BACTERIAL EMPIRE
2020, VOL. 3, NO. 3, 32-40

INVESTIGATION OF MICROBIOLOGICAL QUALITY OF SELECTED STREET VENDED FOODS SOLD IN UYO METROPOLIS, AKWA IBOM STATE, NIGERIA

Aniekpeno I. Elijah[1], *Aniekan Ben*[1] *and Victor E. Edem*[2]

Address (es):
[1] Department of Food Science and Technology, University of Uyo, P.M.B. 1017 Uyo, Akwa Ibom State, Nigeria.
[2] Department of Natural and Environmental Sciences, Division of Microbiology, Crown-Hill University, Eiyenkorin, P.M.B. 1605, Ilorin, Kwara State, Nigeria.

*Corresponding author: victoredem001@yahoo.com

https://doi.org/10.36547/be.2020.3.3.32-40

ABSTRACT

Street vended food play an important role in developing societies as they support livelihood of millions of people in the society. This study evaluated the microbial quality of selected street-vended foods in Uyo Metropolis, Akwa Ibom State, Nigeria. Popular food samples were collected from five different locations with intensive vending activities and analyzed for total bacterial count (TBC), total *Salmonella (*TSC), *E. coli* and *Vibrio cholera* counts (VCC). Results indicated that TBC ranged from 1.33 x 10^5 + 0.03 cfu/g to 6.00 x 10^5 + 0.03 cfu/g while TSC ranged from 1.00 x 10^3 + 0.02 cfu/g to 3.00 x 10^4 + 0.04 cfu/g. Total *E.coli* count ranged from 1.00 x 10^1 + 0.00 cfu/g to 2.09 x 10^3 + 0.01 cfu/g which was above WHO standard of 0 cfu/g. VCC was detected in 7 food samples with the highest count being 7.20 x 10^2 + 0.02 cfu/g. There were significant differences (P<0.05) in microbial counts among food samples and vending locations. Bacterial species isolated from the food samples include: *Aerococcus viridans, Cornynebacterium uberis, Escherichia coli, Klebsiella species, Lactobacillus salivarius, Micrococcus luteus, Micrococcus varians, Proteus mirabilis, Pseudomonas pyogenes, Pseudomonas pyogenia, Salmonella paratyphi, Salmonella typhi, Staphylococcus albus, Staphylococcus aureus, Staphylococcus epidermidis, Vibrio cholera.* Data obtained from the questionnaires showed poor handling and preparation of food by vendors, hence the need to train and educate vendors on food hygiene. Application of hazard analysis and critical control point (HACCP) is necessary to improve the safety of street foods and consequently safety of consumers.

Keywords: Street-vended-foods, microbiological-quality, Uyo, bacterial-count, *Salmonella*-count, *E. coli* and *Vibrio-cholera*-counts

INTRODUCTION

Food is any substance that people or animal eat or drink or that plant absorb to maintain life and growth. **Ezeronye (2007)** defined food as any substance consumed for support for the body; it is usually of plant or animal origin. In other words, foods are substances (either solid or liquid) that are consumed for adequate nutritional status. It is usually composed of carbohydrates, fats and oil, protein, vitamins, minerals, fibre and water that can be eaten or drunk by animals and humans for nutrition or pleasure **(Davidson, 2008).**

From microbiological perspective, food can be viewed as a fertile ecosystem in which organisms vie for nutrients **(Nester *et al*., 2004)**. They are complex organic substances which living organisms require for producing energy for metabolic processes and for building up of body tissues when broken down within the body of a living organism, they may be used for repairing worn out tissues and cells, replacement of dead old cells, fight against antigens and proper functioning of body system among others. The lack of food or its inadequacy will result in diverse disorderliness and malfunctioning **(Anibijuwon & Sunday, 2012)**. Excess food can be detrimental to living organism, so likewise do contaminated foods have effect in living organisms when ingested.

Street foods also known as 'Ready-to-eat' (RTE) foods could be defined as foods; raw or cooked, hot or chilled, that are ready for immediate consumption at the point of sales without any further treatment. The United States Department of Agriculture defined RTE food as food that is in a form that is edible without washing, cooking or heating by the consumer and is reasonably expected to be consumed in that form. Foods such as washed, cut fruits and vegetables are considered as RTE foods. Also, foods presented for consumption for which further washing or cooking is not required and from which rinds, peels, husks, shells are removed are also considered as RTE **(DBPR, 2002)**.

Processing of these value-added products require strict hygiene applications throughout the processing chain. This is because these foods are susceptible to microbiological spoilage and could harbor pathogens even under the best management conditions and practices.

On consumption of food, occasionally human beings consume undesirable biological agents and toxins. Food is not only of nutritional value to those who consumed them but also often are ideal culture media for the growth of microorganisms **(Gadaga *et al*., 2007)**. Foods are normally contaminated with bacteria and other microbes since the environment in which we live is colonized by them. Food prepared locally for human consumption is at greater risk of contamination and vice versa. Also, the health status of the individual preparing the food is a major determinant.

Safe food is a basic human right despite the fact many foods are frequently contaminated with naturally occurring pathogenic microorganisms which cannot be detected organoleptically but can cause diseases including death especially if the way they are conserved during exposition for sale provides condition for those microorganisms to grow and reach considerable levels of contamination **(WHO, 2000)**.

In Nigeria, there has been an increase in consumption of ready-to-eat foods over the last decade, because they are relatively cheap, easily accessible and convenient. Also, they are easily available and affordable. It provides variable food source, employment and with a potential of improving food security and national status and general social security. Most people are very much interested in satisfying their hunger and the convenient of RTE foods rather than its microbiological quality and hygiene. The fact that RTE food is an indispensable part of urban and rural diets, it has its own associated health problems. Since it does not require any further processing before consumption, street-food can be a good vehicle for the transmission of food-borne microorganisms **(Monday *et al*., 2014)**.

Street-vended foods provide major source of income for vast number of persons, particularly women, chance of self-employment and opportunity to develop business skills with low capital investment, least expensive and most accessible means of obtaining nutritionally balanced meal outside the home for many low income people **(WHO, 2000; Dipeolu *et al*., 2007)**. Street foods play an important role in developing societies as they support livelihood of millions of the urban poor. Despite the economic and nutritional benefits of street foods, the consumption of these foods is readily contaminated from different sources **(Tambekar *et al*., 2008).** There are number of factors that can result to food borne diseases; these may include failure to cook food thoroughly, holding food at ambient temperature optimal for bacterial growth, poor handling, storage and transportation of cooked foods, lack of hygienic practices among others **(Mensah *et al*., 2002)**. Food borne diseases are diseases resulting from the ingestion of bacteria, toxins and cells produced by microorganisms present in food. It is capable of reducing the productivity and economic output, and also imposes substantial stress on healthcare system.

