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Assessing the bacteriological quality of some cooked and fried ready to eat street foods vended in Ekpoma, Edo State-Nigeria: Public Health Implications

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----------**ABSTRACT**----------

Badly prepared and recontamination of ready to eat street foods are the main causes of food related diseases. The bacteriological examination of six different ready to eat street foods, three each of cooked (Jollof rice, Beans and Moi-moi) and Fried (Yam, Fish and Plantain) offered for sale in Ekpoma and its environs were examined between the month of August and October 2019. A total of one hundred and forty four (144) food samples were randomly collected from four famous vending zones, two each of mobile and stationary vendors from different locations in Ekpoma and were analyzed using standard protocols. The results obtained revealed that Mean aerobic plate counts ranged from 3.2 X 10^4 ± 2.65cfu/g (Jollof rice) sold by mobile vendor A to 1.0 x 10^5 ± 10.00 cfu/g(Fried fish and Jollof rice) vended by stationary vendor C and D respectively. Six bacterial genera were recovered from the screened samples, Bacillus cereus, Klebsiella Pnuemoniae, Staphylococcus arueus, Salmonella spp, Vibrio spp and Escherichia coli. The study also showed that the ready-to-eat were contaminated with varying degree of microorganisms indicating inadequate processing and poor handling practices which can pose danger to the well being of the unaware consumers. Based on microbiological reference guidelines for ready to eat foods by the Centre for Food Safety, Food and Environmental Hygiene Department contamination level was within the borderline reference limit. There was a significant difference (P<0.05) observed in the level of bacterial contamination in the various food types and vending stations. However there was statistically no significant difference (P>0.05) between the microbial loads in the cooked and fried street foods. Painstaking effort by the relevant authorities saddled with the responsibility of maintaining food safety and public health of its inhabitants should be geared towards developing practical methodologies in ensuring street food safety. Furthermore, health education to improve the knowledge of food vendors on safe food and hygiene practices is imperative.

Keywords: *Food vendors, Street foods Hygienic measures, Microbiological quality, Ready-to-eat foods, Cooked and fried foods.*

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I. INTRODUCTION

Food is any substance usually from plant source and animal origin that humans, fauna and flora eat, drink or absorb for continuous existence. Lack or inadequate supply of it drastically impedes the normal metabolic processes of life. Majority of these foods are often polluted with naturally present virulent microorganisms which often cannot be examined organoleptically but can lead to varying degree of diseases including death. They are classified into six essential nutrients namely carbohydrate, protein, vitamin, mineral, water, fat and oil respectively. Street foods consist of different category ranging from meals, drinks and snacks. Street foods such as meat pie, fried potatoes, fried yam, beef sausage roll, joll of rice, akara, egg roll, moi-moi, pealed orange, beans, walnut, fish, meat, eba, fufu, apple etc may be fried, cooked or raw and are described as ready to eat foods obtained directly from mobile hawkers or stationary street vendors and consumed instantly or at a later time without additional heating and processing (Tsang, 2002). Assessing the safety standard of food means a quantitative analysis of the amount of microbial pollutants contain therein. Greater levels of contamination is an indication of poor quality of the food in terms of storage and handling, hence greater chances of transmiting infections (Oranusi et al., 2013). One major factor in examining the quality and portability of water and food is bacterial enumeration which also reveals the sanitary level adopted by sellers of such foods in the course of making, handling and packaging them for exchange. Food and water acts as vectors for the transmission of microbial infections which are often caused by the members of the enterobacteriaecea

