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Microbial Quality and Antibiotic Sensitivity Pattern of Isolated Microorganisms from Street Foods Sold in Akure Metropolis, Nigeria

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Abstract

The frequent incidence of food borne diseases had been attributed to the unhygienic status of street foods. Therefore, microbial quality and sensitivity pattern of isolated microorganisms from some street foods sold in Akure metropolis were examined. Some indicator parameters were also adopted to measure the sanitary qualities of the vendors' premises. The microbial load, occurrence of microorganisms and percentage of antibiotic resistance were determined using standard microbiological methods. The bacterial and fungal count obtained from examining street foods ranged from (1.1 × 102 - 1.08 × 106) CFU g-1 and (1.0 × 102 - 8.34 × 104) SFU g-1, respectively. *Staphylococcus aureus, Escherichia coli, Salmonella typhi, Shigella dysenteriae, Klebsiella pneumoniae, Proteus vulgaris, Enterobacter aerogenes, Streptococcus lactis, Pseudomonas aeruginosa, Bacillu*s spp, *Vibrio parahaemolyticus, Saccharomyces cerevisiae, Aspergillus* spp, *Penicillium* spp, *Rhizopus stolonifer, Mucor mucedo* and *Candida albicans* were isolated microorganisms from the street foods. The isolates show a varying degree of resistance to commonly used antibiotics. The percentage resistance shown by these isolates to the antibiotics ranged from 13.3% to 100 %. The microbiological status of the examined food samples suggested that there is the need to monitor the safety of these ready to eat foods sold on the streets. Hence, bodies saddled with the monitoring of such foods should establish effective measures to ascertain the safety of these foods for unsuspecting consumers.

Keywords: Food safety, foodborne, microbial load, food vendor, MDR.

1. Introduction

Street food vending and fast food enterprises are one of the major businesses that contribute to the socio-economic development in many countries (Rane, 2011). The street foods and fast foods had been the choice of many people especially the urban dwellers because the food is ready - to - eat, cheap, convenient, sweeten with a different flavor and accessible as immediate want (Rath and Patra, 2012). The busy activities and long-term schedule of individual per day have opened ways for the increased number of street- hawk foods and fast foods These foods are commonly sold at bus stops, industrial sites, marketplaces, pupil school's gates, campuses, interstate highways and stalls at corner of the streets, where there are numerous consumers. This operation is carried out at locations that do not meet the sanitary qualities and specification of food safety bodies (FAO/WHO, 2010). Although, street foods have partially alleviated the problem of food insecurity and hunger by its steady availability but major concerns still remain its hygienic status during production and marketing system.

Street foods are rich in high–level of white flour, sugar, polyunsaturated fat, salts, a combination of different spices, flavour and numerous additives to fascinate consumers. This content with other factors, such as moisture, exposure to air and temperature of storage, are supportive growth factors for different pathogenic microorganisms (FAO, 2009). Another important reason that necessitates the assessment of the microbial quality of street food is, several methods are adopted in the processing of these foods, which involves different people rendering assistance during the production to hasten readiness, in order to meet up with the choice of people within a short time.

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The incidence of foodborne diseases is increasing rapidly due to unhygienic methods of processing food (WHO, 2015a). Most microbial etiologic agents of foodborne diseases have developed resistance to commonly used antibiotics (CSPI, 2013). The transmission of antibiotic resistance genes to another pathogenic organism has contributed to food illnesses, higher morbidity and mortality rates (Economou and Gousia, 2015). It is therefore expedient, to carry out microbiological analysis to investigate the quality and safety of street foods in most of our cities and local communities. The present study is therefore undertaken to provide information on the microbial load, type of organisms and antibiotic sensitivity pattern of microorganisms isolated from street foods sold in Akure metropolis, Nigeria.

