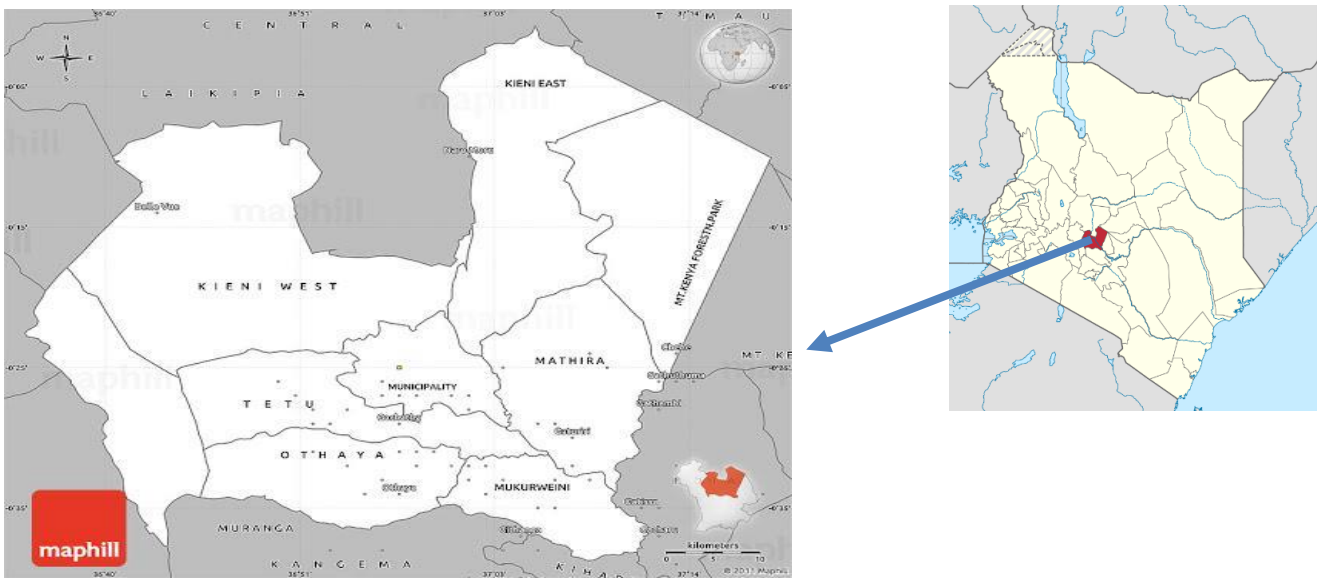

Figure 3. 1: Map of Kenya showing Nyeri and its sub-counties. Source: (Maphill, 2013; NordNordWest, 2015)

Nyeri County is bordered by Kirinyaga County to the East, Nyandarua to the West, Muranga to the South, Laikipia to the North and Meru to the Northeast. The 30 wards and 8 sub-counties that make up Nyeri County. The sub-counties include Kieni East, Kieni West, Mathira East, Mathira West, Nyeri Central, Mukrweini, Tetu, and Othaya. (County Government of Nyeri, 2021).

3.1.2 Study design

This study, which was carried out between May and August of 2021, employed a descriptive and analytical cross-sectional design. Surveys using semi-structured questionnaires were used for the descriptive component to learn more about the sociodemographic traits, knowledge of food safety, and cleanliness practices of the juice merchants. The analytical component established the microbiological status and chemical properties of the fruit juice through laboratory analyses; as well as statistical analyses to establish the determinants of the safety and quality of street-vended fruit juices.

3.2 Study methodology

Study methodology consisted of the materials and methods that this study used in its data collection.

3.2.1 Study population

The participants in the study were the fruit juice street vendors in Nyeri County.

3.2.2 Sampling

3.2.2.1 Sample size determination

Exhaustive sampling was done for the fruit juice street vendors.

3.2.2.2 Sampling procedure

3.2. 2.2.1 Sampling procedure for street vendors and fresh fruit juice

Multi-stage sampling was used in getting the sampling units for this study. Nyeri County was purposely selected because this kind of study has not been carried out in the area before. The towns from which the samples of fruit juice and street vendors were gathered were chosen by convenience sampling. Exhaustive sampling was then done for the fruit juice street vendors. Fruit juice samples were collected via simple random sampling, and they were then analyzed in the lab for microbial load, pesticide residues, and vitamin C content.