family (Nkere et al., 2011). Nigerians hitherto used to patronize developed supermarket where safe foods were sold until the early 1980s when social and economic meltdown truncated the income of the average class significantly. Thereby resulting to purchasing their desire goods from street vendors and traditional open air markets (Nzeka, 2011). Many instances such as long distances in between job and residential places, absence from home due to travelling and studying, need for a complete change in terms of food type and location make many people resort to purchasing ready to eat street foods which often may be poorly made and packaged. The proliferation in the consumption of street foods over time is due to their relative availability, convenient, moderate price provision of variable food alternatives, employment and the possibility of improving food security (Draper, 1996). People are often keen in satisfying their quest for food at the expense of these ready to eat foods neglecting their hygiene status. They are good transmission routes for foodborne microbes because additional treatment is not necessary before eating. In the past epidemic outbreaks of food infections traced to ready to eat foods have been correlated to different foodborne microbes. Disorders that results due to foodborne sickness are a key global health issue causing reasonable abnormality and fatality rate yearly (Hanson et al., 2012). Bacteria such as Staphylococcus aureus, Salmonella spp, Vibrio chloreae and Escherichia coli can lead to food poisoning in addition to other food-borne infections such as cholera, tuberculosis, diarrhoea and typhoid fever (Foskett et al., 2003). Some clinical manifestations of food borne illness among others include headache, stomach aches, nausea, diarrhoea, and vomiting. Many researchers have shown that the common bacterial contaminants implicated in ready to eat street foods are Salmonella spp., Listeria monocytogenes, Campylobacter jejuni, Staphylococcus aureus, Bacillus cereus, Escherichia coli, Vibro chloreae Clostridium perfringens e.t.c. Reasearch on the bacteriological safety of some ready to eat foods vended on Onitsha-Owerri highways in south east Nigeria showed the bacterial pollutants to be Bacillus Cereus, Staphylococcus aureus, Aspergillus Niger, Escherichia coli, Shigella spp., Salmonella spp., Enterococci, and Pseudomonas (Oranusi and Braide, 2012). Ready to eat street foods are most times sold at unclean vicinity exposing these foods to air and dust and often stored at unsuitable temperatures which favour bacteria growth and excessive handling by the food vendors. Oranusi et al. (2013) reported poor unhygienic practices by food handlers and food vendors being healthy carriers serving as potential source of transmission of enteric fevers. Therefore this present research was done to assess the bacteriological status of selected street foods sold in Ekpoma and its environs and also to ascertain whether these street foods is in tune with acceptable microbiological standards and specifications for foods. The findings of this study will be beneficial to the unaware consumers, governmental bodies saddle with the responsibility of maintaining public health of its citizenry and the sellers themselves on the health issues these foods might cause.

II. MATERIALS AND METHODS

Sampling technique and Sample vicinity

This assessment was done in Ekpoma environs domiciliated in Esan-West Local Government Area of Edo State. It has an area of 502km^2 with about 190,000 people who comprise an adult male population of over 60,000 and adult female population of 50,000 respectively. It lies on a geographical coordinate of latitude 6°45′N 6°08′E and has an elevation of approximately 364meters above sea level. (Okun and Okosun, 1990).

A total of one hundred and forty four (144) food samples were randomly collected from four famous vending zones designated as A, B, C &D with A and B as mobile vendors and C and D as stationary vendors. Six different food types, three each of cooked (jollof rice, Beans and moi-moi) and fried (Yam, fish and plantain) ready to eat foods were obtained between the month of August and October 2019 when newly prepared. They were placed into sterile container and stored in ice packs before bringing them to the Department of Microbiology, Ambrose Alli University, Ekpoma, Edo State Nigeria for bacteriological assessment within sixty minutes of collection.

Physico-chemical analysis

Moisture and acidity content of the samples were examined as described by Cole (2002). The pH readings were obtained using a digital Jenway Model 3510 benchtop pH metre.

Sample Processing

Ten (10) grams of each samples was mixed thoroughly in 90ml of sterile distilled water at 360rpm for 50seconds using a vortex mixer after which samples were serially diluted to obtain 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6} respectively

Isolation and quantification of microbes

0.1ml of 10^{-4} dilution series of each food type was inoculated into sterile Petri dishes in triplicates before appropriate media such as Nutrient agar (NA), Eosin Methylene blue (EMB), Mannitol salt agar (MSA)

and Thiosulphate Citrate Bile Salt Sucrose agar (TCBS), all of Hi media were dispensed into it to ascertain the total aerobic bacteria, Coliform, Staphylococcus aureus and Vibrio chloreae, counts respectively. Salmonella Shigella agar (SSA) Fluka product was inoculated after 24hrs pre-enrichment of sample mixture in selenite-F broth, for the recovery of Salmonella. All inoculated plates were incubated at 30°C for 24-48hrs, thereafter enumeration of colonies was done with the aid of the illuminated colony counter (Gallenkamp, Englang). The mean counts from the triplicate Petri dishes were expressed as colony forming unit per gram (cfu/g). Morphological traits of the colonies were checked; discrete colonies on the different media were isolated for sub-culturing onto other media to obtain axenic cultures, which were subsequently stored on Nutrient agar slants for later biochemical tests at 4°C

Coliform testing

Presumptive test**:** One (1) ml of each sample mixture was dispensed into sterile lactose broth with inverted durham tubes and incubated at 37^0C for 24-48hrs for the assessment of acid and gas production.

