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Microbiological Assessment of Some Cooked Ready-to-eat Street Foods Sold in Calabar and Its Environs

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Abstract Food is an essential instrument for health promotion and disease prevention. Poorly prepared and recontamination of ready-to-eat street food may be the cause of outbreaks of foodborne disease. The microbiological assessment of six selected cooked ready-to-eat street foods (Moimoi, Afang Soup, Stew, Porridge Yam, Porridge Beans, and Jollof Rice) sold freely and openly in Calabar and its environs was assessed. A total of five hundred and forty (540) cooked ready-to-eat street food samples were collected from three types of food vendors; Stationary Vendors with Shade (SVWS), Stationary Vendors without Shade (SVWOS), and Mobile Vendors (MV) from different locations in Calabar and analyzed using standard techniques. Results obtained showed that the aerobic plate count, *Staphylococcus aureus* count, and *Escherichia coli* count for cooked ready-to-eat street foods sold at stationary vendors with shade (SVWS) ranged from 1.20×10^6 to 4.20×10^6 cfu/g for aerobic plate count, 1.20×10^6 to 3.6×10^6 cfu/g for *Staphylococcus aureus* count, and 0.9×10^6 to 2.50×10^6 cfu/g for *Escherichia coli* count. For stationary vendors without shade (SVWOS), it ranged from 1.29×10^6 to 3.50×10^6 cfu/g for aerobic plate count, 1.60×10^6 to 4.00×10^6 cfu/g for *Staphylococcus aureus* count, 1.00×10^6 to 2.80×10^6 cfu/g for *Escherichia coli* count. Aerobic plate count, *Staphylococcus aureus* count, and *Escherichia coli* count for mobile vendors (MV) ranged from 1.80×10^6 to 5.00×10^6 cfu/g for aerobic plate count, 1.60×10^6 to 5.80×10^6 cfu/g for *Staphylococcus aureus* count, 1.20×10^6 to 4.20×10^6 cfu/g for *Escherichia coli* count, respectively. The level of contaminations observed was above the acceptable microbiological limits. Thus, indicating non enforcement of regulatory acts and food safety procedures to hazard analysis critical control points (HACCP).

Keywords: *cooked ready-to-eat street foods, microbiological quality, HACCP, Calabar*

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1. Introduction

Safe food is a basic human right despite this right, many foods is frequently contaminated with naturally occurring pathogenic microorganisms. Such pathogens cannot be detected organoleptically (seen, or tasted), but can cause disease of varying severity, including death specially if the way they are conserved during exposition for sales provides conditions for those microorganisms to grow and reach considerable levels of contamination. Thus, food safety issues are of major importance to world health [1]. The term “Food” refers to the broad range of edible materials that comprise the essential body nutrients required for life and growth. Cooked ready-to-eat street food is the food that is ready for immediate consumption at the points of sale [2]. The FAO defined street food as ready-to-eat foods and beverages prepared and/or sold by vendors and hawkers especially in streets and other similar public places [3].

A general observation of our society shows a social pattern characterized by increased mobility due to urbanization, large number of itinerant workers and less family or home centered activities resulting in large percentage of the population depending on ready-to-eat. This situation however, has resulted that food sanitary measures and proper food handling have been transferred from individual, families to the food vendors who rarely enforce such practices [4]. Food we purchase are not sterile in the sense that they normally contain germs (bacteria, viruses, yeast and moulds), some of which can lead to food intoxication and infections when present above the recommended reference level [5]. Also, foods harbor a variety of microorganisms, bacteria and fungi which are ubiquitous in soil and around us (air) and could easily contaminate foods [6]. Contamination and growth of pathogens such as *Staphylococcus aureus*, *Salmonella* species, *Bacillus* species, and *Escherichia coli* can result in perceptible changes in the quality of food. Some foods can transmit a wide range of diseases in a condition termed food infection, where the food serves as a vehicle for the transfer of the pathogen to the consumer, in whom the pathogen grow and causes disease [6]. Pathogenic organisms such as *Listeria monocytogenes*, *Salmonella enterica*, and *Escherichia coli* have all been implicated in foodborne infection [6]. Another condition that might arise is food intoxication, where the pathogens grow in the food and produce toxins that can affect the consumer of the food [6].

