Research Journal of Food Science and Nutrition
Volume 5(2), pages 35-45, April 2020
Article Number: EF0A2D6F2
ISSN: 2536-7080
https://doi.org/10.31248/RJFSN2020.091
https://integrityresjournals.org/journal/RJFSN

Full Length Research

Microbiological quality of selected street vended foods during wet and dry season in parts of Port Harcourt metropolis, Rivers State, Nigeria

Oyet, G. I., Achinewhu, S. C., Kiin-Kabari, D. B.* and Akusu, M. O.

Department of Food Science and Technology, Rivers State University, Port Harcourt, P.M.B 5080, Port Harcourt, Nigeria.

*Corresponding author. Email: kabaridavid@yahoo.com

Received 18th March, 2020; Accepted 27th April, 2020

ABSTRACT: Microbiological quality of selected ready-to-eat (RTE) street vended foods (SVF) were determined to evaluate the impact of wet and dry seasons on food safety in 3 locations (Makoba-station 1, Elekahia-station 2 and Rivers State University-station 3). Six food products investigated were roasted plantain (RP), roasted fish (RF), roasted yam (RY), suya (SY), meat pie (MP) and doughnuts (DN). Total Aerobic Count (TAC), Total Coliform Count (TCC), Faecal Coliform Count (FCC), Total Staphylococcus Count (TSC), Total Salmonella Count (TSC^2), Total Bacillus Count (TBC), Total Mould Count (TMC) and Total Yeast Count (TYC) were examined. Results revealed that TAC had significantly ($p<0.05$) highest value of 8.46 log_{10}CFU/g in RF2 with no growth in samples RP2, MP1 and DN2 during the wet season while TAC were isolated in all samples during dry season with a range of 5.18 to 7.44 log_{10}CFU/g. TCC was highest in RF2 (8.04 log_{10}CFU/g) and SY2 (7.33 log_{10}CFU/g) during the wet and dry seasons, respectively. FCC ranged from 6.00 to 8.45 log_{10}CFU/g for samples RF2 and MP1 during wet season while 5.15 to 7.10 log_{10}CFU/g was isolated during dry season. TSC ranged from 6.00 to 8.00 log_{10}CFU/g representing 55.55% growth rate during the wet season while no growth was observed in all the samples during dry season except RP1 (5.62 log_{10}CFU/g) and RF2 (6.76 log_{10}CFU/g). There was Salmonella growth in all the SVF with values ranging from 5.00 to 7.04 log_{10}CFU/g during the dry season with NG in SY1 while TSC^2 were only isolated in RF1 and SY2 during wet season with the values of 7.11 log_{10}CFU/g and 7.57 log_{10}CFU/g, respectively. TBC ranged from 6.00 to 8.30 log_{10}CFU/g with NG isolated in samples RP3, RF3, RY2, MP3 and DN1 at wet season while significantly highest value of 6.63 log_{10}CFU/g (SY2) was isolated in SY2 and 61.11% NG during dry season. TMC in all the SVF had higher values during wet season than the dry season. TYC was highest in RY2 (7.81 log_{10}CFU/g) and SY1 (8.76 log_{10}CFU/g) during wet and dry seasons, respectively. The study thus, revealed that seasonal variations and locations of SVF have a great impact on their microbiological quality.

Keywords: Foodborne pathogens, food safety, microbiological quality, street vended foods, wet and dry season.

INTRODUCTION

The emergence of vended street food is becoming a Nigerian version of Domino Pizza (fast food) Centre, where you can get quick access to roasted plantain, yam, potatoes, fish and corn. Most of the operators of these mini restaurants do not have any idea of food safety and the implications its portent to final consumers (Dipeolu et al., 2007). The hygienic condition of the environment, the air quality, food handler's health, the quality of water used, the storage condition and food handling materials as well as the packaging materials are all suspicious chains of food contamination. Despite the economic and nutritional benefits of ready to eat street foods, the consumption of these roadside foods has been subjected to potentially increase the risk of foodborne diseases as street foods are easily contaminated from different sources (Tambekar et al., 2008). Street food vending represents an important food security strategy for low-income population worldwide (WHO, 2000). However, no comprehensive hazard and risk analysis framework exists as regards to specific aspects of chemical/toxicological and biological hazards in street foods (Ilaria et al., 2014). According to Nzeka (2011), Nigeria had a history of developed supermarket industries until social and economic changes in the early 1980s affected food fashion of the country's middle class significantly. Since then, most Nigerians shop at traditional open-air markets or purchase their goods from traders and street vendors. Extensive street-vending of foods in Nigeria has been attributed to various factors such as deterioration of rural living conditions, segregation and poor housing, increase in poverty level, unemployment, migration to the cities and accelerated urbanization leading to enormous urban congestion, as well as distances between the workplaces and homes in the cities like Port Harcourt. Lack of cooking knowledge, changes in family cohesion and a shortage or absence of establishments that serve reasonably priced foods close to the workplace are also contributing factors (Tinker, 1997; Maxwell et al., 2000).

Street foods are "ready-to-eat" foods and beverages prepared and sold by vendors and hawkers especially in the streets and other similar public places (FAO, 1997). Studies have revealed frequent contamination of street foods in many developing worlds including Nigeria. For instance, in a study by Oranusi and Braide (2012) on the microbial safety of ready-to-eat foods; meat pie, beef sausage roll and egg roll, peeled orange, walnut and apple vended on highways; Onitsha-Owerri, Southeast, Nigeria revealed "the contamination of these foods by pathogens such as *Salmonella spp., Staphylococcus aureus, Escherichia coli, Bacillus cereus, Shigella spp., Enterococci, Aspergillus niger and Pseudomonas"*. Other researchers including Falola et al. (2011), Ossai (2012) and Mbah et al. *(*2012) have reported "contamination of street foods by pathogens" in different parts of Nigeria. Street foods are part of the catering business in developing countries, particularly in urban areas. Most of these products are ready-to-serve or ready-to-eat foods sometimes prepared under poor cooking and trading conditions which can lead to poor nutritive value and low hygienic quality. Meat, fish, cereals, milk among others are found available at all times as street vended foods (Obayelu et al., 2009). Consumption of unsafe street vended foods are affecting all social groups speedily (Mensah et al., 2002). Hence, adoption of adequate handling practices, adherence to appropriate preparation techniques and storage practices are factors that will ensure provision of hygienic foods and food materials to the populace (Ifediora et al., 2006; Umar et al., 2019).