Confirmatory test**:** The positive tubes shown by gas bubble on top of the inverted Durham tubes was re-inoculated with the aid of a sterile wire loop onto Eosin Methylene Blue agar plates and subsequently incubated at 37°C an44°C for 24hrs. Colonies which showed bluish black colour with green metallic sheen and reddish/brown colonies were noted and transferred onto agar slants.

Completed test**:** Colonies which gave the green metallic sheen on Eosin Methylene Blue agar were again re-inoculated into lactose broth with inverted durham tubes and incubated at 37°C for 24hrs to observe gas production (Oranusi et al., 2004).

Identification of bacterial isolates

The isolated bacteria were identified by using their cultural and morphological characteristics on media. This was followed by microscopic investigation of the bacterial isolates under the microscope. The cultural features examined included shape elevation, surface edge and consistency. Physiological and biochemical tests were employed to confirm their identification (Cheesbrough, 2010)

Statistical analysis

The data extracted for the mean total aerobic plate count, vendor types (Mobile and Stationary) and the food types (Cooked and Fried) were analyzed using the IBM SPSS software version 25. Student's t-test was used to establish the relationship between the variables. Further more data obtained for moisture content of the various food types were correlated with those of the mean total aerobic bacteria count to ascertain the relationship between these variables.

III. RESULTS

The study was done to investigate the bacteriological status of some cooked and fried streets foods sold in Ekpoma and its environs. Table 1 showed the distribution, numbers and location of street food samples collected. Table 2 represent the number of colonies counted on Nutrient agar for all the food samples within the vending sites. Table 5 showed the result of mean and standard deviation of the microbial counts of all the cooked and fried ready-to-eat street foods samples. The result showed that the highest aerobic bacteria plate count was realized in fried fish and jollof rice sold by stationary vendor C and D with same values of $1.0 \times 10^5 \pm 10.00$ cfu/g respectively. While the lowest value was found in jollof rice sold by mobile vendor A with the reading of $3.2 \times 10^4 \pm 2.65$cfu/g. Highest Staphylococcus aureus count was noticed in Beans sold by stationary vendor C with a value of $2.85 \times 10^5 \pm 4.00$cfu/g while the lowest was detected in fried fish sold by Stationary vendor D with $5.20 \times 10^4 \pm 13.05$cfu/g. Highest Escherichia coli count was seen in Moi moi with a value of $1.80 \times 10^5 \pm 10.00$ at the stationary food vendor C, while the least count was found in Moi-moi with a value of $4.60 \times 10^4 \pm 5.20$ cfu/g at the stationary food vendor D. There was absence of Vibrio chloreae and Salmonella sp in all the vending zones except in the stationary vendor C located at Ujoelen Abbattoir Hausa Quarters with the highest and lowest counts of $1.00 \times 10^5 \pm 2.00$ cfu/g to $5.00 \times 10^4 \pm 8.00$ cfu/g and $9.00 \times 10^4 \pm 5.00$ cfu/g to $6.40 \times 10^4 \pm 1.00$cfu/g observed in Moi-moi and fried yam respectively. Significant difference ($p<0.05$) was observed in the levels of the aerobic bacteria counts of the different food types and the vendor types. However there was statistically no significant difference ($P>0.05$) between the microbial loads in the cooked and fried street foods

The moisture content and pH readings of the samples are presented in (Table 7) respectively. The pH ranged between 6.90 - 6.1. The highest pH value of 6.90 was obtained from rice and fried plantain sold by the mobile vendor A and stationary vendor D while the lowest pH reading was observed in rice sold by the stationary vendor D. The moisture content ranged between 3.1% and 0.5%. The highest moisture content value of 3.1% was obtained from Moi-moi and Beans sold by the mobile vendor A and stationary vendor C while the lowest value of 0.5%.was observed in fried fish sold by the Mobile vendor A. Comparative assessment of

moisture content and the aerobic bacteria counts of the samples was done using (IBM SPSS version 25). The finding revealed a weak correlation having R value as 0.266 and p value at 0.01. The correlation between these two parameters indicates that as moisture content increases total aerobic bacteria counts also increases vice versa. The bacteria implicated in the cooked and fried ready to consume street food samples in this study were Escherichia coli, Bacillus cereus, Vibrio spp, Klebsiella pnuemoniae, Salmonella spp and Staphylococcus aureus (Table 6).