Furthermore, studies on microbiological quality and safety of street vended foods in Uyo metropolis have received little or no attention from food agencies. Thus, this study forms a basis for justification of microbial examination owing to the general unhealthy and unhygienic practices used during food preparation by food vendors which has led to the growing concern for food safety. It is therefore pertinent to isolate, identify and characterize food borne pathogens associated with ready-to-eat foods and the relationship between their occurrence and the hygienic practices in order to create public awareness. The outcome of this study could provide useful information about potential food poisoning outbreak relating to street vended foods sold in Uyo metropolis. Again, food handlers in Uyo could be guided in their daily activities.

MATERIALS AND METHODS

Samples collection

Samples were collected in sterile packages after preparation in the same manner as how a consumer would buy them from different mobile and fixed vendors. It was transported without delay to the laboratory in aseptic conditions within one to two hours of collection where the product type, purchase date and place of purchase was recorded and kept in their original packages, not in the cooling box so as to replicate consumer behavior, until beginning of the analysis. Samples and locations were coded to aid identification as follows: A- Rice and stew, B- Porridge beans, C- Ekpangkukwo, D- Moi moi, E- Noodles, UTC- Uniuyo Town Campus, UMC- Uniuyo Main Campus, UTH- Uniuyo Teching Hospital, ITP- Itam Park, AAM- Akpan Andem Market.

Sterilization of media

All materials were adequately and appropriately sterilized before and after use. Glass wares such as test tubes, glass rod, pipette, measuring cylinder, beakers and conical flasks required for this research work were soaked and washed thoroughly with detergent and rinsed with distilled water properly and drained. They were wrapped with aluminum foil paper and dried in the oven in inverted position at 180 ^{o}C for 60 min. The working area was swabbed with ethanol. Contamination by microorganisms from the external environment was reduced by closing windows and putting off fans in the laboratory. Prepared media and distilled water was autoclaved at 121^{o}C for about 30 min at 15 psi (per square inch). Metal equipment like the inoculating loop was heated to redness in an open flame before and after use. Every isolation and inoculation was done near the flame to reduce contamination of the agar plates tube.

Preparation of culture media

The following culture media were used; nutrient agar for the determination of total bacterial count, potato-dextrose agar (fluka) for the determination of total fungal count, *Salmonella Shigella* agar for the determination of *Salmonella Shigella* count, eosin methylene blue agar for the determination of *Escheriche coli* count; thiosulphate citrate bile salt sucrose agar for the determination of total *Vibrio cholera* count and cysteine lactose electrolyte deficient (CLED) agar for differentiation of bacterial isolates. Each of the growth media were accurately weighed according to the manufacturer's specifications and mixed in a recommended quantity of water in a conical flask. The growth media were sterilized in an autoclave at a temperature of 121 ^{o}C for 15 psi. *Salmonella shigella* agar was melted at 100 ^{o}C in conical flask because it was already sterile.

Preparation of samples

About 10 g of each food sample was weighed and mixed with 90 ml of 0.1% sterile peptone water in a mortar and homogenized. The resultant homogenate was diluted serially down to 10. From the appropriate dilutions 1 ml was plated in duplicate onto the different media using pour plate technique on nutrient agar (in duplicate) for aerobic colony count (ACC). The plates were allowed to set for 15 min and were incubated in inverted position for 24 h. All plates were incubated at 37 ^{o}C for 24 – 48 h; EMBA-inoculated plates were incubated at 72 h. At the end of the incubation periods, plates containing 30 – 300 colonies were counted using illuminated colony counter to obtain viable bacterial colonies (Gallenkamp, England). The counts for each plate were expressed as colony forming unit per gram of sample (cfu/g). Morphological attributes of the colonies on the media were observed; discrete colonies on the different media were purified by repeated sub-culturing on nutrient agar. Pure cultures were stored on agar slants at 4 ^{0}C for further characterization.

Enumeration of total *Salmonella* count

About 1 ml of each sample was taken and added into test tube containing 9 ml of normal saline (0.85%W/V) and was mixed well using vortex. Then, the serial dilution was made up to 10^{-3} using test tube no.3. 1 ml suspension was transferred and poured on to a sterile *Salmonella-Shigella* agar (SSA) in duplicate for *Salmonella* count. The plates were incubated at 37 ^{o}C for 24 h for optimum growth of cells. After the incubation period, the result of the total *Salmonella Shigella* Species count were expressed in colony formation units per gram sample **(Feglo & Sakgi, 2012)**

Enumeration of *Escherichia coli* count

About 1 ml of dilution 10^{-3} levels was poured-plated in duplicate on eosin methylene blue agar (EMB). The plates were kept in an incubator at 44 + 0.5 ^{o}C for 72 h. After pour-plating and incubation on EMB agar, plates with colonies ranging from 30 – 300 with greenish metallic sheen which are indicative of *Escherichia coli* colonies were counted and recorded **(Nkere *et al.*, 2011).** The cell count was converted to colony forming units per gram (cfu/g).

Enumeration of *Vibrio cholerae* count

About 1 ml of sample diluent at 10^{-3} was transferred to a plate of thiosulfate-critrate-bile salts-sucrose (TCBS) agar. The colour of this media is deep green. The pour plate technique was done. The agar plate was incubated at 37 ^{o}C for 24 h. for samples with vibrio species present such as *V. cholera*, ferment sucrose, resulting in pH shift and production of yellow colonies. The result of the *Vibrio* species count was expressed in colony formation units per gram sample.

Characterization and identification of the isolates

As reported by **Edem *et al.* (2017),** standard inocula were prepared from the preserved stock culture by taking a loopful of the isolates and aseptically inoculating onto sterile nutrient agar plates. The plates were incubated at 28°C for 24 h. Morphological and biochemical characterization was carried out using standard methods **(Harrigan & McCane, 1976),** while the isolates were identified by reference to Bergey´s Manual of Systematic Bacteriology **(Holt *et al.*, 2000)**. Fungal isolates were identified using colonial appearance and microscopic characteristics **(Chessbrough, 1984; Barnett & Hunter, 1987).**

Statistical analysis

Data obtained were subjected to the analysis of variance (ANOVA), and the Duncan's test was used as a post-hoc mean separation technique for treatments. Differences among the data were determined at 5% level of significance. The data analysis was completed using SPSS version 20.

RESULTS

Total fungal count of street vended foods in Uyo metropolis

Table 1 presents the total fungal count of street vended foods in Uyo metropolis. Only porridge beans obtained from Uniuyo teaching hospital and Uniuyo Town Campus recorded fungal growth with a total fungal growth of $7.00 \times 10^{1} + 0.001$ cfu/g and $3.00 \times 10^{1} + 0.00$ cfu/g respectively

Table 1 Total fungal count in street vended food in the Uniuyo metropolis

	LOCATION				
Food sample	**UTC**	**UMC**	**UTH**	**ITP**	**AAM**
A	Nil	Nil	Nil	Nil	Nil
B	$3.0 \times 10^{1b} + 0.00$	Nil	$7.00 \times 10^{1a} + 0.001$	Nil	Nil
C	Nil	Nil	Nil	Nil	Nil
D	Nil	Nil	Nil	Nil	Nil
E	Nil	Nil	Nil	Nil	Nil

Values are means + SD of triplicate determinations. Means in the same row with different superscripts are significantly ($p<0.05$) different. UTC – Uniuyo Town Campus, UMC – Uniuyo Main Campus, UTH – Uniuyo Teaching Hospital, ITP – Itam Park, AAM – Akpan Andem Market, A – Rice and stew, B – Porridge beans, C – Ekpankukwo, D – Moi Moi, E – Noodles.