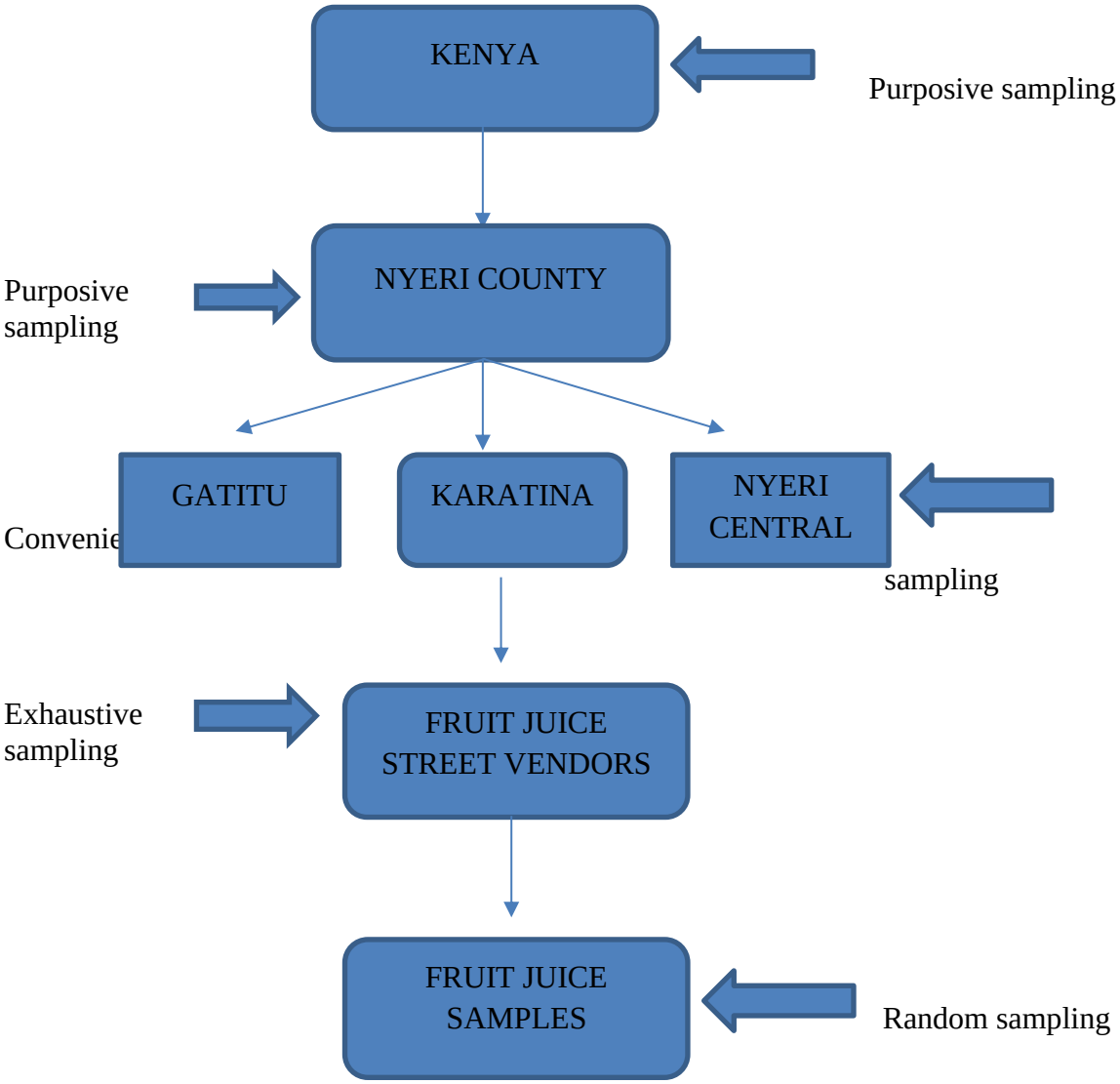

Figure 3. 3: Sampling schema

3.3. Definitive data collection

3.3.1 Establishment of street vendors' socio-demographic characteristics, fruit juice processing knowledge and practices in relation to hygiene and food safety in Nyeri County

The data collection method was a questionnaire which had different sets of questions to evaluate the knowledge and practices of street vendors regarding sanitation and food safety (Appendix 1). A checklist (Appendix 2) was used for observation purposes to establish hygiene practices that the vendors' employed during the processing of the fruit juice.

3.3.1.1 Data collection techniques

Based on the methodology outlined by Cortese et al. (2016), in-person interviews were done using close-ended questionnaires with multiple-choice questions because it supported greater accuracy and completeness of the questionnaire. A predefined checklist was used along with direct observation at the point of sale of the fruit juices to help guide the process.

3.3.1.2 Data collection tools

Multiple-choice questionnaires with closed-ended questions were utilized to assess the street vendors' knowledge of food safety and hygiene standards. A checklist was used to record the findings that were noted during the direct observation.

3.3.2 Laboratory analytical techniques

3.3.2.1 Determination of levels of contamination with *E. coli, Salmonella* and *S. aureus* in the fruit juices marketed in Nyeri by street vendors

Laboratory analyses of the fruit juice samples were done to determine the levels of *Escherichia coli*, *Salmonella* and *Staphylococcus aureus.* These analyses were performed at Kenya Bureau of Standards laboratory in Nairobi which is ISO 17025:2005 certified by Kenya National Accreditation Service (KENAS).

3.3.2.1.1 Enumeration of *Escherichia coli*

Escherichia coli analysis was done according to the procedure outlined in ISO 16649-1:2001; where one ml of the sample is transferred onto the Minerals Modified Glutamate Agar and incubated for four hours at 37^0C. The membrane is then transferred to Tryptone-Bile-Glucuronic Agar and incubated for 18-24 hours at 44^0C. Blue colonies present on the petri dishes are then enumerated. All the media used for the enumeration of *E. coli* is prepared according to the manufacturers' instructions.

3.3.2.1.2 Enumeration of *Salmonella*

For *Salmonella* analysis, the fruit juice samples were pre-enriched using buffered peptone water and incubated for about eighteen hours. The culture is then further enriched using

selective media that was able to detect motile and non-motile *Salmonella*; and then the colonies are identified and enumerated after 6 days (ISO 6579-1:2017).

3.3.2.1.3 Enumeration of *Staphylococcus aureus*

ISO 6888-1:1999/Amd 2:2018 outlines the procedure for the enumeration of *Staphylococcus aureus*; where the sample is inoculated on the surface of a solid selective culture medium. These plates were then aerobically incubated at 37-39^{0}C and checked after 24 hours, and again after 48 hours. Calculation was then done based on the number of colonies counted.

3.3.2.2 Establishment of the levels of pesticide residues and Vitamin C content in the vended fruit juices

Fruit juices samples collected were taken to the KEBS Nairobi laboratory to be analysed for pesticide residues and Vitamin C content. Gas chromatography was used to establish pesticide residues while iodometric redox titration was used to determine the Vitamin C content.

3.3.2.2.1 Determination of Vitamin C content

Vitamin C content determination was done using iodometric redox titration. A predetermined amount of starch was added to the fruit juice samples being tested. If Vitamin C is still present in the juice sample, it neutralizes the iodine preventing the formation of a blue-black color. Iodine was added in a drop-wise manner continuously until a blue-black complex formed, signifying the endpoint (Ikewuchi & Ikewuchi, 2011).

3.3.2.2.2 Determination of pesticide residues

Quick Easy Cheap Effective Rugged and Safe (QuEChERS) multi-residue analysis was used to determine the presence of pesticide residues in fruit juice samples. The method includes three extraction steps: an initial extraction in a water/acetonitrile system, an extraction or partitioning stage after adding salt, and a clean-up step utilizing dispersive solid-phase extraction. For readings, the QuEChERs technique was utilized (Payá *et al.*, 2017).

3.3.2.3 Determination of the effect of vendors' knowledge and practices on microbial safety, pesticide residues and nutritional value of street-vended fruit juices

The impact of the street vendors' knowledge of food safety and hygiene practices on the quality and safety of the fruit juices they sell was examined using statistical analysis.

3.3.3 Pretesting study tools

The questionnaire was pretested in Nairobi County's Central Business District amongst 10 street vendors to assess their suitability and effectiveness. A site visit was also undertaken at the Kenya Bureau of Standards (KEBS) laboratory to ascertain that all the equipment that were to be used in the analyses had up to date calibrations and that their calibration certificates are available.

3.3.4 Research personnel

The Principal Investigator carried out all the data collection by herself. One research assistant was recruited and worked closely and was supervised by the principal investigator.

3.3.5 Ethical considerations

- This study took into account ethical considerations that allowed the correct and unbiased documentation of results and findings.
- The researcher (s) was not expected to exploit the respondents in any way. Details of the study and what is expected of the respondents was clearly explained to them so that they could make an informed choice on whether to participate in the study or not.
- The findings and the results of this study should be shared with the respondents and any other interested parties who benefit from the information herein.