IV. DISCUSSION

Pathogenic bacteria are the most common known causes of food contamination and food borne illnesses. Six (6) different types of cooked and fried ready-to-eat street foods marketed at different vicinity of Ekpoma and its environs by different vendor stations were examined in this study. The findings that emanated showed that the total aerobic plate counts of Staphylococcus aureus, Escherichia coli, Salmonella spp and Vibrio chloreae were higher than the stipulated reference value. These high microbial counts recorded are indicative of post contamination in the light that cooking temperature eliminates all possible microorganisms except thermophile and spore forming bacteria. However, the significant difference ($p<0.05$) observed in the level of microbial contamination in the various food types (jollof rice, Beans, Moi-moi, fried yam, fried fish and fried plantain) and vending stations could be associated with inadequate handling and processing by vendors, contamination caused by storage facilities, either poor hygiene or poor quality of grains and water used. Similarly, the extensive handling and mixing in the course of preparation may have brought in alien contaminants via food handlers, via cooking utensils and from the surrounding due to the exposure of the foods to aerosolized particles such as dust at the point of exchange from seller to buyers. This invariably enhances the number of bacteria as most of them are contained in the air and dust around where such foods are sold (FDA, 2000). Direct consumption of street foods increases the likely hood of food borne disorder caused by different pathogens, because it is not easy to judge the hygiene status and the cleanliness of the surrounding where such foods are prepared and packaged for sales. Water usually takes two forms free or available water and those bound to different molecules such as proteins and carbohydrates. Moisture content supports the multiplication of bacteria, moulds and yeast which adversely affect the quality of food. It is describe as total water present in a food. It is often measured as percentage of the total weight of the sample. The water content obtained from food samples in this study was low ranging from 0.5% to 3.1%. Such foods if kept at humid temperature will facilitate the growth of yeast and moulds. High water content fastens food spoilage by enhancing the growth of microbes especially bacteria. The pH results ranged from 6.1 to 6.9 which show that the food samples under assessment were a bit acidic to neutral. This pH values range accelerates the multiplication and continuous survival of bacteria in the food samples. This work revealed that all the food samples are contaminated with different bacteria species. Which include Staphylococcus aureus, Vibrio chloreae, Bacillus cereus, Salmonella spp, Klebsiella pnuemoniae, and Escherichia coli. This finding is in line with the study done by Ajao and Atere (2009) and Oranusi and Braide, (2013).

Bacillus cereus is a foodborne pathogen implicated in the production of toxin which causes food poisoning. It is found in raw food, dust and soil surviving cooking temperatures as a heat resistant spore (Rajkowski and Bennett, 2003). It is a rod shaped Gram positive motile bacterium. Some strains are detrimental to man while others are beneficial to animals as probiotics. It is the causative agent of the "Fried rice syndrome", where the bacterium is gotten from fried rice meals kept at room temperature for hours.

Escherichia coli in cooked and fried ready-to-consume street foods depicts secondary contamination, as it is known to be present in the gastrointestinal tract of warm blooded animals and not present in the environment as a natural flora. However, pollution can emanate from the use of unclean water which is a major predisposing factors bedevilling the study area. The isolation of Escherichia coli in this study may be linked to direct or indirect fecal contamination. It belongs to the genus Enterobacteriaceae. Some strain can cause urinary tract infections, nosocomial pneumonia, diarrhea, meningitis, gastroenteritis and dysentery. Escherichia coli 0157 H7 strain is a subunit of the Enterohaemorrhagic Escherichia coli (EHEC) which cause serious illness called Haemorrhagic colitis characterized by severe abdominal pain and bloody diarrhea (Dolores and Doyle 2001)