Today, many people still suffer the ill-effects of poor levels of food safety and hygiene. These effects could be associated with a product purchased in a supermarket, a meal in a restaurant or ready-prepared foods purchased from Takeaway premises, or a table by the side of the road with an umbrella or canopy. Despite the lessons learnt from major food poisoning incidents over the years, too many cases of outbreaks associated with food poisoning are still occurring as a result of an increased consumption of unsafe food. This is an indication of failure on the part of food business operators and their employees to abide on basic principles of personal and food hygiene. According to Pepple (2017), more than 200,000 persons die every year in Nigeria of food poison caused by food contamination during processing, preservation and service. Fatiregun et al. (2010) recorded the incidence of 60 cases and 3 deaths due to foodborne disease with a symptomatic gastro intestinal disorders among people who ate in a funeral service while Di-Pinto et al. (2010) reported on the occurrence of listeria monocytogenes in ready-to-eat foods from supermarkets in Southern Italy among others. Hence, there is no doubt that the safety of food is a matter of concern to all food manufacturers, catering businesses, organizations in the supply and distribution chain, retailers and those preparing meals at home. Based on this, recent legislation now requires food business operators to operate a food safety management system, such as; Hazard Analysis and Critical Control Point (HACCP), Good Manufacturing Practices (GMPs), Good Agricultural Practices (GAPs) and National Advisory Committee on Microbiological Criteria for Foods. This is with a view to reducing the toll of death and ill-health associated with unsafe food (Jeremy, 2007). Thus, this study investigated the presence of microbiological organisms in some street vended foods in parts of Port Harcourt, Rivers State, Nigeria during wet and dry seasons.

MATERIALS AND METHODS

Study area

The study was conducted in three selected parts of Port Harcourt metropolis, Rivers States namely: 1. Makoba: Terminal and Deports (Housing Oil and Gas, Truck Park/slump environment), 2. Elekahia: (urban- defining Industrial and Residential Area) and 3. Rivers State University gate: (Urban-Academic Environment). Port Harcourt lies along the Bonny River and located in Niger Delta part of Nigeria. Port Harcourt metropolis covers about 360 sqkm. As of 2016, the Port Harcourt urban area has an estimated population of 1,865,000 inhabitants, up from 1,382,592 as of 2006 (Demographia, 2015).

Sample size and sample collection

Convenient sampling techniques was used to select food vendors, hawkers and most consumed foods in the study area. Six different food samples were purchased from roadside food vendors and hawkers in each study location in two consecutive days during each season, making a total of 18 (Eighteen) food samples. These consisted of roasted fish, roasted plantain, roasted yam, meat pie,

Table 1. Season and food samples with processing methods for the experiment.

Season	Station 1	Station 2	Station3
	RP1	RP2	RP3
Raining	RF1	RF2	RF3
	RY1	RY2	RY3
	SY1	SY2	SY3
Dry	MP1	MP2	MP3
	DN1	DN2	DN3

RP = Roasted plantain, RP1= RP from Makoba, RP2 = RP from Elekahia and RP3 = RP from Rivers State University. RF = Roasted fish, RF1 = RF from Makoba, RF2 = RF from Elekahia and RF3 = RF from Rivers State University. RY = Roasted yam, RY1 = from Makoba, RY2 = RY from Elekahia and RY3 = RY from Rivers State University. SY = roasted suya, SY1 = from Makoba, SY2 = RS from Elekahia and SY3 = RS from Rivers State University. MP = baked meat pie, MP1 = from Makoba, MP2 = MP from Elekahia and MP3 = MP from Rivers State University. DN = fried doughnut, DN1 = from Makoba, DN2 = DN from Elekahia and DN3 = DN from Rivers State University (Source: Oyet et al., 2020).

charcoal grilled meat "suya" and doughnut. The food samples were then wrapped in an aluminum foil paper, placed in ice cooler and transported immediately to the Microbiology Laboratory in the Department of Food Science and Technology, Rivers State University, Port Harcourt, Nigeria. They were stored at 4°C prior to analyses.

Experimental design

The study was done using a complete randomized design in a factorial experiment. Three (3) factorials were used (Factors A, B and C, with factor A as season, B as location and C as street vended foods samples) given as 2X3X3 factorials. The experimental design of the study is shown in Table 1 using the previous method of Oyet et al. (2020).

Microbiological analysis

Microbiological qualities of the samples such as Total Aerobic Count (TAC), Total Coliform Count (TCC), Faecal Coliform Count (FCC), Total Staphylococcus Count (TSC), Total Salmonella Count (TSC^2), Total Bacillus Count (TBC), Total Mould Count (TMC) and Total Yeast Count (TYC) were determined using the method reported by Ojokoh (2006). All glass wares used for the analysis were sterilised by autoclaving at 121°C for 15 minutes and allowed to cool to 45°C.

Preparation of Nutrient Agar (28 g), MacConkey (39 g), and Eosine Methylene Blue Agar (39 g) were all done separately by dissolving the measured quantity into 1000 ml distil water in sterile conical flasks and homogenized vigorously. Each of the conical flask were adequately covered with cotton wool and foil paper. Then, they were autoclaved at 121°C for 15 minutes and allowed to cool to 45°C. They were dispensed in sterile petri dishes and allowed to solidify as described by Ojokoh (2006). Peptone water (15 g) was weighed and dissolved in 1000 ml of distilled in a sterile beaker, mixed to dissolve completely before 225 ml was measured into a sterile conical flask from where 9 ml each was pipette into sterile test tubes, covered with cotton wool and autoclaved at 121°c for 15 minutes.

Serial dilution, inoculation and incubation, sub-culture, grams staining and identification of isolates were also carried out using the method illustrated by Ojokoh (2006).

Biochemical test

The following biochemical test were carried out for identification and confirmation of the colonies isolated: Indole Test, Motility Test, Oxidase Test, Catalase Test, Methyl Red Test and Voges Proskeur Test using Cheesbrough (2006) method.

Data analysis

Data obtained from this study were subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Sciences (SPSS) version 21. Mean values were separated using Turkey's multiple comparison range test and significance accepted at $p \leq 0.05$ probability level. All experiments and analysis were carried out in duplicates.

RESULTS AND DISCUSSIONS

Microbial quality of street vended foods (SVF) during rainy season

The results for the microbial quality of street vended foods during raining season are shown in Table 2a. Total Aerobic Count (TAC) was found to ranged from 7.00 to 8.46 log_{10}CFU/g with no growth detected in roasted plantain from Elekahia (station 2), meat pie from Makoba (station 1)

Table 2a. Microbial quality of street vended foods during the rainy season (Log_{10}CFU/g).