The global incidence of food borne illnesses is difficult to estimate but it has been reported that in 2000 alone 2.1 million people died from diarrheal diseases. A great proportion of these cases can be attributed to contamination of food and drinking water [1]. Illness resulting from the consumption of contaminated food has become one of the most widespread public health problems in contemporary society. A number of observational studies have shown that these foods are sometimes held at improper temperatures, excessively handled by food vendors and sold at dirty surroundings [7]. Documented evidences have continued to link pathogenic microorganisms in food to incidences of food borne diseases. Food borne illness caused by microbial contamination of foods is an important international public health problem with consequent economic reduction, and is known to be a major cause of diarrhea diseases especially in developing countries [7]. Multiple lines of evidence reveal that foods exposed for sale on road sides may become contaminated either by spoilage or pathogenic microorganisms [8]. The American Centre for Disease Control (CDC) reported that about 77% of food poisoning occurs in restaurants, 20% in homes and about 3% from commercial foods relating to non-compliance with food standards and secondary pollution [9].

Studies have revealed the frequent contamination of street food in many developing world including Nigeria. Studies by [10,11], and [12] have reveal high loads of bacterial pathogens on popular street foods in different part of India. In Africa, [13] reported the presence of *Bacillus cereus, Staphylococcus aureus, Shigella sonnei, Escherichia coli,* and *Salmonella arizonae* on different foods sold on streets of Accra. There has also been report on the contamination of street-vended ready-to-eat food sold in Egypt [14].

In Calabar, hawking of cooked ready-to-eat street foods is very common. These food vendors enjoy huge patronage from different societal classes. Unfortunately, none of these food vendors is licensed or monitored by relevant agencies saddled with the responsibility of ensuring the safety of foods. Thus, owing to the manner and conditions these vendors operate, there is likelihood that some of the cooked ready-to-eat street foods may be contaminated by foodborne pathogens. Although, there is information about microbiological quality of fruits in Calabar metropolis, no information is available regarding the microbiological quality of cooked ready-to-eat street foods sold in Calabar and its environs. Hence, the present study was undertaken to determine the microbiological assessment of cooked ready-to-eat street foods sold in Calabar and its environs whether these foods meets the acceptable microbiological standards and specification for foods. The work will be of immense benefit to the unsuspecting consumers, government health agencies and the vendors on any health risk such food(s) might pose.

2. Materials and Methods

2.1. Sample Collection

A total of five hundred and forty (540) samples comprising of six different cooked ready-to-eat food types (afang soup, stew, porridge yam, porridge beans, moimoi and jollof rice) collected in one batch (afternoon), were analyzed microbiologically. These foods were sourced from different areas in Calabar (University of Calabar axis, Watt market axis, Edgerly axis, Marian market axis, Odukpani axis, and Eight mile axis) in the same quantity from different food vendors (stationary vendors with shade (SVWS), stationary vendors without shade (SVWOS), and mobile vendors (MV). Thirty (30) samples of each food type were purchased in sterile containers directly from the vendors and immediately brought to the Department of Food Science and Technology Laboratory for analysis. In all the areas, five (5) samples each were used for a particular food type and total of 30 samples from the 6 areas each. All together, 540 samples of six different food types sold in Calabar and its environs were examined (see Table 1, Table 2, and Table 3).

Table 1. Distribution of the food types sampled in the study from Stationary Vendors with Shade (SVWS)

AREAS	FOOD TYPES						TOTAL
	Afang Soup	Stew	Porridge Yam	Porridge Beans	Moimoi	Jollof Rice	
UNICAL AXIS	5	5	5	5	5	5	30
WATT MARKET AXIS	5	5	5	5	5	5	30
EDGERLY AXIS	5	5	5	5	5	5	30
MARIAN MARKET AXIS	5	5	5	5	5	5	30
ODUKPANI AXIS	5	5	5	5	5	5	30
EIGHT MILE AXIS	5	5	5	5	5	5	30
TOTAL	**30**	**30**	**30**	**30**	**30**	**30**	**180**

