Hygiene Practices and Microbial Contamination of Street-vended Foods in Kenyatta University's Environs

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***Abstract* — Street-vended foods are a major threat to public health because of their microbial contamination. This study investigated hygiene practices and microbial contamination of street foods in Kenyatta University's environs. Both cross-sectional and experimental designs were adopted. Four (4) major vending stalls at the main entrance to Kenyatta University, gate (A) and at the hind gate at KM shopping center were identified for this study. Twelve (12) food samples were collected from these stalls; sausages, samosas and kachumbari. The foods were collected and transported in cooler boxes to the Microbiology Laboratory at Kenyatta University within 3 hours for analyses. Standard microbiological methods were used for enumeration of Salmonella, coliforms and Escherichia coli. No Salmonella was detected per 25g in all food samples tested. Fifty percent (50%) of kachumbari samples tested positive for E.coli whereas samosas and sausages tested negative. Kachumbari, from all vending stalls, had total coliform levels 4.12 $\log_{10}$ cfu/g, 4.26 $\log_{10}$ cfu/g and 4.21 $\log_{10}$ cfu/g, that did not meet the quality standards (4.00 $\log_{10}$ cfu/g) for ready-to-eat foods. Total coliform counts were below detection limits in samosas and sausages. All (100%) the stalls were exposed to potential contaminants: 75% of the vendors did not wear protective clothing, they handled money and sold food simultaneously, and polythene bags exposed to open air, were used for packaging take away rations. All the foods evaluated were safe for human consumption except kachumbari. Policies on safe street food to be enforced and education and training of vendors on environmental and personal hygiene to be strengthened.**

***Index Terms* — Hygiene, Microbial contamination, Street-vended foods.**

I. Introduction

Street-vended foods are ready-to-eat foods and beverages which are prepared and sold by vendors in towns and public places. Vending of street foods is a growing trade worldwide. The advent of urbanization has led to an increase in urban population giving rise to the expansion and growth of street food trade in many countries. Vending street food plays an important socio-economic role in meeting the food and nutritional requirements of urban residents at affordable prices to the lower and middle income groups [1]. Further, vending of street foods provides employment and income for many people [2]. Increased urbanization has resulted in a progressively high proportion of urban food consumers particularly those who do not have much time to prepare their own food or go to eating places [3], [4]. A study in India showed that 42% of working women and men between 25-45 years, and 61% of students between 14-21 years consumed foods from the streets at least once a day [5]. While it is regularly thought that children under-five is fed from home [6] observed that many mothers working at the markets in Accra sometimes fed their babies on food items from street vendors.

In Kenya, forty (40%) percent of Nairobi residents consume these foods [7]. With the recent increase in student population in Kenyan universities, there has been a steady rise in the number of street food vendors selling to university students, staff and the local community. Besides providing nutritional requirements, street foods are appreciated for their unique flavors, convenience and increased reliability to consumers [8]. It is apparent that consumption of street vended foods is common and plays an essential role in meeting the daily nutritional requirements of urban populations hence; the safety of these foods is of great significance and therefore deserves attention.

Despite these benefits street vended foods are perceived to be a major public health risk and pose numerous health concerns. The most important health hazards related to foods sold in the streets include microbial contamination, environmental contamination, use of unauthorized chemical additives, parasitic transmissions and pesticide residues [9]. Microbial contamination of street foods is the major cause of foodborne illnesses like diarrhea, cholera, typhoid fever and food poisoning [10, 11]. Contamination of street foods with pathogenic microorganisms has been well documented and several outbreaks of diseases have been traced to consumption of contaminated street foods [12]. WHO estimated that up to 70% of diarrheal diseases may be caused by contaminated foods and that food borne diseases are the major cause of illness leading to an estimated 2.1 million deaths globally most of whom are children in developing countries [13]. Foodborne bacterial pathogens commonly detected in street vended foods are *Bacillus cereus, Clostridium perfringens, Staphylococcus aureus* and *Salmonella* spp [14]. Studies have shown that street foods are sometimes sold in very dirty surroundings, are held at improper temperatures and are poorly handled by the vendors, hence making them prone to contamination [15]. In addition, the food vendors have been reported to present serious safety and health concerns to consumers; most of them lack knowledge in safe food handling practices, environmental sanitation and hygiene. Lack of clean running water also influences the risk of contamination [16]. Indeed, when street foods are prepared in unhygienic and unregulated environment, they could contribute to increased

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food safety burden [17]. Several studies on the microbial contamination of street vended foods and their probable risks have been done globally [8, 18] and in Kenya [1], [3], [7], [16], [19]. However, there is scanty data on the microbial composition of street vended foods in the environs of institutions of higher learning in Kenya, and in particular around Kenyatta University. Therefore, the aim of this study was to establish the microbial safety of street foods and the hygiene practices of street food vendors in Kenyatta University's environs.