Samples	TAC	TCC	FCC	TSC	TSC^2	TBC	TMC	TYC
RP1	7.60^{f}±0.015	NG	NG	NG	NG	8.25^{a}±0.69	**NG**	6.30^{e}±0.06
RP2	NG	NG	NG	6.00^{e}±0.00	NG	6.95^{g}±0.00	6.00^{d}±0.00	NG
RP3	8.36^{b}±0.27	8.00^{a}±0.000	NG	6.00^{e}±0.00	NG	NG	NG	NG
RF1	7.00^{g}±0.00	NG	NG	7.82^{b}±0.01	7.11^{c}±0.00	7.95^{b}±0.00	6.30^{c}±0.06	NG
RF2	8.46^{a}±0.02	8.04^{a}±0.06	6.00^{c}±0.00	6.00^{e}±0.00	NG	8.30^{a}±0.00	6.00^{d}±0.00	NG
RF3	7.72^{e}±0.00	7.04^{c}±0.06	NG	6.00^{e}±0.00	NG	NG	NG	NG
RY1	8.08^{d}±0.00	6.78^{d}±0.00	7.54^{b}±0.00	6.00^{e}±0.00	NG	6.48^{i}±0.00	6.70^{b}±0.00	NG
RY2	7.49^{g}±0.02	7.79^{b}±0.01	7.49^{b}±0.02	NG	NG	ND	6.00^{d}±0.00	7.81^{a}±0.00
RY3	7.78^{e}±0.00	NG	NG	NG	NG	6.78^{h}±0.00	NG	NG
SY1	7.60^{f}±0.00	6.85^{d}±0.02	NG	6.85^{d}±0.00	7.38^{b}±0.05	7.15^{f}±0.00	NG	NG
SY2	7.30^{h}±0.00	8.00^{a}±0.00	NG	NG	7.57^{a}±0.02	7.80^{c}±0.01	6.00^{d}±0.00	7.80^{a}±0.01
SY3	7.78^{e}±0.00	NG	NG	NG	NG	7.54^{d}±0.00	7.25^{a}±0.07	7.26^{c}±0.01
MP1	NG	NG	8.45^{a}±0.04	NG	NG	7.92^{b}±0.01	6.30^{c}±0.03	NG
MP2	8.32^{b}±0.03	8.00^{a}±0.00	NG	7.98^{a}±0.01	NG	6.00^{j}±0.00	6.30^{c}±0.00	NG
MP3	NG	7.72^{b}±0.01	NG	8.00^{a}±0.00	NG	NG	NG	6.48^{d}±0.02
DN1	7.78^{e}±0.02	NG	NG	7.04^{c}±0.06	NG	NG	NG	7.60^{b}±0.00
DN2	NG	NG	NG	NG	NG	7.30^{e}±0.00	6.00^{d}±0.00	NG
DN3	8.18^{c}±0.00	NG	NG	NG	NG	6.00^{j}±0.00	6.30^{c}±0.00	NG

Mean values bearing different superscripts in the same column differ significantly ($p<0.05$) ± standard deviation of duplicate samples.
CFU = Colony Forming Unit, NG = No growth, TAC = total aerobic count, TCC = total coliform count, FCC = faecal coliform count, TSC = total staphylococcus Count, TSC^2 = total salmonella count, TBC = total bacillus count, TMC = total mould count, TYC = total yeast count. RP = Roasted plantain, RP1= RP from Makoba, RP2 = RP from Elekahia and RP3 = RP from Rivers State University. RF = Roasted fish, RF1 = RF from Makoba, RF2 = RF from Elekahia and RF3 = RF from Rivers State University. RY = Roasted yam, RY1 = from Makoba, RY2 = RY from Elekahia and RY3 = RY from Rivers State University. SY = roasted suya, SY1 = from Makoba, SY2 = RS from Elekahia and SY3 = RS from Rivers State University. MP = baked meat pie, MP1 = from Makoba, MP2 = MP from Elekahia and MP3 = MP from Rivers State University. DN = fried doughnut, DN1 = from Makoba, DN2 = DN from Elekahia and DN3 = DN from Rivers State University.

meat pie from Rivers State University (station 3) and doughnut from Elekahia labeled as samples RP2, MP1, MP3 and DN2, respectively with significantly ($p<0.05$) highest TAC detected in roasted fish from Elekahia (RF2).

The presence of high count of Total Aerobic Bacteria indicated inadequate processing and or post process recontamination due to cross-contamination with raw materials and dirty equipment/utensils as well as storage of food at improper temperature which could lead to rapid multiplication of pathogenic and toxigenic organisms (Aruna and Rajan, 2017). In a similar study by Eke-Ejiofor and Maxwell (2019), roasted plantain along Borokiri were found to have higher values of TAC of 1.3 x 10^7 CFU/g than those obtained from other locations. They concluded that high traffic in Borokiri area and other link roads led to increased dust formation that constituted major sources of contamination. Makoba area of Port Harcourt is similarly known for high traffic activities from heavy duty trucks for the movement of petroleum products and cements across the Niger Delta region. Other food samples such as roasted plantain, yam, suya, meat pie and doughnuts were not excluded as they had various degrees of contaminations by TAC across the 3 locations of the studied area. The contamination of these food samples might have occurred during exposure of the food samples to dust by improper handling practices by sellers/buyers and storage practices as suggested by FAO/WHO (2007).

High total coliform count (TCC) of 8.04 log_{10}CFU/g was recorded in roasted fish (RF2), followed by 8.00 log_{10}CFU/g recorded in roasted plantain (RP3), suya (SY2) and meat pie (MP2).

Least values of 6.78 log_{10}CFU/g and 6.85 log_{10}CFU/g for RY1 and SY1, respectively were isolated while no growth (NG) was observed in samples RP1, RP2, RF1, RY3, SY3, MP1 and in all the doughnut samples from the 3 study locations.

Mass isolation of coliform bacterial in roasted fish could be due to the high presence of water activity (fluid) contained in the fish product compare to that of doughnuts, suya and meat pie with low water activities or post-harvest contamination through food handlers and the environment which was above the standards for ready-to-eat-foods recommended by ICMSF (1996). The findings in this study is in agreement with the work of Ananias and Rowland (2017) who reported that chicken products were more vulnerable to contamination because chicken contains more fluid than beef and goat meat which could facilitate quick multiplication of coliforms. The issue of fish handling during processing, type of water used in cleaning the fish, the environment of operation where the cleaning, processing, preservation and storage coupled with display may account for high coliform load. According to Nkere et al. (2011) and Umar et al. (2019), lack of proper environmental sanitation and poor personal hygiene accounted for most of the food contamination among vendors of street food.

Faecal coliform count (FCC) were observed in samples RF2, RY1, RY2 and MP1 only, with high growth rate of *E. coli* (8.45 log_{10}/CFU/g) in baked meat pie (MP1). No faecal growth was detected from any food samples sold in the Rivers State University (RSU). The findings from this current study agreed with the work of Eke-Ejiofor and Maxwell (2019) who reported that *E. coli* was found in four (4) locations in the street roasted plantain namely: Borokiri, Elekahia, Waterline and Rumuokoro junctions while University of Port Harcourt (Uniport), RSU and the control showed no growth for *E. coli.* This may be due to the high level of environmental sanitation practiced within the university environment compare to other locations. Makoba location is known for its unhygienic condition occasioned by the activities of tanker drivers and the poor sanitary condition observed around the location. It is a well-known phenomenon that most of the drivers sleep in the truck cabin together with their help mate called motor boy. During this period, they defecate and urinate all around the area contaminating the environment with faecal matters. Food vendors are thus, seen with food on tables and canopies around this location and are characterized by poor handling and sanitary practices resulting in the heavy load of faecal coliform isolated in this study area. According to Rashmi et al. (2012), the presence of *E. coli* in the food suggested faecal or sewage contamination and it spreads from person-to-person. Stewart and Humphrey (2002) attributed the cases of food infection and intoxication to poor and inadequate sanitary condition observed in processing of many locally made foods. Thus, proper hygiene and storage, as well as avoiding cross contamination are the major ways for preventing food-borne diseases. Suneetha et al. (2011) stated that the presence of microorganisms is an indication of unhygienic conditions related to the location of the food stalls, especially in dusty roadsides. This is in line with the study conducted in the street of Lokoja by Madueke et al. (2014) who reported that the collected food samples tested positive for *E. coli*. *Escherichia coli* and *Staphylococuss aureus* are commonly associated with poor hygiene and sanitation and are usually implicated in the outbreak of foodborne illnesses (Odu and Ameweiye, 2013). *E. coli* have been identified as a normal flora of the human and animal intestine and has been implicated as a leading cause of foodborne illness all over the world. Fowoyo and Igbokwe (2014) also stated in their study that the isolation of *E. coli* may be as a result of poor environmental conditions due to dust, bio aerosols, contamination of the water and poor hygiene practices.