2. Materials and Method

Study Area

Akure is the capital of Ondo State in southwestern, Nigeria. The city has a population density of 387,100. It is occupied by students, farmers, civil servants, artisans. Its coordinates are 7o15 I0 II N 5o 11 I42 II E. Tertiary institutions, shopping centers and hospitals are available in the city. The city has been classified as an oil-producing state, which has increased the human activities and state economy. During the present study, Akure metropolis was divided into five zones: Federal University of Technology, Akure (FUTA) and its environ as "zone A," Alagbaka and its environ as "zone B," King's Market and its environ as "zone C," Motor Parks in Akure as "zone D," and Highways as "zone E" (Figure 1). Some sanitary qualities were observed at the point of sample collection, such as closeness to drainage, presence of sanitary facility, the occurrence of flies, the presence of hand towel, closeness of the waste bin, hair cover on vendors, apron on the body and staff nail. The frequency of the hygienic status was calculated based on the number of samples collected in each zone.

Collection of Food Samples

Food samples,, such as popcorn, egg roll, meat pie, dough nut, sausage roll, hawk ready to eat foods (HRF), SNK (snacks from international food company) and foods from fast food joints (FSF), were collected from highly populated and busy areas in Akure metropolis. Food samples were aseptically collected from June 2013 to February 2014. The food samples in ice bag were transferred to the laboratory for immediate analysis.

Isolation of Microorganisms

Food samples were homogenized, and one gram of each homogenate was weighed out into 10 ml of sterile water as a stock solution. Serial dilution was carried out to obtain appropriate aliquot. Serially diluted sample (1.0 ml) was transferred into Petri dish containing Plate Count Agar (PCA, Lab M) for bacteria and Potato Dextrose Agar (PDA, Lab M) for fungi. The plates were incubated at 37 °C for 24 h and 48 h for bacteria and fungi, respectively. At the end of the incubation period, colonies were counted using the colony counter (TT-20, Techmel and Techmel, USA). The counts for each plate were expressed as colony forming unit per gram (CFU g-1) for bacteria and spore forming unit per gram (SFU g-1) for fungi. Microbial growth from the plate was subcultured to obtain pure cultures and these were kept at 4 oC for further study.

Identification of Microorganisms

Gram stain technique and biochemical tests were carried out according to the methods of (Cappuccino and Sherman 1999; Cheesbrough 2000) and the results obtained were interpreted according to Bergey's Manual of Systematic Bacteriology (Krieg et al., 2010). Some isolates were further confirmed by using the Analytical Profile Index (API 20 E and API 20 NE kits, API System, Biomerieux, Marcy-l'Etoile, France) and interpreted using API lab plus software. Identification of fungal isolates was carried out by staining with lactophenol blue and examined under a microscope. The feature characteristics of fungi were interpreted according to Samson et al. (2010).

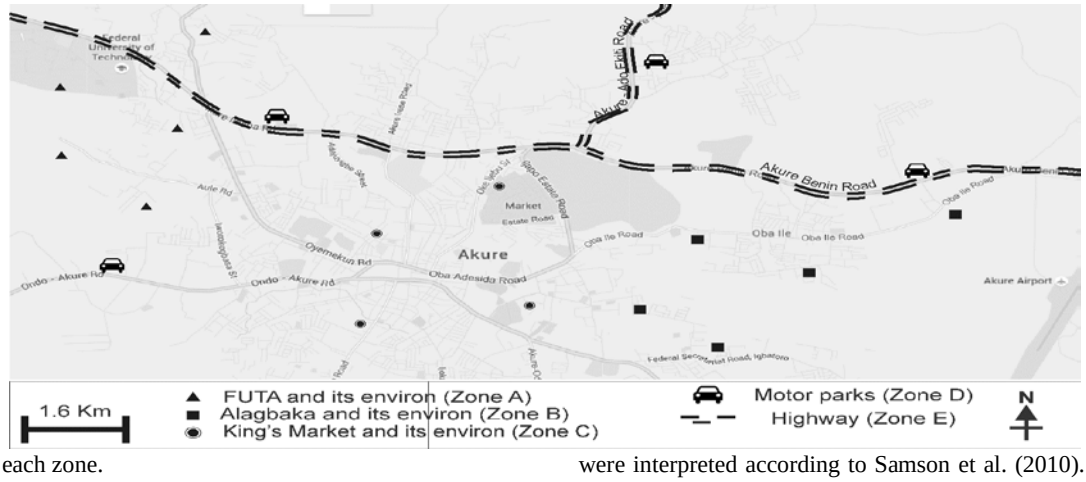

Figure 1. Map of Akure Metropolis showing zones where street foods were collected

