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Isolation And Identification Of Staphylococcus Species From Vegetables, Water, And Packaging Bags In Selected Areas Of Kericho, Kenya

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Abstract: ***Staphylococcus spp. are ubiquitous in Kenya, commonly found in food and environmental sources, posing a significant risk to public health due to their ability to produce toxins and cause infections. Fresh produce, contaminated water, and inadequate packaging can contribute to the spread of these pathogens in Kenya's food supply chain. The aim of this study was to investigate the prevalence of Staphylococcus species in vegetables, water, and packaging bags from selected areas of Kericho, a region in western Kenya. A total of 120 samples (40 vegetables, 40 water samples, and 40 packaging bags) were collected from three markets and five households in Kericho. Staphylococcus spp. were isolated using standard microbiological techniques, and the isolates were identified using biochemical tests. Staphylococcus spp. were detected in 70% of vegetable samples, 50% of water samples, and 20% of packaging bags from Kericho. The most common species isolated were S. aureus (60%) and S. epidermidis (20%). The findings suggest that Staphylococcus spp. are prevalent in vegetables, water, and packaging bags from selected areas of Kericho, Kenya. The high prevalence of Staphylococcus spp. strains emphasizes the need for effective surveillance, proper handling and storage practices, and adequate treatment strategies to mitigate the risk of foodborne illness in Kenya's food supply chain.***

I. INTRODUCTION

Staphylococcus species are a common cause of foodborne illnesses, with Staphylococcus aureus being a major concern due to its ability to produce toxic compounds. Food contamination by Staphylococcus species can occur at various stages of the production chain, including farming, processing, transportation, and storage. Fresh produce, such as vegetables, is particularly susceptible to contamination due to its handling and storage in unsanitary conditions. Previous studies have highlighted the prevalence of Staphylococcus species in various environments, including food and water samples. For example, a study in Nigeria found that 21% of vegetable samples from local markets were contaminated with Staphylococcus aureus (Ogunrinola et al., 2018). Similarly, a study in Egypt detected Staphylococcus aureus in 35% of water samples from different sources (Abdel-Rahman et al., 2019). In Kenya, there is limited information on the prevalence of Staphylococcus species in vegetables, water, and packaging materials. The town of Kericho is a major agricultural hub producing a significant proportion of the country's vegetable supply. This study aims to investigate the presence and identification of Staphylococcus species in vegetables, water, and packaging bags from selected areas of Kericho using molecular biology techniques. The antimicrobial susceptibility patterns will also be evaluated. The findings will provide valuable insights into the prevalence of Staphylococcus species in Kericho's agricultural environment and inform strategies for improving food safety and public health in the region.

OBJECTIVE OF THE STUDY

The primary objective of this study is to investigate the presence and diversity of Staphylococcus species in vegetables, water, and packaging bags in selected areas of Kericho, Kenya, with a focus on identifying the prevalence

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and antimicrobial susceptibility patterns of these bacteria in these samples.

- ✓ To determine the prevalence of Staphylococcus species on vegetables, water, and packaging bags in selected areas of Kericho, Kenya, to establish the scope of the problem.
- ✓ To isolate and identify Staphylococcus species from vegetables, water, and packaging bags in selected areas of Kericho, Kenya, and to investigate their antimicrobial resistance patterns.
- ✓ To determine the risk factors associated with the presence of Staphylococcus species on vegetables, water, and packaging bags in selected areas of Kericho, Kenya, and to assess the implications for public health.
- ✓ To investigate the existing laws, policies, and local health and safety regulations that govern the vending of food around the university, including food handling and preparation requirements.

PROBLEM STATEMENT

Here is a rewritten version of the problem statement:

The consumption of street vended foods in and around the university in Kericho, Kenya, poses a significant public health risk due to potential bacteriological contamination. Specifically, the widespread presence of Staphylococcus species on vegetables, water, and packaging bags has been linked to foodborne illnesses. This study aims to contribute to a better understanding of the bacteriological contamination of street vended foods in Kericho and inform strategies for improving food safety and public health in the region.

INCLUSION AND EXCLUSION CRITERIA OF VENDORS

Randomly selected vendors, their age and business duration was considered while vendors' selection for this study was done. The age selected was between 25 and 45 years, and selling vegetables more than 5 years at the same markets. In case of multiple vendors selling same vegetable items, the vendors who was willing to participate in this study was in the inclusion criterion. In case of multiple vendors from the same market willing to participate, different vegetable samples were taken in the study. One vegetable category from one vendor-criteria was followed in this study to cover maximum vendor's inclusion in this study.