The Total Staphylococcus Count (TSC) ranged from 6.00 to 8.00 log_{10}CFU/g with no growth (NG) observed in samples RP1, RY2, RY3, SY2, SY3, MP1, DN2 and DN3. Staphylococcus count in roasted fish (RF1) was 7.82 log_{10}CFU/g with high significant ($p<0.05$) value in meat pie (MP3) with the value of 8.00 log_{10}CFU/g. The presence of *S. aureus* is an indication of respiratory contamination from the food handlers in contact with the food. Sandel and Mckillip (2004) stated that this contamination can be introduced into the street food samples during handling, processing or vending. According to Madueke et al. (2014), roasted plantains from all locations in Port Harcourt were contaminated with pathogenic bacteria*, E. coli* and *S. aureus*. This is partly similar with the result in this study where *S. aureus* where isolated in roasted plantain from two study locations out of 3 locations investigated. *E. coli* and *S. aureus* are known opportunistic microbes and foodborne pathogens that have been implicated in foodborne outbreaks (Mudgil et al., 2004; Oranusi and Braide, 2012).

Total Salmonella Count (TSC) of 7.57 log_{10}CFU/g, 7.38 log_{10}CFU/g and 7.11 log_{10}CFU/g were isolated in SY2, SY1 and RF1, respectively with significant ($p<0.05$) difference and no growth (NG) recorded in other samples. Vended street foods are commonly associated with gastrointestinal diseases such as diarrhea and typhoid fever caused by *Salmonella* due to improper handling and serving practices (Tambekar et al., 2008).

Bacillus Count (TBC) ranged from 6.00 to 8.30 log_{10}CFU/g with no growth seen in samples RP3, RF3, RY2, MP3 and DN1 representing 27% of no growth. The values detected for *Bacillus* revealed that, raining season favoured 73% microbial growth rate. There was no significant ($p>0.05$) difference in *Bacillus* growth detected at Makoba for roasted plantain (8.25 log_{10}CFU/g) and Elekehia for roasted fish (8.30 log_{10}CFU/g). According to Fowoyo and Igbokwe (2014), *Bacillus spp* was among the fifteen (15) bacterial pathogens that were isolated from air and hawked food samples. The presence of *Bacillus* in roasted plantain, fish, yam, meat pie, suya and doughnut

Table 2b. Biochemical reactions of suspected organisms associated with microbiological quality of street vended foods during rainy season.

Suspected org.	Gram RXN	VP	Indole	Motility	OX	Citrate
E. coli	- rod	-	+	+	-	+
Staph. Aureus	+ cocci	-	-	-	+	+
Salmonella sp	- rod	-	-	+	-	-
Bacillus	- rod	-	+	+	+	-

RXN = reaction, VP = Voges Proskeur, Ox = Oxidase, (-) = Negative, (+) = Positive.

is of public health concern. The current study corroborates with the findings of Bryan et al. (1997) which observed that *Bacillus cereus* and *S. aureus* counts was high as 7.0 logcfu/g value was isolated in meat ball samples. The predominance of *Bacillus* isolates (73%) in food samples in this study could be related to the presence of spores in the raw materials like meat and ingredient like spices, onion and pepper. These heat-resistant spores may have survived cooking, roasting and baking while vegetative bacteria were eliminated (Djoulde et al., 2015). Study conducted in Pakistan also reported high counts of bacterial pathogens like *S. aureus, E. coli and Bacillus cereus* with values of 5.0, 6.0 and 7.9 logcfu/g, respectively in street-vended foods (Bryan et al., 1992).

Total Mould Count (TMC) also ranged from 6.00 to 7.25 log_{10}CFU/g representing 61% growth rate during wet season while 39% food samples recorded no growth in RP1, RP3, RF3, RY3, SY1, MP3 and DN1 food samples. Again, the high growth rate of mould during the wet season may be due to the high relative humidity of the wet season which support high growth rate of mould on the food samples.

Total Yeast Count (TYC) of 33% were detected in samples RP1, RY2, SY2, SY3, MP3 and DN1, with significantly ($p<0.05$) high values of 7.81 log_{10}CFU/g and 7.80 log_{10}CFU/g observed in samples RY2 and SY2, respectively. Accordingly, 12 samples representing 67% were without any detectable yeast growth during the wet season. This is in agreement with the findings of Lamye et al. (2017) who reported that a decrease in yeast counts in yoghurt during the rainy season was observed. The implication is that yeast do not thrive well under cool temperature. The presence of high yeast and mould counts in yoghurt samples could also be an indication of inefficient preheating process during manufacturing, using unsatisfactory sterilized plastic cups in packaging or inefficient storage temperature as outlined by Saudi et al. (1989). Mould and yeast contamination causes deterioration and influences biochemical characteristics and flavour of the product, as well as its appearance and commercial desirability.

Biochemical Studies

Biochemical reactions of suspected organisms associated with microbiological quality of street vended foods (SVF) during wet season revealed all *E. Coli* to be indole, motility and citrate positive (+) as presented in Table 2b. *Staphylococcus aureus* were all Gram, oxidase and citrate positive (+), *Salmonella* were motility positive (+) and Gram-negative (-) while *Bacillus* were indole, motility and oxidase positive (+). Both Gram-positive and Gram-negative bacteria isolated are responsible for most of the outbreak of the food poisoning in vended foods during the wet season in Port Harcourt and other parts of Nigeria. Nyenje et al. (2012) stated that ready-to-eat food sold in Alice Town constituted a likely potential hazard to human health. Tassew et al. (2010) also stated that foodborne pathogens are the leading cause of illness and death in developing countries while Sears and Kaper (1996) noted that exotoxins of Gram-negative enteropathogenic bacteria play an important role in the pathogenesis of diarrheal disease, causing hypersecretion of liquids.

Bacteria vary in their metabolic and enzymatic activities. For instance, *E. coli* and *Bacillus spp* that tested positive (+) has the ability to convert tryptophan to indole as observed in current study and this was in agreement with the work of Bachoon and Wendy (2008). *Staphylococcus aureus* and *Salmonella spp* tested negative (-). *Salmonella* yield negative Voges-Proskauer and positive motility and methyl red tests and do not produce cytochrome oxide. *Salmonella* are also unable to convert tryptophan or phenylalanine and are usually urease and indole negative. Hence, the results for biochemical reactions signify the presence of the implicated organisms in food samples.