3.3.6 Data quality control

When samples were being taken, care was taken to ensure that the integrity of the samples was always maintained. This was to allow for true outcomes during analyses. A sampling plan was put in place to aid in knowing how many samples to pick, at what time samples should be

picked (morning, afternoon, evening), which sampling materials should be used, and how long they should stay before analyses. Timeliness was ensured by sticking to the Gantt chart and having the right deliverables within the given timelines.

3.3.7 Data analysis

The data collected was analyzed to make sense out of all the raw data. Survey data was analyzed using the Statistical Package for Social Sciences (SPSS) program version 20. Descriptive statistics such as means and frequencies were used to present the findings. Correlation and regression analysis were also used to determine the relationship between various parameters. Analyses of variance were performed using the Genstat statistical software version 15 to determine the differences among microbial organisms isolated and vitamin C levels analyzed on different juices collected from various sites. Differences were significant at $p \leq 0.05$ and were compared using the Fisher's protected LSD test.

CHAPTER FOUR: RESULTS

4.1 Socio-demographic characteristics of respondents

Table 4.1 provides information on the respondents' demographic attributes. Females made up the majority of fruit juice vendors (75%) and they predominantly fell into the 31–40 age group (40%), closely followed by those in the 36–40 age group (33%). About 27.5% of respondents had completed their basic education, while 17.5% had completed their higher education. Of the respondents, half (55%) had completed their secondary education. Only 7.5% of the respondents (70% were married), 20% were unmarried, and 70% were married. The vast majority of respondents (95%) had not had a food handlers' medical checkup in the previous six months, and the majority of respondents (87.5%) had not received training on food safety and hygiene procedures.

Table 4. 1: Demographic characteristics of respondents

Characteristics (n=40)	Category	Percentage
Gender	Male	25.0
	Female	75.0
Age (Years)	20-25	2.5
	26-30	25.0
	31-35	40.0
	36-40	32.5
Education	Primary	27.5
	Secondary	55.0
	Tertiary	17.5
Marital status	Single	20.0
	Married	70.0
	Widowed	7.5
	Separated	2.5
Training in food safety and hygiene practices	Yes	12.5
	No	87.5
Food handlers’ medical examination in the last six months?	Yes	5.0
	No	95.0

4.2 Hygiene Practice by Vendors

All participants responded in the affirmative that they washed their hands with soap and water before handling fruits and fruit juices (Table 4.2). All the interviewed respondents washed their fruits before blending while the overwhelming majority (97.5%) thought unwashed fruits were not safe for making fruit juices. The vendors were asked if they clean their workplaces before processing juices, with 87.5% responding that they did. All the respondents washed their utensils using clean water and soap. Majority (52%) of the respondents agreed that having the fruit juices unrefrigerated for the whole day was unsafe, however, 45% of the respondents thought it would be safe at the end of the day while 2.5% did not know whether it was safe or not. All of the interviewed respondents added additives to the fruit juices, kept their juices covered to prevent contamination, 77.5% of them agreed to be eating at the point of sale during processing fruits juices while 22.5% did not eat. When the respondents were asked how they managed the waste generated during fruit processing, all the respondents said that they emptied their waste receptacles when and if needed in addition they cleaned them at the end of every working day.

Table 4. 2: Hygiene practices of juice vendors in Nyeri

Statement (n-40)	Percent Response	
	Yes	**No**
Do you wash your hands with soap and water before handling fruits and fruit juices?	100.0	-
Do you wash the fruits before blending?	100.0	-
Do you think unwashed fruits are safe for making fruit juices?	2.5	97.5
Do you clean your work surfaces before you start the processing of fruit juices?	87.5	12.5
Do you wash your utensils with clean water and soap?	100.0	-
Is it safe to keep fruit juices unrefrigerated for the whole day?*	45.0	52.5
Do you use additives/preservatives in your fruit juices?	100.0	-
Do you eat or drink during fruit juice processing or at the point of sale?	77.5	22.5

Do you empty your waste receptacle as and when needed?	100.0	-
Do you clean your waste receptacle at the end of every working day?	100.0	-
Do you keep all the juices covered to prevent contamination by flying insects?	100.0	-

*2.5% did not know

4.3 Food Safety and Hygiene Knowledge

Results of the participants' knowledge and awareness of food safety are shown in Table 4.3. About 25% of those surveyed thought it would be safe to combine freshly prepared juice with leftover juice from the day before, but the majority (75%) believed it would be risky to do so. At the same time, the majority of the respondents (52.5%) agreed to working even if they had symptoms such as a runny nose or running stomach while 47.5% of the respondents thought it would not be a good idea to continue working with such symptoms. Most of the vendors who were surveyed (57.5%) concurred that someone who is injured cannot handle food. A majority of respondents (60%) categorically responded that the quality of the juice would remain the same in response to the question of whether the safety of fruit juices left on the counter would be affected, while 40% of respondents concurred that the quality of the juice would be compromised. Majority (55%) of the vendors did not know the importance of hand washing after visiting washrooms and whether it was important to have medical examinations after every six months. On whether foodborne diseases can affect everyone, all the respondents said that these diseases cannot spare anyone and can lead to death. All of them also agreed that utensils, and processing equipment are major sources of contamination. All the respondents agreed that bad odor is a sign of food spoilage and a majority (77.5%) of the vendors could tell whether fruit juice is spoiled. About 57.5% of the vendors reported that they only clean food contact surfaces when dirty while 42.5% reported that this was done daily. All the respondents agreed that water used for washing fruits should be clean as water used in fruit juice preparation can be an agent of contamination and vendors should only buy fruits from reputable suppliers.

All the respondents confirmed that they had adequate knowledge on food borne diseases and that they can affect everyone indiscriminately and even cause death. They also responded in the affirmative that bad odor is a sign of food spoilage, water used for washing fruits should be clean, bad odor is a sign of food spoilage and that water, utensils and processing equipment used in fruit juice preparation can be agents of cross contamination.

Table 4. 3: Food safety and hygiene knowledge among juice vendors in Nyeri

Statement (n-40)	Percent Response	
	True	**False**
Leftover fruit juice from the previous day's preparation can be mixed with a freshly prepared batch of juice	25.0	75.0
You can continue working even if you have a running nose or stomach	52.5	47.5
You can handle foods even if you have wounds on your hands	42.5	57.5
Fruit juices can be left on the counter and this would not compromise its safety	40.0	60.0
You must wash your hands after visiting the washrooms and before handling food*	12.5	32.5
Food handlers should undergo medical examinations after every six months*	12.5	32.5
You can tell that a food is spoilt just by looking at it	77.5	22.5
Food contact surfaces should only be cleaned when they are dirty	57.5	42.5

*****55% did not know

4.4 Hygiene Practices by the vendors

Table 4.4 shows hygiene practices performed by fruit juice street vendors. Majority (87.5%) of the respondents ensured their environment is free from sources of contamination, such as flies, stagnant water, and undisposed waste while 12.5% of the respondents did not bother with the cleanliness of the environment. Majority (72.5%) of the respondents ensured that surfaces from which the fruit juices were made were free of personal effects such as bags and phones. All the respondents ensured there is sufficient lighting in the processing area to be able to see any physical hazards that may find their way into the fruit juices and also ensured proper waste

management. However, 95% of the respondents did not have adequate handwashing facilities such as soap, clean water to enable them to perform adequate handwashing.

