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Microbiological Safety of Ready-to-eat Foods Sold in Primary Schools in Abeokuta, South-West Nigeria

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Abstract · A study was conducted to assess the microbial safety of ready-to-eat (RTE) foods sold in private and public primary schools in Abeokuta, South-western Nigeria. One hundred and sixty RTE food samples were collected from forty food vendors in thirty primary schools and analysed microbiologically. Socio-economic status and their knowledge of food safety were assessed using the structured questionnaires. Total bacterial counts, total coliform counts and total fungal counts of RTE foods in public primary schools ranged from 6.27 $\log_{10}$cfu/g to 6.47 $\log_{10}$cfu/g, 6.00 $\log_{10}$cfu/g to 6.28 $\log_{10}$cfu/g and 5.85 $\log_{10}$cfu/g to 6.16 $\log_{10}$cfu/g respectively while those of private primary schools ranged from 6.30 $\log_{10}$cfu/g to 7.47 $\log_{10}$cfu/g, 6.15 $\log_{10}$cfu/g to 6.54 $\log_{10}$cfu/g and 5.60 $\log_{10}$cfu/g to 6.70 $\log_{10}$cfu/g respectively. Bacteria isolated from these samples were *Bacillus cereus, Pseudomonas aeruginosa, Klebsiella pneumoniae, Staphylococcus aureus, Proteus* spp*, Enterobacter aerogenes, Shigella dysenteriae* and *Escherichia coli* while the fungal isolates include *Aspergillus niger, Aspergillus fumigatus, Rhizopus* spp*, Penicillium viridicatum, Mucor* spp and *Fusarium* spp. RTE foods sold in both private and public primary schools were found to be highly contaminated. Inappropriate storage conditions, inadequate knowledge of food safety, attitudes and practices of the food vendors are the factors that may allow the food contamination. These findings demonstrate that ready-to-eat foods vended in public and private primary schools in Abeokuta, South-western Nigeria constitute an hazard to the pupils' health. Provision of health education to the vendors and enforcing implementation of appropriate hygienic practices would improve food quality.

Keywords · Ready-to-eat foods · Microbial safety · Primary schools

Introduction

Ready-to-eat foods have been described as the status of foods being ready for immediate consumption at the point of sale. They could be raw or cooked, hot or chilled and can be consumed without further heat treatment (Tsang, 2002). These foods are prepared and sold

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by vendors on streets and other public places like markets, schools, hospitals, etc (Goldstein *et al*., 2001). These foods provide a source of readily available, inexpensive nutritional meals to the consumers while providing a source of income for the vendors (Muinde and Kuria, 2005).

A general observation of our society shows a social pattern characterized by increased mobility, large numbers of itinerary workers and less family or home activities. This situation however has resulted in more ready to eat foods taken outside home. Thus, food vendor services are increasing and responsibility for good manufacturing practices of food such as good sanitary measures and proper food handling have been transferred from individuals/families to the food vendors who rarely enforce such practices (Musa and Akande, 2002). Also, food vendors are often poorly educated, unlicensed, untrained in food hygiene and majority of them work under crude, unsanitary conditions with little or no knowledge about the cause of food borne disease (Barro *et al*., 2007).

Several factors predispose ready-to-eat foods to contamination by microorganisms. For example, stands are often crude structures and running water may not be readily available. Also, toilets and adequate washing facilities are rarely available. The washing is normally carried out in large bowls or buckets, and insects and rodents may be attracted to sites where there is no organized sewage disposal. Finally, food is not adequately protected from flies and refrigeration is usually unavailable (Mensah *et al.*, 2002). Other factors include the traditional processing methods of food preparation, inappropriate holding temperatures and poor personal hygiene of food handlers. Consumers who depend on such food are more interested in its convenience and usually pay little attention to its safety, quality and hygiene (Mensah *et al*., 2002; Muinde and Kuria, 2005; Barro *et al.*, 2006).

In Nigeria, there is little or no knowledge of food borne diseases and their transmission among food handlers selling foods in primary schools, and no rules are provided from many of these schools and even the government. Also, most food vendors in Nigerian schools are not duly licensed, and their staffs are not properly selected. On a daily basis, many primary school pupils in Abeokuta and their teachers are exposed to various kinds of food borne illnesses via the consumption of the vended foods in their schools. Hence, there is need to examine the microbiological quality of ready-to-eat foods in public and private primary schools in Abeokuta, South-western Nigeria, to reduce the risk of possible food poisoning among the school children.

