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Bacteriological Quality and safety of Street Vended Foods in Delta State, Nigeria

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Abstract

Safety of food is a basic requirement of food quality. A total of 106 street food samples (fried meat, fried fish, bean porridge, owho soup, banga soup, egusi soup, starch, fufu, eba, stew, jollof rice and plain rice) were randomly obtained from nine towns (Agbor, Asaba, Obiaruku, Abraka, Sapele, Ughelli, Warri, Oleh and Patani) in Delta state, Nigeria. The samples were bacteriologically analysed using standard methods. All the screened food samples had varying level of bacterial contamination ranging from 1.2 x 10^2 to 1.1 x 10^7 cfu/g for total viable count and 36 MPN/g to 2100 MPN/g for total coliform count. 69% of the sampled foods had bacterial count above the acceptable limits (< 10^4 cfu/g), while 67% of the sampled food items had total coliform count exceeding the recommended safe level (< 100 coliform/g). Nine bacterial species were isolated from the foods sampled. The microorganisms were *E. coli, Bacillus sp., S. aureus, E. faecalis, citrobacter sp., Proteus sp. Klebsiella sp., S. epidermis and Salmonella sp*. More than one pathogenic microrganisms were isolated from fufu, owho soup, banga soups, egusi soup and starch. The present finding revealed that street foods are potential vehicles for transmitting foodborne illnesses, thus the need to develop practical strategies geared toward street food safety.

Key words: street food, food contamination, pathogens, diseases, Delta state, Nigeria.

Introduction

Street foods are increasingly becoming the main source of inexpensive, convenient and nutritious foods for urban and rural poor. These foods ranging from traditional meals, snacks and beverages are prepared on street or at home and sold by vendors and hawkers on the street and other related unrestricted places for immediate consumption or consumption at a later time without further processing or preparation (Mensah *et al.,* 2002).

In Nigeria, consumption of street food has witnessed a phenomenal growth over the years as rapid population growth, urbanization, unemployment and poverty, occupational pressures and lifestyle changes has created a poll of mobile and transient population who depend almost entirely on these relatively low cost foods for their nutrition. Furthermore street food trade provides employment and substantial income for families involved in the informal sector (Martin, 2006).

However, the largely unregulated nature of the trade, and poor hygienic practices as well as lack of running water, toilet, proper storage and waste disposal facilities at preparation and services points has resulted in poor unsanitary conditions, exposure to potential contaminants and an increased risk to public health (Omemu and Aderoju, 2008). Consequently, street food safety has remained a major public health concern globally, and more importantly in Nigeria were the regulation of this critical sector is virtually non-existent or inadequate, making street foods a hazardous source of nutrition (Oyeyi and Lum-nwi, 2008; Wada Kura *et al.,* 2009).

Although epidemiological data on the incidence of food borne diseases are inadequate, and the outbreak often not investigated, the recurrent episodes of food borne illnesses with symptoms of gastrointestinal distress like diarrhea, vomiting, abdominal cramp and nausea has remained a major cause of mortality and morbidity in Nigeria. (Nweze, 2010).

Previous studies have revealed high bio-load and vast array of microorganisms of public health concerns in street vended foods (Akinleye, 1987; Olukoya *et al*., 1991; Omemu and Aderoju, 2008; Oyeyi and Lum-nwi, 2008; Wada Kura *et al*., 2009). The isolated microorganisms include: *E. coli., Salmonella spp., Clostridium spp., Proteus spp., Pseudomonas spp., Klebsiela spp., Citrobacter spp., Stapyloccocus spp., Bacillus spp.,* etc. These microorganisms are portal for potential pathogenic bacterial and food borne illness. Considering the existing burden of infectious

diseases and the moribund healthcare delivery system in Nigeria; there is need to continually evaluate the microbiological profile of these street foods geared towards awareness creation and prevention of pains, disability, loss of income, disruption of family stability and impaired standard of life associated with the consumption of contaminated foods. This study was therefore designed to evaluate the bacteriological safety of street vended food in Nigeria and their safety for human consumption.

Materials and Methods

Study location: Delta state, south- south geo-political zone of Nigeria is located approximately between longitudes 5^0 and 6^0 45 East and latitude.$5^0$00 and $6^0$30 North. The state has an estimated population of 4, 098, 291 million people and covers a land area of about 16, 842km^2.

