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Isolation and Identification of Bacterial Contaminants and the Potential Link between Food Contamination and the Risk Factors in Selected Cooked Street Foods on Mombasa Island

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Abstract

The street food sector has experienced significant growth in the past few decades due to rapid urbanization. Despite the economic benefits of the sector, it has been recognized as a potential hazard to public health when food is not prepared and handled hygienically. The objective of this study was to isolate and identify Bacterial contaminants and establish the potential link between food contamination and the risk factors in selected cooked street foods on Mombasa Island. The study adopted a descriptive survey and experimental design. One hundred vendors were selected using purposive and systematic random sampling. Representative samples of the food items were randomly collected from five vendors in each of the three locations for microbiological analysis. Standard methods from the Bacteriological Analytical Manual of Foods were used to determine coliform counts, total plate counts, and isolate *Ecoli* and *Salmonella strains*. One hundred vendors were selected using simple random sampling method. From the census in the area, there were 130 vendors selling these three food items. Sample size was 107 vendors. Questionnaires were administered to vendors. Data analysis was done using Statistical Package for Social Sciences (SPSS) computer software. Chi-square ($\chi 2$) was used to test the relationship between training and various aspects of hygiene. T- Test and Analysis of Variance was used to assess any significant differences between the three areas and between male and female, respectively. The International Commission of Microbiological Specification for Foods standards, (1996), were used to determine the acceptable limits of the bacterial counts in the food items tested. From the study results, *Salmonella* was detected in 8.9% of the 45 samples analyzed, which were beef samosas. These

samples were considered contaminated, as *Salmonella* should be absent in all food items prepared and sold for consumption. The presence of *Salmonella* in the beef samosas could have been due to improper food handling or use of leftover foods. Unhygienic practices by some of the vendors, and probably insufficient cooking or reheating of the meat product could have been a contributing factor. This study confirmed the results of others that have identified meat products as being liable to contamination if not well handled.

Keywords: *E.Colli, Salmonella, Street food, Bacterial Contaminants, Food Contamination and Mombasa Island.*

1.0 Introduction

1.1 Background of the Study

The characteristic of street foods is their retail location, that is '"on the street": from pushcarts, baskets, trays or basins with few having permanent structures. According to Draper (l996), they are an extremely heterogeneous food category encompassing, meals, drinks, and snacks. The street food trade is a growing sector in many developing countries today. Its expansion is linked to urbanization and the need of urban populations for both employment and food. Urbanization is characterized with considerable distance between home and workplace, tight time schedules and long working hours (Mwangi, 2002).

The street food trade is a necessary part of the urban modem day life, especially in a developing country like Kenya. This trade however, is seen as a problem, a challenge, and an opportunity for development (WHO and Ministry of Health, Kenya, 1994). The problem is control of quality and safety of foods offered for sale while the opportunity is the strengthening of traditional and local food habits, and development of small industries and cooperative marketing structure. The burden of food-borne diseases is significant in all parts of the world (FAO, 2001b). For some notable food-borne hazards, the reported incidence of diseases has increased over the last decades. While cooked street foods provide an essential service to a large population and a source of income for a large number of sellers, they are recognized as a possible hazard to public health (Garin et al., 2002).

Microbiological agents such as, bacteria, viruses, and parasites are the cause of the food-borne diseases (FAO/WHO, 1984). They are manifested with gastrointestinal symptoms such as diarrhea, abdominal pain, nausea, and vomiting (FAO/WHO, 986). The social and economic impact of food contaminants is of serious consequence to many countries. Food-borne diseases are very costly in terms of loss of income manpower and medical care (Motarjemi *et al*., 1995). For example, the cost of treating *Salmonellosis* was estimated to be US$1000 million in 1987 in the United States of America. According to Altekruse et al., (1995), over 10 percent of the United States population experience food borne illness each year, at an annual cost of $10 billion.

Against the above background, if street vended foods are going to play an increasingly important role in national economy, current information on such aspects as food-borne health risks and constraints to compliance with the *Codex Alimentarius* standards is required. Other considerations would include cultural eating habits and awareness of the vendors regarding food safety, hygiene and quality assurance.