The purpose of this study is therefore to assess the microbiological quality of ready-to-eat foods sold in public and private primary schools in Abeokuta, South-western Nigeria, as well as to assess the knowledge, attitudes and practices of the food vendors to food hygiene and food safety.

Materials and Methods

Study population

The study was conducted in thirty primary schools (fifteen public private schools and fifteen private primary schools) in Abeokuta, Nigeria. Forty RTE food vendors were selected. Information on the socio-economic background, hygienic food practices and knowledge of food safety were collected through structured questionnaires.

Sample collection

A total of one hundred and sixty samples of ready-to-eat foods (joll of rice, fried rice, white rice, white yam, beans, spaghetti and yam-porridge) were collected randomly from forty vendors in thirty selected public and private primary schools within the three Local governments of Abeokuta (Abeokuta North, Abeokuta South and Odeda local governments). The samples were collected at break times when pupils were having their meals. The samples were collected in sterile containers, transported to the laboratory and analyzed within an hour of collection.

Microbiological analyses

Approximately 5.0g of each sample was chopped with 50.0ml of sterile peptone water (Biolab). Tenfold dilutions of homogenates were then made with sterile peptone water. Total bacterial counts and total coliform counts were determined by plating in a standard Plate count agar (Oxoid) and MacConkey agar (Oxoid) plates respectively, in triplicates. The plates were incubated at 37^{o}C for 48h. Colonies were counted on the plates and recorded. Pure cultures of bacterial isolates were obtained on the nutrient agar plates. Bacterial isolates were characterized on the basis of their cultural, morphological and biochemical properties and identified using Bergey's Manual of Determinative Bacteriology (Holt *et al*., 1994). Colonies on the MacConkey agar plates were picked and sub cultured using MacConkey agar. Colonies typical to gram negative coliforms were confirmed by examining them to determine if they were non- spore forming gram negative rods that produce gas from lactose and then subjected to Indole, Methyl red, Voges-proskaur and Citrate (IMVC) tests.

Total fungal counts were determined by pour plating on Potato dextrose agar plates supplemented with lactic acid to inhibit bacterial growth, and incubated at room temperature (26± 2^{o}C) for 72 hours. Pure cultures of the isolates were obtained by sub-culturing on the potato dextrose agar plates. Fungal isolates were characterized by their cultural properties, stained with cotton blue Lactophenol solution and observed under low power objective lens.

Statistical Analysis

Total bacterial, coliform and fungal counts were expressed as Log_{10}cfu/g± S.D. Significant differences were established by Duncan Multiple Range test at 5% level of significance.

Results

Socio-economic background of RTE food vendors in primary schools in Abeokuta

Table 1 shows the characteristics of RTE food vendors in public and private primary schools in Abeokuta. In schools sampled, forty food vendors were assessed. Foods are sold mainly by women aged between 20 years and >50 years. 25% of the vendors in public primary schools did not know their ages and the majority of them (35%) are within the age range of 30- 39 years. 75% of these women are married, 15% are widows while the remaining 10% are single. In private primary schools, majority (80%) of the vendors are between the age of 30 years to 39 years, who are married while the remaining 20% are either single or divorced. No widow sells RTE foods in private primary schools in Abeokuta. Out of the twenty vendors in public primary schools, 55% had primary school

education, 30% had secondary school education and 15% had either college or polytechnic education. None of them had either university education or no formal education. Moreover, all these women had attended course on food hygiene, but only 20% had contacted food- borne diseases before (Table 1). However, in private primary schools, all their food vendors had received formal education with 20% having college/ polytechnic education, but none of them had attended any course on food hygiene. Only two vendors (10%) had contracted salmonellosis before. In addition, all the vendors cook their foods with well water, borehole water and tap water. None of the vendors cooks her foods with river or stream water. Most of the vendors (60%) in public primary schools live in bungalow buildings, 40% live in self contained apartments while none of them lives in a flat apartment; whereas in private primary schools, 60% of their vendors live in self contained apartment, 30% live in flat while only 10% live in bungalow building. The characteristics of these vendors are believed to have impacts on the microbiological quality of the foods they sell to the pupils of the schools examined.