Total bacterial count of street vended foods sold in Uyo metropolis

Total bacterial count of street vended foods sold in Uyo metropolis is presented in Table 2. The results obtained show that total bacterial count was significantly (P<0.05) higher in rice and stew, moi moi and noodles obtained from Akpan Andem Market than in other food samples from other locations. However, total bacterial count was significantly (P<0.05) higher in porridge beans from Uniuyo Town Campus as well as Ekppangkukwo from Itam Park than in other locations. This indicated that location and type of food had significant (P<0.05) effect on total bacterial count.

Table 2 Total bacterial count in street vended foods in Uniuyo metropolis

	Location				
Food sample	**UTC**	**UMC (x10^5 cfu/g)**	**UTH**	**ITP**	**AAM**
A	2.33^{d}+0.02	2.15^{e} +0.01	4.00^{b} +0.05	3.60^{c} +0.03	4.30^{a} +0.02
B	4.10^{a}+0.02	3.90^{b} +0.04	1.66^{e} +0.03	2.50^{c} +0.05	2.30^{d} +0.02
C	2.04^{b}+0.04	1.96^{c} +0.02	1.33^{e} +0.03	2.50^{a} +0.05	1.80^{d} +0.02
D	2.80^{e}+0.04	4.50^{d}+ 0.03	5.00^{c} +0.01	5.10^{b} +0.05	5.20^{a} +0.03
E	5.70^{b}+0.05	4.10^{d} +0.02	3.90^{e} + 0.03	5.00^{c} +0.03	6.00^{a} +0.05

Values are means + SD of triplicate determinations. Means in the same row with different superscripts are significantly (p<0.05) different. UTC – Uniuyo Town Campus, UMC – Uniuyo Main Campus, UTH – Uniuyo Teaching Hospital, ITP – Itam Park, AAM – Akpan Andem Market, A-rice and stew, B – Porridge beans, C – Ekpankukwo, D – Moi Moi, E – Noodles.

Total *Salmonella shigella* count in street vended foods in Uyo metropolis

Total *Salmonella Shigella* count of street vended foods sold in Uyo metropolis is presented in Table 3. The result showed that total *Salmonella shigella* count was significantly (p< 0.05) higher in rice and stew and noodles from Uniuyo town Campus than in same food samples from the other locations. However, total *Salmonella Shigella* count was significantly (p< 0.05) higher in porridge beans from Uniuyo Teaching hospital than that from other locations. The result obtained indicated that total *Salmonella Shigella* count was significantly (p< 0.05) higher in ekpangkukwo from Uniuyo Main Campus than in other locations, while moi-moi obtained from Itam Park had a significantly (p<0.05) higher total *salmonella shigella* count than moi-moi from other local.

Table 3 Total *Salmonella Shigella* count in street vended foods in Uyo Metropolis

	Locations				
Food Sample	**UTC**	**UMC (in cfu/g)**	**UTH**	**ITP**	**AAM**
A	2.00 x 10^{4a} +0.05	1.50 x10^{4c}+0.01	1.80 x 10^{4b}+0.03	1.90 x 10^{3e}+ 0.02	8.70 x 10^{3d} +0.05
B	4.00 x 10^{3c}+0.01	3.00 x 10^{3e}+0.05	9.00 x10^{3a}+0.03	3.50 x10^{3d}+ 0.05	7.60 x10^{3d} +0.02
C	1.20 x 10^{3d} + 0.02	3.00 x10^{3a}+0.04	2.00 x10^{3b}+ 0.02	1.70 x10^{3c} +0.01	1.00 x10^{3e}+ 0.02
D	1.45 x10^{4b}+0.02	1.15 x10^{4c}+0.05	1.10 x10^{4c}+ 0.02	2.10 x 10^{4a}+ 0.02	2.10 x10^{4a} +0.03
E	3.00 x10^{4a}+0.04	5.00 x10^{3d}+0.05	4.00 x 10^{3e} +0.01	1.90 x 10^{4b}+ 0.04	1.10 x10^{4c}+ 0.05

Values are means SD of triplicate determinations. Means in the same row with different superscripts are significantly (p<0.05) different. UTC – Uniuyo Town Campus, UMC – Uniuyo Main Campus, UTH – Uniuyo Teaching Hospital, ITP – Itam Park, AAM – Akpan Andem Market, A – Rice and Stew, B – Porridsge beans, Ekpankukwo, D – Moi Moi, E – Noodles.

Total *Escherichia coli* count in street vended foods in Uyo metropolis

Total *Escherichia coli* count in Street vended Foods in Uyo metropolis is presented in Table 4. Result indicated that the type of food sample and the location had significant (p<0.05) effect on total *E. coli* count. Total *E. coli* count in Rice and Stew obtained from Uniuyo town Campus and Itam Park were significantly (p<0.05) higher than that obtained from other locations but not significantly (p<0.05) different from each other. Porridge beans obtained from Akpan Andem Market had significantly (p>0.05) higher total *E. coli* count than in food samples obtained from other locations. However, no *E. coli* was detected in porridge beans obtained from Uniuyo Town Campus. The result also showed that total *E. coli* count was significantly (p<0.05) higher in ekpankukwo and moi-moi from Uniuyo Teaching Hospitral than that obtained from other locations. However, noodles obtained from Itam Park had significantly (p>0.05) higher total *E. coli* count than other locations. No *E. coli* was detected in moi-moi, rice and stew and noodles obtained from Akpan Andem Market.

Table 4 Total *Escherichia coli* in street vended foods in Uyo Metropolis

	Location				
Food sample	**UTC**	**UMC (in cfu/g)**	**UTH**	**ITP**	**AAM**
A	1.00 x 10^{2a} + 0.02	6.00 x 10^{1b}+ 0.03	1.00 x 10^{1c}+ 0.00	1.00 x 10^{2a}+ 0.01	Nil
B	Nil	1.00 x 10^{1d}+ 0.00	1.00 x 10^{2c}+ 0.01	1.10 x 10^{2b}+ 0.03	4.10 x 10^{2a}+ 0.02
C	2.80 x 10^{2d} + 0.05	4.50 x 10^{2b}+ 0.05	5.30 x 10^{2a}+ 0.03	1.30 x 10^{2e}+ 0.03	3.50 x 10^{2c}+ 0.02
D	1.10 x 10^{2c} + 0.03	1.50 x 10^{2b}+ 0.02	2.10 x 10^{2a}+ 0.01	1.50 x 10^{2b}+ 0.03	Nil
E	4.10 x 10^{2d} + 0.05	8.10 x 10^{2b}+ 0.02	5.10 x 10^{2c}+ 0.02	2.09 x 10^{3a}+ 0.01	Nil

Values are means SD of triplicate determinations. Means in the same row with different superscripts are significantly (p<0.05) different. UTC – Uniuyo Town Campus, UMC – Uniuyo Main Campus, UTH – Uniuyo Teaching Hospital, ITP – Itam Park, AAM – Akpan Andem Market, A – Rice and stew, B – Porridge beans, C – Ekpankukwo D – Moi Moi, E – Noodles.