1.2 Problem Statement

In many developing countries, street vended foods are an increasingly important part of daily life. However, the livelihoods of those in this informal food business and the health of consumers could be jeopardized if problems of food safety and hygiene are not addressed. The hygienic aspect of vending operations is a major concern. Stands are or often located in areas where running potable water is not readily available and sanitation is poor. Safe food storage temperatures are difficult to maintain, as food is often displayed for long periods. Some foods may not be adequately reheated before being served, thus leading to contamination by microorganisms such 3S *Salmonella*. III addition, adequate washing facilities are rarely available, and the washing of hands, utensils and dishes are often done in buckets or bowls. Some vendors operate a few meters away from garbage dumps and discard wastewater in the streets.

These practices attract insects and rodents to food service points, and pose the risk of contamination especially to the inadequately covered food items. In many cases, toilets are not available, thus forcing the vendors to dispose of body wastes in nearby areas, and return to their vending sites without washing their hands. These poor sanitary conditions with the pollutants are likely to contaminate food with all kinds of pathogenic organisms. The majority of consumers, who are not aware or concerned about safety, are also exposed to substantial health risks.

Despite the adverse socio-economic and health consequences of contaminated foods and beverages, food-borne diseases have not been are not adequately investigated in order to develop quality control measures and policy formulation. Presently, application of the general principles of food hygiene, in accordance with the Codex Alimentarious Commission standards and codes of practice, is central to global efforts to prevent food contamination and ensure food safety in the food chain. Unfortunately, the application of such standards and principles is limited and difficult to be met by street foods vendors in developing countries. This study sought to isolate and identify bacterial contaminants particularly, *Escherichia coli* and *Salmonella* and establish the potential link between food contamination and the risk factors in selected cooked street foods on Mombasa island.

1.3 Objective of the Study

i. To isolate and identify bacterial contaminants particularly, *Escherichia coli* and *salmonella* in selected cooked street foods on Mombasa Island.
ii. To establish the potential link between food contamination and the risk factors in selected cooked street foods on Mombasa Island.

2.0 Literature Review

2.1.1 Socio-economic Contribution of Street Vended Foods

Street food vending is a global business, and the trade makes substantial contribution to urban economies (WHO, J 996). The street food sector has experienced substantial growth due to the socio-economic changes in many countries (Kishwar, 2001). It is estimated that, two and a half billion people worldwide consume street foods (FAO, 2001 b). It provides employment for a large number of people especially women. In Kenya, the majority of vendors are women who balance

the income generating opportunities of street vending, with traditional household and child-care duties (Mwangi, 2012). School children depend on street foods (FAO, 1997).

For example, school canteens in Chonburi, Thailand and Iloilo, Philippines used local street food vendors to supply them with a daily light meal. In addition, in lle-ife, Nigeria, 96 percent of elementary school children typically buy their breakfast from street vendors. Studies on street foods conducted across Asia found that street foods are not only cheaper than restaurant or fast foods, but are more cost effective them home prepared foods (Kishwar, 2001: Tinker, 1997).

According to Escalante (2001), the street food trade is vital for the providence of income to the small farmers. These fanners supply the food vendors with the local produce, thus stimulating and generating employment in the agricultural sector. Street food vendors/hawkers use fresh, unpackaged, and locally sourced ingredients for their foods, thereby providing income for the local farmers. If they are eliminated, these small-scale farmers would lose to the large-scale producers who are able to sell to formalized sector of major retail and distribution networks.

Street foods may be the least expensive and best method of obtaining a nutritionally balanced meal outside the home, if the consumer is informed and able to choose the proper combination of food. In Kenya, vast majority of vending households feed from the street food pot on a daily basis (Mwangi, 2002). These foods are able to provide more than adequate protein, iron, and substantial amounts of daily energy requirements. Another important aspect of street vended foods is the crucial role it plays in the preservation of traditional and local culture (Escalante, 2001). Some traditional snacks or foods only appeal to consumers by the way the vendors prepare them on the streets. Preparation of some traditional foods (like githeri) is usually time and fuel consuming for the urbanite (Mwangi, 2002).