Table 2. Distribution of the food types sampled in the study from Stationary Vendor without Shade(SVWOS)

AREAS	FOOD TYPES						TOTAL
	Afang Soup	Stew	Porridge Yam	Porridge Beans	Moimoi	Jollof Rice	
UNICAL AXIS	5	5	5	5	5	5	30
WATT MARKET AXIS	5	5	5	5	5	5	30
EDGERLY AXIS	5	5	5	5	5	5	30
MARIAN MARKET AXIS	5	5	5	5	5	5	30
ODUKPANI AXIS	5	5	5	5	5	5	30
EIGHT MILE AXIS	5	5	5	5	5	5	30
TOTAL	**30**	**30**	**30**	**30**	**30**	**30**	**180**

Table 3. Distribution of the food types sampled in the study from Mobile Vendor (MV)

AREAS	FOOD TYPES						TOTAL
	Afang Soup	Stew	Porridge Yam	Porridge Beans	Moimoi	Jollof Rice	
UNICAL AXIS	5	5	5	5	5	5	30
WATT MARKET AXIS	5	5	5	5	5	5	30
EDGERLY AXIS	5	5	5	5	5	5	30
MARIAN MARKET AXIS	5	5	5	5	5	5	30
ODUKPANI AXIS	5	5	5	5	5	5	30
EIGHT MILE AXIS	5	5	5	5	5	5	30
TOTAL	**30**	**30**	**30**	**30**	**30**	**30**	**180**

2.2. Microbiological Analysis

Ten (10) grams of each food sample was mixed with 90 ml Nutrient Broth (Biotec, UK) and serial dilutions of each food sample homogenate were made to 10^{-5} dilutions. Exactly 0.1 ml aliquot portions of the dilutions were spread onto duplicate sterile plates of Nutrient Agar, Eosin Methylene Blue (EMB) Agar, and Mannitol Salt Agar (MSA) for total aerobic count, *Escherichia coli*, and *Staphylococcus aureus*, respectively. Enumeration of bacteria and isolation of bacterial colonies was done after incubation of plates at 37°C for 24 to 48 hrs. After the incubation time, the different culture plates were examined for microbial growth. Colonies were counted using the colony counter (Gallenkamp, England). Bacterial counts were expressed as colony forming unit per ml of sample homogenate (cfu/ml).

2.3. Identification of Isolates

Pure cultures were obtained and stored on nutrient agar slants at $4^{O}C$ pending identification. The isolates were confirmed based on cultural characteristics and biochemical tests which include carbohydrate utilization, and reaction on Tri-sugar Iron (TSI) medium, IMViC test, starch hydrolysis, gelatin liquefaction, nitrate reduction, oxidase urease production and motility test. The bacterial isolates were identified by comparing their characteristics with Bergey's Manual of Determinative Bacteriology [30].

2.4. Statistical Analysis

The values obtained for total aerobic plate count, *Escherichia coli* and *Staphylococcus aureus* counts were subjected to analysis of variance.

3. Results

Table 4 showed the result mean microbial counts of cooked ready-to-eat street foods sold at University of Calabar Axis. The result indicated that the highest aerobic plate counts was found in afang soup sold by Mobile Vendors (MV) with the value of 2.80×10^6 cfu/g while the lowest value was found in stew sold by stationary food vendors with shade (SVWS) with a value of 1.20×10^6 cfu/g. Highest count of *Staphylococcus aureus* was found in moimoi sold by MV with the value of 4.30×10^6 cfu/g and the lowest count was found in stew sold by SVWS with the count of 1.20×10^6 cfu/g. *Escherichia coli* counts was detected most in moimoi sold by MV with the value of 2.20×10^6 cfu/g. Statistical result shows a significant ($p<0.05$) difference of microbial count in the various food samples.