Total *Vibro cholerae* count in some street vended foods in Uyo Metropolis

Total *Vibro cholera* count in some street vended foods in Uyo Metropolis is presented in Table 5. The result showed that the total *Vibrio cholera* count was significantly ($p<0.05$) higher in moi-moi from Uniuyo Town Campus than in the same food samples gotten from other locations. However, no *Vibrio cholera* count was detected in moi-moi from Itam Park and Akpan Andem Market. Porridge beans from Uniuyo Town campus also showed total *Vibrio cholera* count significantly ($p<0.05$) higher than porridge beans from Itam Park while no Vibrio cholera count was detected in ekpangkukwo and noodles samples from all locations.

Table 5 Total vibrio cholerae count in some vended foods

	Locations				
Food samples	**UTC**	**UMC**	**UTH**	**ITP**	**AAM**
A	Nil	$1.00 \times 10^{1b} +0.00$	Nil	$1.00 \times 10^{2a} +0.01$	Nil
B	$5.80 \times 10^{2a} +0.05$	Nil	Nil	$1.00 \times 10^{2b} +0.02$	Nil
C	Nil	Nil	Nil	Nil	Nil
D	$7.20 \times 10^{2a} + 0.02$	$6.40 \times 10^{2b} +0.05$	$5.70 \times 10^{2c} +0.03$	Nil	Nil
E	Nil	Nil	Nil	Nil	Nil

Values are means SD of triplicate determinations. Means in the same rows with different superscripts are significantly ($p<0.05$) different. UTC – Uniuyo Town Campus, UMC – Uniuyo Main campus, UTH – Uniuyo Teaching Hospital, ITP – Itam Park, AAM – Akpan Andem Market, A – Rice and stew, B – porridge beans, C – Ekpankukwo, D – Moi Moi, E – Noodles.

Morphological characteristics and frequency of occurrence of fungal species in street vended foods in Uyo metropolis

Table 6 presents the morphological characteristics and frequency of occurrence of fungal species as identified in the street-ended foods in Uyo metropolis. The result showed that two fungal species were isolated. The fungal species: *Aspergillus fumigatus* and *Penicillum frequentans* were obtained from porridge beans from Uniuyo Town campus and Uniuyo Teaching Hospital respectively.

Table 6 Morphological characteristics and frequency of occurrence of fungal species in vended foods in Uyo metropolis

Colony Colour	**Somatic Structure**	**Nature of Hyphae**	**Special Vegetative structure**	**Asexual Spore**	**Special Reproductive Structure**	**Most Probable organism**	**Prevalence Frequency**	**Percentage Prevalence Frequency (%)**
Smoky or grey-green	Filamentous	Septate	Footcell	Globose conidia	Short conidiophores	Aspergillus fumigatus	1	50
Small blue colony	Filamentous	Septate	Broom-like shape	Sub globose Conidia	Branded conidiophores	Penicillum frequentans	1	50
TOTAL							2	100

Frequency of occurrence for bacterial species street vended foods in Uyo metropolis

Table 7 shows the frequency of prevalence of bacteria isolated from street-vended samples collected in different locations. Table 7 revealed that *Escherichia Coli* had the highest number of occurrence while *Micrococcus luteus* had the lowest number of occurrence.

Morphological and biochemical characteristics of bacterial species in street vended foods in Uyo metropolis

Results in Table 8 showed the biochemical and morphological characteristics, carbohydrate fermentations and names of bacterial species from isolated street – vended food samples in Uyo metropolis.

Table 7 Percentage frequency of prevalence of bacterial isolates in street ended foods in Uyo metropolis

S/N	**Bacterial Isolates**	**Prevalence Frequency**	**Percentage Prevalence Frequency (%)**
1	*Klebsiella species*	7	5.19
2	*Staphylococcus epidermidis*	8	5.92
3	*Pseudomonas pyogenes*	8	5.92
4	*Escherichia coli*	21	15.56
5	*Salmonella typhi*	18	13.33
6	*Corynebacterium uberis*	6	4.44
7	*Micrococcus varians*	5	3.70
8	*Aerococcus viridians*	6	4.44
9	*Staphylococcus albus*	7	5.19
10	*Proteus mirabilis*	7	5.19
11	*Salmonella paratyphi*	12	8.89
12	*Micrococcus luteus*	4	2.96
13	*Lactobacillus salivarius*	7	5.19
14	*Pseudomonas pyogenia*	7	5.19
15	*Staphylococcus aureus*	5	3.70
16	*Vibrio cholera*	7	5.19
TOTAL		**135**	**100**

Table 8 Morphological and biochemical characteristics of bacterial species in street vended foods in Uyo metropolis

Cultural Characteristics	Cell Shape	Gra	Motility	Met	Coa	Indo	Oxi	Cat	Citr	spor	Ure	Glucose	Lactose	Mannitol	Maltose	Xylose	Sucrose	Probable Bacterial Isolates Identified
Mucoid milky circular colonies	Rod	-	-	+	-	-	-	+	+	-	+	AO	OO	AO	AO	OO	AO	*Klebsiella species*
Tiny white circular colonies	Cocci	+	-	-	-	-	-	+	-	-	+	AO	OO	AO	AO	OO	OO	*Staphylococcus epidermidis*
Irregular milky colonies	Rod	-	+	+	-	-	+	+	+	-	+	AO	OO	OO	AO	AO	AO	*Pseudomonas pyogenes*
Greenish metallic colonies	Rod	-	+	+	-	+	-	+	-	-	-	AG	AG	AG	AG	AO	AO	*Escherichia coli*
Circular creamy colonies	Rod	-	+	+	-	-	-	+	-	-	-	AG	AO	AG	AG	AO	OO	*Salmonella typhi*
Milky raised colonies on N.A	Rod	+	-	-	-	-	-	-	+	-	+	AG	OO	OO	AO	OO	AG	*Cornynebacterium uberis*
Tiny white colonies on N.A	Cocci	+	-	-	-	-	-	+	+	-	+	AO	OO	AO	AO	OO	AO	*Micrococcus varians*
Tiny white colonies on N.A	Cocci	+	-	+	-	-	-	+	+	-	-	AO	OO	AO	AO	OO	AO	*Aerococcus viridiands*
White flat circular colonies	Cocci	+	-	-	-	-	-	+	+	-	+	AO	OO	AO	AO	OO	OO	*Staphylococcus albus*
Irregular greenish colonies	Rod	-	+	+	-	+	+	+	+	-	+	AG	AO	AO	AO	OO	AG	*Proteus mirabilis*
Circular creamy colonies	Rod	-	+	+	-	-	-	+	-	-	-	AO	OO	AO	AO	OO	OO	*Salmonella paratyphi*
Tiny white colonies on N.A	Cocci	+	-	-	-	-	-	+	+	-	+	OO	OO	OO	OO	OO	OO	*Micrococcus luteus*
Large circular colonies	Rod	+	-	-	-	-	-	-	-	-	-	AO	AO	AO	AO	OO	AO	*Lactobacillus salivarius*
Irregular milky colonies	Rod	-	+	+	-	-	+	+	+	-	+	AO	AO	AO	AO	AO	AO	*Pseudomonas pyogenia*
Golden yellow colonies	Cocci	+	-	-	-	-	-	+	-	-	+	AG	AG	AG	OO	OO	AG	*Staphylococcus aureus*
Irregular yellow colonies on TCBS	Rod	-	+	+	-	+	+	+	+	-	-	AO	AO	AO	AO	AO	AO	*Vibrio cholerae*