2.1.2 Food Safety in Street Vended Foods

Food can be exposed to pathogenic agents, both chemical and biological (viruses, parasites and bacteria), from which no one in either developing or developed countries are spared (WHO, 2003). The safety of foods is therefore a serious consideration, which deserves considerable attention, as it is the first step in reducing food borne illness. WHO, (2002a), states that, food safety is a basic human right and safe food contributes to economic growth and poverty alleviation. Losses in public confidence in the street foods do not only jeopardize incomes of vendors, but also their employees, producers and traders.

Due to the significance of food safety, a Joint FAO and WHO experts committee on food safety met in Geneva in 1983 (WHO, 996). They recommended that efforts should be made to educate the personnel involved in the street food trade, and improve the environmental conditions in which the trade is practiced. Further, in 2002, WHO drew up a global food safety strategy including surveillance and capacity building (WHO, 2002a). As a result, the Joint FAO and WHO *Codex Alimentarius* Commission (Codex) elaborated many international standards on food safety (WHO, 2002a). International agreements managed by World Trade Organization put even further emphasis on the importance of Codex standards to protect public health, and ensure fair practices in the food trade (WHO, 2003). Loss of foreign exchange caused by importing countries rejecting food containing unacceptable levels of contaminants is a problem for many exporting countries.

Particularly affected are the developing ones with agriculture-based economies (WHO, 2013). The tourism industry is vulnerable, if the reputation of the country regarding food safety is compromised.

2.1.3 Food-Borne Illnesses as Challenges to Food Safety

Food-borne illnesses are a major international health problem and an important cause of reduced economic growth (Mensah *et al.*, 2002). Outbreaks of foodborne illness can damage trade and tourism (FAO/WHO, 2001). This eventually leads to loss of earnings, unemployment, and litigation. Diseases caused by contaminated foods or drinks are still one of the leading causes of morbidity in several countries (Angelillo *et al*., 2000). Under certain circumstances, they can lead to serious consequences. In industrialized countries, while diseases such as cancer and cardiovascular disorders are the major causes of death, food-borne diseases though less newsworthy, make an enormous contribution (WHO, 1989).

Food-borne illness can be caused by microbiological, chemical or physical hazards (WHO Information. 2C02). Food contamination by biological agents is now recognized as a public health problem all over the world (WHO, 1989). Most countries with systems for reporting cases of the illness, have documented significant increase over the past few decades in the incidence of diseases caused by pathogens such as, *Salmonella, entero-haemorrhagic Esherichia coli and Camphylobacter jejune* (WHO Information, 2002, CDCP, 2002). Food exposure to agriculture and environmental chemicals is a concern to public health officials in most countries (WHO, 2003). In developing countries, where an overwhelming majority of acute toxicities occurs, the little published information indicates that there is significant exposure of the general population to pesticide residues in food. Mycotoxins and other naturally occurring toxins are also known to present acute and chronic health hazards and are a worldwide problem (WHO, 2003).

2.1.4 Microbial Contamination in Street Vended Food

The potential for contamination of street feeds with pathogenic microorganisms has been documented. Several outbreaks of diseases including cholera have been reported (Draper, 1996). Studies on street vended foods in America, Asia and African countries have revealed high bacterial counts and a high incidence of food-borne pathogens in food (Mosupye and Holy, 1999). For example, in Italy over 26,000 food-borne illnesses were reported (Angelillo *et al*., 20(0). *Salmonella spp.* and *hepatitis* A accounted for over 90 percent of all the cases.

In the mountain region of Pakistan, tourists who bought snacks or prepared meals from vendors in the region complained of diarrhea during or following travel (Mosupye and Holy, 1999). Calcutta Municipal Corporation and FAO Technical Cooperation Programmes carried a two-year study to improve the conditions in the street food trade. They found that, street foods were prone to microbiological contamination (Chakravarty and Canet, 1996). Samples tested of sweetened and sometimes flavored buttermilk had high plate counts. E. coli, used mainly as an indicator of faecal contamination was detected in 55 percent of the samples tested. This confirmed improper food handling practices.