Table 5 showed the result of mean microbial counts of cooked ready-to-eat street foods sold at Watt Market Axis. The result showed that the highest aerobic plate counts were detected in afang soup sold by MV with the value of 3.90×10^6 cfu/g while the lowest value was detected in jollof rice and stew sold by SVWOS with the value of 1.80×10^6 cfu/g. Highest *Staphylococcus aureus* counts was detected in moimoi sold by MV with the value of 5.80×10^6 cfu/g while the lowest was detected in stew sold by SVWS with the value of 1.40×10^6 cfu/g. Highest *Esherichia coli* counts was observed in jollof rice sold by MV with the value of 3.20×10^6 cfu/g while the lowest was detected in stew sold by SVWS with the value of 1.00×10^6 cfu/g. Statistical result shows a significant ($p<0.05$) difference of microbial count in the various food samples.

Table 6 showed the result of mean microbial counts of cooked ready-to-eat street foods samples sold at Edgerly Axis. The result showed that the highest aerobic plate count was observed in stew sold by MV with a value of 5.00×10^6 cfu/g while the lowest value was found in porridge yam, afang soup, and moimoi sold by SVWS with the value of 1.20×10^6 cfu/g. Highest *Staphylococcus aureus* count was observed in jollof rice sold by MV with the value of 4.20×10^6 cfu/g while the lowest was detected in moimoi sold by SVWS with the value of 1.40×10^6 cfu/g. Highest *Escherichia coli* counts were observed in moimoi with a value of 2.50×10^6. There was a significant ($p<0.05$) difference of microbial count in the various food samples.

Table 7 showed the result of mean microbial counts of cooked ready-to-eat street foods sold at Marian Market Axis. The result indicated that the highest count of aerobic plate count was observed in moimoi sold by SVWS with the value of 4.20×10^6 cfu/g while the lowest value was observed in afang soup sold by SVWS with the value of 2.00×10^6 cfu/g. Highest *Staphylococcus aureus* counts was detected in jollof rice sold by MV with the value of 5.20×10^6 cfu/g while the lowest value was observed in afang soup sold by SVWS with a value of 2.20×10^6 cfu/g. Highest *Escherichia coli* counts was observed in stew sold by MV with the value of 4.20×10^6 cfu/g. There was a significant ($p<0.05$) difference of microbial counts in the various food samples.

Table 8 showed the result of mean microbial counts of cooked ready-to-eat street foods sold at Odukpani Axis. The highest aerobic plate counts was observed in stew sold by MV with the value of 3.20×10^6 cfu/g while the lowest count was observed in afang soup sold by SVWS with the value of 1.20×10^6 cfu/g. Highest *Staphylococcus aureus* counts was observed in afang soup and moimoi sold by MV with the value of 3.80×10^6 cfu/g while the lowest value was in porridge beans sold by SVWOS with the value of 1.60×10^6 cfu/g. The highest *Escherichia coli* count was observed in porridge beans sold by MV with the value of 2.40×10^6 cfu/g. There was a significant ($p<0.05$) difference of the microbial counts in the various food samples.

Table 4. Mean microbial count of cooked ready-to-eat street foods sold at Unical Axis (cfu/g)

Vendors Samples Station	Food Types	Aerobic Plate count (APC)	*S. aureus* count	*E. coli* count
Stationary Food Vendors with shade (SVWS)	Porridge Beans	1.60×10^6	3.20×10^6	ND
	Porridge Yam	1.30×10^6	2.10×10^6	0.90×10^6
	Jollof Rice	1.80×10^6	1.80×10^6	ND
	Stew	1.20×10^6	1.20×10^6	ND
	Afang Soup	1.90×10^6	2.80×10^6	ND
	Moimoi	1.70×10^6	2.40×10^6	ND
Stationary Food Vendors without shade (SVWOS)	Porridge Beans	1.80×10^6	2.20×10^6	ND
	Porridge Yam	1.29×10^6	3.20×10^6	ND
	Jollof Rice	2.40×10^6	2.10×10^6	ND
	Stew	2.20×10^6	1.40×10^6	ND
	Afang Soup	2.20×10^6	2.90×10^6	ND
	Moimoi	2.00×10^6	2.60×10^6	ND
Mobile Food Vendors (MV)	Porridge Beans	2.00×10^6	2.80×10^6	1.20×10^6
	Porridge Yam	1.80×10^6	4.20×10^6	1.20×10^6
	Jollof Rice	2.00×10^6	2.90×10^6	1.30×10^6
	Stew	2.20×10^6	2.80×10^6	1.40×10^6
	Afang Soup	2.80×10^6	3.00×10^6	1.40×10^6
	Moimoi	2.40×10^6	4.30×10^6	2.20×10^6

ND: Not Detected.