Table 4. 4: Hygiene practices by fruit juice vendors at the point of sale

Statement (n-40)	Percent Response	
	Yes	**No**
Surrounding environment is free from sources of contamination, for example, flies, stagnant water, undisposed waste, general unhygienic environment	87.5	12.5
The surfaces are clean and fee from personal effects or items like bags, phones	72.5	27.5
There is sufficient lighting in the processing area to be able to see any physical hazards that may find their way into the fruit juices	100.0	-
Free flowing water supply. If not, adequate water storage in clean containers	92.5	7.5
Proper waste management. There is a waste receptacle that is clean made of impervious material	100.0	-
Adequate handwashing facilities (soap, clean water, hand towels, sanitizer)	5.0	95.0

4.5 Street vendors' personal hygiene practices

The vendors had more than average knowledge on hygienic practices when handling food (Table 4.5). All the vendors maintained a clean physical appearance while 97.5% had not put on jewelry such as rings, earrings, and watches while handling food. A majority (95%) had clean and short fingernails and did not eat or chew around the point of sale or processing area. The vendors (77.5%) occasionally washed their hands between activities. However, 92.5% of the respondents did not have their hair covered adequately while preparing juice. The scores of the fruit juice dealers' knowledge of food hygiene are displayed in Figure 4.1. Only 2.6% of respondents (23.6%) had poor food hygiene knowledge, compared to 23.8% who had fair knowledge and 73.6% who had good hygiene knowledge. These results show a significant relationship between hygiene knowledge and the safety and quality of the resultant fruit juices sampled from them.

Table 4. 5: Street vendors personal hygiene practices

Statement (n=40)	Percent Response	
	Yes	**No**
The vendors maintain a clean physical appearance	100.0	-
The vendors have no jewelry (rings, earrings, watches)	97.5	2.5
They have clean and short fingernails	95.0	5.0
They are not eating/chewing around the point of sale/processing area	92.5	7.5
Occasional washing of hands in between activities	77.5	22.5
Hair covering is in place and adequately covering all the hair	7.5	92.5

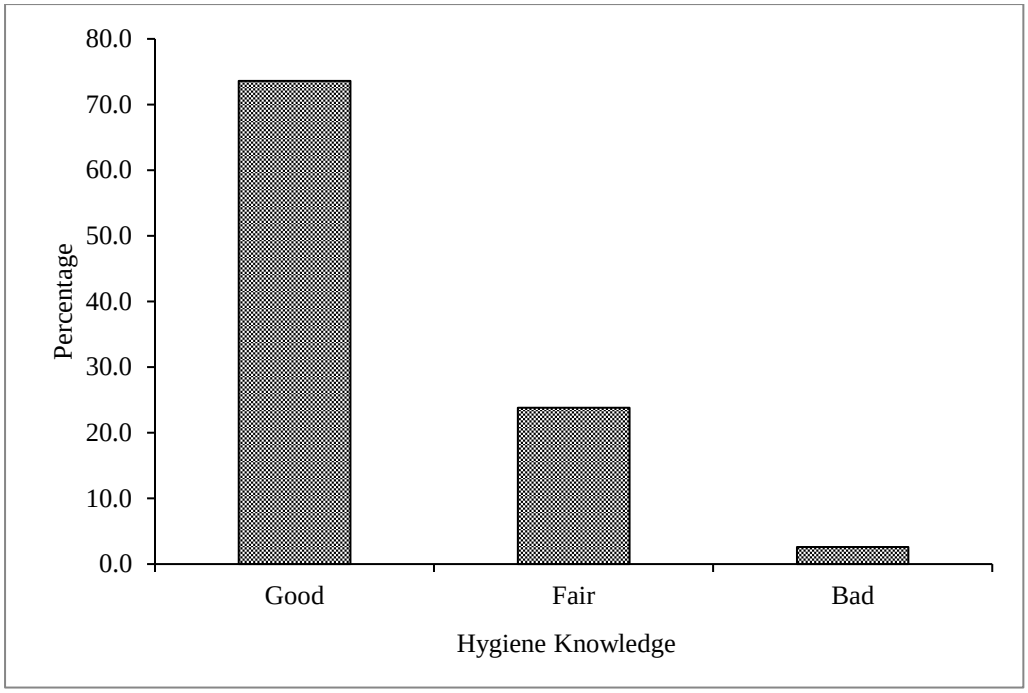

Figure 4. 1: Hygiene practices levels among the respondents

4.6 Distribution of demographic characteristics, juice safety and hygiene practices of fruit juice street vendors in Nyeri County

A correlation analysis was done between specific food safety factors and demographic traits. (Appendix 4). Training in food safety and hygiene practices was shown to be substantially associated with medical examination (r- 0.675, $p < 0.01$). The level of education was found to be strongly correlated with whether leftover juice was mixed with fresh ones (r- 0.522, $p < 0.01$). It was discovered that training in food safety was inversely connected with educational attainment (r- 0.399, $p < .01$) and positively correlated with marital status (r- 0.402, $p <0 .01$).

Table 4. 6: Correlation coefficients among demographic characteristics of juice vendors and the hygiene practices

	Gender	Age	Level of education	Marital status	Training in food safety and hygiene practices	Undergone food handlers' medical examination in the last six months?	Eat or drink during fruit juice processing	Leftover fruit juice mixed with a freshly prepared batch of juice	Food handlers should undergo medical examinations after six months
Gender	1								
Age	-.053	1							
Level of education	.174	-.592**	1						
Marital status	.205	.347*	-.331*	1					
Training in food safety and hygiene practices	.131	.380*	-.399*	.402*	1				
Undergone food handlers' medical examination in the last six months?	.397*	.426**	-.380*	.309	.607**	1			
Eat or drink during fruit juice processing	-.104	-.308	.442**	-.301	-.339*	-.426**	1		
Leftover fruit juice mixed with a freshly prepared batch of juice	.200	-.193	.522**	.041	-.044	-.132	.311	1	
Food handlers undergo medical examinations after six months	.185	.198	-.338*	.144	.121	.465**	-.070	-.144	1