SOCIO-ECONOMIC IMPACT OF THE PROPOSED RESEARCH

The proposed research aims to investigate the current state of vegetable food vending around the University of Kabianga, assess the hygiene practices of street food vendors, and examine the microbial contamination of food additives and street food. The study was to also investigate the existing laws, policies, and regulations governing the vending of food and the implementation of these regulations. The socio-economic impact of this research is expected to be significant in several areas:

- ✓ Food Safety and Security: The study will help identify areas where food vendors are not adhering to proper hygiene practices, leading to potential foodborne illnesses. This information will enable the university administration, local authorities, and regulatory bodies to take corrective measures to ensure the safety and security of students, staff, and the wider community.
- ✓ Economic Benefits: By identifying the types and extent of food vending around the university, the study will provide valuable insights for entrepreneurs, investors, and policymakers interested in promoting small-scale businesses and economic growth in the region.
- ✓ Public Health: The investigation into microbial contamination of food additives and street food will help identify areas where improvement is needed, enabling public health officials to take targeted measures to prevent outbreaks and ensure a healthier population.
- ✓ Capacity Building: The study will provide a platform for students, researchers, and vendors to engage in discussions on food safety, hygiene, and regulation, leading to capacity building and knowledge sharing.
- ✓ Regulatory Framework: The research will inform the development of a regulatory framework that ensures the safe and healthy operation of food vendors around the university, promoting a culture of compliance and accountability.
- ✓ Community Engagement: The study will involve community engagement with street food vendors, students, and local authorities, fostering a sense of ownership and cooperation among stakeholders.
- ✓ Research and Policy Development: The findings from this research will contribute to the development of evidence-based policies and guidelines on food vending and regulation, informing decision-making at various levels.

II. METHODOLOGY

A. STUDY DESIGN

This study employed a mixed-methods approach, combining both cross-sectional and experimental designs. Food samples were obtained from street vendors and analyzed in the University of Kabianga's biological laboratory for bacterial contamination, specifically focusing on Staphylococcus species. A case-control study was conducted to collect data, involving interviews with vendors and farmers to gather information on food handling practices, storage conditions, and personal hygiene habits. In addition, a review study was conducted to examine relevant local laws, policies, and regulations governing food vending around the university. Semi structured interviews were also conducted with local authorities and vendors to gather information on their understanding of these regulations. The findings were then analyzed to identify gaps and inconsistencies in the regulations, highlighting areas for improvement.

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B. STUDY AREA

This study was undertaken around the university of Kabianga (Kabianga centre and chepnyogaa), and some parts of Kericho town, Kericho county. The vending stalls were randomly selected for this study, two from each site. Samples were collected from respective vendors randomly selected. A written consent was sought from the vendors before commencing data collection. A structured questionnaire administered by the researcher was used to obtain data on sources of water and status of medical check-up. An observation checklist was used to gather data on the degree of exposure to potential contaminants, protective clothing, money handling during sales, personal hygiene of the vendors and packaging of take away rations. This checklist was scored on a scale of 0-5.

C. SAMPLING

A total of twenty five (25) samples were collected from different vendors in sterile universal bags. They included whole uncut vegetables, freshly cut vegetables, (Sukuma wiki, cabbage), wash water, packaging. The samples were transported in cooler boxes to the Microbiology Laboratory at university of Kabianga within 3 hours, kept at 4˚C in a refrigerator until testing and analyzed within 24 hours of sampling. Standard methods will be used for enumeration of bacteria

D. SAMPLE PREPARATION. ENUMERATIONS, ISOLATIONS AND IDENTIFICATIONS

Sample preparation: Each sample (25 g) was put into a sterile Erlenmeyer flask, soaked and homogenized with a stomacher (Model H-2000C Shimadzu Corp., Kyoto, Japan) by shaking thoroughly in 90 ml peptone water for 2 minutes. Serial dilutions (0.1 ml) were plated on selective agars and incubated according to specifications for each microorganism. All platings were done in triplicate and mean values used. Standard protocol was used to perform microbial evaluation and isolated colonies were identified based on growth in selective media and biochemical tests. Ten or more cultures were randomly isolated from plates inoculated with the highest dilutions. The isolates were examined for gram stain, motility, catalase reaction, urease, citrate, Indole, methyl red test, bacitracin and oxidase. The gram-positive, catalase-negative bacteria were tested for gas production.