Sampling

The state was divided into three zones using the senatorial district: *NORTH, CENTRAL AND SOUTH* to ensure adequately representative sampling. Following the procedure nine major towns were chosen for samples collection and analysis in Delta state, Nigeria. Three towns from each senatorial (*NORTH senatorial district: Asaba, Agbor and Obiaruku; SOUTH senatorial district: Warri, Oleh and Patani; CENTRAL senatorial district: Abraka, Sapele and Ughelli)*. All samples were collected in sterile containers held at 4^0c and analyzed within 3 hours. A total of 108 street food samples, 12 street foods samples from each town and 36 samples per senatorial district were analyzed which included: fried fish, fried meat, bean porridge, owho soup, banga soup, egusi soup, starch, fufu, eba, jollof rice, plain rice and stew. The study lasted July 2011 to January 2012.

Sample Analysis.

Ten grams portion of each food sample were macerated in 90 ml of sterile 0.1% peptone water as diluents. To make a 1:10 dilution, further ten- fold serial dilution were made and examined by means of the pour plate method (*Yeboah-Manu et al., 2010*). The plates were marked for easy identification and 1ml of the dilution used for the inoculation and incubated.

Bacteria Enumeration and Isolation

Total bacterial count was determined by pour plate techniques using standard methods. Nutrient agar medium was used for the enumeration of bacteria in the samples. The total bacterial count was obtained by incubation aerobically at 37^0C for 24 hours. Total coliform count was determined by MPN index method using 3-3-3 regimen. MacConkey broth was used and positive result was associated with acid and gas production on incubation at 37^0C for 48 hours (*Fawole and Oso, 2001)*. Morphological features and biochemical reactions patterns were used for the identification of bacterial isolates. Dilutions with 25-250 colonies were selected and counted. The number of colony forming units per gram (cfu/g) were calculated by multiplying the number of bacteria by the dilution.

Results

In this investigation, a total of 106 street food samples were examined for bacterial contamination as owho soup was not sampled in Agbor and Obiaruku. Results showed that all the street food samples were contaminated with varying level of bacterial count ranging from 1.2 x 10^2 cfu/g to 1.1 x 10^7 cfu/g. Sixty nine percent (73/106) of the screened street food samples had total bacterial count of > 10^4 cfu/g and were classified as unsatisfactory while thirty one percent (33/106) were classified as satisfactory and had total bacterial count of < 10^4 cfu/g (Table 1a). The total coliform count in the food samples ranged from 36 MPN/g to 2100 MPN/g. Sixty seven percent (71/106) of the street food samples had total coliform exceeding the recommended limits of < 100 coliform/g, while thirty three percent (35/106) had acceptable limits (Table 1 b). The results of individual foods analysis showed (Table 2) that 67% (6/9) of the total fried meat samples had bacterial count of > 10^4, while 56% (5/9) had total coliform > 100 coliform/g, 78% (7/9) of the fried fish samples had bacteria count > 10^4, while 67% had unacceptable total coliform count. The bean porridge samples had 78% (7/9) unacceptable total bacterial count and an unacceptable total coliform count of 78% (7/8), owho soup had 100% (6/6) unacceptable level of total bacteria and coliform count, while banga had 67% (6/9) unacceptable level of bacterial and coliform respectively. Unacceptable level of bacteria count in egusi soup was 78% (7/8), while coliform was 67% (6/9). Starch and fufu had 100% unacceptable total bacterial and coliform count. In eba samples, unacceptable total bacterial and coliform count was 44% (4/9) respectively, while stew samples had 44% (4/9) unacceptable level of bacterial count and 22% (2/9) of unacceptable coliform count. Jollof rice had 56% (5/9) total bacterial count > 10^4, while 78% (7/9) of the coliform count exceeded the recommended limit of > 100 coliform/g. Plain rice had 33% (3/9) of unacceptable bacteria and coliform count

respectively. Nine bacteria genera were isolated from the food samples. Further characterization revealed this organism to be *E. coli, Bacillus sp., S. aureus, E. faecalis, Citrobacter sp., Proteus sp. Klebsiella sp., S. epidermis and Salmonella sp*. Analysis showed that 68% (21/31) of the soup samples (owho, banga, egusi and stew) tested positive for *E. coli.,* while *salmonella sp.,* was isolated from 52% (16/31) of the soup samples and 61% (11/18) of fried meats and fish samples. Bacillus sp., was isolated from eba and owho soup samples only. *S. epidermis* was isolated in all the food samples. The entire fufu samples tested positive for *E. coli*, while *E. faecalis* were isolated from fried meat and fish samples. Street food samples from *Agbor, Patani, Abraka, Oleh, Asaba and Warri* had more diverse bacteria load and more than one pathogenic microorganism was isolated.