Antibiotic Sensitivity Test

Antibiotic susceptibility test was carried out using the agar disc diffusion method following the recommendation of the Clinical and Laboratory Standards Institute (CLSI, 2012). The inoculum was prepared from 18 h old broth culture of each isolate and their absorbance was adjusted to 0.5 McFarland equivalent. Inoculum size (0.1 mL) was spread on Mueller-Hinton agar and the antibiotic discs were placed at the equidistance of the plate. The antibiotics used include gentamicin (GEN 10 μg), tetracycline (TET 25 μg), chloramphenicol, (CHL 30 μg), erythromycin (ERY 10 μg), amoxicillin (AMX 25 μg), cotrimoxazole (COT 25μg), nitrofurantoin (NIT 20 μg), nalidixic acid (NAL 30 μg), ofloxacin (OFL 5 μg), augmentin (AUG 30 g), streptomycin (STR 30 μg), ciprofloxacin (CFX 30 μg) obtained from Abtek Biological Ltd, Liverpool, L9 7AR, UK. The zones of inhibition were measured and interpreted according to CLSI (2012). The fungal isolates were tested against antifungal drugs, namely ketoconazole (15 µg), fluconazole (25 µg) and nystatin (1µg). This was done according to the standard methods described by CLSI (2009). The Multiple Antibiotic Resistance (MAR) index of the isolates was calculated as a/b, where 'a' represents the number of antibiotics to which the particular isolate was resistant to and 'b' represents the number of antibiotics to which the isolate was exposed.

Statistical Analysis

Experiments were carried out in triplicates. Data obtained from the present study were analyzed by one-way analysis of variance (ANOVA) and means were compared with New Duncan's Multiple Range Test (SPSS 17.0 version). Differences were considered significant at $P \leq 0.05$

3. Results

The hygienic status of each vendor at different zones was recorded in Table 1. The frequency and percentage of the hygienic condition were reported based on the number of the area examined.

Table 2 shows the total bacterial count (CFU g^{-1}) obtained from examined street foods. The total bacteria count (CFU g^{-1}) for popcorn in all the zones ranged from 3.10×10^2 -5.60×10^2, egg roll (3.60×10^4 - 1.00×10^5), meat pie (2.60×10^5 - 1.08×10^6), dough nut (2.40×10^4 - 1.10×10^5), sausage roll (1.70×10^4 - 9.80×10^4), hawked ready to eat foods [HRF] (3.7×10^5 - 7.70×10^5), food samples from fast food [FSF] (5.30×10^4 - 9.90×10^4). Meat pie possessed highest bacteria count of 1.08×10^6 CFU g^{-1} ($p<0.05$), while snack produced by a food company (SNK) has the lowest and consistent bacteria count of 1.10×10^2 CFU g^{-1}.

Table 1: Hygienic status of the vendor's where ready to eat food samples were collected

Hygienic parameter	Frequency and Percent (%)				
	A	B	C	D	E
Closeness to drainage	10 (62.5)	7 (43.8)	14 (87.5)	NA	12 (75.0)
presence of sanitary facility	8 (50.0)	12 (75.0)	4 (25.0)	0 (0.0)	3 (18.8)
presence of hand towel	10 (62.5)	12 (75.0)	8 (50.0)	0 (0.0)	2 (12.5)
waste bin within	7 (43.8)	6 (37.5)	12 (75.0)	0 (0.0)	9 (56.3)
hair cover on Vendor	4 (25.0)	8 (50.0)	15 (93.8)	6 (50.0)	12 (75.0)
Apron on body	5 (31.3)	4 (25.0)	11 (68.8)	0 (0.0)	8 (50.0)
Vendor's nail well kept	13 (81.3)	10 (62.5)	8 (50.0)	5 (41.7)	4 (25.0)
Total number of area sampled	n=16	n=16	n=16	n=12	n=16

A =FUTA zone, B=Alagbaka zone, C= King's market zone, D= Highways, E= Motor parks, NA: not available, n= no of samples, value outside the bracket is the frequency while value inside the bracket is the percentage calculated for the hygienic parameter.