Bacterial exotoxins have enterotoxin, cytotoxic, hemolytic and neurotoxic effect. It is the bacterial enterotoxins which are responsible for production of various types of gastrointestinal manifestations like diarrhea and vomiting during different foodborne bacterial illnesses. Stewart and Humphrey (2002) noted that some bacterial toxins such as *Salmonella* are very potent and relatively easy to produce and classified as bio-threat agents.

Microbial quality of street vended foods during dry season

Results of microbial quality of street vended foods (SVF) during dry season revealed high Total Aerobic Count

Table 3a. Microbial quality of street vended foods during the dry season (CFU)

Samples	TAC	TCC	FCC	TSC	TSC²	TBC	TMC	TYC
RP1	5.48^{hi}±0.00	6.48^{bc}±0.00	6.07^{abc}±0.10	5.62^{b}±0.00	6.06^{defg}±0.03	3.00^{c}±0.00	5.30^{a}±0.00	8.42^{b}±0.02
RP2	5.77^{fgh}±0.10	5.39^{g}±0.13	5.30^{c}±0.00	ND	5.00^{i}±0.00	ND	5.60^{a}±0.00	ND
RP3	6.63^{cd}±0.01	6.65^{abc}±0.07	ND	ND	5.24^{hi}±0.00	ND	5.00^{a}±0.00	ND
RF1	7.38^{a}±0.00	6.38^{cd}±0.00	6.36^{ab}±0.03	ND	6.55^{abcd}±0.03	4.30^{b}±0.00	5.00^{a}±0.00	8.42^{b}±0.02
RF2	7.19^{ab}±0.10	6.83^{abc}±0.05	6.45^{ab}±0.04	6.76^{a}±0.14	6.42^{bcde}±0.00	2.00^{d}±0.00	5.57^{a}±0.39	7.48^{c}±0.00
RF3	6.92^{bc}±0.01	6.20^{cde}±0.12	ND	ND	6.62^{abc}±0.04	3.00^{c}±0.00	5.00^{a}±0.00	6.48^{d}±0.00
RY1	5.63^{h}±0.21	5.63^{efg}±0.21	5.24^{c}±0.334	ND	6.00^{efg}±0.00	ND	5.30^{a}±0.00	ND
RY2	6.12^{ef}±0.16	6.28^{cde}±0.46	5.80^{bc}±0.14	ND	5.66^{fgh}±0.26	ND	5.30^{a}±0.00	ND
RY3	5.18^{i}±0.04	5.48^{fg}±0.00	5.66^{bc}±0.26	ND	5.15^{hi}±0.00	ND	ND	ND
SY1	7.44^{a}±0.01	7.26^{a}±0.00	7.10^{a}±0.03	ND	ND	3.00^{c}±0.00	ND	8.76^{a}±0.00
SY2	7.19^{ab}±0.10	7.33^{a}±0.21	ND	ND	6.89^{ab}±0.02	6.63^{a}±0.01	5.65^{a}±0.07	5.18^{f}±0.00
SY3	7.27^{ab}±0.02	7.11^{ab}±0.05	ND	ND	7.04^{a}±0.00	ND	5.30^{a}±0.00	5.32^{e}±0.00
MP1	6.08^{ef}±0.06	ND	5.65^{bc}±0.07	ND	6.16^{cdef}±0.02	ND	5.30^{a}±0.00	ND
MP2	5.65^{gh}±0.07	5.39^{g}±0.13	5.81^{bc}±0.69	ND	5.65^{fgh}±0.07	ND	ND	ND
MP3	6.55^{d}±0.09	5.60^{defg}±0.00	5.45^{bc}±0.21	ND	5.65^{fgh}±0.07	ND	5.30^{a}±0.00	ND
DN1	6.15^{e}±0.00	6.15^{cdef}±0.00	5.15^{c}±0.21	ND	6.00^{cdefg}±0.0	ND	ND	ND
DN2	6.96^{bc}±0.04	ND	5.15^{c}±0.21	ND	5.65^{fgh}±0.07	ND	5.30^{a}±0.00	ND
DN3	6.01^{efg}±0.15	5.24^{g}±0.34	5.57^{bc}±0.39	ND	5.59^{ghi}±0.16	2.00^{d}±0.00	5.30^{a}±0.43	ND

Mean values bearing different superscripts in the same column differ significantly ($p<0.05$), ± standard deviation of duplicate samples.
CFU = Colony Forming Unit, TAC = total aerobic count, TCC = total coliform count, FCC = faecal coliform count, TSC = total staphylococcus count, TSC² = total salmonella count, TBC = total bacillus count, TMC = total mould count, TYC = total yeast count. RP = Roasted plantain, RP1= RP from Makoba, RP2 = RP from Elekahia andRP3 = RP from Rivers State University. RF = Roasted fish, RF1 = RF from Makoba, RF2 = RF from Elekahia and RF3 = RF from Rivers State University. RY = Roasted yam, RY1 = from Makoba, RY2 = RY from Elekahia and RY3 = RY from Rivers State University. SY = roasted suya, SY1 = from Makoba, SY2 = RS from Elekahia and SY3 = RS from Rivers State University. MP = baked meat pie, MP1 = from Makoba, MP2 = MP from Elekahia and MP3 = MP from Rivers State University. DN = fried doughnut, DN1 = from Makoba, DN2 = DN from Elekahia and DN3 = DN from Rivers State University.

(TAC) of 7.44 log_{10}CFU/g and 7.38 log_{10}CFU/g in suya and roasted fish, respectively from Makoba as shown in Table 3a. The TAC was observed in all food samples which pre-supposes 100% implications which is in agreement with the work of Sarkar et al. (2012). According to Aruna and Rajan (2017), street vended foods with high TAC is an indication of possible presence of microbial contaminants resulting from poor handling, processing methods and improper storage temperature which can only be prevented through the application of good manufacturing practices (GMP).

Total Coliform Counts (TCC) ranged from 5.24 to 7.33 log_{10}CFU/g which represented 89% coliform growth rate of the SVF samples and only two samples (MP1 and DN2) recorded no growth. The presence of dusty environment and other human activities might have supported the growth rate of TCC. The isolation of coliform presumes the identification of potential disease-causing bacteria and thus the presence of coliform is a signal for the determination of microbial pollutant in SVF which is in agreement with the work of Ananias and Rowland (2017).