Studies carried out in Africa revealed that street foods sold to school children in Nigeria, showed unacceptable levels of bacteria (Mensah et al., 2002). *E.coli* was also isolated from some samples. The research findings indicated that, there was need for stricter implementation of the food sanitation code and the licensing of street food vendors. In Senegal, over 200 cases of food poisoning were traced to street foods made from dairy products (Mosupye & Holy, 1999).

In Accra, Ghana, a research carried out indicated that despite poor environmental hygiene, street vended foods were in general microbiologically safe (Mensah et al., 2(02). Similar findings were reported for salads and gravies in Johannesburg. A project on improving street foods in South Africa showed that they had relatively low microbiological counts and low incidences of pathogens. *Salmonella* was absent in all cases tested (Martins and Anelich, 2000). It appeared that, the street vendors from the regions tested in the Gauteng province of South Africa, observed good hygienic practices for the preparation of safe foods. Many recent studies have shown that foods sold in streets are generally not more contaminated than foods sold in local restaurants (Tinker, 1997). However, levels of contamination in both establishments are clearly potentially harmful to the health of the consumer.

2.1.5 Factors Contributing to Contamination of Street Vended Foods

Mensah et al., (2002), identified key factors that contributed to contamination of foods. They included: preparation of food long before consumption; storage at ambient temperatures; inadequate cooling and reheating; contaminated processed food; undercooking; exposure of food to flies and working with food at ground level.

Personal hygiene of vendors, lack of adequate sanitation and refuse disposal were other factors implicated in causing microbial contamination in street vended foods Draper, (1996). In a study undertaken by WHO in 1993 of its member states, contamination was from raw foods, dirty water, infected handlers and inadequately cleaned equipment (WHO, 1996). The Bangkok street food project noted that contamination of vendors hands and utensils ranged from 18 to 69 percent depending on the area (Dawson et al., 1996). Where tap water was available, the contamination of the utensils was significantly low. This project demonstrated that food safety in street food operations could be improved, through the implementation of risk-based corrective action, even if such improvements could not immediately reduce the risks to the levels that could be fully controlled. Availability of potable water could play a major role in the production of safe and quality food. According to the WHO report of 1989, in most well documented outbreaks, contaminated surfaces, kitchen utensils and human hands played a significant role in cross contamination. These factors were identified particularly in already cooked and ready to eat foods such as poultry, meat, and meat products. Other sources of contamination of street foods were poor quality ingredients, exposure to environmental contamination, lack of sanitation, defective hygienic practices and lack of knowledge concerning food safety (Garin *et al*., 2002).

3.0 Research Methodology

The study was carried out in three locations namely Old town, Majengo and Mwembe Tayari in Mombasa Island. Mombasa is the second largest city in Kenya, and a major tourist center with a population of approximately 939,000(Kenya Census, 2009). These three locations have

characteristics such as major bus stops, markets, shopping areas, construction sites and commercial areas, which favor street food vending. The study adopted a descriptive survey design. The focus was on vendors who were selling the most popular street vended foods, namely, mahamri, mbaazi and samosa in Mombasa Island, Kenya.

One hundred vendors were selected using simple random sampling method. From the census in the area, there were 130 vendors selling these three food items. Sample size calculation using Fisher et al. (1983) formula, gave a sample of 97 vendors. To cater for non-responses, 10% was added to get a number of 107. Finally, the sample size of 100 was adopted, as the seven were considered inconsistent

Questionnaires were administered to vendors with the help of two assistants. They were filled together openly as most of the vendors did not have permanent structures and locating them would have been difficult. Focus group discussions were held with a group of four vendors at any given time. Observation checklist was used to gather information on the current situation of the vendors and the vending sites. Observation was carried out at the same time as the questionnaire was being administered.

Data analysis was done using Statistical Package for Social Sciences (SPSS) computer software version 22.0. Chi-square ($\chi 2$) was used to test the relationship between training and various aspects of hygiene. T- Test and Analysis of Variance was used to assess any significant differences between the three areas and between male and female, respectively. Consent to carry out the research was obtained from the office of the Governor, Mombasa. The vendors were briefed on the purpose and importance of the study and a verbal consent was obtained from each of them before data collection.