4.7 Association between food safety practices score and demographic characteristics amongst fruit juice street vendors

The relationship between various parameters is shown in Table 4.7. Dependent variables were regressed on predicting variables. Level of education significantly predicted (F=20.96, P < 0.000) if one works when he has running stomach or nose, leftover juice can be mixed with new one (F=14.25, P < 0.001), wounded people can handle food (F= 11.39, P < 0.003) and if leaving juice on the counter would remain safe (41.65, P < 0.000) which indicates that level of education plays a significant role in shaping food safety (P < 0.005). Gender also significantly predicted whether one can handle food with wounds in the hand (F=10.41, P < 0.009), that the surrounding environment is free from contamination (F=11.38, P < 0.002). Medical examination also predicted (F=10.48, P < 0.003) if one would wash their hands after visiting the washrooms

Table 4. 7: Linear regression for level of education, gender, and medical examination training as determinants of food safety practices scores

Parameter	Predictor	B	Std. error	F-value	t-value	P value
You can continue working even if you have a running nose or stomach	Level of education	0.449	0.98	20.96	4.578	0.000
Leftover juices from previous day are mixed with freshly prepared batch	Level of education	0.341	0.09	14.25	3.775	0.001
Is it safe to keep fruit juices	Level of education	0.301	0.123	5.95	2.441	0.19
You can handle foods even if you have wounds on your hands	Level of education	0.311	0.100	11.39	3.12	0.003
Fruit juices can be left on the counter and this would not compromise its safety	Level of education	0.534	0.083	41.65	6.454	0.000
You can handle foods even if you have wounds on your hands	Gender	0.417	0.152	10.41	2.737	0.009
Vendors have clean and short fingernails	Gender	-0.200	0.750	7.12	-0.669	0.011
Surrounding environment is free from sources of contamination	gender	-0.367	0.109	11.38	-3.374	0.002
You have to wash your hands after visiting the washrooms and before handling food	Have you undergone a food handlers' medical examination	1.5	0.463	10.48	3.237	0.003

4.8 Microbial load of Different Pathogens Contaminating Fruit Juices

Staphylococcus aureus were detected in fruit juice samples from mango, passion, pineapple and tree tomato collected from Nyeri CBD, Gatitu and Karatina (Table 4.8). *E. coli* was detected in fruit juice samples from mango, pineapple, paw paw and watermelon from Karatina while *Salmonella* spp was only detected in pineapple fruit juice collected from Gatitu trading center. The highest contamination of fruit juices was observed from samples collected from Karatina. Pesticide residues were however not detected in all the samples (Table 4.10)

Table 4. 8: Levels of various microorganisms in fruit juices sold by vendors in various locations in Nyeri

Fruits	**Nyeri CBD**			**Gatitu**			**Karatina**		
	E. coli	*Salm*	*S. aureus*	*E. coli*	*Salm*	*S. aureus*	*E. coli*	*Salm*	*S. aureus*
Mango	ND	ND	<1	ND	ND	<1	<10	ND	<10
Passion	ND	ND	<1	ND	ND	<1	NS	ND	NS
Pineapple	ND	ND	<1	ND	<1	<1	<10	ND	<10
Tree tomato	ND	ND	<1	ND	ND	<1	NS	ND	NS
Pawpaw	NS	NS	NS	NS	NS	NS	<10	NS	<10
Watermelon	NS	NS	NS	NS	NS	NS	<10	NS	<10

ND – Not detected, NS- Not Sampled, Salm- *Salmonella*

4.9 Levels of vitamin C in fruit juice

The vitamin C content of various fresh fruits is given in Table 4.9. All fruits sampled contained vitamin C but in different concentrations. By comparing the six fruits, tree tomatoes had the highest concentration of vitamin C (111.1 mg/100g) followed by mango (40.48 mg/100g), passion fruit (38.29 mg/100g), and pawpaw (37.24 mg/100g). Fruits from Gatitu had the highest concentration of Vitamin C while those from Nyeri had lowest concentration of vitamin C.

Table 4. 9: Estimated levels of vitamin C among fruit juices sold by fruit vendors in various locations in Nyeri

Fruits Juice	Vitamin C (mg/100g)		
	Nyeri CBD	**Gatitu**	**Karatina**
Mango	7.53	40.48	30.92
Passion	7.46	6.23	38.29
Pineapple	8.06	11.08	12.5
Tree tomato	9.42	111.1	
Pawpaw			27.28
Watermelon			14.11
Mean	8.12	42.22	24.62
LSD (P≤0.05)	4.42	45.49	14.81

CBD = Central Business District; LSD = Least Significant Difference

4.10 Pesticides

Ten pesticide residues (isotopes of DDD, DDE, DDT, Methoxychlor, Aldrin, BHC) were analyzed for in the fruit juices sampled and the results came back negative. This implies that the juices were free from pesticide contamination and consumers would not be affected by are chronic effects of exposure to pesticides such as cancers, birth defects, immunotoxicity, neurological and developmental toxicity, and disruption of the endocrine system.

CHAPTER FIVE: DISCUSSION

5.1 Demographic Background of Street juice Vendors

Fruit juice vendors were predominantly female and mostly in the age range of 31 to 40, showing that food vending was a popular industry among women, especially those over thirty. Similar findings were reported by Mlay, (2018); Kaddumukasa *et al.,* (2018); Muyanja *et al*., (2011) and JevSnik *et al*., (2007) where majority of the street vendors were female with males making up the minority. Mitullah, (2003); Wogu, (2011) and Gabriel, (2014) also cited women as the main participants in street vending business. However, the results herein contradict those reported by Ahmed *et al.,* (2021); Hossen *et al*., (2020); Ma *et al*., (2019); Simforian, *et al*., (2015); Bhowmik, (2012); Muinde and Kuria (2005) where majority of the vendors were males. According to Mlay, (2018) involvement of women in food preparation is largely an African culture where at a young age, women are involved in preparation and serving of food. These types of business are also mostly associated with the younger generations who are active. The finding is congruent to those of Muinde and Kuria (2005) where majority of the respondents were youthful. A vast majority of the respondents were married with a few who are single and others widowed. These were echoed by Hossen *et al*., (2020) where (91.5%) of the vendors were married. This shows that many of the respondents ventured into the fruit juice vending business as a way to supplement family's income and sustain their economic needs. However, these observations contradict those reported by Duffet, (2017) where a majority of the respondents were not married.