II. Methodology

A. Study Design

This study which was carried out between March and April 2019, adopted both the cross-sectional and experimental designs. Submit your manuscript electronically for review.

B. Study Area

This study was undertaken in Kenyatta University's environ's. Kenyatta University is a public university located in Kahawa off the Nairobi-Thika highway, Kiambu County, Kenya. It is approximately 18 Kilometers North-East of the Central Business District (CBD) of Nairobi, the capital city of Kenya. The coordinates of Kenyatta University main campus are 1°10'50.0"S, 36°55'41.0"E.

C. Sampling and Sample Collection

Kenyatta University has one main entry and one exit gates. The main gate at the front of the university (gate A) and another gate at the back near the KM shopping center. Near these gates is a total of twelve (12) vending stalls. Out of these, four (4) vending stalls were randomly selected for this study, two from each site. Three food samples, sausages, samosas (fried pastry filled with minced beef or lentils) and kachumbari (a raw vegetable salad made from ripe tomatoes, red bulb onions, coriander and fresh chilies) were purchased from each stall. A total of twelve (12) food samples were collected in sterile universal bags and transported in cooler boxes to the Microbiology Laboratory at Kenyatta University within 3 hours, kept at 4˚C in a refrigerator until testing and analyzed within 24 hours of sampling. Standard methods were used for enumeration of bacteria [20].

D. Questionnaire Survey

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.

E. Microbiological Analyses

Food samples (25 g) were homogenized with a stomacher (Model H-2000C Shimadzu Corp., Kyoto, Japan) 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 [21].

i. Aerobic Counts of Viable Microorganisms in Food

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 [22].

ii. Salmonella

Pre-enrichment was done in buffered peptone water (origin) at 35 °C for 16 hours, 0.1 ml of this plated on Brilliant Green Agar (Oxoid) and incubated at 42 °C for 24 hours [23].

iii. Escherichia Coli and Coliforms

Violet-Red-Bile agar (origin) was used and plates were incubated at 37 °C for 18 hours. The results of those that were positive for coliforms were tabulated and the most probable number indicated using the MPN chart. After incubation, fermentation and gas production was checked then KOVAC's reagent added to its corresponding peptone water. The presence of E. coli was indicated by a red ring at the surface of the medium. The number of E. coli was then tabulated using the MPN chart [24].

F. Data Analysis

The Statistical Package for the Social Sciences version 22.0 was used to analyze data from the survey while food contamination was analyzed based on the International Commission on Microbiological Specifications for Foods (ICMSF) standards on microbial quality of ready-to-eat foods [25].

III. Results

A. Location of the Food Vendors

Fifty percent (50%) of the vendors were located at the main entrance into Kenyatta university (gate A) while another fifty percent (50%) were located at the hind gate near KM shopping center. These vendors all had push carts that were roofless, and the sides of the structures made of tin material.

B. Food Handling Practices of Street Food Vendors

Twenty five percent (25%) of the respondents reported to have medical examination more than 3 months apart, 50% after every 3 months while 25% had never gone for medical check-up. None of the respondents had fresh running water. In terms of protective clothing, 25% of the respondents always wore an apron while handling food, 25% wore gloves but none of the respondents covered their hair while

handling food. Three quarters (75%) of the vendors received money simultaneously as they served food. In terms of packaging of the take away rations, 75% used paper bags, 25% used polythene bags and none used plastic food containers (Table 1).

TABLE 1: FOOD HANDLING PRACTICES OF STREET FOOD VENDORS

	Frequency	Percentage
Medical examination		
After every 3 months	2	50
After more than 3 months	1	25
Never	1	25
Total	4	100
Access to fresh running water		
Yes	0	0
No	4	100
Total	4	100
Always wear the apron		
Yes	1	25
No	3	75
Total	4	100
Always wear gloves		
Yes	1	25
No	3	75
Total	4	100
Always cover hair		
Yes	0	0
No	4	100
Total	4	100
Handling of money		
Receiving money as they serve food	3	75
Money received by separate person	1	25
Total	4	100
Packaging take away rations		
Polythene bags	1	25
Paper bags	3	75
Plastic food containers	0	0
Total	4	100

C. *Microbial Quality of Food Samples*

Aerobic Plate Count (APC) also called total viable count was done to indicate microbial quality of the food samples. Food samples were categorized into three (satisfactory, acceptable and unsatisfactory), depending on the number of colony forming units obtained after the APC (ICMSF, 2006). Based on the three categories, all samples of *samosas* and sausages were satisfactory (APC = $<10^4$) while samples of *kachumbari* were unsatisfactory (APC =>10^5) (Table 2).