4.0 Results

4.1.1 Hygienic Practices of the Street Food Vendors

Poor hygienic practices were observed among the vendors examined. Regarding personal hygiene, 1] % were smoking, 25% were coughing over the food items and 26 % had a skin rash. Smoking was the observed among the male vendors in all the three study sites. Handling of food and money without washing hands in between and not having short and clean fingernails, were both relatively commonly seen in 91% and 54% of the vendors respectively. Vendors who had no protective clothing and those wearing jewelry (fingerings, bangles and bracelets) accounted for 48% and 51% respectively. In addition to the hygienic practices, 70% had not gone for routine medical examination during the study period. All the hygienic practices seen in this study, were in contrast to the standard by WHO (1996), *Codex Alimentarius* General Requirements for Food Hygiene (FAO/WHO, 200 J) and the guidelines in The Foods, Drugs and Chemical Substance Act, Kenya (1992).

4.1.2 Microbiological Food Quality Analysis

Bacterial Counts

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Mean values for the bacterial counts are shown in Table 1. Mean total plate count values for the beef samosas samples were higher, 1.6xl05CFU/g, compared to 9.0xl04CFU/g and 5.9xl04CFU/g of 39 mbaazi and mahamri respectively. Mean coliform counts in beef samosas were 21 per g, while the counts of mahamri and mbaazi were 15.00 per g and 14 per g respectively. Mean *E.coli* counts were higher in beef samosas, 7 per g compared to mahamri, 6 per g and mbaazi, 5 per g. Four samples of beef samosas tested from different vendors tested positive for *Salmonella.*

Table 1: Mean Bacterial Counts in the Sampled Food Items

Source	TPC (CFU/g)	CC/g	*E.coli/g*	*Salmonella*
Mbaazi (n=15)				
Range	$1.7x10^3$-$3.6x10^5$	5.00-29.00	3.00-8.00	Nil
Mean	$9.0x10^4$	14.00	5.00	
Mahamri (n=15)				Nil
Range	$1.4x10^3$-$4.4x10^5$	5.00-25.00	3.00-10.00	
Mean	$5.9x10^4$	15.00	6.00	
Samosas (n=15)				
Range	$1.4x10^3$-$1.3x10^6$	4.00-75.00	4.00-10.00	0-4
Mean	$1.6x10^5$	21.00	7.00	

One-way analysis of variance (ANOVA) was used to establish any statistical significant differences in the mean bacterial counts in the three locations studied. These results show that there was a significant difference ($P<0.05$), in the mean total plate counts between the three locations studied (Table 1). Mean total plate counts in Old Town were higher, an implication that they differed from the ones of Mwembe Tayari and Majengo. Regarding the mean total plate counts for the three food types, they differed significantly from one another ($P<0.05$), an implication that the foods were from different populations.

The mean coliform counts differed significantly ($P<0.05$), from one location to the other (Table 2). Mean coliform counts in Old Town were higher, an implication that they differed from the ones of Mwembe Tayari and Majengo. A significant difference was found in the mean coliform counts in the three food types ($P<0.05$) with beef samosas having the highest coliform counts (Table 1).

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Table 2: ANOVA test for total plate count and coliforms

Total plate counts	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	$2.3x10^{11}$	2	$1.2x10^{11}$	2.405	.103
Within Groups	$2.0x10^{12}$	42	$4.8x10^{10}$		
Total	$2.3x10^{12}$	44			
Coliforms					
Between Groups	232.933	2	116.467	.753	.477
Within Groups	6496.267	42	154.673		
Total	6729.200	44			

One sample t-test was carried out to determine any statistical differences between the hypothesized and the sampled total plate count mean from the study area. The mean from the analyzed samples differed from the standard hypothesized mean of 1.0 x 10^6CFU/g. The mean total plate count of the analyzed sample was less, $7.0x10^4$CFU/g, than the standard mean of $1.0x10^6$CFU/g, an implication that the level of the total plate counts was within the acceptable limits. There was a statistical difference between the hypothesized mean and the sampled mean at 95% confidence interval.