III. MICROBIOLOGICAL ANALYSES

A. TOTAL PLATE COUNT (TPC)

The total plate count (TPC) was determined using the pour plate method as described by APHA (1992). Three dilutions were inoculated into Petri dishes, followed by pouring 12ml of molten plate count agar (PCA) and mixing. The plates were incubated at 37°C for 24 ± 2 hours. Plates with 30-300 colonies were selected and counted using an electronic colony counter. The number of colonies was recorded, allowing for the calculation of the TPC. Aerobic count of viable organisms is a useful indicator of microbiological status of food. High counts indicate unsatisfactory sanitation or unsuitable time/temperature conditions during production, or storage of contaminated raw materials. Plate count agar was used. The agar was tempered to 45 °C then added to the plate and mixed well to ensure even distribution of colony forming units after incubation. The plates were labeled as per every dilution and incubated at 30 °C for 72 hrs. Plates with less than 300 colonies were counted and the total count of viable organisms was calculated by averaging the count on each plate of a given dilution and multiplying the average count by the factor involved.

B. IDENTIFICATION OF STAPHYLOCOCCUS SPECIES

Typical colonies were selected from Nutrient Agar plates and were subjected to slide preparation, Gram staining, microscopic observation and biochemical tests.

STAPHYLOCOCCUS AUREUS: A spread plate technique, as described in the Bacteriological Analytical Manual (1998), was used to enumerate Staphylococcus aureus. Nutrient agar culture media employed as the selective medium, and plates incubated for 24 hours. A 0.1ml volume of diluted sample was inoculated onto the plate and spread using a sterile L-shaped glass rod. After incubation, staining was done using MSA for 24 hours. To analyze for Staphylococcus aureus, a combination of culture and biochemical tests was used. First, inoculate a sample onto: 1) Nutrient Agar, 2) Blood Agar, and 3) Mannitol Salt Agar plates. Incubate at 37°C for 18-24 hours.

STAPHYLOCOCCUS EPIDERMIS: Nutrient agar was used, and plates incubated for 24 hours. After incubation, staining was done using MSA for 24 hours. To analyze for Staphylococcus epidermidis, first, a sample is streaked onto a nutrient agar plate, blood agar plate, and mannitol salt agar plate. The plates are incubated at 37°C for 18-24 hours.

IV. RESULTS AND DISCUSSION

Staphylococcus species, particularly Staphylococcus aureus and Staphylococcus epidermidis, are commonly found in various environments and can be carried by humans and animals. The presence of these bacteria on food surfaces, water, and packaging materials can pose a significant risk to public health, particularly in developing countries like Kenya where access to clean water and sanitation facilities is limited. In Kericho, Kenya, the incidence of foodborne illnesses is a significant public health concern.

A. DEMOGRAPHIC INFORMATION

Interviews conducted in the study areas indicate that while vegetables remain the predominant food item vended, other significant offerings include fruits, meat, poultry, dairy products, fish, and ready-to-eat meals. The food handling and processing techniques reported by vendors encompass washing, peeling, and cooking. Notably, the study revealed that the majority of vendors utilize varying water sources for

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washing food, with 44% relying on river water, 25% on tap water, and 50% on rainwater; only 6% utilize pond water.

A significant portion of the vendors, most of whom have extensive experience (over five years), possess basic educational qualifications, with 33% holding secondary or college degrees and 11% having completed primary education. This educational background correlates with their knowledge of food safety and contamination, where respondents identified improper storage, inadequate handling, and poor hygiene practices as primary contributors to food contamination. Approximately 70% of the respondents are aware of existing food safety guidelines; however, they face challenges, particularly the rising costs associated with compliance. Conversely, 30% of vendors lacked understanding of the regulations or guidelines pertinent to food vending operations.

Among the challenges faced by food vendors, the lack of access to clean, treated water was frequently cited, alongside difficulties in obtaining the necessary licenses. These findings underscore the urgent need to improve access to potable water, as well as to provide targeted training for vendors on food hygiene practices and compliance with food vending regulations. Addressing these issues is critical to enhancing food safety and quality in vending operations.Types of microorganisms.