The presence of Staphylococccus aureus, a pathogenic organism is of great public health concern. Staphylococcus aureus produce some enzymes which help in Staphylococcal invasiveness of the immune system and many heat stable extracellular substances known as enterotoxins that render the foods unsafe even though it appears pleasant to the eyes (Prescott et al. 2005). The severity of the symptoms may vary with the amount of inoculum ingested and susceptibility of the individuals to the toxin. Some symptoms of Staphylococcal food poisoning include vomiting, nausea, diarrhea and abdominal pain (Amusan et al. 2010). The appearance of Staphylococcus aureus is mainly as a result of human interface; this is a reflection of the unclean practices by the food vendors since the organism is normally found in the skin and nose. In this

research, the isolation of coliform bacteria (Salmonella spp, Vibrio chloreae, Klebsiella pnuemoniae and Escherichia coli) reflects the likely hood of fecal pollution as also opined by (Adams and Moss 2000). The detection of Vibrio chloreae and Salmonella spp in vending site C domicile within an abattoir premise may be attributed to contamination of the soil, water and possibly the food by free ranging domestic animals. This poses a serious health threat to the unaware consumers of such street foods. Hence, Osamwonyi et al. (2013) opined that it is compulsory that foods must be free from contaminations as much as possible. The results from this study is worrisome as high aerobic colony counts (ACC) of known foodborne pathogens and hygiene indicator organisms were implicated in the ready to eat cooked and fried street food samples investigated, with all exceeding the Microbiological guidelines for ready-to-eat foods (2014) by the Centre for Food Safety, Food and Environmental Hygiene Department which stipulates that ready-to-eat foods with aerobic colony counts between 0 - $<10^3$ is satisfactory, between 10^3 - $<10^5$ as borderline, $\geq 10^5$ and above is unsatisfactory. Hence, the foods examined in this study are of borderline microbiological quality based on International Standards for foods. This scenario places the health of consumers of such street foods at risk. Painstaking effort by the relevant authorities saddled with the responsibility of maintaining food safety and public health of its citizenry should be geared towards consideration of the source of the food producer and retailer also the vendors should be implored to review cooking, hygiene procedures and adopt measures to improve the situation. Furthermore follow up investigative samples should be taken. The high microbial loads of the food samples could be attributed to the preparation of such foods at ambient temperature which favours the proliferation of pathogenic and spoilage microbes coupled with the mishandling and complete disregard for hygienic practises on the side of the food handlers. To reduce this trend, there should be training and enlightenment programs for the food vendors who often do not have formal education on safe and good hygiene practices especially hand washing and obedience of legislation in food handling, preparation, packaging and processing as well as environmental sanitation.

V. CONCLUSION AND RECOMMENDATION

The health issues that results from the consumption of unsafe street foods can be reduce by avoiding poor and excessive handling, the need for good personal hygiene and caution in course of cooking storing and packaging of such foods for sale. It is imperative that efforts should be put in place to constantly remind food sellers of the need to maintain good microbiological quality of food. Training on hygiene and sanitation, provision of portable water and effective waste management system, screening of food handlers on regular basis for healthy carriers and the enactment of code of conduct for the street food industry are prescribe to bridge the gap between knowledge and practices of safe street food sales.

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Conflicts Of Interest

Authors have declared that no competing interests exist.

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Table 1: Number of Street foods (cooked and Fried) samples collected and their location

VENDOR ZONES	**FOOD TYPES**						
	Jollof rice	Beans	Moi-Moi	Fried Yam	Fried Fish	Fried Plantain	TOTAL
A	6	6	6	6	6	6	36
B	6	6	6	6	6	6	36
C	6	6	6	6	6	6	36
D	6	6	6	6	6	6	36
TOTAL	24	24	24	24	24	24	144

Legend: A = Mobile Food vendor along Iruekpen market road
` B = Mobile Food vendor within Ujemen
C = Stationary Food vendor located at Ujoelen Abbattoir Hausa Quarters
D = Stationary Food vendor located at Market Square

Table 2: Results of the aerobic bacteria plate counts on Nutrient agar for all food samples within the vending zones.