TABLE 2: THE MEAN LOG10 BACTERIA COUNT FOR THE VARIOUS FOOD

Food type	Mean $\log_{10}$ cfu/g
Samosas (n=4)	10×10^0
Sausages (n=4)	10×10^0
Kachumbari (n=4)	4.13501×10^5

D. *Indicator Organisms and Pathogens*

Presumptive test showed *kachumbari* samples (4/4) (100%) were coliform positive. *Kachumbari* from all the vending stalls had total coliform levels 4.12 $\log_{10}$ cfu/g, 4.26 $\log_{10}$ cfu/g and 4.21 $\log_{10}$ cfu/g that did not meet the quality standards (4.00 log10 cfu/g) of ready-to-eat foods (ICMSF, 2006). On the other hand, *samosas* and sausages tested negative for coliforms (Table 3).

TABLE 3: DETECTION OF TOTAL COLIFORMS USING THE MPN TECHNIQUE (PRESUMPTIVE TEST)

Food type	Frequency of food samples that tested positive for total coliforms	Percentage of food samples that tested positive for total coliform
Sausages (n=4)	0	0
Samosas (n=4)	0	0
Kachumbari (n=4)	4	100

Key: *MPN- Most Probable Number.

Total coliform levels were detected in all (100%) *kachumbari* samples but not in the *samosa* and sausage samples. *E. coli* was detected in (2/4) (50.0%) of *kachumbari* samples but not detected in *samosa* and sausage samples. *Salmonella* was not detected in any of the samples tested (Table 4).

TABLE 4: PREVALENCE OF INDICATOR ORGANISMS AND PATHOGENS DETECTED IN FOOD SAMPLES

Indicator organism	**Food sample**		
	***Samosas* (n=4)**	**Sausages(n=4)**	***Kachumbari* (n=4)**
Total coliforms (TC)	0 (0%)	0 (0%)	4 (100%)
E. coli	0 (0%)	0 (0%)	2 (50.0%)
Salmonella spp	0 (0%)	0 (0%)	0 (0%)

IV. DISCUSSION

A. *Compliance with Medical Requirements*

Results from this study revealed that there was non-compliance in observing appropriate health measures. [16] reported that about a quarter (42%) of the food handlers in their study had no valid medical certificates. These results contravene the provisions of the Public Health Act CAP 242 and the Food Drugs and Chemical substances Act CAP 252 of the laws of Kenya which demand total compliance in good food handling practices. Hence these results suggest weakness in the enforcement of the Public Health Act and the Food Drugs and Chemical substances Act or ignorance on the part of the food handlers.

B. *Location of the Food Vendors*

The location of the food vendors may exacerbate contamination of food. Most vendors congregate in overcrowded areas where there are high numbers of potential customers. In this study the vendors were located in busy crowded areas and had push-carts that had no canopies. These conditions allow dust, flies and exhaust fumes to find their way into the food causing contamination hence posing a health hazard to consumers of these foods. A study by [26] found that only 29% of the vending sites had a canopy while [17] reported that 33% of the vendors in her study were sheltered. Both these findings are contrary to the findings of the present study. According to [3] these kinds of structures do not adequately protect street foods from vehicles' smoke, surrounding dust and flies which carry many pathogenic microbes hence, they are a health risk to the consumers.

C. Food Handling Practices of the Food Vendors

Water is a critical raw material in all street-vended operations. In this study virtually all (100%) vendors did not have access to fresh running water. Contaminated water can create a public health risk when used for drinking, or for washing utensils and hands. Poor access to fresh running water can harbor fecal bacteria and serve as a source of bacterial contamination in food. Due to the shortage of clean potable water, many vendors tend to re-use water, especially for cleaning dirty dishes [11] hence increasing chances of cross contamination and subsequent transfer of pathogens to food. Further, some food handlers wash their hands in the same bucket used for cleaning utensils a practice that may lead to contamination of food with fecal matter. Re-used water contains diffused organic materials which act as a culture medium that allows proliferation of several pathogenic microorganisms, hence compromising food safety [17].

Appropriate clothing for food preparation is essential in maintaining high hygienic standards. In this study most of the vendors did not wear any protective clothing such as an apron, gloves or covered hair. Similarly, [17] found that out of the 15 street vendors studied, only 8 (53%) wore protective clothing. [16] reported that out of 242 food handlers studied, 21% worked without protective garments, 31.5% wore dirty uniform and 76.6% had no head gear. Failure to wear protective clothing while serving food has been identified as the likely cause for contamination of food [27].