Food-borne pathogens

E.coli was found in all the 45 samples tested. The mean counts for *E.coli* was 7.00 per g in beef samosas and 5.00 per g and 6.00 per g in mbaazi and mahamri respectively. There was no significant difference in the mean count of the *E.coli* contamination in the three food types (P>O.05). An implication that, the foods were from the same population. However, there was a significant difference (P<0.05), in the mean counts of *E.coli* in the three locations. Mean counts of *E.coli* differed from one location to the other in the study area with Old town having higher counts (Table 3).

Table 3: ANOV A test E.coli

		Sum of Squares	Df	Mean Square	F	Sig.
E.coli	Between Groups	27.911	2	13.956	3.764	.031
	Within Groups	155.733	42	3.708		
	Total	183.644	44			

Salmonella was found in 8.9% of the 45 samples tested, which were beef samosas. In this, study all the food items that had *Salmonella*, were considered contaminated. The ratio of contamination was 1:11. For every 11 samples collected, one was contaminated, which was a 9% rate of contamination per sample. Two of the beef samosas samples that had *Salmonella* contamination were from old town and one each from Majengo and Mwembe Tayari. From the results total plate counts, coliform counts and *E.coli* counts in the food samples were within the acceptable limits according to The International Commission of Microbiological Specification for foods (1996). Salmonella was positive in some samples therefore, they were considered unsatisfactory.

4.1.3 Nature of the Roads Where Food Hems Were Sold

Table 4, shows the nature of the road where the food items were sold and wastewater disposal. Forty percent from 5 samples analysed from vendors selling along murram roads were contaminated as compared to 12.5% from 8 samples and 5.3% from 19 samples collected along dusty roads and tarmac roads with potholes respectively. There was no statistical significant association between the nature of the road and food contamination (P>0.05). Vendors poured wastewater along the road or at the place of sale. As a result, 12.5% out of the 16 samples analyzed from vendors who poured wastewater at their place of sale were contaminated. Out of 15 samples collected from vendors who poured wastewater along the road, 13.3% were contaminated. However, no statistical significant association was found between wastewater and food contamination (P>0.05), even though the food samples analyzed were contaminated.

Table 4: Nature of the road and water sewage in relation to food contamination

	Contaminated		Total	P-value
	Yes	No		
Nature of the road				
Tarmac (no potholes)	-	13(100%)	13(100%)	
Dusty	1(12.5%)	7(87.55)	8(100%)	
Murram	2(40%)	3(60%)	5(100%)	0.05
Tarmac (with potholes)	1(5.3%)	18(94.7%)	19(100%)	
Total	4(8.9%)	41(91.1%)	45(100%)	
Waste water disposal				
Place of sale	2(12.5%)	14(87.5%)	16(100%)	
Along the road	2(13.3%)	13(86.7%)	15(100%)	0.67
Total	4(19.9%)	27(87.1%)	31(100%)	

4.1.4 Hygienic Practices That Were Considered as Risk Factors

Some of the poor hygienic practices of the vendors in Table 5 were a contributing factor to food contamination. Most of the contaminated samples were from vendors who wore jewelry, 11.5% out of 26 samples. Vendors who were coughing over food had 23% out of 13 samples contaminated. Out of the 45 samples of the food items analyzed, 33.3% of the contaminated samples were from vendors who were smoking, compared to 7.1% of those who were not smoking. Despite having no skin rash, samples from these vendors were more contaminated (18.2% out of 11 samples), than those with a skin rash. Regarding short fingernails, 11.1% from the 18 samples analyzed were contaminated compared to 7.4% from 27 samples of the vendors who did not have short nails. No statistical significant association was found between the practices and food contamination (P>0.05).