FOOD SAMPLES	**NO OF COLONIES COUNTED**	**VOLUME OF INOCULUM**	**DILUTION FACTOR**
Vendor Sample Station A			
Jollof rice	30, 31, 35	0.1ml	10^{-4}
Beans	38, 38, 44	0.1ml	10^{-4}
Moi-Moi	58, 60, 62	0.1ml	10^{-4}
Fried Yam	38, 36, 40	0.1ml	10^{-4}
Fried Fish	49, 39, 50	0.1ml	10^{-4}
Fried Plantain	36, 34, 36	0.1ml	10^{-4}
Vendor Sample Station B			
Jollof rice	36, 33, 39	0.1ml	10^{-4}
Beans	59, 61, 65	0.1ml	10^{-4}
Moi-Moi	66, 69, 70	0.1ml	10^{-4}
Fried Yam	79, 78, 80	0.1ml	10^{-4}

Fried Fish	62, 60, 67	0.1ml	10^{-4}
Fried Plantain	55, 53, 58	0.1ml	10^{-4}
Vendor Sample Station C			
Jollof rice	36, 34, 41	0.1ml	10^{-4}
Beans	59, 63, 65	0.1ml	10^{-4}
Moi-Moi	88, 82, 90	0.1ml	10^{-4}
Fried Yam	55, 58, 59	0.1ml	10^{-4}
Fried Fish	100, 90, 110	0.1ml	10^{-4}
Fried Plantain	79, 78, 80	0.1ml	10^{-4}
Vendor Sample Station D			
Jollof rice	100, 90, 110	0.1ml	10^{-4}
Beans	59, 63, 65	0.1ml	10^{-4}
Moi-Moi	75, 78, 80	0.1ml	10^{-4}
Fried Yam	94, 93, 90	0.1ml	10^{-4}
Fried Fish	100, 75, 80	0.1ml	10^{-4}
Fried Plantain	101, 96, 98	0.1ml	10^{-4}

TABLE 3: Results of Mean and Standard Deviation of Aerobic Bacterial count (ABC) Cfu/g for all food samples

Food Types	**Vending Station**			
	A Mean ± SD*	B Mean ± SD*	C Mean ± SD*	D Mean ± SD*
Jollof rice	$3.2 \times 10^4 \pm 2.65$	$3.6 \times 10^4 \pm 3.00$	$3.7 \times 10^4 \pm 3.61$	$1.0 \times 10^5 \pm 10.00$
Beans	$4.0 \times 10^4 \pm 3.46$	$6.2 \times 10^4 \pm 3.06$	$6.2 \times 10^4 \pm 3.06$	$6.2 \times 10^4 \pm 3.06$
Moi-Moi	$6.0 \times 10^4 \pm 2.00$	$6.8 \times 10^4 \pm 2.08$	$8.7 \times 10^4 \pm 4.16$	$7.8 \times 10^4 \pm 2.52$
Fried Yam	$3.8 \times 10^4 \pm 2.00$	$7.9 \times 10^4 \pm 1.00$	$5.7 \times 10^4 \pm 2.08$	$9.2 \times 10^4 \pm 2.08$
Fried Fish	$4.6 \times 10^4 \pm 6.08$	$6.3 \times 10^4 \pm 3.60$	$1.0 \times 10^5 \pm 10.00$	$8.5 \times 10^4 \pm 13.23$
Fried Plantain	$3.6 \times 10^4 \pm 1.15$	$5.5 \times 10^4 \pm 2.51$	$7.9 \times 10^4 \pm 1.00$	$9.8 \times 10^4 \pm 2.52$

*SD: Standard Deviation

Table 4: Results of microbial colony counts for the cooked/fried street foods samples