Table 5. Mean microbial count of cooked ready-to-eat street foods sold at Watts Market Axis (cfu/g)

Vendors Samples Station	Food Types	Aerobic Plate count (APC)	*S. aureus* count	*E. coli* count
Stationary Food Vendors with shade (SVWS)	Porridge Beans	2.10×10^6	3.20×10^6	1.20×10^6
	Porridge Yam	2.00×10^6	2.50×10^6	1.40×10^6
	Jollof Rice	2.00×10^6	1.80×10^6	2.00×10^6
	Stew	2.00×10^6	1.40×10^6	1.00×10^6
	Afang Soup	2.20×10^6	2.80×10^6	2.00×10^6
	Moimoi	2.80×10^6	2.40×10^6	1.20×10^6
Stationary Food Vendors without shade (SVWOS)	Porridge Beans	2.80×10^6	3.80×10^6	1.20×10^6
	Porridge Yam	1.90×10^6	2.80×10^6	1.80×10^6
	Jollof Rice	1.80×10^6	2.40×10^6	1.80×10^6
	Stew	1.80×10^6	2.20×10^6	2.20×10^6
	Afang Soup	3.40×10^6	2.90×10^6	1.10×10^6
	Moimoi	2.70×10^6	3.20×10^6	2.40×10^6
Mobile Food Vendors (MV)	Porridge Beans	3.10×10^6	4.20×10^6	1.80×10^6
	Porridge Yam	2.00×10^6	5.40×10^6	2.20×10^6
	Jollof Rice	3.20×10^6	3.20×10^6	3.20×10^6
	Stew	2.20×10^6	3.10×10^6	2.10×10^6
	Afang Soup	3.90×10^6	4.20×10^6	1.80×10^6
	Moimoi	3.20×10^6	5.80×10^6	2.80×10^6

ND: Not Detected.

Table 6. Mean microbial count of cooked ready-to-eat street foods sold at Edgerly Axis (cfu/g)

Vendors Samples Station	Food Types	Aerobic Plate Count (APC)	*S. aureus* count	*E. coli* count
Stationary Food Vendors with shade (SVWS)	Porridge Beans	2.00×10^6	2.00×10^6	1.00×10^6
	Porridge Yam	1.20×10^6	1.80×10^6	ND
	Jollof Rice	1.90×10^6	3.40×10^6	ND
	Stew	2.00×10^6	2.20×10^6	ND
	Afang Soup	1.20×10^6	1.80×10^6	ND
	Moimoi	1.20×10^6	1.40×10^6	ND
Stationary Food Vendors without shade (SVWOS)	Porridge Beans	2.00×10^6	3.20×10^6	1.40×10^6
	Porridge Yam	2.40×10^6	2.10×10^6	ND
	Jollof Rice	1.80×10^6	3.20×10^6	1.10×10^6
	Stew	3.20×10^6	1.80×10^6	ND
	Afang Soup	3.00×10^6	2.60×10^6	ND
	Moimoi	2.40×10^6	1.80×10^6	1.40×10^6
Mobile Food Vendors (MV)	Porridge Beans	2.90×10^6	3.80×10^6	1.30×10^6
	Porridge Yam	2.80×10^6	2.40×10^6	1.20×10^6
	Jollof Rice	2.00×10^6	4.20×10^6	1.40×10^6
	Stew	5.00×10^6	1.60×10^6	1.60×10^6
	Afang Soup	2.80×10^6	2.80×10^6	1.40×10^6
	Moimoi	3.20×10^6	2.60×10^6	2.50×10^6

ND: Not Detected.