Table 5: Hygienic practices of the vendors in relation to food contamination

Hygienic practices	Contaminated		Total	P-value
	Yes	No		
Jewellery				
Yes	3(11.5%)	23(88.5%)	26(100%)	
No	1(5.3%)	18(97.7%)	19(100%)	0.63
Total	4(8.9%)	41(91.1%)	19(100%)	
Short Nails				
Yes	2(11.1%)	16(88.9%)	18(100%)	
No	2(7.4%)	25(92.6%)	27(100%)	0.91
Total	4(8.9%)	41(91.1%)	45(100%)	
Rashes				
Yes	2(5.9%)	32(94.1%)	34(100%)	
No	2(18.2%)	9(81.8%)	11(100%)	0.24
Total	4(8.9%)	41(91.1%)	45(100%)	
Smoking While Selling Food				
Yes	1(33.3%)	2(66.7%)	3(100%)	
No	3(7.1%)	39(92.9%)	42(100%)	0.25
Total	4(8.9%)	41(91.1%)	45(100%)	
Coughing Over Food				
Yes	3(23%)	10(77%)	13(100%)	
No	1(3.1%)	31(96.9%)	32(100%)	0.07
Total	4(8.9%)	41(91.1%)	45(100%)	

4.1.5 Food Service and Handling

Bare hands were used for serving food items and as a result, 9.1% out of 22 samples were contaminated (Table 6). There was a statistical significant association (P<0.05) between using of bare hands to serve and food contamination. Samples from vendors who handled money and food without washing hands in between were contaminated (9.3% out of 43 samples), although there was no statistical significant association between the two variables (P>0.05).

Table 6: Items used for service and food handling in relation to food contamination

	Contaminated		Total	P-value
	Yes	No		
Items Used for Service				
Spoon	-	16(100%)	16(100%)	
Bare hands	2(9.1%)	20(90.9%)	22(100%)	
Hands covered with paper	-	4(100%)	4(100%)	0.002
Paper used for wrapping	2(66.6%)	1(33.4%)	3(100%)	
Total	4(8.9%)	41(91.1%)	45(100%)	
Handling Food and Money				
Yes	4(9.3%)	39(90.7%)	43(100%)	
No	-	2(100%)	2(100%)	0.41
Total	4(8.9%)	41(91.1%)	45(100%)	

4.1.6 Transportation of Food and Treatment of Leftovers

Some vendors prepared their food items at home and transported them to the vending sites, as they did not have stalls and facilities at the point of sale. Basins, trays and sufurias were used to carry the food and the majority (90%) walked to the sales point. Where use of vehicles was required, matatu (public transport) was used as a means of transport. Thirty-four samples were analysed from vendors who prepared the food at home and transported to the site. Of this, 8.8% were contaminated compared to 9.1% of the 11 samples prepared by vendors at the stalls (Table 7). This shows that the food items are likely to be contaminated along the way during transportation, although statistically there was no significant association between the two variables (P>0.05).

Sixty nine percent of the vendors did not sell all the food items prepared and 29% preserved them for resale the following day. Due to lack of refrigerators by some vendors, they left the food items open on top of shelves or in the cupboard. From 31 leftover samples sold, 9.7% were contaminated. This shows that lack of proper preservation can lead to food contamination, though there was no statistical significant association between leftover foods and food contamination (P>0.05).

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Table 7: Place of food preparation and leftover foods in relation to food contamination

	Contaminated		Total	P-value
	Yes	No		
Where food is prepared				
At home	3(8.8%)	31(91.2%)	34(100%)	
In stall	1(9.1%)	10(90.9%)	11(100%)	0.56
Total	4(8.9%)	41(91.9%)	45(100%)	
Left over food				
Yes	3(9.7%)	28(90.3%)	31(100%)	
No	1(7.1%)	13(92.9%)	14(100%)	0.77
Total	4(8.9%)	41(91.1%)	45(100%)	

5.0 Discussions

The International Commission of Microbiological Specification for Foods standards, (1996), were used to determine the acceptable limits of the bacterial counts in the food items tested. From the study results, *Salmonella* was detected in 8.9% of the 45 samples analysed, which were beef samosas. These samples were considered contaminated, as *Salmonella* should be absent in all food items prepared and sold for consumption. The presence of *Salmonella* in the beefsamosas could have been due to improper food handling (use of bare hands, Table 6) or use of leftover foods (Table 7). Unhygienic practices by some of the vendors (Table 5), and probably insufficient cooking or reheating of the meat product could have been a contributing factor. This study confirmed the results of others that have identified meat products as being liable to contamination if not well handled. A study carried out in Johannesburg, South Africa, found a *Salmonella sp*. and a non-0157: H *E.coli* strain each in one meat sample (Mosupye and Holy, 1999). Garin et al., (2002) found the presence of *E. coli* exceeding 10 CFU/ml and high prevalence of *Salmonella* in beef sandwiches.