Microbial Quality of ready-to-eat foods sold in Primary schools in Abeokuta

The total bacterial counts of RTE foods sold in primary schools in Abeokuta are shown in Table 2. The food samples had an average bacterial counts ranging from 6.27 $\log_{10}$ cfu/g to 7.47 $\log_{10}$ cfu/g. Food samples (Beans) obtained from public primary schools were observed to have the lowest counts while the highest counts were observed in similar food samples obtained from private primary school. Ready-to-eat (RTE) foods sold in private primary schools were found to be more contaminated than the foods sold in public primary schools. In general, all the RTE foods analysed are fairly above the acceptable levels of bacterial contamination (<5.0 $\log_{10}$ cfu/g).

Table 3 shows the total coliform counts of RTE food samples sold in primary schools in Abeokuta. It was observed that the total coliform counts ranged from 6.00 $\log_{10}$ cfu/g to 6.54 $\log_{10}$ cfu/g. White rice food sold in private primary schools had the highest coliforms, followed by fried rice food sold in private primary schools while spaghetti samples from public primary schools had the least coliform counts. Also, ready-to-eat foods sold in private primary schools were observed to be more contaminated than those sold in public primary schools. All the food samples obtained from primary schools in Abeokuta were observed to be highly contaminated with coliform bacteria because their counts are above the acceptable levels (<4.0 $\log_{10}$ cfu/g). Hence, these foods may be regarded as unsafe for human consumption.

Table 4 shows the total fungal counts of RTE foods sold in primary schools in Abeokuta. The fungal counts ranged from 5.60 $\log_{10}$ cfu/g to 6.70 $\log_{10}$ cfu/g, with fried rice sold in private primary schools having the least counts while the porridge yam sold in private schools had the highest counts.

In general, it was observed that RTE food samples in both public and private primary schools in Abeokuta had unacceptable levels of contamination (>5.0 $\log_{10}$ cfu/g for total counts and > 4.0 $\log_{10}$ cfu/g for Enterobacteriaceae). Hence, these foods could be adjudged as not safe for human consumption.

The microorganisms isolated from RTE food samples sold in primary schools in Abeokuta are shown in Table 5. Bacteria isolated from these samples were *Staphylococcus aureus, Escherichia coli, Enterobacter aerogenes, Shigella dysenteriae, Klebsiella pneumoniae, Pseudomonas aeruginosa, Bacillus cereus* and *Proteus spp* while the fungi isolated included *Aspergillus niger, Aspergillus fumigatus, Rhizopus spp, Penicillium*

viridicatum, Mucor spp and *Fusarium spp* The presence of some of these organisms such as *E. coli, Klebsiella pneumoniae, Enterobacter aerogenes, Shigella dysenteriae, Bacillus cereus* and *Staphylococcus aureus* in foods indicates that such foods are highly contaminated and not safe for human consumption.

Discussion

Ready-to-eat (RTE) foods provide a source of readily available and nutritious meals for the consumers; however, the safety and microbiological quality of these foods should be the first priority, since they do not receive any heat treatment before consumption.

The high total microbial counts coupled with the detection of some food- borne pathogens like *Escherichia coli, Klebsiella pneumoniae, Enterobacter aerogenes, Shigella dysenteriae, Bacillus cereus* and *Staphylococcus aureus* from RTE food samples surveyed in this investigation revealed that consumption of the foods sold in public and private primary schools in Abeokuta pose a potential health hazard to the consumers (school pupils and teachers). The results of this study revealed that foods sold in various primary schools in Abeokuta are at unacceptable levels of microorganisms. Vendors in these schools appeared to be selling sub-standard foods to school pupils and teachers because of their low purchasing power. Consumers are also more interested in satisfying their hunger than in the quality of the foods sold to them. The results of this study corroborate with the previous reports of Okolie, *et al*., 2012 and Mensah *et al*., 2002 who detected various food- borne pathogens in foods sold for school children in Lagos, Nigeria and Accra, Ghana respectively.