Discussion

Although epidemiological investigation continues to be extremely difficult in Nigeria and the outbreaks of food borne diseases generally under reported. Gastroenteritis has remained a major health care problem in Nigeria both in terms of human suffering and economic cost. The isolation of bacterial in all the street food samples (n=106) and the unacceptable total bacterial count of > 10^4 cfu/g established in 69% (73/106) of screened food samples implies extreme contamination and potential health risk of these street food samples. The findings correlated with similar earlier study (Olukoya *et al*., 1991; Mensah *et al*., 2002; Yeboah – Manu *et a*l., 2010*)*. The high incidences of bacterial contamination encountered in this study are mainly due to the unsanitary and largely unhygienic nature of the food preparations and services areas as foods are good indicators of the state of environment in which they are prepared or served (Ehiri *et al.,* 2001; Omemu and Aderoju, 2008). Majority of the street centers are located beside waste disposal points and dusty roads or streets with human and vehicular traffic which encouraged multiple contaminations due to the deposition of bioaerosol on exposed food products, transfer of from dirty hands and utensils and flies (Yassin and Almouqatea, 2010). Furthermore lack of running water, sewage disposal infrastructure, inappropriate storage conditions and the preparation and presentation of these food in the open or in crude structures, as well as the mesophilic temperature range and corresponding high relative humidity prevailing in Delta state, Nigeria contributed significantly to the unacceptable level of contaminations (FAO/WHO,2005; Munide and Kuria, 2005). The isolation of *S. epidermis* in all the food samples analyzed in this study confirmed low level of adherence to simple hygienic practices occasioned by largely unregulated sectors. The organism (*S .epidermis*) is a normal flora of the human skin, respiratory tract, urethra, external ear and mouth. Their presences in the food samples were largely due the unwholesome practices of the food handlers (Nwamaka et al., 2010).

The isolation of coliform bacteria in all the food samples, with 67% of the samples count exceeding the recommended limits of < 100 coliform/g makes these foods hazardous for human consumption. Coliform bacteria, chiefly fecal coliform are enteric bacteria, whose natural habitat is the intestinal tract of humans and animals (Pelczar et al., 2005). They are fecal indicators, and their isolation in the street food samples indicates the presence of fecal or sewage contaminants introduced into the food via the use of contaminated water or contamination from the unsanitary environment and equipments or via human handler or operators (Pelczar *et al.*, 2005). The isolated enteric bacteria are known pathogens responsible for millions of cases of infectious gastrointestinal diseases and death each year. The nine genera of microorganism encountered in this study correlated with earlier reports (Chumber *et al,* 2007; Yeboah- Manu *et al*., 2010). Their detection in the street food samples suggests the possibility that other intestinal pathogens like the enteropathogenic strain of *E. coli (0157:H7), Campylobacter sp*., *listeria sp.,* protozoan like *Giardia lamblia, Entamoeba histolytica* etc, and enteric viruses like *Hepatitis* A virus, *rotavirus, astrovirus* etc may also be present in the food samples (James, 2005) These diverse groups of pathogenic microorganisms are transmitted by fecal oral route, often by the ingestion of contaminated foods and water. The isolation of unacceptable level of *S. aureus,* an entertoxin producer responsible for staphylococcal food poisoning in 65% of the soup samples, 55% of fried meat and 61% of fried fish samples evidently revealed that street foods are sources of bio toxins that may make food injurious to health on an acute or chronic basis (Achi and Madubuike, 2007). Earlier studies reported the isolation of *S. aureus* in some street vended foods in Nigeria (Oyeyi and Lum-nwi, 2008; Wada- kura *et al.,* 2009). The isolation of *S. aureus* is a pointer to largely poor personal hygiene, improper storage facilities, use of low quality raw materials and unhygienic environment. *Salmonella sp.,* isolated in the fried meat and fish are major causes of food borne gastroenteritis and typhoid fever, while *E. coli* isolation in soups, jollof rice, bean porridge, fufu and starch is the underlying factor responsible for the high prevalence of diarrhea, fever, nausea, and cramps in children and adult exposed to contaminated foods in Nigeria (Nweze, 2010). The wide array and high bio-loads of microorganisms isolated in this study are attributable to excessive handling, inappropriate methods of storing foods,

and lack of basic food safety principles among the operators (Mensah *et al.*, 2002). Furthermore the preparation of traditional delicacies (owho, banga, egusi soup, starch and fufu) involves laborious processes which allowed for more contact time between the handlers and the food, leading multiple abuse and exposure to potential contaminants. Also the use of cheap and low grade raw materials by the street food vendors geared primarily towards profit maximization also contributed to the high and diverse microorganism isolated in the study. The use of the so called food thermo flask to store food before sales also contributed to the proliferation of the bacteria and consequently the high level of microbial count recorded in the study as these device hold foods at bacterial growth temperatures.