The detection of Faecal Coliform Count (FCC) in SVF ranged from 5.15 to 7.10 log_{10}CFU/g with significantly ($p<0.05$) high faecal coliform isolated in sample SY1 and least in samples DN1 and DN2. The study recorded 78% FCC growth rate among the 18 SVF while FCC was not isolated in samples RP3, RF3, SY2 and SY3 which represented 22% no growth. The high presence of FCC in SVF from Makoba could be attributed to the general poor sanitary condition of the location and the unhygienic condition of the food handlers. The microbial load of 78% showed that the dry season did not hinder the growth of faecal coliform. Also, most of the foods were displayed in the open tables using umbrellas as shades and house flies forming colonies around the food which were sold to customers. For SY1, faecal load may also come from the handling of raw material, as well as water used in washing the meat before cutting into sizes. Sharmila (2011) reported that the hands of the food handlers are the most important vehicle for the transfer of organisms from faeces, nose and skin to the food. It was also observed by Rane (2011) that most handlers of street food in developing countries are ignorant of basic food safety measures. Consequently, street foods are commonly exposed to various contaminants at different stages of handling. Todd (1992) reported that people who patronize street vended foods often suffer from foodborne diseases like diarrhea, cholera, typhoid fever and food poisoning. Recently, Umar et al. (2019) agreed that poor hygienic condition of the food handler is a suspect for food contamination.

Total Staphylococcus Count (TSC) was observed only in roasted plantain (5.62 $\log_{10}$CFU/g.) from Makoba and roasted fish (6.76 $\log_{10}$CFU/g) from Elekahia. No Staphylococcus growth was isolated in other SVF samples during dry season with no growth rate of 89% recorded while detectable growth was 11%. This may suggest that Staphylococcus count was not commonly isolated in SVF during dry season.

The present study showed a 95% growth rate of Total Salmonella Count (TSC^2) in the SVF samples with 5% (SY1) no detectable growth rate. The high growth rate revealed that dry season did not prevent the growth of Salmonella in SVF samples. Suya obtained from Rivers State University (SY3) and Elekahia (SY2) recorded the highest Salmonella isolates during the dry season with the values of 7.04 $\log_{10}$CFU/g and 6.89 $\log_{10}$CFU/g, respectively. The findings agreed with the work of Sharmila (2011) who showed that foodborne bacterial pathogens commonly detected in street vended foods are *Bacillus cereus*, *Clostridium perfringens*, *Staphylococcus aureus* and *Salmonella spp*. Mepba et al. (2007) also stated that many of these vended street foods may have a high degree of hand contact in the process of preparation and vending which predisposes these foods to various levels of bacterial contamination especially those of human origin.

The value for Total Bacillus Count (TBC) isolated ranged from 2.00 to 6.63 $\log_{10}$CFU/g with significantly ($p<0.05$) low value recorded in samples RF2 and DN3 and significantly high value in sample SY2 while eleven SVF samples recorded 61% non-detectable TBC growth rate. Achinewhu and Amadi (1995) also isolated *Bacillus cereus* in some street foods in Port Harcourt to some degree. Akinnibosun and Airiohuodion (2015) stated in their study that the distribution of microorganisms in SVF is to a large extent affected by environmental factors such as temperature, pH and amount of sunlight. This is an indication that dry season prevented the growth of Bacillus in street vended food to some extent during isolation and characterization of the microorganisms maybe as a result of high sunlight and decreased water activity. The findings in this study is partly in agreement with the work of Umoh and Odoba (1999) and Omemu and Aderoju (2008) who reported that *B. cereus* was isolated from 42 samples with lower growth rate of 26.3%. *Bacillus cereus* has been responsible for outbreaks of foodborne illness because it produces heat stable (emetic) and heat sensitive (diarrheal) toxins when foods are held under conducive condition for several hours (Mosupye and Holy, 1999; Mensah et al., 2002). Thus, foodborne illnesses associated with *Bacillus cereus* could be at minimal during dry season.

Total Mould Count (TMC) ranged from 5.00 to 5.65 $\log_{10}$CFU/g with detectable growth rate of 78% and no detectable rate of 22%. These values were however not statistically significant ($p>0.05$) in all the street vended food samples studied excluding samples RY3, SY1, MP2 and DN1 with no mound growth. Thus, mould thrives during dry season in majority of the street vended food samples. From the study, it was evident that yeast had a poor growth rate during dry season compare to mould growth rate of 78%. The water activity of the food samples could be responsible for the no growth rate of yeast in meat pie, doughnut and roasted yam in all the 3 study locations. The growth rate of yeast (39%) and mould (78%) is in agreement with the work of Adebayo-Tayo et al. (2012a, b, c,). These fungal pathogens have been reportedly isolated from different food sources in Nigeria (Chukwuka et al., 2010; Odu and Ameweiye, 2013). The most common fungi reported by Akintobi et al. (2011) were *Aspergillus flavus, A. niger, Fusarium solani, Penicillium digitatum, Rhizopus stolonifer and yeasts.* In this study, mould (78%) was the most predominant fungal isolated. Sarkar et al. (2012) stated that higher yeast count during the dry season might reflect the ability of more yeast to grow during warmer weather, as well as increased diversity and alteration in microbial flora leading to higher levels of contamination.

Biochemical studies

The study also considered the biochemical reactions of isolated organisms associated with microbiological quality of street vended foods (SVF) during dry season. The result revealed *E. Coli* as Gram (-) rod and Indole, Methyl Red (MR) and Catalase positive (+) as presented in Table 3b. *Staphylococcus aureus* showed oxidase (OX), citrate and catalase positive while *Salmonell*a citrate and MR positive (+) and negative (-) for Gram test, voges proskeur (VP), Indole, OX and Catalase. Bacillus was Gram (+) rod, OX, Citrate and Catalase (+) while VP, Indole, Coagulate and MR negative (-). From the biochemical characterization techniques, the study confirmed the presence of *E. coli*, *S. aureus, Salmonella sp and bacillus* in the SVF samples. *E.*

Table 3b. Biochemical reactions of suspected organisms associated with microbiological quality of street vended foods during the dry season.

Suspected org.	Gram RXN	VP	Indole	Coagulase	OX	Citrate	MR	Catalase
E. coli	- rod	-	+	-	-	-	+	+
S. aureus	+ cocci	-	-	-	+	+	-	+
Salmonella sp	- rod	-	-	-	-	+	+	-
Bacillus	+ rod	-	-	-	+	+	-	+

RXN = reaction, VP = voges proskeur, OX = oxidase, (-) = negative, MR = methyl red, (+) = positive.

coli (-) rod showed that the organism cannot use citrate as a carbon source, being Methyl positive. *E. coli* is able to produced stable acids and products (mixed formation of glucose mechanism). It is a known fact that *E. coli* is part of the normal intestinal flora, though some strains are pathogenic and can cause gastroenteritis, meningitis and wounds infections. Gram (-) bacteria can cause many types of infections and can spread to human in a variety of ways. *Staphylococcus aureus* and *bacillus* are gram positive rods and are known for their pathogenic influence in street vended food samples.

Conclusion

The isolation of Total aerobic, Total Coliform, Total Staphylococcus, Total Salmonella and Total Bacillus counts from the street vended roasted plantain and fishes in this study, demonstrated that most of the well-known foodborne pathogens were implicated in cases originating from consumption of these food samples during dry and wet season. The observed lower bacteria counts during the dry season than wet season implied that the distribution of some microorganisms is to a large extent affected by the environmental factors such as temperature, pH, amount of sunlight and humidity of the season. Apart from environmental factors, human handling of the food samples were observed to be responsible for the spread of these pathogenic organisms as the highest occurrence of microbes were recorded in roasted plantain and fishes. Hence, adequate food handling protocols and hygiene practices should be ensured by food vendors. These can prevent contamination, cross-contamination and the production of these bacteria in the street vended foods at large.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Achinewhu, S. C., & Amadi, E. N. (1995). Bacteria flora of some street foods in Port Harcourt, Nigeria. *Niger Delta Biology,* 1, 59-61.