Table 2: Total Bacterial count (CFU g^{-1}) in sampled Street foods from different zones in Akure metropolis

Food samples	A	B	C	D	E
Pop corn	$3.10^{a} \times 10^2$	$5.60^{c} \times 10^2$	$4.00^{ab} \times 10^2$	$5.30^{c} \times 10^2$	$5.10^{bc} \times 10^2$
Egg roll	$3.60^{a} \times 10^4$	$6.70^{b} \times 10^4$	$6.40^{b} \times 10^4$	$1.00^{c} \times 10^5$	$5.70^{b} \times 10^4$
Meat pie	$5.00^{b} \times 10^5$	$2.60^{a} \times 10^5$	$1.08^{d} \times 10^6$	$6.70^{c} \times 10^5$	$5.00^{b} \times 10^5$
Dough nut	$2.40^{a} \times 10^4$	$7.00^{b} \times 10^4$	$1.10^{c} \times 10^5$	$3.40^{ab} \times 10^4$	$5.30^{ab} \times 10^4$
SNK	$1.10^{a} \times 10^2$	$1.10^{a} \times 10^2$	$1.10^{a} \times 10^2$	$1.10^{a} \times 10^2$	$1.10^{a} \times 10^2$
Sausage roll	$5.50^{ab} \times 10^4$	$1.70^{a} \times 10^4$	$1.20^{c} \times 10^4$	$6.70^{bc} \times 10^5$	$9.80^{c} \times 10^4$
HRF	$4.60^{ab} \times 10^5$	$7.40^{bc} \times 10^5$	$7.70^{c} \times 10^5$	ND	$3.70^{a} \times 10^5$
FSF	$9.90^{b} \times 10^4$	$9.90^{b} \times 10^4$	$1.26^{c} \times 10^5$	ND	$5.30^{a} \times 10^4$

Values are mean of replicates (n=3), means with different letters within a row, for each count obtained from food sample are significantly different by Duncan test ($P < 0.05$). A =FUTA zone, B=Alagbaka zone, C= King's market zone, D= Highways, E= Motor parks, ND= Samples are not available at zone, SNK: snack produced by an international food company, FSF: food samples from fast food joints, HRF: hawk ready to eat foods.

Fungal count in street foods collected from different zones in Akure metropolis is reported in Table 3. The fungal count (SFU g^{-1}) obtained for popcorn in all zones ranged from 6.00×10^2 to 1.90×10^3, egg roll (4.00×10^3 - 1.90×10^4), meat pie (9.60×10^3 - 2.20×10^4), doughnut (7.60×10^2 - 1.90×10^3), snack produced by a food company [SNK] (1.00×10^2 - 1.10×10^2), sausage roll (6.00×10^3 - 1.80×10^4), hawk ready to eat foods [HRF] (5.50×10^3 - 8.30×10^4) and food samples from fast food [FSF] (7.60×10^3 - 1.30×10^4). Meat pie examined in zone E has 2.20×10^4 SFU g^{-1}, while snack produced by a food company (SNK) in zone A has a lowest fungal count of 1.00×10^2 SFU g^{-1}, which was not significantly different ($P<0.05$) from what obtained in other zones.

Tables 4 and 5 show the occurrence of microorganisms isolated from the street foods with the highest occurrence of *S. aureus* (23.3 %) and *Saccharomyces cerevisiae* (34.3 %), respectively. Twelve bacteria and eight fungi were isolated from the sampled street foods from Akure in Nigeria.