E.coli was found in all the samples tested, though they were within the acceptable limits of 10.00 per g. Their presence raised suspicion of improper food handling and poor hygienic practices along the food chain. Coliform and total plate counts of 100 per g and 1x $l0^6$CFU per g respectively in the food items were within the acceptable limits (ICMSF, 1996). However, these counts could have been lower if food vendors improved and intensified their hygienic practices. The unhygienic practices of the vendors that could have lead to food contamination are outlined in Table 6.

6.0 Conclusions

From the study, while street vended foods play an important role III food supply they are also recognized as health risks if not prepared and handled hygienically. For example, 8.9% of beef samosa samples tested positive for *Salmonella.* This study confirms the results of others that have shown that the quality of meats products if not handled and produced well is generally

unsatisfactory. The major factors that led of contamination of the street vended foods in this study were, defective hygienic practices, in particular use of bare hands to serve food and unsanitary environment such as wastewater sewage. Holding of foods for long periods at uncontrolled temperatures for more than 6h and sometimes selling leftover food items were also identified as contributing factors to food contamination. These factors were mainly due to Jack of knowledge in basic food hygiene and preparation. For the vendors who had basic food hygiene knowledge, the hindrance was the enabling environment. A vendor in Old Town, expressed fear of investing in the right equipment for displaying and holding food for fear of being confiscated by the municipal council workers. This is due to the fact that, they are not recognized and licensed.

The production of relatively safe street vended foods that have low bacterial counts could be possible, if appropriate measures such as education of the street food vendors in food safety risks and food handling practices are taken. There is need for vigilant monitoring of the street food vendors by food inspectors and control staff. However this can only be achieved if the street food vendors are licensed, as it would be easy to train, monitor and control them.

7.0 Recommendations

The study recommended the following;

Street food vendors should be officially recognized and included in the urban development programme. This will aid in the economic growth of the country.

Vendors should be licensed and the municipal council simplify the procedures without imposing tedious requirements that cannot be achieved by the vendors. They could be moved to specific locations or sites where people congregate and where they can be easily monitored by the public health authorities. In such sites, they could be provided with sanitary facilities such as running water, toilets, garbage disposal services and electricity at a set amount of fees. Any vendor or city authorities that contravenes the regulations should be charged in a court of law.

The issuance of license to operate (which could be valid for a certain period, like one year, unless the vendor is found guilty of a serious offence) should include restrictions on the type of food to be sold and the location for sale. The criteria for granting licenses should be based on the commitment of the vendors to the preparation of safe food and subject to their knowledge of safe food handling practices.

The local authority should device a policy to assist, control and regulate the street food sector in order to maintain the benefits of the street vended food, while assuring the safety of the food sold. Designs and construction of vending stalls push carts (the hot sausage vending trolley) and markets could be part of the action plan of the authority to improve the safety of street vended foods.

Training programs should be facilitated based on basic food and personal hygiene, proper food preparation and handling practices and small business management. Vendors, who will have gone through this training, can be given certificates or badges to display, as this would give them recognition and enhance a sense of pride in their work.

There should be regulations set specifically to cover street foods. According to a public health officer, the regulations that are there are for all foods. Steps should be taken, to design codes of practice for the street vended foods that would apply to the whole county. These could be modified to suit the local city. Food inspectors could then be trained to adequately monitor the safety of the street foods and ensure proper implementation of the codes of practice. Street foods consumed by children, especially those sold around the schools, should be given special attention as they are more vulnerable to food-borne diseases.

8.0 References

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