Table 7. Mean microbial count of cooked ready-to-eat street foods sold at Marian Market (cfu/g)

Vendors Samples Station	Food Types	Aerobic Plate Count (APC)	*S. aureus* count	*E. coli* count
Stationary Food Vendors with shade (SVWS)	Porridge Beans	3.30 x10^6	2.80 x10^6	2.30 x10^6
	Porridge Yam	2.60 x10^6	3.20 x10^6	1.20 x10^6
	Jollof Rice	2.50 x10^6	3.60 x10^6	2.50 x10^6
	Stew	3.40 x10^6	3.20 x10^6	1.30 x10^6
	Afang Soup	2.00 x10^6	2.20 x10^6	ND
	Moimoi	4.20 x10^6	3.20 x10^6	3.20 x10^6
Stationary Food Vendors without shade (SVWOS)	Porridge Beans	3.20 x10^6	2.90 x10^6	2.80 x10^6
	Porridge Yam	2.40 x10^6	3.60 x10^6	ND
	Jollof Rice	3.50 x10^6	2.80 x10^6	ND
	Stew	2.40 x10^6	3.80 x10^6	2.22 x10^6
	Afang Soup	3.50 x10^6	4.00 x10^6	2.80 x10^6
	Moimoi	3.20 x10^6	2.80 x10^6	1.40 x10^6
Mobile Food Vendors (MV)	Porridge Beans	2.40 x10^6	4.30 x10^6	2.10 x10^6
	Porridge Yam	3.50 x10^6	3.90 x10^6	ND
	Jollof Rice	2.40 x10^6	5.20 x10^6	2.40 x10^6
	Stew	3.50 x10^6	4.80 x10^6	4.20 x10^6
	Afang Soup	3.50 x10^6	2.60 x10^6	3.20 x10^6
	Moimoi	3.20 x10^6	4.20 x10^6	2.40 x10^6

ND: Not Detected.

Table 8. Mean microbial count of cooked ready-to-eat street foods sold at Odukpani Axis (cfu/g)

Vendors Samples Station	Food Types	Aerobic Plate Count (APC)	*S. aureus* count	*E. coli* count
Stationary Food Vendors with shade (SVWS)	Porridge Beans	2.60 x10^6	1.80 x10^6	ND
	Porridge Yam	1.80 x10^6	2.80 x10^6	1.60 x10^6
	Jollof Rice	1.60 x10^6	2.80 x10^6	ND
	Stew	2.80 x10^6	2.70 x10^6	ND
	Afang Soup	1.20 x10^6	2.40 x10^6	ND
	Moimoi	2.20 x10^6	2.60 x10^6	ND
Stationary Food Vendors without shade (SVWOS)	Porridge Beans	2.20 x10^6	1.60 x10^6	ND
	Porridge Yam	1.90 x10^6	2.60 x10^6	1.80 x10^6
	Jollof Rice	1.80 x10^6	2.80 x10^6	1.00 x10^6
	Stew	2.00 x10^6	2.90 x10^6	ND
	Afang Soup	1.90 x10^6	2.40 x10^6	ND
	Moimoi	2.50 x10^6	2.80 x10^6	1.60 x10^6
Mobile Food Vendors (MV)	Porridge Beans	2.60 x10^6	3.20 x10^6	2.40 x10^6
	Porridge Yam	2.00 x10^6	3.40 x10^6	2.00 x10^6
	Jollof Rice	2.60 x10^6	3.20 x10^6	1.40 x10^6
	Stew	3.20 x10^6	3.20 x10^6	1.20 x10^6
	Afang Soup	2.50 x10^6	3.80 x10^6	1.40 x10^6
	Moimoi	3.00 x10^6	3.80 x10^6	1.80 x10^6

ND: Not Detected.