Profile of the street food vendors and personal hygiene in Uyo metropolis

Table 9, 10 and 11 summarized the food handling practices, characteristics of vending environment and food vendors who participated in the study. The result in Table 9 showed that 73.3% of the vendors interviewed were women. The age range of vendors was between 15 - ≥ 55 *years* with the highest percentage (40.00%) in the age group of 25 – 34 year's olds. Most of the vendors (60.00%) had primary school qualification, 26.7% had a secondary school qualification while 2% had no formal school.

Table 10 summarized the Preparation, storage and handling practices of the vendors of street foods in Uyo Metropolis. About 33.3% of the vendors stored their foods in a wheelbarrow while 20.0% displayed foods openly in the stalls and only 46.7% stored them in sealed containers. Only 6.7% (1/15) of the stalls covered their utensils and 86.7% of the vendors washed their utensils using cold and soapy water. About 53.3% of the vending sites were protected by the sun, wind and dust. Evidence of the presence of houseflies was observed at 66.7% of the stalls. It was observed that 60.0% of the stalls had garbage bins, while Table 11 presented the personal hygiene of the vendors and vending site which showed that 33.3% worked without aprons while 66.7% used their bare hands during handling, preparation and serving of foods. All of the vendors (100%) did not cover their hair during the handling, preparation and serving of foods. About 93.3% exchanged money during the handling.

Table 9 Profile of street food vendors in Uyo Metropolis (n=15)

Parameter (%)	Frequency
General Information	
Gender	
Female	11(73.3)
Male	4(26.7)
Age range	
15-24	3(20.0)
25-34	6(40.0)
35-44	3(20.0)
45-54	2(13.3)

n ≥ 55	1(6.7)
Educational Attainment	
Did not attend formal school	2(13.3)
Primary school completed	9(60.0)
Secondary school completed	4(26.7)
College completed	0
Vending Duration	
<1 years	1.(6.7)
1-2 years	2(13.3)
3-5 years	4(26.7)
6-9 years	6(40.0)
n≥ 10 years	2(13.3)
Types of vendor	
Stationary	10(66.7)
Mobile	5(33.3)
Undergone Food safety training	2(13.3)

Table 10 Preparation, storage and handling practices of vendors of street foods in Uyo Metropolis

Parameter **(%)** **Frequency**
Preparation time
Night before selling
6(40.0)
Morning of selling
4(26.7)
During day
5(33.3)
Place of preparation
At home
6(40.0)
At the site of sell
9(60.0)
Food storage
In wheelbarrows
5(33.3)
Openly in the stalls/uncovered
3(20.0)
In sealed (transparent/opaque) containers
8(46.7)
Leftovers
Consumed
7(46.7)
Stored for use next day
8(53.3)
Throw away
0
Care of Utensils by the vendors
Method of washing utensils before and after serving to another consumer
Hot water and soap
2(13.3)
Cold water and soap
13(86.7)
Frequency of washing of serving utensils (plates and cutlery)
Only at the end of the day
1(6.7)
Immediately after use
5(33.3)
When exhausted
9(60.0)
How many times water is used before replacement
Once
1(6.7)
Twice
3(20.0)
Several
11(73.3)
Covered utensils
1(6.7)

Table 11 Hygienic practices of vendors and vending environment of street foods in Uyo Metropolis

Parameter **Frequency** **(%)**
Use of apron
Half apron used
5(33.3)
Not used
10(66.7)
Hair
Covered
0
Uncovered
15(100)
Have long finger nails
6(40.0)
Handling money while serving food
14(93.3)
Handles food with bare hand
10(66.7)
Hand washing method
Using clean water
4(26.7)
Using clean water and soap
10(66.7)
Any water
1(6.7)
Hand washing
After blowing of nose and scratching
4(26.7)
After using toilet
15(100)
After touching money
0
Medical check up
Once a year
2(13.3)
When I feel sick
12(80.0)
No check-up
1(6.7)
Hygienic status of vending environment and waste disposal practices of food vendors
Vending stall protected from sun, dust and wind
8(53.3)
Far from rubbish, waste water, toilet facilities, open drains and animals
2(13.3)
There were adequate waste or food disposal facilities available
5(33.3)
Presence of houseflies in the stall

10(66.7)

Frequency of waste disposal
Daily
5(33.3)
Twice weekly
2(13.3)
Weekly
8(53.5)

Bins were available for garbage disposal
9(60.0)

DISCUSSION

In other to prevent the occurrence of food-borne diseases, it is necessary to ensure that foods sold to consumers are hygienic and safe for consumption. The microbial load and the presence of pathogenic microorganisms in food will reflect the food hygienic quality and the associated potential health hazards **(Hoque *et al.*, 2015).** Two fungal species were encountered; *Aspergillus fumigatus* and *Penicillum frequentans.* These fungal species are airborne and not part of the food analyzed, but in large numbers can produce poisonous carcinogens like aflatoxins **(Freese *et al.*, 1998; Acho-Chi, 2002; Rizzon and Miele, 2012; Oz *et al.*, 2014)**

All of the sampled foods contain total bacterial counts of 10^5 cfu/g. These foods are therefore considered fit for human consumption **(FAO, 2005).** It was also observed that *Salmonella Shigella* count were very high in all the food samples considering the standard for food which is 0 cfu/g for the *Salmonella Shigella* **(AOAC, 1999; FDA, 2001).** All the tested samples were infected or contaminated with *salmonella* or *shigella* species. The presence of *Salmonella Shigella* in food is an indication of poor handling, transportation, exposure of these food samples after cooking since these organisms are water borne *(Dilbaghi and Sharma, 2007; Cogan et al., 2013).*