Conclusion

Street food trade has remained largely unregulated in Nigeria, notwithstanding the sector contribution to the nation's food security. Wholesome and nutritious street foods have a positive impact on food security, while consumption of street foods of low and below minimum safety standard is injurious to health on an acute or chronic basis. Consequently, education of the target groups and provision of basics facilities will greatly improve street food quality and safety. To the effect, regulation, effective monitoring and enforcement of the existing punitive measures is therefore recommended.

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Table1: Total Bacterial Count (CFU/g) of Street Vended Foods Samples

Sample Area	Fried meat	Fried fish	Bean porridge	Owoh soup	Banga soup	Egusi soup	Starch	Fufu	Eba	Stew	Jollof rice	Plain rice
Agbor	$2.2x10^5$	$4.3x10^5$	$3.2x10^5$	-	$1.0x10^5$	$1.0x10^5$	$2.3x10^6$	$3.5x10^5$	$1.7x10^5$	$2.1x10^5$	$3.3x10^5$	$1.1x10^5$
Asaba	$1.0x10^4$	$1.1x10^4$	$1.0x10^5$	-	$2.2x10^4$	$2.5x10^5$	$3.1x10^5$	$4.1x10^7$	$2.7x10^5$	$2.2x10^5$	$1.5x10^4$	$2.1x10^2$
Obi aruku	$3.5x10^5$	$1.5x10^5$	$2.0x10^4$	-	$2.5x10^4$	$2.7x10^4$	$2.3x10^5$	$4.4x10^6$	$5.1x10^3$	$1.5x10^4$	$1.7x10^5$	$1.8x10^2$
Warri	$1.75x10^5$	$1.0x10^5$	$4.1x10^4$	$2.5x10^5$	$3.1x10^3$	$3.1x10^4$	$1.7x10^6$	$5.1x10^5$	$4.1x10^3$	$2.1x10^5$	$2.4x10^5$	$1.7x10^3$
Oleh	$2.0x10^5$	$2.0x10^5$	$1.0x10^5$	$4.8x10^5$	$1.5x10^5$	$1.7x10^5$	$2.2x10^6$	$2.1x10^5$	$1.7x10^4$	$1.1x10^4$	$2.1x10^4$	$1.0x10^5$
Patani	$3.1x10^5$	$1.7x10^5$	$2.1x10^5$	$1.0x10^6$	$2.1x10^5$	$1.5x10^6$	$1.9x10^5$	$3.5x10^7$	$3.5x10^4$	$2.7x10^4$	$1.3x10^5$	$1.3x10^5$
Abraka	$1.3x10^5$	$3.1x10^5$	$2.1x10^5$	$3.7x10^5$	$2.3x10^5$	$1.1x10^5$	$2.5x10^5$	$2.1x10^6$	$2.7x10^5$	$1.0x10^5$	$2.1x10^4$	$1.0x10^4$
Sapele	$1.2x10^4$	$1.4x10^4$	$1.0x10^5$	$1.7x10^6$	$2.7x10^5$	$2.7x10^5$	$1.1x10^5$	$3.1x10^5$	$1.7x10^4$	$5.1x10^3$	$3.1x10^4$	$4.0x10^4$
Ughelli	$2.8x10^4$	$1.8x10^5$	$1.1x10^5$	$1.0x10^7$	$1.0x10^5$	$3.1x10^5$	$3.1x10^5$	$3.7x10^5$	$1.1x10^5$	$2.2x10^3$	$1.0x10^5$	$1.0x10^3$

Table2: Total Coliform Count (MPN/g) of Street Vended Foods Samples

Sample Area	Fried meat	Fried fish	Bean porridge	Owoh soup	Banga soup	Egusi soup	Starch	Fufu	Eba	Stew	Jollof rice	Plain rice
Agbor	210	601	1005	-	190	211	211	311	35	45	211	111
Asaba	97	257	210	-	430	409	321	171	75	31	101	76
Obiaruku	410	1100	88	-	89	130	433	200	99	108	200	105
Warri	78	91	429	1100	200	99	225	411	114	73	711	11
Oleh	500	1000	771	2100	510	311	300	1100	71	31	105	70
Patani	100	1790	1071	912	711	200	760	214	200	78	106	70
Abraka	68	89	96	413	73	178	210	721	106	106	311	25
Sapele	71	36	178	1900	96	038	198	280	78	71	65	41
Ughelli	200	410	177	520	181	099	150	199	161	87	71	106