Table 9. Mean microbial count of cooked ready-to-eat street foods sold at Eight Miles Axis (cfu/g)

Vendors Samples Station	Food Types	Aerobic Plate Count (APC)	*S. aureus* count	*E. coli* count
Stationary Food Vendors with shade (SVWS)	Porridge Beans	1.60 x10^6	2.00 x10^6	ND
	Porridge Yam	1.40 x10^6	3.20 x10^6	ND
	Jollof Rice	1.20 x10^6	2.60 x10^6	ND
	Stew	3.00 x10^6	1.90 x10^6	1.40 x10^6
	Afang Soup	2.00x10^6	3.20 x10^6	ND
	Moimoi	1.40 x10^6	1.90 x10^6	ND
Stationary Food Vendors without shade (SVWOS)	Porridge Beans	1.90 x10^6	3.40 x10^6	1.40 x10^6
	Porridge Yam	1.50 x10^6	2.90 x10^6	ND
	Jollof Rice	1.80x10^6	3.20 x10^6	1.70 x10^6
	Stew	2.80 x10^6	3.20 x10^6	1.20 x10^6
	Afang Soup	3.20 x10^6	3.40 x10^6	1.20 x10^6
	Moimoi	1.90 x10^6	2.40 x10^6	1.00 xx10^6
Mobile Food Vendors (MV)	Porridge Beans	2.00 x10^6	5.20x10^6	1.20x10^6
	Porridge Yam	1.80 x10^6	3.60 x10^6	1.30 x10^6
	Jollof Rice	2.40 x10^6	3.10 x10^6	1.40 x10^6
	Stew	4.20 x10^6	3.90 x10^6	1.20 x10^6
	Afang Soup	3.80 x10^6	4.20 x10^6	2.40 x10^6
	Moimoi	2.00 x10^6	4.20 x10^6	1.50 x10^6

ND: Not Detected.

Table 9 showed the result of mean microbial counts of cooked ready-to-eat street foods sold at Eight Miles Axis. The highest aerobic plate count was observed in stew sold by MV with the value of 4.20x10^6 cfu/g while the lowest count was in jollof rice sold by SVWS with the value of 1.20x10^6 cfu/g. The highest *Staphylococcus auerus* counts was observed in porridge beans sold by MV with the value of 5.20x10^6 cfu/g while the lowest was in stew and moimoi sold by SVWS with the value of 1.90x10^6 cfu/g. The highest *Escherichia coli* count was observed in afang soup sold by MV with the value of 2.40x10^6 cfu/g. There was significant ($p<0.05$) difference of microbial counts in the various food samples.

4. Discussion

Pathogenic bacteria are the most common known causes of food contamination and foodborne illnesses. In this study, six (6) different types of cooked ready-to-eat street foods sold in various areas of Calabar and its environs by different vendor station were examined. Naturally, cooking temperature kill all possible microorganisms except thermophile and spore forming bacteria. In this study, it was observed that the total aerobic plate counts, *Staphylococcus aureus* counts, and *Escherichia coli* counts were higher than the recommended reference value. The International Commission for Microbiological Specifications for Foods [16] states that ready-to-eat foods between 0-10^3 are acceptable, 10^4-10^5 is tolerable and 10^6 and above is unacceptable. The consumption of cooked ready-to-eat foods directly from street vendors potentially increase the risk of foodborne diseases caused by a variety of pathogens, because it is difficult to attest to the hygiene of these vendors or the sanitary conditions at the point of cooking and packaging of the food. The significant difference ($p<0.05$) observed in the levels of microbial contamination of the different food types and vending station could be a reflection of the level of exposure and the handling processes among the vendors. The high aerobic plate count in this study is higher than those reported in similar studies by [18] and Brooks [19] but agrees with the findings reported by [21]. The high aerobic plate count observed in this study might be attributed to factors such as the environment, which include exposure of the foods to air, type of water used, the utensils used in the preparation and personal hygiene of the vendors. It is believed that extensive handling and mixing in the course of selling could have introduced these pathogens. Exposure of the foods to air or dust at the point of sale is likely to increase the counts of the bacteria as virtually most bacteria are carried in aerosols by dust and air [17].