The respondents' educational backgrounds varied across the factors, with the majority having completed secondary school while others just completed primary or tertiary level schooling. This result implies that the majority of respondents had a basic education, recognized the necessity to implement sanitary food safety standards, and could use excellent methods for handling fruit juices. This finding mirrors those of Rahman *et al*., (2016) where the researchers reported education as playing vital role in food safety awareness. However, these findings contradict those of Kaddumukasa *et al*. (2018) Chukuezi, (2010); Choudhury *et al.* (2011); Donkor *et al* (2009); Omemu & Aderoju,

(2008); and Muinde & Kuria, (2005) where majority of fruit juice vendors had primary level of education. People who work in street vending business often do so for a variety of reasons, including low educational levels and joblessness. Vendors' education positively impacts on awareness about food hygiene, henceforth those with higher education levels tend to have higher knowhow on existing safety knowledge on food (Hossen *et al*., 2020). Majority of respondents had not been trained on food safety and hygiene practices and out of these; overwhelming majority (95%) had not done food handlers' medical examination in the last six months prior to the current study. These findings agree with those of Ahmed et al., 2021, who found that the majority (67.8%) of food handlers had never received any type of formal training in food handling or safety, while only 5.9% of participants had received specialized training from accredited institutions and only 26% had received informal basic training. The sheer fact that the majority of vendors had not received training on food safety procedures and had not undergone a medical examination in the previous six months is a concerning trend and could pose a threat to food safety. Training on food safety and hygiene is important in safeguarding quality and safety of foods produced (Chouthury 2011). Fruit juice vendors need to be trained on a regular basis as a way of ensuring juices sold in the street meet the safety standards. FAO, (2008) emphasizes that in order to ensure food safety, food handlers must possess the necessary knowledge and skills in food handling. In addition, it is recommended that basic training on food hygiene to every person involved in fruit vending/ food business is licensed.

5.2 Hygiene Practice by Vendors

The knowledge on hygiene practices was intended to make sure the vendors understand some of the practices to ensure food safety. The study's findings revealed that every participant washed their hands with soap and water before handling fruits and fruit juices, washed fruits before blending, and believed that unwashed fruits should not be used to make fruit juices. Similar observations were reported by Hossen *et al*., (2020) and Mlay, (2018) who observed that most food vendors were aware that absence or lack of hand washing could be a source of food borne illnesses. This implies that the vendors were not ignorant and possessed basic knowledge of food safety and hygiene practices.

The respondents overwhelmingly agreed that cleaning work surfaces and washing their utensils using clean water and soap safeguarded the safety of the fruit juices. On the other hand, 52% thought having their fruit juices unrefrigerated for the whole day was unsafe, however, 45% of the respondents thought it would be safe at the end of the day. Hossen *et al*., (2020) had made similar observations where the majority of the vendors knew that good and appropriate cleaning and handling of utensils can reduce the risk of food contamination, and they were informed that cleaning equipment after work was important and could reduce cross-contamination. The observation that nearly half the respondents thought that unrefrigerated juice would be safe at the end of the day necessitates the need for formal training on food safety handling, a factor that was also pointed out by Mlay, (2018).

All of the interviewed respondents kept their juices covered to prevent contamination, majority of them agreed to be eating at the point of sale during processing fruits juices and all the respondents emptied their waste receptacles. These results are similar to those of Mlay (2018) where it was observed that food contamination by dust and flies is as a result of vendors not covering their food and the utensils. It is important that fruit juices already prepared are covered to avoid contamination from dust, and flies and the utensils used for preparation of juices are kept clean at all times (Kinton and Ceseran, 1992). The waste receptacle needs to be emptied as soon as possible and not only when it is full or in the evening as it could be the main source of contamination.

All the interviewed respondents added additives to the fruit's juices, mostly sweeteners to improve the taste of the prepared juices. According to Raju and Bawa, (2007) food additives play an important role in fruit processing ensuring fruit quality and safety. Several additives such as preservatives, sweeteners, acidulants, antioxidants, and food colors may be added during food processing. However, according to the Food and Drug Administration (FDA) these types of juices should not be classified as natural juice and as such should be labeled as beverages containing natural ingredients. The FDA also raises concern over the use of additives, for instance sweeteners are artificial and are neurological poisons that affect blood sugar.

5.3 Food Safety and Hygiene Knowledge

The majority of participants, according to the findings on food safety awareness, thought it was dangerous to combine leftover juice from the day before with a freshly made batch. At the same time, most of the respondents worked even when they had symptoms such as a runny nose or running stomach while nearly half of the respondents thought it would not be a good idea to continue working with such symptoms. Majority of the interviewed respondents also agreed that one should not handle food if he or she is wounded. The observation on handling food while sick or wounded contradicts those reported by Hossen *et al.,* (2020) where only a few of the respondents dissented with not touching food while wounded. A majority of respondents (60%) categorically said that the quality of the juice will remain the same when asked whether fruit juices left on the counter jeopardize their safety. These observations are worrying and necessitates the need for awareness on food safety because when nearly one quarter of a sample population thinks it is ok to mix freshly prepared fruit juice with old one and the quality of leftover juice would remain the same when left over then it becomes a food safety issue.

The observation that half (55%) of the fruit juice vendors do not know the importance of hand washing after visiting washrooms and whether it is important to have medical examinations after every six months are worrying. The findings also mirror those of Hossen *et al*., (2020); Mlay, (2018) where nearly half of the participants did not wash their hands after toilet visits. Even though the practice of hand washing is a simple and an efficient way to clean up contaminants, its implementation by street food vendors was poor. This suggests that the knowledge of vendors about health and hygiene is not closely associated with safe food practices but to social and cultural context on how food is handled (Mlay, 2018). It is important to note that the vendors understood foodborne diseases can lead to death. The results mirror those reported by Ishaq *et al.,* (2019) where it was reported that foodborne diseases affect most people, and these are transmitted through various types of food items. According to the World Health Organization (2015), foodborne diseases are a major cause of diseases and death, and a key obstacle to socio-economic development mostly in developing

countries. Diarrheal disease agents were reported as the most common cause of foodborne illness. A simple majority of the respondents reported that they only clean contact surfaces when they are dirty indicating that contaminating agents would be common in these stalls. All the respondents agreed that clean water was used for washing fruits used for fruit juice preparation as dirty water can be an agent of contamination. These contaminating agents can be transmitted through contaminated food/ water/ utensils, inhalation, waste disposal etc. (Ishaq *et al.*, 2020).

5.4 Hygiene Practices by the Street Vendors

The vendors performed various hygienic practices within and around their working or sales points portraying a positive attribute towards food safety. Majority ensured that their environment was free from sources of contamination, surfaces from which the fruit juices were made were free of personal effects such as bags and phones, and all of them ensured there was sufficient lighting in the processing area to be able to see any physical hazards that may enter into the fruit juices. This shows that the respondents had good waste management practices and ensured the surrounding area was free of any source of contamination. Food preparation spaces should be kept spotless and kept away from any potential sources of contamination (FAO, 2008). It is also important that sufficient drainage and waste disposal systems are provided to reduce the risk of contamination of food and water. About 95% of the respondents did not have adequate handwashing facilities such as soap, clean water, hand towels and sanitizers. This finding is consistent with Musa and Akande's (2003) findings that many food vendors lacked access to hand washing facilities, soap, and water for cleaning their utensils. The same was reported by Mlay, (2018) where more than half of the respondents did not have hand washing facilities and only 28.1% had access to potable water. Proper hand washing is a necessity and should be done with soap and running water.