Table 3: Fungal count (SFU g^{-1}) from sampled junk foods collected from different zones in Akure metropolis

Food samples	A	B	C	D	E
Pop corn	$6.00^{a} \times 10^2$	$1.00^{b} \times 10^3$	$1.30^{c} \times 10^3$	$7.50^{a} \times 10^2$	$1.90^{d} \times 10^3$
Egg roll	$4.00^{a} \times 10^3$	$1.90^{c} \times 10^4$	$1.60^{c} \times 10^4$	$6.00^{a} \times 10^3$	$1.20^{b} \times 10^4$
Meat pie	$1.00^{a} \times 10^4$	$2.70^{b} \times 10^4$	$1.40^{a} \times 10^4$	$9.60^{a} \times 10^3$	$2.20^{b} \times 10^4$
Dough nut	$7.60^{a} \times 10^2$	$7.60^{a} \times 10^2$	$1.50^{b} \times 10^3$	$8.00^{a} \times 10^2$	$1.90^{c} \times 10^3$
CNP	$1.00^{a} \times 10^2$	$1.10^{a} \times 10^2$	$1.10^{a} \times 10^2$	$1.10^{a} \times 10^2$	$1.10^{a} \times 10^2$
Sausage roll	$1.80^{c} \times 10^4$	$6.00^{a} \times 10^3$	$1.20^{b} \times 10^4$	$8.80^{a} \times 10^3$	$1.70^{c} \times 10^3$
HRF	$5.50^{a} \times 10^3$	$9.00^{b} \times 10^3$	$8.30^{ab} \times 10^4$	NA	$1.60^{c} \times 10^4$
FSF	$1.00^{ab} \times 10^4$	$7.60^{a} \times 10^3$	$1.00^{a} \times 10^4$	NA	$1.30^{b} \times 10^4$

Values are mean of replicates (n=3), Values are mean of replicates (n=3), means with different letters within a row, for each count obtained from food sample are significantly different by Duncan test ($P < 0.05$). A =FUTA zone, B= Alagbaka zone, C= King's market zone, D= Highways, E= Motor parks, NA= Samples are not available at zone**,** SNK: snack produced by a food company, FSF: food samples from fast food joints, HRF: hawk ready to eat foods.

Table 4. Distribution and occurrence (%) of bacterial isolates from examined street foods in different zones

Bacterial Isolates	Zones [a]	Pop corn	Egg roll	Meat pie	Dough nut	SNK	Sausage roll	HRF	FSF	N	% occurrence
S. aureus	A, B, C, D, E	+	+	+	+	–	+	+	+	24	23.30
E. coli	A, B, C, D, E	–	+	+	–	+	+	+	+	18	17.50
S. typhi	A, B, C, D, E	–	+	+	+	–	+	+	+	15	14.60
S. dysenteriae	A, B, C, D, E	–	+	+	–	+	+	+	+	9	8.70
S. lactis	A, B, C, D	+	–	–	+	+	+	–	+	7	6.80
B. subtilis	B, C, D, E	–	+	+	–	–	–	+	+	7	6.80
P. aeruginosa	A, B, C, D	–	+	+	–	–	–	+	–	7	6.80
K. pneumoniae	B, D, E	–	+	+	–	–	+	–	+	5	4.90
P. vulgaris	A, C	–	–	–	+	–	–	+	+	3	2.90
B. cereus	D, E	–	–	+	–	–	–	+	+	3	2.90
E. aerogenes	A, C, E	–	+	–	–	–	+	–	–	3	2.90
V. parahaemolyticus	B, E	–	–	–	–	–	+	+	–	2	1.90

–: organisms are absent; +: organisms are present; N= number of isolates

[a]Bacterial isolate is present in food examined in the zone, where A =FUTA zone, B=Alagbaka zone, C= King's market zone, D= Highways, E= Motor parks, SNK: snack produced by a food company, HRF: hawk foods, FSF: food samples from fast food joints**.**

Table 5. Distribution and occurrence (%) of fungal isolates from examined street foods in different zones