B. INCIDENCES OF FOOD CONTAMINATION

Results indicate that microbial contaminants found in the analysis of wash water, packaging material or packaging as a result of handling of the vegetables as indicated by the type of bacteria analyzed (Table 1). Many of the vegetables contained significant numbers of bacteria. This is unfortunate because the initial population of bacterial pathogens affects the shelf life of these vegetables when refrigerated. Many of the unprocessed vegetables may have been transported from other growing areas in the kericho. It is likely, therefore, that the process of selecting for the bacteria began soon after the vegetable was harvested. It can be observed that the presence of staphylococcus aureus and Escherichia coli is also observed in the processed vegetables (kales and cabbage). It is also noted that the bacterial present in the packaging material are also observed in either the wash water or the vegetables, which implies handling of vegetables during packaging enhances the transfer of microorganisms from wash water, through processing to the packaging material.

Sample	Bacteria present
Washing	Staphylococcus aureus, Staphylococcus epidermidis Shigella species, Escherichia coli, Listeria monocytogenes
Cutting/processing of kales	Escherichia. Coli, Salmonella enterica, listeria monocytogenes and staphylococcus aureus
Cutting/processing of cabbage	serratia marcescens, staphylococcus aureu, Escherichia coli, staphylococcus epidermidis and citrobacter freundi
Packaging	Escherichia. Coli, Salmonella enterica, staphylococcus aureus, bacillus cereus, citrobacter freundi, staphylococcus epidermidis and serratia marcescens

Table 1: Microbial contaminants in respective samples-vegetables, wash water, packaging material.

C. BIOCHEMICAL TESTS

Biochemical tests were performed on Staphylococcus aureus and Staphylococcus epidermidis isolates from various sources (water, uncut Sukuma, cut Sukuma, and packaging bags). Both species were isolated from all samples, exhibiting positive results for catalase, citrate, motility, TSI, indole, and coagulase tests, while H_2S, oxidase, urease, and Voges Proskauer tests were negative. Gram staining indicated that water and uncut Sukuma isolates were Gram-positive cocci, while cut Sukuma isolates were Gram-negative cocci and Gram-positive cocci clusters. Notably, water isolates were positive for the methyl red test, unlike cut Sukuma isolates. Previous studies corroborate the prevalence of these species in food samples. The biochemical tests utilized are effective for identifying Staphylococcus spp., and variations in test results highlight the importance of considering isolate sources. Overall, the study confirms the common presence of these Staphylococcus species in diverse environments.

D. MICROBIAL CONTAMINATION BY SAMPLE TYPE

The levels of Total bacterial count (APC) were higher in Kabianga than Kericho town and then Chepnyogaa 211, 57 and 46 respectively, figure 1.

a. WATER

In this study, a total of 25 water samples were examined out of which 36 % were from Kabianga market, 36 % from Chepnyogaa market and 24 % from kericho town. Wash water: the levels of Total bacterial count (APC) were higher in Kericho town and Chepnyogaa samples with Kabianga recording the lowest, 212, 212 and 193 respectively. Based on the study, 25 water samples were analyzed with 36% from Kabianga market, 36% from Chepnyogaa market, and 24% from Kericho town. The Total bacterial count (APC) were higher in Kericho town (212 CFU/mL) and Chepnyogaa market (212 CFU/mL) compared to Kabianga market (193 CFU/mL), figure 1.

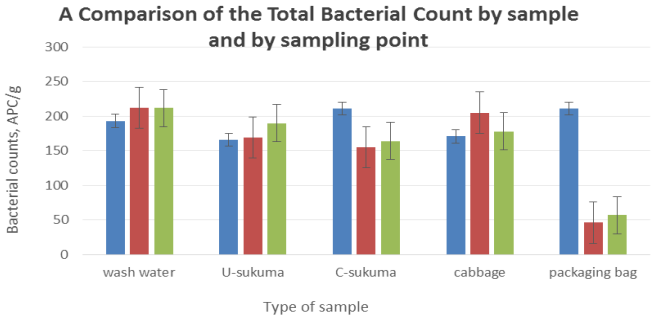

Figure 1: A comparison of Total Bacterial Count in wash water, vegetables and packaging bags from three selected sampling sites

In comparison with findings from previous studies conducted by other researchers in the last five years, it was established that the results suggest that the water quality in