Adebayo-Tayo, B. C., Odu, N. N., Anyamele, L. M., Igwiloh, N. J. P. N., & Okonko, I. O. (2012a). Microbial quality of frozen fish sold in Uyo metropolis. *Nature and Science,*10(3), 71-77.

Adebayo-Tayo, B. C., Odu, N. N., Esen, C. U., & Okonko, I. O. (2012c). Microorganisms associated with spoilage of stored vegetables in Uyo metropolis, Akwa Ibom State, Nigeria. *Nature and Science,* 10(3), 23-32.

Adebayo-Tayo, B. C., Odu, N. N., Igwiloh, N. J. P. N. & Okonko, I. O. (2012b). Microbiological and physicochemical level of fresh catfish (*Arius hendelotic)* from different markets in Akwa Ibom State, Nigeria. *New York Science Journal,* 5(4), 46-52.

Akinnibosun, F. I., & Airiohuodion, P. (2015). Microbial assessment and proximate analysis of pop corn sold along Benin-Sapele expressway. *Nigeria Journal of Chemical, Biological and Physical Science,* 5(2), 1711-1719.

Akintobi, A. O., Okonko, I. O., Akano, O. R., Agubiade, S. O., & Onianwa, O. (2011). Isolation and identification of fungi associated with spoilage of some selected fruits in Ibadan, South Western Nigeria. *Academia Arena*, 3(11), 1-110.

Ananias, B., & Rowland, K. (2017). Bacterial contamination of ready-to-eat meats vended in highway markets in Uganda. *African Journal of Food Science*, 11(6), 160-170.

Aruna, N., & Rajan, V. (2017). Microbial analysis of street foods of different locations at Chennai city, India. *Innovat International Journal of Medical & Pharmaceutical Sciences*, 2(1), 21-23.

Bachoon, D. S., & Wendy, A. D. (2008). Microbiology laboratory manual. *Ed. Michael Stranz. Mason, OH: Cengage Learning*. Exercise 15, "Normal Flora of the Intestinal Tract" Print.

Bryan, F. L., Jermini, M., Schmitt, R., Chilufya, E. N., Michael, M., Matoba, A., Mfume, E., & Chibiya, H. (1997). Hazards associated with holding and reheating foods at vending sites in a small town in Zambia. *Journal of Food Protection*, 60(4), 391-398.

Bryan, F.L., Teufel, P., Riaz, S., Rooh, S., Qadar, F., & Malik, Z. (1992). Hazards and critical control points of vending operations at a railway station and a bus station in Pakistan. *Journal of Food Protection*, 55(7), 534-541.

Cheesbrough, M. (2006). *District laboratory practice in tropical countries.* Cambridge University Press.

Chukwuka, K. S., Okonkwo, I. O, & Adekunle, A. A. (2010). Microbial ecology of organisms causing pawpaw (*Carica papaya L.)* fruit decay in Oyo State, Nigeria. *American-Eurasian Journal of Toxicological Sciences,* 2(1), 43-50.

Demographia (2015). *Demographia World Urban Areas (Built Up Urban Areas or World Agglomerations), 11th edition*. Retrieved from https://www.urbangateway.org/es/system/files/documents/urbangateway/db-worldua.pdf

Dipeolu, O. A., Akinbode, O. S., & Okuneye, A. P. (2007). Income generating potentials of street food vending businesses in