Majority of the food vendors in the present study handled food as well as money with bare hands at the same time. This concurs with findings from [17] who observed that all the vendors in her study served the chicken products while at the same time handled money. These findings are also in agreement with observations by other researchers [3,16, 28] who noted that street vendors handled money as well as food with bare hands. Despite [29] recommending the use of disposable gloves and clean tongs, forks, or spoons during handling of food, none of the interviewed street vendors handled food with any special equipment or disposable gloves [17]. Therefore, it is recommended that food handlers should not handle food with bare hands and handle money simultaneously to avoid incidences of cross contamination that can be a health risk [30].

Personal hygiene is crucial while handling food because human beings have been reported to be the major contamination sources of foods. In most cases, the vendors do not have adequate washing facilities, and some sleep at the vending sites to protect their wares [3] while others start their duties without taking a proper bath, hence pose a risk to consumers. Unsanitary handling of food by some vendors has been found to be the source of contamination. The vendors can be carriers of pathogens like *Escherichia coli, Salmonella, Shigella, Campylobacter* and *S. aureus,* then eventually transfer this food borne hazards to the consumers. A study in Santa Fe de Bogota, Colombia revealed that over 30% of a group of food handlers examined were carriers of *Salmonella typhi*, *Staphylococcus aureus*, *Salmonella enteritidis*, and *Shigella* [11]. Therefore, food handlers' hands are the most important vehicle for the transfer of pathogenic organisms. This underscores the need for regular training and sensitization on personal hygiene, safe handling practices to prevent microbial contamination of food.

Street foods are also subjected to contamination from the materials used for wrapping, such as reusable polyethylene bags [31]. In the present study most of the vendors used packing bags which were exposed to the environment. [32] observed that pathogens may invade the interior surfaces of the bags during packaging due to poor handling by the vendors. Sometimes the vendors blew air into the polyethylene bags to open them before packing food, in this process a number of pathogens can be passed on to the consumer.

D. Food Holding Temperatures

Food storage temperature is an important contributing factor to further increase in contamination. The preparation of food long before its consumption and storage at ambient temperature are identified as key factors that contribute to food poisoning outbreaks. In the present study all the food items were cooked elsewhere and kept at ambient temperature in the cart awaiting sale. No microbial contamination was tested in the sausages and *samosas* possibly due to heat treatment during preparation and being kept in a heated cart awaiting sales. On the other hand, the warm temperature in the cart may have favored the development of microbial organisms tested in the *kachumbari*. Holding foods at ambient temperatures for long periods of time encourages the occurrence of food poisoning outbreaks [33] and harbor high microbial populations [3].

E. Microbial Quality of the Food Samples

The overall occurrence of food contamination based on the enumeration of total coliforms, *E. coli* and *Salmonella spp.* in this study was 41.7%. [23] observed nearly similar occurrence (35%) according to microbiological criteria. On the contrary, a lower food contamination occurrence (3%) was observed in Doha, Qatar and this was attributed to food safety training and certification requirements set by authorities licensing and inspecting the food handlers [34]. Total viable counts in all samples varied between 10.0–4.135×10^5 cfu/g. In the present study, *kachumbari* tested positive for total coliforms. This can be attributed to excessive post handling and use of raw contaminated vegetables. These findings differed from those by [35] who observed a higher coliform contamination (41.3%). The presence of coliforms in street vended foods may be linked to contamination due to use of contaminated water during preparation and washing, lack of proper heating or contact with contaminated surfaces such as chopping boards and knives [21].

The mean for *E. coli* was several orders high compared to the Kenya Bureau of Standards recommended value. Comparable findings were reported by [23]. [36] reported high levels of *E. coli* in *kachumbari* and attributed it to unhygienic practices. *E. coli* survives in the human gastro-intestinal tract and is normally found in faeces, therefore its presence in food indicates fecal contamination during preparation or from the materials used. The presence of *E. coli* in *kachumbari* may also be attributed to poor post handling processes, poor hygiene practices, the vendors' failure to wear protective clothing such as aprons, gloves and head gear or handling money and food with open palms.

V. Conclusion

Food vendors stationed outside the two gates of Kenyatta University do not fully comply with the food handling practices and health measures laid out in the Public Health Act Cap 242 Article 26 (1) and the Food, Drugs and Chemical Substances Act Cap 254 laws of Kenya, therefore food borne illnesses and poor food handling practices are a major threat to public health. These practices may predispose consumers to food borne illnesses. *Kachumbari* poses a great risk to consumers rendering it unsafe for consumption. The Kenyan government through the relevant ministries should strengthen and enforce policies for safe street food trade and create awareness among the street vendors and consumers through regular education and training on food safety and hygienic practices in handling food. Future studies may be carried out to cover other pathogens not included in this study.

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