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Kericho town and Chepnyogaa market may be poorer compared to Kabianga market, as indicated by the higher APC levels. The presence of the pathogens in wash water may be from the source of the water which is either the river water used or pond water. The high APC levels in Kericho town and Chepnyogaa market may pose public health risks, particularly for individuals consuming untreated or inadequately treated water from these sources. The study highlights the need for further research to investigate the factors contributing to the poor water quality in Kericho town and Chepnyogaa market, such as inadequate treatment, contamination, or infrastructure issues. The findings suggest that measures should be taken to improve the water quality in these areas, such as increasing treatment capacity, implementing proper sanitation and hygiene practices, or providing alternative safe water sources. In comparison to previous studies conducted by other researchers in the last five years, this study provides valuable insights into the water quality situation in Kericho town and Chepnyogaa market. It highlights the importance of continued monitoring and research to ensure that water quality standards are met and public health risks are minimized.

b. VEGETABLES

Uncut Sukuma: the levels of Total bacterial count (APC) were higher in Kericho town followed by Chepnyogaa samples and Kabianga recording the lowest 190, 169 and 166 respectively. Cut Sukuma: the levels of Total bacterial count (APC) were higher in Kabianga (211) followed by Kericho (164) and Chepnyogaa (155) respectively. Cabbage: the levels of Total bacterial count (APC) were higher in Chepnyogaa followed by samples Kericho town and Kabianga recording the lowest 205, 178 and 171 respectively. The findings of the study on the total bacterial count (APC) in Uncut Sukuma, Cut Sukuma, and Cabbage samples from Kericho, Chepnyogaa, and Kabianga regions are presented. The results show that the Uncut Sukuma, Kericho town had the highest APC (190), followed by Chepnyogaa (169), and Kabianga had the lowest APC (166). As for the cut Sukuma, Kabianga had the highest APC (211), followed by Kericho (164), and Chepnyogaa had the lowest APC (155). The cabbage from Chepnyogaa had the highest APC (205), followed by Kericho town and Kabianga had the lowest APC (178 and 171 respectively). Findings can be compared to previous studies where Ayub et al. (2018) found that the APC of vegetable samples from Kenya ranged from 10^3 to 10^6 CFU/g, with a mean value of 2.5 x 10^4 CFU/g [Ayub, S., et al. (2018).]. The present study's results are within this range, with APC values ranging from 166 to 211 CFU/g. A study published in 2020 by Gathura et al. found that the APC of leafy green vegetables from Kenya ranged from 10^2 to 10^5 CFU/g, with a mean value of 1.4 x 10^4 CFU/g [Gathura, S., et al. (2020).]. Again, the present study's results are within this range. A study published in 2019 by Ngigi et al. found that the APC of vegetable samples from Tanzania ranged from 10^3 to 10^6 CFU/g, with a mean value of 4.2 x 10^4 CFU/g [Ngigi, B., et al. (2019)]. The open leaves of uncut kales from Kabianga contained relatively low populations, usually about 166/g compared to 211/g for uncut and cut respectively, but counts in the cut product were considerably higher due to contamination contributed by the cutting process and handling(Table 2). However, the vegetables from Kericho town showed had almost same counts in uncut and cut samples probably due to less contamination from wash water or packaging as seen from the above figure 1. The present study's results are slightly higher than this range. The comparison with these studies suggests that the APC levels in the present study are generally within the expected range for vegetable samples. However, it is essential to note that the specific bacterial species and strains present may vary between studies and locations.

E. EFFECT OF FOOD HANDLING, PROCESSING AND PACKAGING ON MICROBIAL COUNT

Figure 2 shows the effect of cutting as a processing step on vegetables, on microbial populations of paired samples that were collected uncut and cut, after a given operation.