Escherichia coli count in the food samples were considered high in relation with standard demands of 0 cfu/g *E. coli* count for quality **(WHO 2002; FDA, 2007; Chang *et al*., 2009).** *Escherichia coli* are the indicator bacteria that suggest either direct or indirect fecal contamination. The presence of *E. coli* might not possess health hazards but when reach an elevated numbers or the presence of certain enteropathogenic or toxigenic *E. coli* strains such as *E. coli* O;157:H7, food borne illness is more likely to occur **(Cabedo *et al*., 2008; Mhone *et al*., 2011).**

Vibrio cholera species is the ethologic agent of cholera disease (which is indicated with Rice and stew-water watery stools). It kills fast in a matter of hours from the inception of the symptoms **(Lando, 2006; FDA, 2007; Vigano *et al,* 2007***)***.** Cholera infection is a serious and dangerous disease in any community because of the speed of circulation even in air. The presence of *Vibrio cholera* species in food is an indication of very recent contamination of samples because the organism does not survive for a long time after separation from the host and is carried by water medium. It is also an indication of contamination after cooking since it responds fast to heating; it has no spores **(Seper *et al,* 2014).** Although the cell counts were low, but standard demands that there should be no *Vibrio cholera* cell in edible food or water because it is enough for one cell to initiate an epidermis infection **(Seper *et al,* 2014).**

Sixteen bacterial species were identified in the food samples. Bacterial species isolated and characterized was in line with taxonomic scheme of **Cowen and Steel (1996)**. The bacterial isolates included the following: *Aerococcus viridans, Cornynebacterium uberis, Escherichia coli, Klebsiella species, Lactobacillus salivarius, Micrococcus luteus, Micrococcus varians , Proteus mirabilis, Pseudomonas pyogenes, Pseudomonas pyogenia, Salmonella paratyphi, Salmonella typhi, Staphylococcus albus, Staphylococcus aureus, Staphylococcus epidermidis, Vibrio cholera* by comparing their morphological and biochemical characteristics with standard reference organisms **(Cheesbrough, 1984).** The findings of this work are in agreement with the work of **Oranusi and Braide (2012).**

Klebsiella species also obtained from this study produce exogenic slimy metabolic by-product which covers the cell and provides protection from chemical attacks. This organism is one of those that cause high drug resistant pneumonia once it gets to the blood stream and lower regions of the lungs.

Micrococcus varians which is a causative agent of tooth decay was found in Rice and stew, porridge beans and ekpangkukwo. The presence of *Micrococcus varians* is an indication of saliva contamination by food handlers and hawkers since it is not a normal flora of the environment **(Penrose *et al*., 2010).** The organism produces cementum at the root of the teeth which produces cementum at the root of the teeth which prevents the organism from chemical attack and heat. It produces an enzyme in the cementum which dissoles the calcium and phosphorus (teeth enamel) and tiny blood capillaries at the root of the teeth thus the teeth will shake with painful inflammation and subsequent removal. If the cementum is not removed in time, it will cause a plague and removal of all the teeth in the mouth **(Vigano *et al*., 2007; Makun *et al*., 2009).**

It was also observed that *Lactobacillus salivarius* was present in rice and stew, porridge beans, ekpankukwo and noodles. The presence of this organism in prepared food is a confirmation of poor food handling by the vendors. *Lactobacillus salivarius* is a normal flora of human gut (mouth), as well as a very recent oral contamination of the food sample.

Staphylococcus aureus was isolated from Rice and stew, porridge beans, moi moi and noodles. *Staphylococcus aureus* is a normal flora of the human body especially the nasal cavity and the ear. *Staphylococcus aureus,* a golden yellow colony on Nutrient Agar is a very serious pathogenic bacterium which is characterized by vomiting and diarrhea. It is gram positive cocci that produce exogenic by products one hour after ingestion of the organism with food **(Kateete *et al*., 2010; Di Ciccio *et al*., 2015).** The exogenic enzyme reacts with the antibodies in the cell wall of the stomach and causes serious contraction of the stomach to bring out its content. If the exogenic enzyme gets into the blood stream, the body will wall off the entire area to arrest the circulation of the bacteria by product which is capable of causing serious shock or stroke. Toxin production strain of *Staphylococcus* is the leading cause of gastro enteritis following handling of food by the person who carries the microorganism in their nose and skin **(Kadariya *et al*., 2014).** These bacteria present in about 60% of a given human population and can also survive on hand knives, chopping board and dish cloths.

Non-pathogenic bacteria isolated from the vended foods included; *Staphylococcus epidermidis, Cornyebacterium uberis, Aerococcus viridians, Staphylococcus albus, Micrococcus luteus.* They are environmental microorganisms that are present in the air or on human body surface. The act as protective organism to the skin thus preventing the skin from aggressive attack by other organisms. Their presence in food shows that the samples were not properly handled **(Christison *et al*., 2008),** *Pseudomonas pyogenes* and *Pseudomonas pyogenia* are always found in the soil. *Pseudomonas pyogenes* is the ethologic agent of gas gangrening and black spotted carbuncles of the skin; the infection has no cure. They were found in Rice and stew, porridge beans, ekpangkukwo and noodles. Other gram negative bacteria such as *Proteus mirabilis* were also isolated. This organism is always present in contaminated meat. It produces a greenish color on the meat 12 h after contamination because the enzyme that turns the meat green is endogenic and can only be released when the cell is dead. This is a character for all gram positive bacteria that produces endotoxins **(Donkor, 2009; Powell, 2010)**. These foods are often prepared by heating but gets cold by the time it is served because the sellers are not able to keep the food at a good holding temperature and therefore ambient temperatures provide a suitable protected from dust, sun and wind; condition for growth of the microorganisms **(Mensah *et al.,* 2002).** The most contaminated food samples were Rice and stew with 12 species and the least contaminated was moi moi samples. This could be attributed to the fact that the samples were put in plates and nylons before cooking, reducing contact of food samples with handlers.

The study revealed that street food trade was conducted by both males (26.7%) and females (73.3%). Generally, the higher proportion of female vendors can be explained by the fact that women are responsible for traditional cooking and child care and generally have lower education and skills levels, which result in their greater involvement in informal sector's such as street food vending. Higher proportions of women vendors may actually be advantageous as female vendors have been reported to provide street floods with higher nutritional quality than male counterparts **(Ohiokpehai, 2003).** This is in agreement with studies in other developing countries including Botswana, Ghana, Brazil, Kenya and Uganda **(Ohiokpehai, 2003; Hanashiro, 2005; Muinde & Kuria, 2005; Muyanja *et al*., 2011).**

There were two major types of vending units involved in this study: the stationary (66.7%) and the mobile. About 26.7% of the vendors cooked food on morning sale, 33.3% cooked food while selling, and 40.0% cooked food on advance consumption. Most of the vendors used the same water to rinse their utensils several times during the day while only 6.67% covered the utensils. The repeated use of the same water may lead to cross contamination from the water to cooked food via the rinsed utensils **(FAO, 2005; Mahale *et al.,* 2008)**. None of

the vendors covered their hai during preparing and serving of food; 40% of them kept long finger nails, 93.3% of them handled money while serving food and 66.7% handle food with bare hands. According to the FAO, the hands are a crucial faxtor in the contamination and spreading of faecal-oral transmitted bacteria; therefore, this risk greatly enhances when food is handled with bare hands **(FAO, 1997**); also money is dirty and may cause contamination of food **(FAO, 1997).** About 53.3% of the stalls were the stalls were protected from dust, sun and wind; only 13.35 were far from rubbish, waste water, toilet facilities, open drains and animals. Dust potentially carries pathogens and therefore may become a vector for their transmission to prepared foods. Similar observations were reported by **Muinde & Kuria (2005)** and **Mensah *et al*, (2002)** in studies conducted on street foods in Nairobi (Kenya) and Accra (Ghana), respectively.