Fungi isolates	Zones [a]	Pop corn	Egg roll	Meat pie	Dough nut	SNK	Sausage roll	HRF	FSF	N	% Occurrence
Saccharomyces cerevisiae	A, B, C, D, E	–	+	+	+	–	+	+	+	11	34.30
Candida albicans	A, C, D, E	+	+	+	–	–	–	–	+	4	12.50
Penicillium chrsogenum	A, B, D, E	+	–	–	+	–	–	–	+	4	12.50
Mucor mucedo	A, B, D,	–	–	+	–	–	–	+	+	4	12.50
A. niger	C, E	–	–	+	–	+	–	+	–	3	9.40
Penicillium commune	A, C	–	–	+	+	–	–	–		2	6.25
R. stolonifer	C	–	–	–	–	–	+	+	–	2	6.25
A. flavus	C, E	–	–	–	+	–	–	+	–	2	6.25

–: organisms are absent; +: organisms are present; N= number of isolates

[a]Fungal isolate is present in food examined in the zone, where A =FUTA zone, B=Alagbaka zone, C= King's market zone, D= Highways, E= Motor parks, NA= Samples are not available at zone, SNK: snack produced by a food company, HRF: hawk foods, FSF: food samples from fast food joints**.**

Table 6 shows the resistance pattern of the bacteria isolates against commercial antibiotics. The isolated microorganisms exhibited varying degree of resistance (13.3-100%) to the readily available antibiotics. *Pseudomonas aeruginosa*, *Shigella dysenteriae*, *Salmonella typhi* and *Escherichia coli* displayed multiple antibiotic resistance.

Table 7 shows the percentage resistance of fungi isolated from street foods against antifungal drugs. The value obtained for the percentage resistance of the fungi was within 33.3% to 100%. *Mucor mucedo, Rhizopus stolonifer* and *Aspergillus flavus* were susceptible to the used antifungal drugs.

The Multiple Antibiotic Resistance (MAR) of the isolated bacteria are shown in Table 8. The MAR index ranged from 0.125 to 0.89. Bacteria, *S. aureus, E. coli*, *S. typhi*, and *P. aeruginosa* have the higher value of MAR ranging from 0.75 to 0.89.

Table 6. Percentage of resistance (%) of bacterial isolates from street foods against commercial antibiotics.

Bacteria	N	Antibiotics											
		AUG	AMX	GEN	TET	ERY	COT	OFL	STR	NAL	CHL	NIT	CFX
E. coli	18	66.7	83.3	55.5	83.3	NT	50.0	27.7	NT	66.7	NT	55.5	NT
S. typhi	15	66.7	73.3	53.3	53.3	NT	80.0	13.3	NT	66.7	NT	80.0	NT
S. dysenteriae	9	66.7	77.8	55.6	44.4	NT	33.3	0	NT	55.6	NT	66.7	NT
P. aeruginosa	7	71.4	100.0	71.4	85.7	NT	100.0	28.5	NT	71.4	NT	100.0	NT
K. pneumoniae	5	0	40.0	40	60.0	NT	0	0	NT	100.0	NT	60.0	NT
P. vulgaris	3	100.0	66.7	100.0	0	NT	0	0	NT	0	NT	66.7	NT
E. aerogenes	3	0	0	0	33.3	NT	0	0	NT	100.0	NT	100.0	NT
Vibrio parahaemolyticus	2	100.0	100.0	50.0	100.0	NT	0	0	NT	50.0	NT	100.0	NT
S. aureus	24	83.3	NT	41.7	75.0	62.5	54.1	NT	91.6	NT	62.5	NT	50.0
S. lactis	7	28.5	NT	42.8	71.4	42.8	0	NT	0	NT	0	NT	57.1
B. subtilis	7	71.4	NT	85.7	42.8	0	42.8	NT	28.5	NT	42.8	NT	71.4
B. cereus	3	100.0	NT	100.0	33.3	66.6	0	NT	33.3	NT	66.6	NT	100.0

Key: N= number of isolates, 0 = all isolates are susceptible, NT= Antibiotics are absent in selected disc for Gram positive or Gram negative bacteria, code for antibiotics were stated in materials and methods.