The occurrence of coliforms in RTE foods indicates contamination with faecal materials and poor microbiological quality. The reason may be contaminated raw materials, contaminated water, cross- contamination during preparation or storage, undercooking and improper handling. The presence of *Staphylococcus aureus* in the food samples examined indicates improper handling and possible cross- contamination. The organism could be introduced into the foods through unclean hands and mouth of the vendors and customers, since the organism is a normal flora. Contamination of the food samples with *S. aureus* can also occur through infected wounds, running hands through hair or scratching the scalp, cuts, burns and dirty clothing of the vendors (Muleta and Ashenafi, 2001; Ghosh *et al*., 2007). *Klebsiella pneumoniae* and *Proteus sp*. could have contaminated the foods through contaminated water, sewage and soil, handling of food by infected vendors and consumers (Adams and Moss, 2002).

In the present study, there was a high literacy rate among the food vendors, as majority of the women selling foods in both public and private primary schools in Abeokuta had at least a primary school education, coupled with the facts that food vendors in public primary schools had knowledge of food safety and hygiene, their educational levels appeared not to improve the microbiological quality of the foods they are selling. On the other hand, one of the factors identified to affect the quality of RTE foods sold in private primary schools is the lack of knowledge on food safety and hygiene as the vendors in these schools had never attended any course on hygiene. Other factors affecting the quality of foods sold in both public and private primary schools in Abeokuta are preparation of food long before its consumption as the foods are normally prepared in the morning, storage at ambient temperature, inadequate cooling and reheating as well as undercooking the food.

Conclusion

In conclusion, the study revealed that most foods sold in both public and private primary schools in Abeokuta are not microbiologically safe for human consumption. Hence, there are some handling practices in the processing of RTE foods for school pupils that require more attention. It is important that the foods are processed under good hygienic practices. Also, there is need for strict implementation of the food sanitation code and the licensing of RTE food vendors in both public and private primary schools. In addition, public health authorities and school authorities should intensify efforts to monitor conditions of sanitation and hygiene of food vendors in their schools. Action along these lines is expected to improve the safety of primary school foods and thereby heighten the pupils' protection.

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Table 1: Characteristics of Ready- to- eat food vendors in Primary Schools

	Public schools	Private schools
Parameters	Frequency (%), n=20	Frequency (%), n=20
Age (years)		
<20	0 (0)	0
20- 29	0 (0)	2 (10)
30- 39	7 (35)	16 (80)
40- 49	6 (30)	2 (10)
>50	2 (10)	0
Unknown	5 (25)	0
Sex		
Female	20 (100)	20 (100)
Male	0 (0)	0
Educational attainment		
Primary school	11 (55)	6(30)
Secondary school	6 (30)	10(50)
Colleges/Polytechnics	3 (15)	2(20)
University	0 (0)	0
No education	0 (0)	0
Marital status		
Single	2 (10)	2 (10)
Married	15 (75)	16 (80)
Widowed	3(15)	2 (10)
Divorced	0 (0)	0
Years of vending experience		
1-2	5 (25)	4 (20)
3-4	8 (40)	16 (80)
5-6	3 (15)	0
>6	4 (20)	0
Type of apartment		
Bungalow	12 (60)	2 (10)
Flat	8 (40)	6 (30)
Self- contained	0 (0)	12 (60)
Type of water used for cooking		
Well water	13 (65)	6(30)
Tap water	11 (55)	10(50)
Borehole	0 (0)	4(20)
River/stream water	0 (0)	0
Type of food sold		
Rice	20 (100)	20 (100)
Beans	20 (100)	8(40)
Eba/Amala/Fufu	0 (0)	0
Bread	0 (0)	0
Porridge /yam	5 (25)	4(20)
Spaghetti / Macaroni	6 (30)	0
Attendance of course on hygiene		
Yes	20 (100)	0
No	0 (0)	20(100)
Food-borne diseases contracted by the vendors		
Cholera	0 (0)	0
Salmonellosis	2 (10)	2(10)
Enteritis	0 (0)	0
Dysentery	2 (10)	0
None	16 (80)	18(90)

Table 2: Mean total bacterial counts of RTE food samples

Food samples	Number of samples analysed	Total bacterial counts (Log_{10} cfu/g ±S.D)	
		Public primary schools	Private primary schools
White rice	55	6.42±1.8[a]	7.35±1.2[b]
Jollof rice	25	6.30±0.1[a]	7.29±0.8[b]
Fried rice	8	ND	6.47± 1.1
Beans	30	6.27±1.3[a]	7.47±0.5[b]
White yam	10	ND	6.65±0.6
Porridge	20	6.45±0.1[a]	6.30±0.06[a]
Spaghetti	12	6.47±0.3	ND