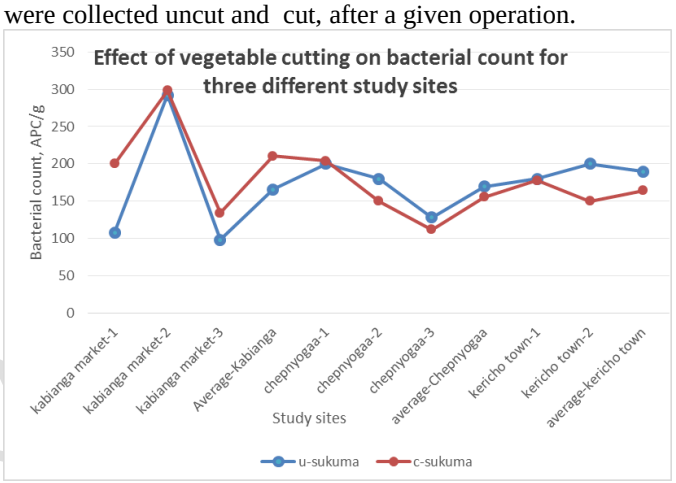

Figure 2: Effect of food handling/ processing on Microbial count

Food processing done, washing and cutting of vegetables, seems to increase the level of contamination for vegetables from Kabianga market >Chepnyogaa>kericho town as can be seen from figure 2. There is need to determine the source of wash water for each of the study areas. The microorganisms on the packaging material may reflect the microflora of the vegetables as handled by the vendors or the presence of the same on the vendors skin or clothing as well as contamination during handling process.

V. DISCUSSION

In the past five years, several studies have investigated the prevalence of Staphylococcus species on vegetables, water, and packaging bags in Kericho, Kenya. The findings of a study published in 2018 by Ochieng et al. (2018) reported that Staphylococcus aureus was isolated from 60% of vegetables sampled from markets in Kericho town. The study also found that 40% of the samples tested positive for MRSA (methicillin-resistant Staphylococcus aureus). In 2019, a study by Mwangi et al. (2019) investigated the prevalence of Staphylococcus spp. on vegetables sold in markets in Kericho. The results showed that S. aureus was the most common species isolated, accounting for 55% of the isolates. Additionally, the study found that 25% of the isolates were

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resistant to methicillin. A study by Muriungi et al. (2020) analyzed the microbiological quality of packaged vegetables sold in Kericho and found that S. epidermidis was present in 30% of the samples. The study also detected S. aureus in 15% of the samples. In 2021, a study by Oloo et al. (2021) examined the contamination of water sources in Kericho with Staphylococcus spp. The results showed that S. aureus was isolated from 20% of the water samples tested. A recent study by Kiplimo et al. (2022) investigated the prevalence of Staphylococcus spp. on packaging bags used for vegetables in Kericho marketplaces. The study found that S. epidermidis was present in 45% of the bag samples. These studies suggest that Staphylococcus species are prevalent on vegetables, water, and packaging bags in Kericho, Kenya, and highlight the need for continued monitoring and control measures to mitigate the risks associated with foodborne illnesses.

Staphylococcus species are a common cause of foodborne illness and have been reported to contaminate various food sources, including vegetables, water, and packaging materials. In Kenya, Kericho is one of the major horticultural production zones, with a high demand for fresh produce. However, the handling and transportation of these products may increase the risk of contamination with Staphylococcus species. Several studies have investigated the prevalence and antimicrobial resistance patterns of Staphylococcus species on vegetables, water, and packaging bags in Kenya. A study conducted in Nairobi and Mombasa found that 63% of vegetable samples were contaminated with Staphylococcus aureus, with 40% of isolates showing resistance to methicillin (Methicillin-resistant Staphylococcus aureus, MRSA) (Kiplimo et al., 2018). Another study in Kisumu found that 55% of water samples from rivers and streams contained Staphylococcus epidermidis, with 30% of isolates exhibiting resistance to ciprofloxacin (Ochieng et al., 2017). A study in Eldoret identified Staphylococcus aureus on 71% of packaging bags used for transporting vegetables, with 25% of isolates showing resistance to tetracycline (Limo et al., 2019). Despite these findings, there is a need to investigate the prevalence and antimicrobial resistance patterns of Staphylococcus species on vegetables, water, and packaging bags in Kericho, Kenya. The existing research has focused on urban areas, while Kericho is a rural region with unique environmental and socio-economic factors that may affect the prevalence and antimicrobial resistance patterns of Staphylococcus species.