Table 7. Percentage resistance (%) of fungi tested against antifungal drugs

Fungi	N	fluconazole	ketoconazole	Nystatin
Saccharomyces cerevisiae	11	0.0	36.6	18.2
Candida albicans	4	75.0	25.0	50.0
Penicillium chrsogenum	4	50.0	50.0	75.0
Mucor mucedo	4	0.0	0.0	0.0
A. niger	3	33.3	66.7	100.0
Penicillium commune	2	50.0	0.0	50.0
R. stolonifer	2	0.0	0.0	0.0
A. flavus	2	0.0	0.0	0.0

N= number of isolates, 0.0 = all isolates are susceptible

Table 8. Number of isolates and value obtained for multiple antibiotic resistance (MAR) index

Bacterial isolates	A		B		C		D		E	
	N	MAR	N	MAR	N	MAR	N	MAR	N	MAR
S. aureus	5	[0 -0.625]	4	[0 -0.75]	6	[0.25-0.75]	4	[0.25-.87]	5	[0.13-0.87]
E. coli	4	[0.13-0.89]	2	[0.75]	4	[0- 0.75]	3	[0.75]	5	[0.5-0.75]
S. typhi	3	[0.13-0.88]	3	[0.25-0.75]	3	[0.13-0.88]	3	[0.25-0.6]	3	[0.125-0.75]
S. dysenteriae	2	[0.25-0.5]	1	[0.5]	2	[0.5 -0.63]	1	[0.63]	3	[0.5]
S. lactis	2	[0.125]	1	[0.5]	3	[0.125-0.5]	1	[0.5]	-	-
B. subtilis	-	-	2	[0.25-0.5]	3	[0.38-0.63]	1	[0.5]	1	[0.5]
P. aeruginosa	2	[0.5-0.875]	2	[0.625-0.75]	2	[0.5 -0.88]	1	[0.75]	-	-
K. pneumonia	-	-	3	[0.125-0.5]	-	-	1	[0.5]	1	[0.38]
P. vulgaris	1	[0.5]	-	-	2	[0.25-0.5]	-	-	-	-
B. cereus	-	-	-	-	-	-	1	[0.625]	2	[0.5-0.75]
E. aerogenes	1	[0.25]	-	-	1	[0.37]	-	-	1	[0.25]
V. Parahaemolyticus	-	-	1	[0.5]	-	-	-	-	1	[0.75]

Value in parenthesis [*] is the range of Multiple Antibiotic Resistance [MAR] index calculated, while N, the value outside the parenthesis is the number of organisms from the each zones, Values are mean of replicates, –: organisms are absent, A =FUTA zone, B=Alagbaka zone, C= King's market zone, D= Highways and E= Motor parks.

4. Discussion

Street food vendors need to abide by the principles of Good Manufacturing Practices (GMP) in order to produce safe and wholesome foods. Aluko *et al*. (2014) revealed that many street-food vendors do not understand this principle due to lack of knowledge on basic food hygiene. Campos *et al*. (2015) also reported that food-handlers' hygienic status is contributing to the poor microbiological quality and safety of the street foods examined in Porto, Portugal. Thus, the low level of personal and environmental hygiene with the inadequate education of most vendors on the safety of food has discredited the acceptance of most ready-to-eat foods.

The microbiological analysis of the examined foods reveals the number of bacteria and fungi, which has a similar trend to what was reported by Adolf and Azis (2012). These authors have reported varying index from 10^3 to 10^6 for the total aerobic count, coliform count, yeast and mold in foods served in elementary schools. The higher microbial loads could be a result of the crowded area, environmental pollutants from open places since microorganisms are ubiquities and most fungal spores disperse uncontrollable (Frazier and Westhoff, 2008). Contaminants from unwashed hands during distribution, materials used for wrapping especially using old newspaper, re-use nylon or polyethylene bags, dirty leaves, continuous use of utensil without cleaning and undercooked methods could also lead to the presence of high microbial loads. The actions highlighted above are directly or indirectly transmitting factors of foodborne pathogens and toxins in foods, which can endanger human health (Proietti *et al*., 2014). Hence, the presence of a higher microbial load in ready to eat food signifies its potential risk. WHO (2015b) showed concerns on the outbreak of foodborne diseases due to improper use of additives, gross contaminations of foods, poor processing methods and low sanitary quality of the environment.