All the vendors maintained a clean physical appearance, the majority did not put on jewelry such as rings, earrings, and watches while handling food while 95% ensured they had clean and short fingernails and did not eat or chew around the point of sale or processing area. They also occasionally washed their hands between activities. These findings are in accordance with those reported by Al-

Shabib *et al*., (2016) where the majority of the respondents were aware that having short fingernails, and hair, and being clean and presentable can reduce cross contamination. Generally, it was found that a higher percentage of the respondents had a good hygiene level.

5.5 Correlation coefficient and regression between various factors

The results demonstrated that the level of education was found to be strongly correlated with certain food safety practices (r- 0.522, $p < .01$). Training in food safety was found to be negatively correlated with level of education (r- 0.399, $p < .01$) and positively correlated with marital status (r- 0.402, $p < .01$). Medical examination was found to be strongly correlated with training in food safety and hygiene practices (r- 0.675, $p < .01$). Multiple regression indicates that level of education significantly predicted ($F=20.96$, $P < 0.000$) if one works if he has running stomach or nose, left over juice can be mixed with new one ($F=14.25$, $P < 0.001$), wounded people can handle food ($F= 11.39$, $P < 0.003$) and if leaving juice on the counter would remain safe (41.65, $P < 0.000$) which indicates that level of education plays a significant role in shaping food safety ($P < 0.005$). Gender also significantly predicted whether one can handle food with wounds in the hand ($F=10.41$, $P < 0.009$), that surrounding environment is free from contamination ($F=11.38$, $P < 0.002$). Medical examination also predicted ($F=10.48$, $P < 0.003$) if one would wash their hands after visiting the washrooms. The findings concur with those of Vyas and Kushwaha, (2017) where significant relationship was found in the consumer's knowledge of food safety issue and education level. According to Gurudasani *et al*., (2009) respondents with higher education above graduation level scored better food safety scores than illiterates and those educated to primary level. According to Alimi (2016) the attitude and perception towards street food is driven by their level of education, income, knowledge of food safety, age and gender.

5.6 Microbial load of different pathogens contaminating Fruit Juices

Staphylococcus aureus was detected in fruit juice samples from mango, passion, pineapple and tree tomato collected from Nyeri CBD, Gatitu and Karatina. Salmonella was only found in pineapple fruit juice obtained from the Gatitu trading center, whereas E. coli was found in fruit juice samples from

mango, pineapple, paw paw, and watermelon from Karatina. The detection of the microbes was within the standard limits. The same microbes were reported by Pius *et al*., (2021) where bacterial load ranging from 5.2 - 5.4 log CFU/ml were detected. Batool *et al*., (2013) also reported the presence of *E. coli, Salmonella, Staphylococcus,* and *Pseudomonas* in different frequencies in open fruit juices. The presence of *Escherichia coli* has been reported in studies by Subbanaya *et al*., (2007); Tambekar *et al*., (2009) in most street vended foods indicating a possible risk of contamination and then infection. According to Tambekar et al. (2009), poor hand washing by vendors, polluted water, utensils, and other sources may be the main sources of Escherichia coli contamination. Inadequate personal hygiene, unsanitary surroundings, motor activity, proximity to waste disposal places, and the presence of microbes on raw materials used to make fruit juices could all contribute to the prevalence of these contaminants (Nayik *et al.,* 2013). Majority of the respondents had indicated that fruit juices would remain unrefrigerated for the entire day, and this could also increase the possibility of microbial contamination. Dewanti-Hariyadi (2013) claims that the type of bacteria present in fruit juices is influenced by the germs present in the specific fruits and the quality of the water used to make the juice. Because these bacteria have been linked to several outbreaks connected to fruit juices, their existence poses significant problems to the fruit juice sector as well as to public health in general. In order to regulate these bacteria in food and liquids and maintain food safety, more work needs to be put into developing tight laws and measures. Foodstuffs should not contain microorganisms, their toxins, or their metabolites in proportions that pose an intolerable risk to human health, according to Commission Regulation (EC) No 2073/2005 of 2005 on microbiological standards for foods (European Union, 2005). Food business operators need to comply with these criteria. When analysis of pesticides was done, no pesticide was detected and therefore it complied with the maximum residue limits for pesticides established by Codex Alimentarius Commission.

5.7 Vitamin C Content of Fruit Juices

According to the findings, mango (40.48 mg/100g), passion fruit (38.29 mg/100g), and pawpaw (37.24 mg/100g) had the next greatest concentrations of vitamin C, with tree tomatoes having the

highest at 111.1 mg/100g. The environment is just one of the pre-harvest and handling factors that could account for the variances in vitamin C levels in the various fruit samples (Najwa and Azrina, 2015). According to Dioha et al. (2011), the analytical method, manufacturing process, degree of ripeness, temperature, climate, maturity state, and soil nutrients were to blame for the variations in vitamin C contents. The amount of vitamin C in fruits can also vary depending on the position of the fruit on the tree and its exposure to sunshine. Vitamin C (ascorbic acid) also tends to degrade when not kept in cold storage. A study carried out by Carr & Frei (1999) concluded that the required amount of Vitamin C for optimum reduction disease risk is 120 mg/day.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Fruit juice vending business is common in major towns of Nyeri County. Majority of the respondents have basic education, however, nearly all of them have no training on food safety. The fruit juice vendors have more than average knowledge on food safety and practices and their knowledge is satisfactory. However, the majority of them neglect some basic fundamental food safety procedures such as washing of hands which might have led to some of the fruit juice samples to be contaminated with *Staphylococcus aureus, E. coli,* and *Salmonella* were still detectable in market fruit juices. These contaminants may be present due to poor personal hygiene, unsanitary working conditions, closeness to waste disposal sites, and the presence of bacteria on the raw materials used to make fruit juices. Pathogens are becoming more prevalent in prepared fruit juices as a result of the lack of understanding about these pollutants. Because these bacteria have been linked to several outbreaks connected to fruit juices, their existence poses significant problems to the fruit juice sector as well as to public health in general.

Street vendors of fruit juices need to be educated on food safety and hygiene practices so that they can avoid being agents of cross-contamination that could pose adverse health effects on consumers. Lack of or limited knowledge in proper hygiene practices and food safety might have led to contamination of some of the sampled fruit juices.