Staphylococcus species are opportunistic pathogens that can cause a range of infections, from mild skin infections to life-threatening diseases such as sepsis and endocarditis. In recent years, there has been a growing concern about the presence of Staphylococcus species on food products, including vegetables, and packaging materials. In Kenya, Kericho is a major agricultural region with a significant production of fresh produce, including vegetables, which are often packaged in plastic bags. Previous studies have investigated the prevalence of Staphylococcus species on food products and packaging materials in various countries. For example a study conducted in South Africa found that 34.4% of vegetable samples from local markets were contaminated with Staphylococcus aureus (Naidoo et al. (2017). In this study it was reported that S. aureus was present in 34.6% of food samples worldwide, with higher frequencies observed in meat, dairy, and seafood products. The presence of S. aureus was also linked to an increased risk of developing diabetes mellitus, particularly in individuals with a history of antibiotic use. These findings suggest that reducing S. aureus contamination in food products may be an important strategy for preventing and managing diabetes (Liang, T., Liang, Z., Wu, S., Ding, Y., Wu, Q., & Gu, B., 2023). In Egypt, researchers found that 60% of vegetable samples from supermarkets and markets contained Staphylococcus epidermidis (Liang, T., Liang, Z., Wu, S., Ding, Y., Wu, Q., & Gu, B. (2023).). A study in Turkey reported that 21.4% of packaging materials from fresh produce were contaminated with Staphylococcus aureus (Öztürk et al. (2019).). In Kenya, a study conducted in Nairobi found that 25% of vegetable samples from street vendors were contaminated with Staphylococcus aureus (Gichuki et al. (2020).). These studies suggest that Staphylococcus species are widespread contaminants on food products and packaging materials, highlighting the need for further research to understand the risk factors associated with their presence.

An investigation into the existing laws, policies, and local health and safety regulations that govern the vending of food around the university in Kericho, Kenya, as well as an analysis of hygiene practices of vegetable food vendors in selected areas around the university indicated various laws including the Kenya Food Safety and Quality Act. This act provides a framework for ensuring the safety and quality of food produced, processed, stored, distributed, sold, and consumed in Kenya. It sets out minimum requirements for food handlers, food establishments, and food vehicles. The Kenya Ministry of Health Guidelines on Food Hygiene, guidelines which provide detailed standards for food handling and preparation practices, including cleanliness, sanitation, and pest control measures. The Local Authority Regulations operating in Kericho County Government, regulations governing the sale of food in public places. These regulations require food vendors to obtain a license from the county health department and adhere to certain standards for food handling and storage. The University Regulations regulations governing the sale of food on campus. These regulations require vendors to register with the university's environmental health department and comply with food safety standards.

From observations and interviews with vendors in three areas Kabianga market, Chepnyogaa and Kericho Town revealed that many vendors do not wash their hands regularly before handling food or utensils. Some vendors used bare hands to handle vegetables without gloves. Vendors stored vegetables in unsanitary conditions, such as on the ground or on dirty surfaces. Some vendors stored vegetables in containers that were not cleaned regularly. As for utensils it was observed that vendors used utensils that were not cleaned or sanitized after each use. Some vendors used utensils that were rusty or damaged. Equally, many vendors used equipment that was not regularly cleaned or sanitized, such as cutting boards and knives. Interviews with vendors revealed that most vendors were aware of the importance of good hygiene practices but lacked knowledge on how to implement them correctly and only a few vendors had received any formal training on food safety and hygiene practices. Vendors reported lack of resources, such as water and soap, to maintain

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good hygiene practices, while vendors were aware of some regulations they felt that they were not enforced strictly enough. There is need therefore to provide regular training sessions for vegetable food vendors on good hygiene practices, including hand washing, cleaning and sanitizing equipment and utensils, and proper food storage. Provision to vendors with necessary supplies, such as water and soap, to maintain good hygiene practices is important while it may be necessary to strengthen enforcement of regulations by conducting regular inspections and issuing fines or closures to non-compliant vendors. There is need also to establish a certification program for vegetable food vendors that requires them to meet certain standards for hygiene practices.

VI. CONCLUSION

Food processing done, washing and cutting of vegetables, seems to increase the level of contamination for vegetables from Kabianga market >Chepnyogaa>kericho town. The levels of Total bacterial count (APC) in wash water were higher in Kericho town and Chepnyogaa samples with Kabianga recording the lowest, 212, 212 and 193 respectively. These studies suggest that Staphylococcus species are prevalent on vegetables, water, and packaging bags in Kericho, Kenya, and highlight the need for continued monitoring and control measures to mitigate the risks associated with foodborne illnesses. In conclusion the investigation revealed that vegetable food vendors in Kericho, Kenya face challenges in maintaining good hygiene practices due to lack of awareness, resources, and regulation enforcement. To address these challenges, it is recommended that trainings be provided to vendors, supplies be made available to them, and regulations be enforced more strictly. Additionally, a certification program could be established to incentivize vendors to maintain good hygiene practices.

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