Ogun State, Nigeria. *ASSET: An International Journal (Series C)}*, 2(1), 180-189.
Di-Pinto, A., Novello, L., Montemurro, F., Bonerba, E., & Tantillo, G. (2010). Occurrence of listeria monocytogenes in ready-to-eat foods from supermarkets in Southern Italy. *The New Microbiologica: Official Journal of the Italian Society for Medical Virology*, 33(3), 249-252.
Djoulde, D., Roger, I., Bayoi, J., & Daoudou, B. (2015). Microbiological quality and safety of street meat-food sold in Soudano Sahelian zone of Cameroon. *International Journal of Current Microbiology and Applied Sciences,* 4(2), 441-450.
Eke-Ejiofor, J., & Maxwell, U.S. (2019). Safety and quality assessment of street vended roasted plantain (bole) in Port Harcourt, Rivers State, Nigeria. *International Journal of Biotechnology and Food Science,* 7(1), 9-13.
Falola, A. O., Olatidoye, O. P., Balogun, I. O., & Opeifa, A. O. (2011). Microbiological quality analysis of meat pies sold by street hawkers: A case study of Mainland Local Government Area of Lagos, Nigeria. *Journal of Medical and Applied Biosciences,* 2, 1-8.
FAO (1997). Agriculture food and Nutrition for Africa. A Resource Book for Teachers of Agriculture. Food and Agricultural Organization, Rome.
FAO/WHO (2007). Food and Agriculture Organization/World Health Organisation. Report on: Improving the nutritional quality of street foods to better meet the micronutrient needs of schoolchildren in urban areas. Pp. 14-17.
Fatiregun, A. A., Oyebade, O. A., & Oladokun, L. (2010). Investigation of an outbreak of food poisoning in a resource-limited setting. *Tropical Journal of Health Sciences*, 17(1), 1117-4153.
Fowoyo, P. T., & Igbokwe, O. E. (2014). Impact of air pollution on the microbiological quality of ready to eat hawked foods sold around a cement factory in Lokoja, Nigeria. *American Journal of Research Communication*, 2(11), 138-157.
Ifediora, A. C., Nkere, C. K., & Iroegbu, C. U. (2006). Weaning food preparations consumed in Umuahia, Nigeria: evaluation of the bacteriological quality. *Journal of Food Technology,* 4(2), 101-105.
Ilaria, P., Chiara, F., & Alberto, M. (2014). Identification and management of toxicological hazards of street foods in developing countries. *Food Chemistry and Toxicology,* 63, 143-152.
International Commission on Microbiological Specification for Foods (ICMSF) (1996). Microorganisms in foods; Samples for microbiological analysis: Principles and specific applications. Recommendation of the International Commission on Microbiological Specification for Foods. Association of Microbiological Societies, University of Toronto Press. ISO.1995.
Jeremy, S. (2007). *The A-Z of food safety*. Thorogood Publishing Ltd, 10-12 Rivington Street London EC2A 3DU, p.204.
Lamye, G. M., Lunga, P. K., Pamo, T. E., & Jules-Roger, K. (2017). Seasonal microbial conditions of locally made yoghurt (shalom) marketed in some regions of Cameroon. *International Journal of Food Science*, 2017(4), 1-16.
Madueke, S. N., Awe, S., & Jonah, A. I. (2014). Microbiological analysis of street foods along Lokoja-Abuja express way, Lokoja. *American Journal of Research Communication*, 2(1), 196-211.
Maxwell, D., Levin, C., Armar-Klemesu, M., Ruel, M., Morris, S., & Ahiadeke C. (2000). Urban livelihood and food and nutrition security in Greater Accra, Ghana. International Food Policy Research Institute, 2033 K Street, N.W., Washington, D.C. 20006-1002 U.S.A. Research Report 112.
Mbah, M., Ogban, G. I., Konlack, G. D., Useh, M. F., & Asuquo, A. E. (2012). The bacteriological status of five selected street vended cooked foods in Calabar, Nigeria. *Journal of Pharmacy and Biological Sciences*, 2(4), 25-29.
Mensah, P., Yeboah-Manu, D., Owusu-Darko, K., & Ablordey, A. (2002). Street foods in Accra, Ghana: How safe are they? *Bulletin of the World Health Organization*, 80(7), 546-554.
Mepba, H. D., Achinewhu, S. C., Aso, S. M., & Wachukwu, C. K. (2007). Microbiological quality of selected street foods in Port Harcourt. *Journal of Food Safety,* 27(12), 1202-1211.
Mosupye, F. M., & Holy, A. (1999). Microbiological quality and safety of ready to eat street vended foods in Johannesburg, South Africa. *Journal of Food Protection,* 62(11), 1278-1284.
Mudgil, S., Aggarwal, D., & Ganguli, A. (2004). Microbiological analysis of street vended fresh squeezed carrot and kinnow-mandarin juices in Patiala City, India. *Internet Journal of Food Safety*, *3*, 1-3.
Nkere, C. K., Ibe, N. I., & Iroegbu, C.U. (2011). Bacteriological quality of foods and water sold by vendors and in restaurants in Nsukka, Enugu State, Nigeria: A comparative study of three microbiological methods. *Journal of Health Population and Nutrition*, 29(6), 560-566.
Nyenje, M.E., Odjadjare, C.E., Tanih, N.F., Green, E. & Ndip, R.N. (2012). Foodborne pathogens recovered from ready-to-eat foods from roadside cafeterias and retail outlets in Alice, Eastern Cape Province, South Africa: Public health implications. *International Journal of Environmental Research and Public Health*, 9(8), 2608-2619.
Nzeka, U. M. (2011). Steady growth of Nigeria's retail food sector. *Global Agricultural Information,* 21, 17-25.
Obayelu, A. E., Okoruwa, V. O., & Oni, O. A. (2009). Analysis of rural and urban households' food consumption differential in the North central, Nigeria: A micro-econometric approach*. Journal of Development and Agricultural*, 1(2), 018-026.
Odu, N. N., & Ameweiye, N. B. (2013). Microbiological quality of street-vended-ready-to-eat "bole" fish in Port Harcourt metropolis. *New York Science Journal*, 6(2), 92-101.
Ojokoh, A. O. (2006). Microbiological examination of ice cream sold in Akure. *Pakistan Journal of Nutrition*, 5(6), 536–538.
Omemu, A. M., & Aderoju, S. T. (2008). Food safety knowledge and practices of street food vendors in the city of Abeokuta, Nigeria. *Food Control*, 19(4), 396-402.
Oranusi, S., & Braide, W. A. (2012). Study of microbial safety of ready-to-eat foods vended on highways: Onitsha-Owerri, South East Nigeria. *International Research Journal of Microbiology*, 3(2), 66-71.
Ossai, O. S. (2012). Bacteriological quality and safety of street vended foods in Delta State, Nigeria. *Journal of Biology, Agriculture and Healthcare*, 2(5), 114-118.
Oyet, G. I., Kiin-Kabari, D. B., Akusu M. O., & Achinewhu, S. C. (2020). Impact of wet and dry seasons on the distribution of polycyclic aromatic hydrocarbons in selected vended street foods in parts of Port Harcourt metropolis. *European Journal of Nutrition and Food Safety*, 12(1), 16-29.
Pepple, N. (2017). Environment and food poisoning: food safety knowledge and practice among food vendors in Garki, Abuja – Nigeria. *Journal of Health Education Research and Development*, 5(2), 1-4.
Rane, S. (2011). Street vended food in developing world: hazard analyses. *Indian Journal of Microbiology,* 51(1), 100–106.
Rashmi, H., Poojara, A., & Krishnan, G. (2012). Microbiological profile of street vended foods in Cochin, Kerala, India.

Bioscience Discovery, 3(2), 179-185.

Sarkar, M. M., Nahar, T. N., Alam, M. K., Rahman, M. M., Rashid, M. H., & Islam, M.A. (2012). Chemical and bacteriological quality of popular Dahi available in some selected areas of Bangladesh. *Bangladesh Journal of Animal Science*, 41(1), 47–51.

Saudi, A. M., El-Essawy, H. A., & Hafez, N. M. (1989). Aspects on the microbiological quality of yoghurt plastic containers. *Veterinary Medical Journal Giza*, 37(3), 397-406.

Sears, C. L., & Kaper, J. B. (1996). Enteric bacterial toxins: mechanisms of actions and linkage to intestinal secretion. *Microbiology and Molecular Biology Reviews*, 60(1), 167-215.

Sharmila, T. (2011). Street vended food in developing world: hazard analyses*. Indian Journal of Microbiology,* 51(1), 100-106.

Stewart, W. L., & Humphrey, K. (2002). *Ready to eat food and foodborne infection (5th edition)*. CBS Publisher and Distributors, New Delhi, India. Pp. 240-245.

Suneetha, C., Manjula, K., & Baby, D. (2011). Quality assessment of street foods in Tirumala. *An Asian Journal of Biological Sciences*, 2(2), 207–211.

Tambekar, D. H., Jaiswal, V. J., Dhanorkar, D. V., Gulhane, P. B., & Dudhane, M. N. (2008). Identification of microbiological hazards and safety of ready-to-eat food vended in streets of Amravati City, India. *Journal of Applied Biosciences*, 7(3), 195-201.

Tassew, H., Abdissa, A., Beyene, G., & Gebre-Selassie, S. (2010). Microbial flora and food borne pathogens on minced meat and their susceptibility to antimicrobial agents. *Ethiopian journal of health sciences*, 20(3), 137-143.

Tinker, I. (1997). *Street foods, urban food and employment in developing countries*. Oxford University Press, New York. Pp. 124-126.

Todd, E. C. D. (1992). Foodborne disease in Canada: A 10-year summary from 1975 to 1984. *Journal of food protection*, 55(2), 123-132.

Umar, A. A., Sambo, M. N., Sabitu, K., Mande, A. T., & Umar, J. (2019). Personal hygiene of street-food vendors in Sabon-Gari local government area of Kaduna State, Nigeria. *Nigerian Journal of Basic and Clinical Sciences*, 16(2), 114-120.

Umoh, V. J., & Odoba, M. B. (1999). Safety and quality evaluation of street foods sold in Zaria, Nigeria. *Food Control*, 10(1), 9-14.

World Health Organisation (WHO) (2000). Food safety: Resolution of the Executive Board of the WHO 105th Session.