VENDING ZONE	**FOOD TYPES**	**E. coli (EMB agar)**	**S. aureus (MSA)**	**Vibrio sp (TCBS agar)**	**Salmonella-Shigella (SSA)**
Mobile Vendor A	Jollof rice	-	193, 207. 200	-	-
	Beans	99, 100, 101	180, 182. 178	-	-
	Moi-Moi	89, 91, 90	157,163, 160	-	-
	Fried Yam	110, 100, 120	140,138, 142	-	-
	Fried Fish	115, 125, 120	110,105, 115	-	-
	Fried Plantain	-	120,116, 124	-	-
Mobile Vendor B					
	Jollof rice	130, 133, 127	270, 263, 277	-	-
	Beans	140, 143, 137	240, 235, 245	-	-
	Moi-Moi	160, 159, 161	190, 184, 196	-	-
	Fried Yam	120, 119,121	175, 165, 185	-	-
	Fried Fish	100,96,104	160, 158, 162	-	-
	Fried Plantain	92, 89, 95	134,138, 130	-	-
Stationary Vendor C					
	Jollof rice	180, 190, 170	260, 257, 263	98, 103, 93	65, 69, 61
	Beans	-	285, 289, 281	92, 88, 96	80, 81, 79
	Moi-Moi	130, 110, 120	171, 164, 178	100, 102, 98	90, 95, 85
	Fried Yam	122, 98, 110	180, 181, 179	50, 58, 42	64, 63, 65
	Fried Fish	-	140, 137, 143	88, 87, 89	70, 66, 74
	Fried Plantain	-	200, 208, 192	92, 90, 94	-
Stationary Vendor D					
	Jollof rice	160, 153, 167	120, 124, 122	-	-
	Beans	101, 99, 100	100, 109, 111	-	-
	Moi-Moi	49, 40, 49	81, 87, 90	-	-
	Fried Yam	80, 88, 86	70, 85, 90	-	-
	Fried Fish	61, 68, 64	38, 53, 64	-	-
	Fried Plantain	99, 92, 95	120, 124, 122	-	-

LEGEND: EMB- Eosin methylene blue agar
MSA- Mannitol Salt agar
TCBS -Thiosulphate Citrate Bile Salt Sucrose agar

SSA- Salmonella-Shigella agar
- Not Detected

5: Results of Mean and Standard deviation of microbial counts for the cooked/fried street foods samples

VENDING ZONE	FOOD TYPES	Aerobic bactera(NA)	E. coli (EMB agar)	S. aureus (MSA)	Vibrio sp (TCBS agar)	Salmonella-Shigella (SSA)
		Mean ± SD*	Mean ± SD*	Mean ± SD*	Mean ± SD*	Mean ± SD*
Mobile Vendor A	Jollof rice	$3.2 \times 10^4 \pm 2.65$	-	$2.00 \times 10^5 \pm 7.00$	-	-
	Beans	$4.0 \times 10^4 \pm 3.46$	$1.00 \times 10^5 \pm 1.00$	$1.80 \times 10^5 \pm 2.00$	-	-
	Moi-Moi	$6.0 \times 10^4 \pm 2.00$	$9.00 \times 10^4 \pm 1.00$	$1.60 \times 10^5 \pm 3.00$	-	-
	Fried Yam	$3.8 \times 10^4 \pm 2.00$	$1.10 \times 10^5 \pm 10.00$	$1.40 \times 10^5 \pm 2.00$	-	-
	Fried Fish	$4.6 \times 10^4 \pm 6.08$	$1.20 \times 10^5 \pm 5.00$	$1.10 \times 10^5 \pm 5.00$	-	-
	Fried Plantain	$3.6 \times 10^4 \pm 1.15$	-	$1.20 \times 10^5 \pm 4.00$	-	-
Mobile Vendor B						
	Jollof rice	$3.6 \times 10^4 \pm 3.00$	$1.30 \times 10^5 \pm 3.00$	$2.70 \times 10^5 \pm 7.00$	-	-
	Beans	$6.2 \times 10^4 \pm 3.06$	$1.40 \times 10^5 \pm 3.00$	$2.40 \times 10^5 \pm 5.00$	-	-
	Moi-Moi	$6.8 \times 10^4 \pm 2.08$	$1.60 \times 10^5 \pm 1.00$	$1.90 \times 10^5 \pm 6.00$	-	-
	Fried Yam	$7.9 \times 10^4 \pm 1.00$	$1.20 \times 10^5 \pm 1.00$	$1.75 \times 10^5 \pm 10.00$	-	-
	Fried Fish	$6.3 \times 10^4 \pm 3.60$	$1.00 \times 10^5 \pm 4.00$	$1.60 \times 10^5 \pm 2.00$	-	-
	Fried Plantain	$5.5 \times 10^4 \pm 2.51$	$9.20 \times 10^5 \pm 3.00$	$1.34 \times 10^5 \pm 4.00$	-	-
Stationary Vendor C						
	Jollof rice	$3.7 \times 10^4 \pm 3.61$	$1.80 \times 10^5 \pm 10.00$	$2.60 \times 10^5 \pm 3.00$	$9.80 \times 10^4 \pm 5.00$	$6.50 \times 10^4 \pm 4.00$
	Beans	$6.2 \times 10^4 \pm 3.06$	-	$2.85 \times 10^5 \pm 4.00$	$9.20 \times 10^4 \pm 4.00$	$8.00 \times 10^4 \pm 1.00$
	Moi-Moi	$8.7 \times 10^4 \pm 4.16$	$1.20 \times 10^5 \pm 10.00$	$1.71 \times 10^5 \pm 7.00$	$1.00 \times 10^5 \pm 2.00$	$9.00 \times 10^4 \pm 5.00$
	Fried Yam	$5.7 \times 10^4 \pm 2.08$	$1.10 \times 10^5 \pm 12.00$	$1.80 \times 10^5 \pm 1.00$	$5.00 \times 10^4 \pm 8.00$	$6.40 \times 10^4 \pm 1.00$
	Fried Fish	$1.0 \times 10^5 \pm 10.00$	-	$1.40 \times 10^5 \pm 1.04$	$8.80 \times 10^4 \pm 1.00$	$7.00 \times 10^4 \pm 4.00$
	Fried Plantain	$7.9 \times 10^4 \pm 1.00$	-	$2.00 \times 10^5 \pm 8.00$	$9.20 \times 10^4 \pm 2.00$	-
Stationary Vendor D						
	Jollof rice	$1.0 \times 10^5 \pm 10.00$	$1.60 \times 10^5 \pm 7.00$	$1.20 \times 10^5 \pm 2.00$	-	-
	Beans	$6.2 \times 10^4 \pm 3.06$	$1.00 \times 10^5 \pm 1.00$	$1.10 \times 10^5 \pm 5.86$	-	-
	Moi-Moi	$7.8 \times 10^4 \pm 2.52$	$4.60 \times 10^4 \pm 5.20$	$8.60 \times 10^4 \pm 4.58$	-	-
	Fried Yam	$9.2 \times 10^4 \pm 2.08$	$8.50 \times 10^4 \pm 4.16$	$8.20 \times 10^4 \pm 10.41$	-	-
	Fried Fish	$8.5 \times 10^4 \pm 13.23$	$6.40 \times 10^4 \pm 3.51$	$5.20 \times 10^4 \pm 13.05$	-	-
	Fried Plantain	$9.8 \times 10^4 \pm 2.52$	$9.50 \times 10^4 \pm 3.51$	$1.20 \times 10^5 \pm 2.00$	-	-