Note: Means with different letters along the rows are significantly different (P< 0.05)
Note:
ND: Not determined

Table 3: Mean total coliform counts of RTE food samples

Food samples	Number of samples analysed	Total bacterial counts (Log_{10} cfu/g ±S.D)	
		Public primary schools	Private primary schools
White rice	55	6.28±0.6[a]	6.54±1.6[b]
Jollof rice	25	6.19±0.08[a]	6.22±0.2[a]
Fried rice	8	ND	6.30± 0.1
Beans	30	6.16±0.5[a]	6.28±0.01[b]
White yam	10	ND	6.15±0.4
Porridge	20	6.15±0.03[a]	6.18±1.2[a]
Spaghetti	12	6.00±0.05	ND

Note: Means with different letters along the rows are significantly different (P< 0.05)
Note: ND: Not determined

Table 4: Mean total fungal counts of RTE food samples

Food samples	Number of samples analysed	Total bacterial counts (Log_{10} cfu/g ±S.D)	
		Public primary schools	Private primary schools
White rice	55	6.00±1.0[a]	5.74±1.3[b]
Jollof rice	25	5.96±0.08[a]	5.76±0.5[b]
Fried rice	8	ND	5.60± 0.07
Beans	30	6.16±1.3[a]	6.04±0.07[a]
White yam	10	ND	6.15±1.1
Porridge	20	5.86±0.06[a]	6.70±0.16[b]
Spaghetti	12	5.85±0.4	ND

Note: Means with different letters along the rows are significantly different (P< 0.05)
Note: ND: Not determined

Table 5: Microorganisms isolated from RTE food samples

Food sample	Microorganisms isolated	
	Public primary schools	Private primary schools
White rice	*Escherichia coli, Bacillus cereus, Staphylococcus aureus, Pseudomonas aeruginosa, Klebsiella pneumoniae, Shigella dysenteriae Penicillium viridicatum, Aspergillus niger* and *Rhizopus spp.*	*Escherichia coli, Bacillus cereus, Staphylococcus aureus, Enterobacter aerogenes, Pseudomonas aeruginosa, Klebsiella pneumoniae, Penicillium viridicatum, Aspergillus fumigatus* and *Rhizopus spp.*
Jollof rice	*Escherichia coli, Klebsiella pneumoniae, Shigella dysenteriae, Pseudomonas aeruginosa, Staphylococcus aureus, Aspergillus niger* and *Fusarium spp.*	*Escherichia coli, Shigella dysenteriae, Staphylococcus aureus, Enterobacter aerogenes, Pseudomonas aeruginosa, Fusarium spp Aspergillus niger* and *Mucor spp*
Fried rice	ND	*Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Fusarium spp* and *Aspergillus niger.*
Beans	*Staphylococcus aureus, Klebsiella pneumoniae, Escherichia coli, Enterobacter aerogenes, Proteus spp, Penicillum viridicatum, Aspergillus niger* and *Rhizopus spp.*	*Escherichia coli, Bacillus cereus, Staphylococcus aureus, Enterobacter aerogenes, Shigella dysenteriae, Pseudomonas aeruginosa, Klebsiella pneumoniae, Penicillium viridicatum, Aspergillus niger* and *Rhizopus spp*
White yam	ND	*Staphylococcus aureus, Escherichia coli, Bacillus cereus, Klebsiella pneumoniae, Proteus spp, Aspergillus niger* and *Fusarium spp.*
Porridge	*Escherichia coli, Proteus spp, Bacillus cereus, Pseudomonas aeruginosa, Aspergillus niger, Aspergillus fumigatus* and *Rhizopus spp.*	*Staphylococcus aureus, Klebsiella pneumoniae, Escherichia coli, Enterobacter aerogenes, Proteus spp, Penicillum viridicatum, Aspergillus niger, Fusarium spp* and *Rhizopus spp*
Spaghetti	*Staphylococcus aureus, Escherichia coli, Bacillus cereus, Klebsiella pneumoniae, Proteus spp, Aspergillus fumigatus* and *Fusarium spp.*	ND

Note: ND: Not determined