Some *genera* that belong to the family Enterobacteriaceae, *Staphylococcus aureus*, *Bacillus* spp and *Pseudomonas aeruginosa* were isolated in the present study. Chung *et al*. (2010), Nyenje *et al*. (2012), and Kim *et al*. (2013) reported similar microorganisms in ready to eat foods examined in Korea and South Africa. Baker *et al*. (2015) confirmed the transfer of bacteria from hand while eating popcorn as unhygienic status of the food handlers. Clarence *et al*. (2009) also reported the occurrence of the *S. aureus, E. coli, Klebsiella* spp, *Pseudomonas* spp, *Bacillus* spp and *Enterococcus* spp in meat pie sold in Benin City, Nigeria**.** These microorganisms may originate from any of the following sources: raw materials, the use of low quality food materials that is half rotten because they are cheap, the body contact with food during preparation, the poor storage of foods by food sellers, the selling street-foods close to sewage drainage, the exposure to dusts and smokes from vehicles, the use of contaminated water for cooking and the re-distribution of leftover foods. The finding of Taban and Halkman (2011) associated the presence of pathogenic organisms to the potential risk of microbiological contamination due to the usage of untreated irrigation water or sewage, methods of slaughtering of animal, inappropriate organic fertilizers or inadequately composted manure, the harvesting, the handling, processing and distributing during the restaurant service.

The high prevalence of *S. aureus* (Table 4) could be associated with its resistance to heat, drying and radiation (Adam and Moss, 2009), which could make it survive some of the processing stages during food preparation. *S. aureus* has been identified as an important foodborne pathogen due to its ability to produce heat stable and potent enterotoxin; a common food poisoning agent. Also, the occurrence of *E. coli*, *Shigella* spp, *Vibrio* spp and *Salmonella* spp in street food was reported by Nyenje *et al*. (2012) and Mugampoza *et al*. (2013). These microorganisms are responsible for several infections, such as diarrhea, typhoid fevers and gastroenteritis. Therefore the presence of coliforms isolated in the present study reveals the hygienic level under which these foods are prepared. FAO (2009) stated that these organisms are presently used as an indicator of the microbial quality of foods since these microorganisms are a typical component of the fecal microbiota and their detection specify the potential occurrence of other microorganisms.

Most of the snacks and street foods were made from cereal flours, corn, sugar, honey, chocolate and other additives, which could be the source of fungi; *Aspergillus* spp, *Penicillium* spp, *Rhizopus stolonifer*, *Mucor mucedo* in the tested street foods. The findings of Makun *et al*. (2010) revealed the colonization of these fungi in some foods and their mycotoxin producing potentials.

The microorganisms isolated from the ready to eat foods showed significant resistance to commonly used antibiotics. Oluyege *et al*. (2009) and Akinyemi *et al*. (2013) reported similar antibiotic resistance percentage of 20% to100 % for *S. aureus*, *E. coli*, *Salmonella* spp, *Shigella dysenteriae*, *Pseudomonas aeruginosa* against some commercial antibiotics. A marked resistance of microorganisms to commonly used antibiotics, like amoxicillin, tetracycline, cotrimoxazole, gentamicin, nalidixic acid, chloramphenicol, ciprofloxacin, streptomycin were associated with coexistence of resistance genes with mobile elements, such as plasmids, transposons and integrons (Sunde and Nordstrom, 2006; Thong and Modarressi, 2011). The transfer of resistance gene in food products and the environment were directly or indirectly linked to several human activities, such as the use of antibiotics in farming to produce some edible foods (Economou *et al*., 2013). The emergence of antibiotic-resistant microorganisms from foods raises concern as most of the resistant strain spread into other environments where they can infect man through some conscious or unconscious activities.

5. Conclusion

The presence of bacteria and fungi in the examined street foods shows that prompt attention of public health officers is needed to train food vendors on how to produce safe foods that will reduce the incidence of foodborne diseases and the transfer of antibiotic resistant microorganisms from food to man.

6. Recommendation

Adequate enlighten programme is important for the food vendors on the principle of good manufacturing practice to ensure the production of safe food and prevent the spread of pathogenic microorganisms in the foods serve to the cities.

No conflict of interest

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