About 60% of the stalls involved had bins for garbage disposal hence the remaining 40% disposed their garbage just near the stalls. According to the FAO, the place of food preparation should be kept clean at all times and should be far from any source of contamination such as rubbish, waste water, dust and animals **(Yassin & Almonuqatea, 2010).** In addition, the vendors disposed of their waste food and water next their stalls. Consequently, this dirty environment attracted flies, which are not only an indication of poor hygiene and sanitary conditions, but they are also vectors of fecal pathogens.

CONCLUSION

From the results obtained, it is observed that the selected vended foods analyzed contain different species of bacteria and fungi which poses health risks to consumers of these foods. However, these risks can be reduced if better sanitary, handling, processing and storage measures are employed as studies have shown that a greater percentage of contamination comes from unhealthy, prolonged exposure to the environment, unhygienic practices as well as handling. In summary, it can be generally concluded that street foods are vended in Uyo Metropolis under unsafe (unhygienic) conditions consisting of the dirty open air environments in which the foods compounded by poor food handling practices and often inadequate storage conditions.

RECOMMENDATIONS

From our research, it has been shown that some vended foods in Uyo metropolis are not microbiologically safe for human consumption as they are capable of causing different types of disease. Therefore, it is recommended that food vendors should be educated through seminars, workshops on the need to prepare foods only in hygienic environment, using sterile as well as adopted improved sanitary handling, processing and storage methods. It is also recommended that proper handling and packaging of foods by food vendors to avoid direct contact with hands etc. which could be sources of contamination. Also the microbiological quality of portable water used by street food vendors should be assessed because water is a potential source of contamination during the preparation, processing and vending of street foods.

Conflict of interest: The authors disclosed that there were no conflicts of interest.

Acknowledgments: We want to express our gratitude to the Technologists in the Department of Food Science and Technology, University of Uyo, Uyo, Nigeria for their efforts, and the food vendors who participated in this study. Thank you all.

REFERENCES

Acho-Chi, C. (2002). The mobile street food service practice in the urban economy of Kumba, Cameroon, Singapore. *Journal of Tropical Geography*, 23 (2), 131-148.

Anibijuwon, I. I. & Sunday, O. J. (2012). Isolation of microorganisms from ready to eat food collected from two selected restaurants in Tanke Oke-Odu, Ilorin. *International Journal of Advanced Biotechnology and Research*, 4, 128-138

AOAC *(*Association of Official Analytical Chemist*)* (1999). *Official Methods of Analysis*. (15th ED.), Washington D.C: USA.

Barnett, H. L. & Hunter, B. B. (1987). *Illustrated genera of imperfect fungi*. Macmillian Publishing Company, New York.

Cabedo, L., Barrot, L. P. & Canelles, A. T. (2008). Prevalence of Listeria monocytogenes and Salmonella in ready-to-eat food in Catalonia, Spain. *Journal of food Protection*. 71(4), 855-859.

Chang, M., Groseclose, S. L., Zaaidi, A. A. & Braden, C. R. (2009). An ecological analysis of sociodemographic factor associated with the incidence of salmonellosis,shigellosis, and E. coli O157:H7 infections in US countries. *Epidemiol Infect*, 137, 810-820.

Chessbrough, M. (1984). *Medical Laboratory Manual for Tropical Countries*. 2nd Ed. ELBS Publication, UK.

Christison, C. A., Lindsay, D. & von Holy, A. (2008). Microbiological survey of ready-to-eat and associated preparation surface in retails delicatessens, Johannesburg, South Africa. *Food Control*, 19, 727-733

Cogan, T. A. & Humphrey, T. J. (2013). The rise and fall of *Salmonella* enteritits in the UK. *Journals of Applied Microbiology*. 94(1), 114-119

Cowan, S. T. & Steel, M. (1996). *Cowan and Steel's Manual for the Identification of Medical Bacteria* (Second Edition). Cambridge university press, London.

Davidson, A. (2008). *The oxford companion for Food. Second Edition*. Oxford University Press, UK.

Department of Business and Professional Regulation (DBPR) (2002). Guiding to preventing contamination from hands. Division of Hotels and Restaurants. Available, http://www.myfloridalicense.com/dbpr/HR/information/document/5030_090.pdf. Accessed 12 October 2019.

Di Ciccio, P., Vergara, A., Festino, A., Paludi , D., Zanardi, E., Ghidini, S. & Lanieri, A., (2015). Biofilm formation by *staphylococcus aureus* on food contact surface: Relationship with temperature and cell surface Hydrophobicity. *Food control*, 50, 930-936.

Dipeolu, A.O, Akinbode, S. O. & Okuneye, P. A. (2007). Income generating potential of street food vending Business in Ogun State, Nigeria, *An International Journal ASSET Series*, 2(1), 180-189.

Donkor, E. S. (2009). Application of the WHO five keys of food safety to improve food handling practice of food vendor in a poor resource community in Ghana. *East African Journal of Public Health*, 6(2), 148-51.

Edem, V. E., Elijah, A. I. & Umoh, S. H. (2017). Microbial quality of *kunun-zaki* sold in Eiyenkorin, Kwara State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment*. 13(2), 112-116.

Ezeronye, O. U. (2007). Cottage food preparation and environment status, a case study with Moi-Moi and Fish, *Nigeria Food Journal*, (20), 1- 3.

FAO (Food and Agriculture Organisation) (1997). Street food: small entrepreneurs, big business. http://www.Fao/NEWS/1997/97/970408-e.htm.].

FAO (Food and Agriculture Organisation) (2005). General Standard for Juices and Nectars; Codex Alimentarius Commission. www.http: codexalimentarius.org/…/standards/…/CXS_247]. Accessed on 10 October, 2019.

FDA (Food and Drugs Administration). (2001). Guidance for Industry: food labeling: safe handling statements, labeling of shell eggs: refrigeration of shell eggs helds for retail distribution: small entity compliances guides. Available at http://www.fda.gov/Food/GuidanceCompliancesRegulatoryInformation/guidanceDocuments/FoodLabelingNutrition/ucn059055.htm. Accessed 12 September, 2019.

Feglo P. & Sakgi, K. (2012). Bacteriological contamination of street vending of food in Kumasi, Ghana. *Journal of Medical and Biomedical Sciences*, 1(1), 1-8.