The presence of *Staphylococccus aureus*, a pathogenic organism is of great public health concern. As widely reported, most strains of *Staphylococcus aureus* are known to be pathogenic due to mostly to the heat stable enterotoxins they produce in direct relationship to their inoculum level [23]. *Staphylococcus aureus* produce some enzymes which are implicated with Staphylococcal invasiveness and many extracellular substances which are heat stable enterotoxins that render the foods dangerous even though it appears normal [29]. Many of their toxin are gene-based that is carried on plasmids. The intensity of the symptoms may vary with the amount of contaminated food ingested and susceptibility of the individuals to the toxin. Some symptoms of staphylococcal food poisoning include vomiting, nausea, diarrhea and abdominal pain [26]. [24] reported that contamination by the food vendors or handlers is the most common means of transmission of this germ. The result in this study differs from that reported by [22). This difference in observed in the count may be attributed to environmental difference. *Staphylococcus aureus* could have been introduced through unclean hands and mouth of the vendor and customers. According to [25], he established that food contamination by *Staphylococcus aureus* resulted from man's respiratory passages, skin and superficial wounds. It is thus apparent that its detection in cooked ready-to-eat street foods poses a lot of health risk to nourishment seeking consumers.

The presence of *Escherichia coli* in cooked ready-to-eat street foods reflects secondary contamination, as *Escherichia coli* is known to be associated with gastrointestinal tract of warm blooded animals, and not known to be present in the environment as a natural flora [26]. However, contamination can occur through the use of non-portable water. *Escherichia coli* has been reported in foods sold at fast foods in a study by [22] and that reported by [20] on kunun-zaki (non-alcoholic beverage). The result in this study is comparable to that reported by [19]. It was however different from that reported by [28], who found no *Escherichia coli* in ready-to-eat burgers and pastry meat in the United Kingdom. The presence of *Escherichia coli* in this study may be due to direct or indirect fecal contamination. *Escherichia coli* is a member of the genus Enterobacteriaceae. Selected strain can cause gastroenteritis, diarrhea, urinary tract infections, meningitis, nosocomial pneumonia, and dysentery. A subunit known as the *Enterohaemorrhagic Escherichia coli* (EHEC) can cause foodborne illness as the *Escherichia coli* 0157H7 strain which cause severe and potentially fatal illness called Haemorrhagic colitis which is characterized by bloody diarrhea and severe abdominal pain [27].

The finding of this study is worrisome as known food pathogens were isolated from the food samples evaluated and all marginally exceeded the International Commission for Microbiological Specification for Foods [16] which stipulates that ready-to-eat foods with plate count between 0-10^3 is acceptable, between 10^4-10^5 is tolerable and 10^6 and above is unacceptable. Thus, the foods investigated in this study are unacceptable based on International Standards for foods. This situation invariably puts the health of the public who consume these foods at risk. Street foods are seen to constitute a major public health risk because of absence of basic infrastructure and services, difficulty in curtailing the large numbers of vending operations as a result of their diversity, mobility and temporary nature [31]. Food handling personnel play pertinent role in ensuring food safety throughout the food chain of food production, processing, and storage [32]. According to reports [33], mishandling and disregard to hygienic measures on the part of the food vendors have been reported to introduce contaminants and pathogens that survive and proliferate in sufficient numbers to cause illness in the consumer. The preparation of foods at ambient temperature makes it conducive for microbial multiplication coupled with the rich nature of these cooked foods, could equally be a factor in the increased microbial loads of the samples. This critical situation calls for stringent public health regulation and implementation of food sanitation practices regarding the sale of cooked foods on street by food vendors. Furthermore, to minimize this trend, there should be training and educating the food vendors on safe and good hygiene practices especially hand washing and enforcement of legislation in food handling and processing as well as environmental sanitation.

5. Conclusion

The findings of this study of some cooked ready-to-eat street foods samples vended in Calabar and its environs revealed high bacterial load in all the food samples and showed that the total aerobic counts, *Escherichia coli*, and *Staphylococcus aureus* counts were above the acceptable limit. The presence of these organisms in the cooked ready-to-eat street foods investigated portends great danger. Hence, it is imperative for relevant agencies in public health and food safety to organize training and teaching on food safety and hygiene for food vendors especially compliance of hazard analysis and critical control points principles (HACCP) during preparation, packaging and serving of these foods to consumers.

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