❖ Values are presented as mean and standard deviation

Table 6: Bacterial isolates from food samples.

Food Samples	Bacteria Isolated
Jollof rice	Escherichia coli, Staphylococcus aureus, Klebsiella Pnuemoniae, Vibrio chloreae, Salmonella spp and Bacillus cereus
Beans	Staphylococcus aureus, Klebsiella Pnuemoniae,Escherichia coli, Vibrio chloreae, Salmonella spp and Bacillus cereus
Moi-Moi	Klebsiella Pnuemoniae, Escherichia coli, Bacillus cereus Staphylococcus aureus,, Vibrio chloreae and Salmonella spp
Fried Yam	Vibrio chloreae,Escherichia coli, Staphylococcus aureus, Klebsiella Pnuemoniae, , Salmonella spp and Bacillus cereus
Fried Fish	Salmonella spp, Escherichia coli, , Bacillus cereus, Klebsiella Pnuemoniae, Staphylococcus aureus and Vibrio chloreae
Fried Plantain	Bacillus cereus, Escherichia coli, Staphylococcus aureus, Klebsiella Pnuemoniae, Vibrio chloreae and Salmonella spp

Table7: Moisture content and pH of food samples from different vending locations.

	Moisture content (%)				**pH**			
Food Samples	Zone A	Zone B	Zone C	Zone D	Zone A	Zone B	Zone C	Zone D
Jollof rice	0.6	0.9	0.7	0.8	6.9	6.4	6.7	6.1
Beans	0.7	1.6	3.1	1.8	6.8	6.8	6.8	6.7
Moi-Moi	3.1	1.7	2.9	2.1	6.5	6.3	6.6	6.5
Fried Yam	2.1	2.0	1.8	2.0	6.6	6.7	6.9	6.6
Fried Fish	0.5	2.3	3.0	1.6	6.3	6.6	.6.7	6.8
Fried Plantain	1.9	2.4	3.0	1.5	6.4	6.0	6.3	6.9

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