Food and Drug Administration (FDA). (2007). Recall – Firm Press Release Quong Hop and Co. Expands recall of tofu. Available at http://www.fda.gov/Safety/Recalls/ArchieveRecalls/2007/ucm1 12279.htm. Accessed on 20 August, 2019.

Freese, E., Solomons, M. W. & Gross, R. (1998). The Microbiological safety of typical Guatemala foods from street vendors, low-income homes and hotels. *International Journal of Food Sciences and Nutrition.* 49(1), 27-38.

Gadaga, T. H., Samende, B. K., Musnan, C. & Chibanda, D. (2007). The microbiological quality of informally vended food in Harare, Zimbabwe. *Food Control Journal*, 20, 149-156.

Hanashiro, A., Morita, M., Glavur, R., M., Maria, H. & Elizabeth, A. (2005). Microbiological quality of selected street foods from a restricted area of S~ao Paulo city, Brazil. *Food Control*, 439-444.

Harrigan, W. F. & McCane, M. E. (1976). *Laboratory methods in food and dairy microbiology*. Academic Press, London.

Holt, J. G., Kreig, N. G., Peter, H. A., Sneath, S. T. & Williams, S. T. (2000). *Bergeys Manual of Systematic Bacteriology*, 9th Edition. Lippincott Williams and Wilkins Publisher, Baltimore.

Hoque, A., Khatun, A., Mohammad, A., Masood, T., Khan, A. & Faruquee, H., (2015). Microbiological hazard ananlysis and exposure assessment of street vended mready-to-eat foods in Dhaka City, Bangladesh. *American-Eurasian Journal of Agricultural and Environmental Sciences*, 15(9), 1725 - 1731.

Kadariya, J., Smith, T. & Thapaliya, D. (2014). Staphylococcus arose and staphylococcal food-Bourne Disease: an ongoing Challenge in Public Health. *BioMed Research International*, Pp. 1-9.

Kateete, D., Kimani, C., Katabazi, F., Okeng, A., Okee, M., Nanteza, A., Joloba, M. & Najjuka, F, (2010). Identification of Staphylococcus aureus: DNase and Mannitol salt agar improve the efficiency of the tube coagulase test. *Annals of Clinical Microbiology and Antimicrobials*, 9(1), 23-29.

Lando, A. (2006). Food Handling and Consumption – Population estimate from the 1998-2006 FDA/FSIS food safety survey and 2006 Demographic Analysis. Center for food safety and applied nutrition, US. Food and Drug Administration, College Park, MD, USA.

Mahale, D. P, Khade, R. G, & Vaidya, K. V. (2008). Microbiological analysis of street vended fruit juices from Mumbai city, India. *Internet Journal of Food Safety*, 10, 31-34.

Makun, H. A., Gbodi, T. A., Akanya, O. H., Salako, A. E. & Ogbadu, G. H. (2009). Health implications of toxigenic fungi found in Nigeria Staples: Guinea corn and Rice. *African Journal of Food Science.* 3(9), 250-256.

Mensah, P., Nicholas, S. L. & Mithani, C. L. (2002). Street food in Accra, Ghana: How safe are they? *Bulletin of World Health Organization*, 80(7), 546-554.

Mhone, T., Matope, G. & Saidi, P. (2011). Aerobic bacteria, coliform, *Ecsherichia coli* and *Staphylococcus aureus* counts of raw and processed milk from selected small holder diary firms of Zimbabwe. *International Journal of Food and Microbiology*, 151(2), 223-26.

Monday, I. E., Francis, J. I. & Mohammad, S. U. (2014). Microbiological quality of ready-to-eat foods (Rice and Moi-Moi) sold by food vendors in Federal polytechnic Bali, Taraba State, Nigeria. *Journal of Enviromental Science, Toxicology and Food Technology*, 8(2), 145-149.

Muinde, O. & Kuria, E. (2005). Hygenic and sanitary practice of vendors and street food in Nairobi, Kenya. *African Journal of Food, Agriculture Nutrition Development*, 15(2), 1-14.

Muyanja, C., Nayiga, L., Brenda, N. & Nasinyama, G. (2011). Practice, knowledge and risk factors of street food vendors in Uganda. *Food control*, 1551-1558.

Nester, E. W., Anderson, D. G, Roberts, C. E. R & Nester, N. T. (2004). *Microbiology: A Human perspective*. Fourth Edition. McGraw Hill, USA.

Nkere, C., Ibe, N. & Irogbu, C. (2011). Bacteriological quality of Food and Water sold by Vendors and in Restaurants in Nsukka, Enugu State, Nigeria: A comparative study of Three Microbiological Methods. *Journal of Health, Population and Nutrition*, 29(6), 560-556.

Oranusi, S. & Braide, W. A. (2012). Study of Microbial safety of ready-to-eat food vended on Highways: Onitsha-Owerri, South East Nigeria. *International Research Journal of Microbiology*, 3(2), 66-71.

Oz, V., Karadayi, S., Cakan, H., Karadayi, B. & Cevik, F., (2014). Assessment of microbiological quality of ready to eat food in Istanbul, Turkey. *Journal of Food, Agriculture and Environment*, 12(3), 56-60.

Penrose, K., Castro, M. C. D., Werema, J. & Ryan, E. T. (2010). Informal urban settlement and cholera risks in Dar es salaam, Tanzania. *PLoS Negleted Tropical Diseases, 4(3), 631-635.*

Powell, D. (2010). Safe food from farm. Retrieved from http://www.barfblog.com/tags/powell/page/4/.

Rizzon, L. A. & Miele, A. (2012). Analytical characteristics and discrimination of Brazilian commercial grape juice and nectar and beverages. *Ciencia e Technologia de Alimentos*, 32(1), 93-97.

Seper, A., Pressler, K., Kariisa, A., Haid, A., Roier, S. & Leither, D. R. (2014). Identification of genes includes in vibrio cholera in dynamic biofilm. *International Journal of Medical Microbiology*, 304(5-6), 749-763.

Tambekar, D. H., Jaiswal, V., Dhanorkar, D., Gulhane, P. & Dudhane, M. (2008). Identification of microbiological hazard and safety of ready-to-eat-food vended in Amravati City, *India Journal of Applied Bioscience*, 7, 195-201.

Vigano, A., Pellissier, N., Hamad, H. J., Ame, S. A. & Pontello, M. (2007). Prevalence of *E. coli*, thermotolerant coliforms, *Salmonella* spp. and *Vibrio*. *Annal di Igiene Medicinal ed Comunita*, 19(5), 395-403

World Health Organization (2000). Food borne diseases; A focus for health education. 53rd world health assembly, Geneva.

World Health Organization (2002). WHO Global strategy for food safety: safer food for better health. Food Safety Issues, WHO. Geneva.

Yassin, M. F. & Almouqatea, S. (2010). Assessment of air borne bacteria and fungi in an indoor and outdoor environment. *International Journal of Enviromental Science and Technology*, 7(3), 535-544.