On a positive note, no pesticide residues were detected from any of the juices sampled. However, the Vitamin C content in all the juices was below the Recommended Dietary Allowance of 120 mg/day for healthy adults; making them lack in nutritional quality if they were the only source of Vitamin C for the consumers in a given day.

6.2 Recommendations

Based on the findings of this study, the following recommendations are proposed to ensure there is improvement in food safety knowledge, hygiene practices, and awareness of the microbial risks associated with fruit juices.

i. The County Government of Nyeri in conjunction with the National Government, through the department of food safety should ensure everyone involved in food preparation and selling has mandatory training on food safety and hygiene practices and that all the vendors have up to date food handler's medical certificates.

ii. Implementation of simple, low-cost food preservation solutions to keep fruit juices safe and vendable for longer.

iii. The County Government should also ensure that the street vendors have access to clean running water to enable them to run their operations in a hygienic manner.

iv. Consistent monitoring of the quality and safety of fruit juices sold in the streets for human consumption must be continuously done to avoid outbreak of foodborne and other chronic diseases.

v. Given that the present work focused on Nyeri county, subsequent studies should endeavor to cover more Counties to compare the level of knowledge among the vendors and microbial contamination levels. Moreover, it would be useful to conduct a comparative study that covers enclosed sale points such as supermarkets and restaurants.

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APPENDICES

Appendix one: food safety knowledge and hygiene practices questionnaire

Questionnaire number…….

County

Sub-county

Ward

SECTION A: SOCIO-DEMOGRAPHIC INFORMATION

1. Name: ……
2. Gender:
    - Female
    - Male
3. Age: ……
4. Level of education:
    - Never attended any school
    - Primary
    - High school
    - University
    - Any other. Please specify ……..
5. Marital status:
    - Married
    - Divorced
    - Widowed
    - Single
6. Do you have any training in food safety and hygiene practices?
    - Yes
    - No
7. Have you undergone a food handlers' medical examination in the last six months?
    - Yes
    - No

SECTION B: ASSESSMENT ON HYGIENE PRACTICE

Questions	**1= Yes**	**2= No**	**3= I don't know**

1. Do you wash your hands with soap and water before handling fruits and fruit juices?			
2. Do you wash the fruits before blending?			
3. Do you think unwashed fruits are safe for making fruit juices?			
4. Do you clean your work surfaces before you start the processing of fruit juices?			
5. Do you wash your utensils with clean water and soap?			
6. Is it safe to keep fruit juices unrefrigerated for the whole day?			
7. Do you use additives/preservatives in your fruit juices?			
8. Do you eat or drink during fruit juice processing or at the point of sale?			
9. Do you empty your waste receptacle as and when needed?			
10. Do you clean your waste receptacle at the end of every working day?			
11. Do you keep all the juices covered to prevent contamination by flying insects?			

SECTION C: ASSESSMENT ON FOOD SAFETY AND HYGIENE KNOWLEDGE

Questions	**1= True**	**2= False**	**3= I don't know**
1. Leftover fruit juice from the previous day's preparation can be mixed with a freshly prepared batch of juice			
2. You can continue working even if you have a running nose or stomach			
3. You can handle foods even if you have wounds on your hands			

4. Fruit juices can be left on the counter and this would not compromise its safety			
5. You have to wash your hands after visiting the washrooms and before handling food			
6. Food handlers should undergo medical examinations after every six months			
7. Food borne diseases can affect anyone			
8. Processing tools and utensils may cause cross contamination			
9. You can tell that a food is spoilt just by looking at it			
10. Only when they are dirty should surfaces that come into contact with food be cleaned.			
11. Fruit washing water needs to be clean.			
12. Food-borne infections can be fatal and are serious.			
13. A bad odor indicates that food has spoiled.			
14. Fruits should only be gotten from reputable suppliers			
15. Water used in the fruit juice preparation can be an agent of contamination			

Appendix two: hygiene practices observation checklist
SECTION A: PROCESSING/POINT OF SALE ENVIRONMENT

		1= Yes	**2= No**	**3= Not applicable**
1.	Surrounding environment is free from sources of contamination, for example, flies, stagnant water, undisposed waste, general unhygienic environment			
2.	The surfaces are clean and fee from personal effects or items like bags, phones			
3.	There is enough lighting in the processing room to see any physical risks that might get into the fruit juices.			

4.	Free flowing water supply. If not, adequate water storage in clean containers			
5.	Proper waste management. There is a waste receptable that is clean made of impervious material			
6.	Adequate handwashing facilities (soap, clean water, hand towels, sanitizer)			

SECTION B: VENDOR'S HYGIENE

		Yes	**No**	**Not applicable**
1.	The vendors maintain a clean physical appearance			
2.	The vendors have no jewellery (rings, earrings, watches)			
3.	They have clean and short fingernails			
4.	They are not eating/chewing around the point of sale/processing area			
5.	Occasional washing of hands in between activities			
6.	Hair covering is in place and adequately covering all the hair			

Appendix three: participants consent forms

Determinants of food safety and quality of fruit juices sold by street vendors in Nyeri County, Kenya

You are being asked to participate in a study to assess the safety and quality of fruit drinks offered by street sellers in Nyeri County.

The project aims to improve the fruit juices sold on the street in Nyeri County in terms of both quality and safety.

You will be required to be completely honest with the enumerator assigned to you about your knowledge of food safety and hygiene practices. The questions the enumerator will ask you once you grant your agreement to participate in the study will be recorded in this form along with your answers. The interview will last roughly 15 minutes with your cooperation, after which the enumerators will depart from your place of business.

The information gathered will only be accessible to study participants and will not be connected to any personal information you provide, such as name, address, or other identifying information. Since the data will be averaged across a large number of participants, it won't be possible to identify you personally from the data.

You or your company have no known risks from this study. You are always free to opt to cease taking part in the study. We do advise you to stick around and answer all the questions, though. You have the right to request that all information collected up until that time be removed or destroyed.

Before the study starts, ask the enumerator if you have any questions about this information sheet.**Consent Form**

Researcher (name):_____Contact:_____

Title of project: Determinants of the safety and quality of fruit juices sold by street vendors in Nyeri County, Kenya

Kindly tick where appropriate:

1. I certify that I have read and comprehend the information sheet for the aforementioned study. I got the chance to think about the information, ask questions, and receive satisfactory answers to my inquiries. ☐
2. I am aware that my involvement is entirely voluntary and that I am free to discontinue at any moment, for any reason, without affecting my legal rights.I understand that relevant sections of information and data collected during the study may be looked at by other members of this research team. ☐
3. I authorize these people to have access to these records. ☐
4. I consent to participate in the study voluntarily and without being required to do so.

Name of respondent: _____

Date: _____
Signature: _____

Appendix 4: