

# Safety and quality assessment of street vended roasted plantain (*bole*) in Port Harcourt, Rivers State, Nigeria

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**Abstract.** The microbiological quality, heavy metal and Polycyclic Aromatic Hydrocarbons (PAH) of roasted plantain sold in selected locations in Port Harcourt metropolis were investigated. Roasted plantain samples were purchased from seven different locations in Port Harcourt metropolis namely; Rivers State University (RSU) campus, University of Port Harcourt (Uniport) Choba, Waterline Junction, Rumukoro Junction, Elekahia Station and Borokiri Station. Samples were analyzed for microbiological, heavy metal, and Polycyclic Aromatic Hydrocarbons (PAH) quality and laboratory roasted plantain used as control. Total Aerobic Count (TAC), Total Staphylococcal Count (TSC), Total Coliform Count (TCC), Total *Escherichia Coli* (TEC) and total mold count of samples were assessed by inoculating into different selective media such as Eosin Methylene Blue (EMB), MacConkey Agar (MCA), Mannitol Salt Agar (MSA), Nutrient Agar (NA) and Potato Dextrose Agar (PDA) respectively and incubated at the desired temperature. *Staphylococcus aureus*, *E. coli*, *Asperillus sp.* and *Penicillium sp.* were identified from the samples (Bole). TAC in roasted plantain samples ranged from  $5.2 \times 10^6$  to  $1.3 \times 10^7$  CFU/g, TSC ranged from  $4.0 \times 10^5$  to  $5.0 \times 10^6$  CFU/g, TCC ranged from  $2.0 \times 10^5$  to  $4.1 \times 10^6$  CFU/g, TEC ranged from  $9.0 \times 10^5$  to  $1.7 \times 10^6$  CFU/g and Total mould count ranged from  $2.0 \times 10^5$  to  $1.5 \times 10^6$  CFU/g. Result showed that street vended roasted plantain (Bole) sold along roadsides were not safe for human consumption, when compared with the set standards by International Commission on Microbiological Specification for Food (ICMSF, 1996) and therefore the need for improved sanitary practices. The result of heavy metals were less than  $<0.001$  (mg/kg) in all the samples examined. Polycyclic Aromatic Hydrocarbons (PAH) (mg/kg) ranged from 0.003 to 0.015 mg/kg with sample from Rumukoro Junction as the lowest and sample from Waterline Junction as the highest which were below the recommended limit of 5.0mg/kg. The study recommended the need for improvement and sustainability of food safety practices of food vendors for improved health of consumers.

**Keywords:** Assessment, safety, quality, roasted, plantain, Port-Harcourt.

## INTRODUCTION

Plantain (*Musa sapientum* var. *Paradisical* Linn) is one of the staple foods widely consumed in the West Africa sub-region, northern America, Mexico and Caribbean (Ohenhen *et al.*, 2006). In Nigeria, its consumption cuts across multiethnic group and the various socio-economic classes because of the ease of preparation and consumption in the roasted form (bole) plantain is often

eaten with palm oil or groundnut. When boiled, it is eaten with vegetable soup or stew. It is also fried into chips, making a popular food among the rich and the poor (Ohenhen *et al.*, 2006).

Street foods like plantain (Bole) are well patronized in Nigeria in general and the Niger Delta in particular, since it is easily accessible and also serves as an important

source of income. However, these street vended food largely do not meet proper hygienic standards and can therefore lead to morbidity and mortality due to food borne illnesses and have subsequent effect on business as well as development street foods have been reported to be contaminated with pathogen and have also been implicated in food borne epidemics.

In Nigeria today, many urban dwellers obtain a significant portion of their diet from street foods which increase the street food demand in major cities (Pikuda and Ilelaboye, 2009). Street vended foods are those foods prepared and ready-to-eat or prepared at home and consumed on the street without further preparation (Martins and Anelichi, 2000). According to FAO (2007), street foods raised concern with respect to their potential food poisoning outbreaks due to improper handling and unhygienic practices among street food vendors.

Roasted plantain being a ready to eat food is mostly involved in food borne diseases due to microbial contamination during processing and preparation. These food borne diseases results from the ingestion of bacteria and their toxins, produced by microorganisms in the food and constitute a major public health problem (Akinbode *et al.*, 2011).

Food safety knowledge can be described as having the information, understanding and skills about safeguarding or protection of food from anything that could harm consumers' health or having the assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use (Codex *et al.*, 2002).

Moreover, food safety is of crucial importance not only to consumers, but also to the food industry, policy makers and the economy (Jevsnik *et al.*, 2008), as millions of people get ill and many die each year, as a consequence of consuming unsafe food (WHO, 2002; WHO 2009). Food safety can be defined as the inverse of food risk, or the assurance that a food will not cause harm to the consumer when it is prepared or eaten in accordance with its intended use (Wilcock *et al.*, 2004; WHO, 2009).

A recent observation in Port Harcourt city shows a social pattern characterized with increased mobility due to urbanization. Large percentage of the population depends on ready-to-eat foods. This has resulted in a situation where food sanitary measures and proper handling have been transferred from individuals and families to the food vendors who rarely enforce such practices (Musa and Akande, 2002).

Most handlers of street food in developing world and in Port Harcourt city in particular are ignorant of basic food safety measures. Consequently, street foods are commonly exposed to various contaminants at different stages of handling (Rane, 2011).

The objective of the study is therefor to evaluate the quality and safety of street vended roasted plantain in Port Harcourt, Rivers State, Nigeria.

## MATERIALS AND METHODS

Roasted plantains were randomly purchased from six (6) different locations in Port Harcourt City namely (Rivers State University campus, Choba Park, Rumuokoro Junction, Waterlines Bus Stop, Elekahia and Borokiri, while the control was prepared in the laboratory.

### Collection of food samples

The six food samples were collected from the vendors at the point of preparation in an exposed form, in which it is sold, with a sterile Ziploc bags in preparation for analysis.

### Analysis

Street roasted plantain samples were analyzed for microbiological parameters, heavy metals and Polycyclic Aromatic Hydrocarbons (PAH) using standard methods.

#### *Microbiological analysis*

Microbial quality was carried out using the method of Ojokoh (2006), which involved preparation of media, diluents, serial dilution, inoculation, incubation, subculture, gram stain

#### *Metal analysis*

Metal analysis was conducted using USEPA Test Method 363°C, while ash solution for metal analysis was aspirated using Atomic Absorption Spectrophotometer. Polycyclic Aromatic Hydrocarbon (PAH) in solid food was determined using the (TNRCC TX METHOD 1005) procedure.

## RESULTS AND DISCUSSION

### **Microbial analysis of street vended roasted plantain (Bole) from six locations in Port Harcourt**

Table 1 shows the microbial analysis result of roasted plantain (Bole) samples collected along the roadside by different vendors in Port Harcourt. The total aerobic count (CFU/g) ranged between  $5.2 \times 10^6$  to  $1.3 \times 10^7$  (CFU/g) with the control having the lowest count and Borokiri sample as the highest. These values obtained were very low when compared with those obtained from the streets in Accra, Ghana (Maxwell *et al.*, 2000). The presence of high count of total bacteria and coliform indicate inadequate processing and post process recontamination due to cross-contamination with raw materials and dirty

**Table 1.** Microbial analysis of roasted plantain from different locations in Port Harcourt.

Sample	TAC CFU/g	TSC CFU/g	TCC/CFU/g	TEC CFU/g	Mould count CFU/g
BK	$1.3 \times 10^7$	$1.5 \times 10^6$	$1.7 \times 10^6$	$9.0 \times 10^5$	$7.0 \times 10^5$
ELE	$9.6 \times 10^6$	$4.0 \times 10^5$	$4.1 \times 10^6$	$1.7 \times 10^6$	$1.5 \times 10^6$
W/L	$1.1 \times 10^7$	$5.0 \times 10^6$	$2.7 \times 10^6$	$1.4 \times 10^6$	NG
R/K	$1.0 \times 10^7$	$2.8 \times 10^6$	NG	$1.2 \times 10^6$	$2.0 \times 10^5$
Uniport	$9.8 \times 10^6$	$1.4 \times 10^6$	$1.1 \times 10^6$	NG	NG
RSU	$7.6 \times 10^6$	$1.3 \times 10^6$	$2.0 \times 10^5$	NG	NG
Cont	$5.2 \times 10^6$	$9.0 \times 10^5$	NG	NG	NG

Keys: BK, Borokiri; ELE, Elekahia; W/L, Waterline Junction; R/K, Rumukoro; Uniport, University of Port Harcourt Junction; RSU, Rivers State University; Cont, Control; NG, No Growth; TAC, Total Aerobic Count; TSC, Total Staphylococcus Count; TCC, Total Coliform Count; TEC, Total *E. coli* Count; CFU/g, Colony forming Unit per gram.

equipment's/utensils as well as storage of food at improper temperature, which could lead to rapid multiplication of pathogenic and toxigenic organisms (Vedesh and Neel, 2017).

In the present study, the highest Total Aerobic Count (TAC) of samples from Borokiri were higher than that obtained from other locations. This may be attributed to intense traffic in Borokiri area and other link roads leading to increased dust formation which constitutes a major source of contamination. This indicates the major effect of overcrowding and environmental dust, as bacterial is widely distributed in nature around human, animal, soil, water and food. The contamination may have either occurred during exposure of the food samples, from the hands of the intending buyers, improper handling and storage practices (FAO/WHO, 2011).

Total Staphylococcal Count (TSC) of the roasted plantain samples (Bole) ranged from  $4.0 \times 10^5$  to  $5.0 \times 10^6$  (CFU/g) with sample from Elekahia station recording the least, while sample from Waterline Junction the highest. These values were in line with the report of Suneetha *et al.*, (2011). The presence of *staphylococcus aureus* is an indication of respiratory contamination from the food handlers in contact with the food. This contamination can be introduced into the street food (roasted plantain) samples during handling processing or vending (Sandel and Mckillip, 2004).

Total Coliform Count (TCC) ranged from  $2.0 \times 10^5$  to  $4.1 \times 10^6$  (CFU/g) with the least value coming from the sample collected from Rivers State University (RSU) campus, while the highest was from the Elekahia station. There was no coliform detected on the control (laboratory roasted plantain) and Rumukoro samples. The detection of coliform indicates the presence of potential disease causing bacteria. Therefore, coliform are important microorganisms because they help raise awareness and determine the source of the bacteria.

Total Escherichia Coli Count (TEC) ranged from  $9.0 \times 10^5$  to  $1.7 \times 10^6$  (CFU/g) with Borokiri recording the least values and Elekahia station having the highest total *E. coli* count. Result of the present study showed that *E. coli*

was found in four (4) locations in the street roasted plantain namely in Borokiri, Elekahia, Waterline and Rumukoro junctions. While Uniport, Rivers State University and the control showed no growth for *E. coli*. The presence of *E. coli* in the food suggests lack of hygiene in handling and poor water quality for the preparation of food. *E. coli* is an indicator of fecal contamination as *E. coli* spread from person-to-person (Rashmi *et al.*, 2012). Thus proper hygiene and storage, as well as avoiding cross contamination are the major ways for preventing food borne diseases. Most food pathogens are of soil or intestinal origin. The presence of microorganisms may also indicate unhygienic conditions related to the location of the food stalls, especially in dusty roadsides (Suneetha *et al.*, 2011). More so, the presence of coliform detected in the plantain samples from Elekahia would be from post process contamination through food handlers and the environment which was below the ICMSF (1996) recommended standards for ready- to-eat-foods.

Results showed that roasted plantain samples from all locations under review were contaminated with pathogenic bacteria, *Escherichia coli* and *Staphylococcus aureus*. This is in line with the study conducted in the street of Lokoja by Madueke *et al.* (2014) who reported that the food samples tested positive for *Escherichia coli*.

Total Mould Count (CFU/g) ranged from  $2.0 \times 10^5$  to  $1.5 \times 10^6$  (CFU/g), with the Rumukoro sample having the least mould count and Elekahia station as the highest.

There were no *E. coli* and mould detected in samples collected from Uniport, Rivers State (RSU) and the control.

Major reasons for the detected microorganism were lack of attention to hygiene, poor access to clean water as well as re-use of water previously used for preparation/washing and improper waste disposal. This finding predisposes street roasted plantain to be a source of public health problem as large population of people in the study area consumes this product. Therefore, steps must be taken to ensure that street roasted plantain is

**Table 2.** Heavy metals and hydrocarbon concentration of roasted plantain samples collected from different locations in Port Harcourt, Rivers State.

S/N	Sample	Nickel (mg/kg)	Lead (mg/kg)	Cadmium (mg/kg)	PAH (mg/kg)
1.	RSU	<0.001	<0.001	<0.001	0.006
2.	Uniport	<0.001	<0.001	<0.001	0.012
3.	RK	<0.001	<0.001	<0.001	0.003
4.	W/L	<0.001	<0.001	<0.001	0.015
5.	ELE	<0.001	<0.001	<0.001	0.007
6.	BK	<0.001	<0.001	<0.001	0.011
7.	Control	<0.001	<0.001	<0.001	0.005

Keys: BK, Borokiri; ELE, Elekahia; W/L, Waterline Junction; R/K, Rumukoro; Uniport, University of Port Harcourt Junction; RSU; Rivers State University campus.

safe for consumption.

Table 2 shows the concentration of heavy metals and hydrocarbon on roasted plantain samples (Bole). Heavy metals such as lead, cadmium and nickel content in the roasted plantain samples (Bole) were all <0.001 mg/kg with no significant ( $P < 0.005$ ) different between each other. The levels of some selected heavy metals in the roasted plantain samples were found to be <0.001 which is below the permissible limit established by the EU, WHO and USEPA from all the locations.

Polycyclic Aromatic Hydrocarbon (PAH) was detected in the roasted plantain samples, with levels ranging from 0.003 – 0.015 mg/kg. Roasted plantain sample collected from waterline junction recorded the highest value of hydrocarbons with Rumukoro sample the least. Results showed that all the roasted plantain samples (Bole), had Polycyclic Aromatic Hydrocarbon (PAH) content significantly ( $P < 0.05$ ) different from each other.

According to the World Health Organization (WHO, 2014), soot deposited in air and food constitutes the largest among all of the environmental risks, recording death in low and middle-income countries, Cardiovascular Disease (CVDS), Chronic Obstructive Pulmonary Disease (COPD) and lung cancer, eye and skin disorder, Asthma, in industrial activities constitutes a principal source of the soot hazard (Nicolas *et al.*, 2014).

## CONCLUSION

The microbial analysis revealed that the level of contamination in the study areas for street vended roasted plantain (Bole) were high. It was observed that Total Aerobic Count (TAC), *Staphylococcus*, *Escherichia Coli* and coliform count were higher than the recommended reference value. The international commission for microbiological specification for foods (ICMSF, 1996) stated that ready-to-eat foods between 0 and  $10^3$  are acceptable,  $10^4$  to  $10^5$  tolerable and  $10^6$  and above unacceptable. The consumption of ready-to-eat roasted plantain (Bole) is a medium for increased risk of

food borne disease.

The level of the heavy metals investigated in the roasted plantain samples were generally below the maximum permissible limit set by World Health Organization, so the concentration of heavy metal may not be harmful to health.

In addition, this study has shown that the levels of Polycyclic Aromatic Hydrocarbon (PAH) in roasted plantain samples sold in Waterlines and Uniport exceeded the permissible limits, it is evident from the present study that the roasted plantain (Bole) samples consumed around the location under review may create high health risk. This can be reduced by improved sanitary practices and standards

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