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EVALUATION OF BACTERIOLOGICAL QUALITY AND SAFETY OF FOOD AND WATER SAMPLES SOLD BY VENDORS IN IMO STATE UNIVERSITY, OWERRI, NIGERIA

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ABSTRACT

Food and water are essential human needs, as their quality is of great importance to consumers in general. Given quality control measures during their production and processing, they are often rendered unsafe by microbial pathogens. This study analyzed ready to eat food and water samples obtained from food vendors at Imo State University using standard microbiological techniques. The bacterial isolates were identified based on their cellular morphology, biochemical characteristics and further confirmed using 16S rRNA sequencing. The antibiotic sensitivity pattern of the bacterial isolates was determined by the Kirby-Bauer disk diffusion method. The result showed that total aerobic and coliform count for fried rice and *fufu* was acceptable according to the World health standard for ready to eat food. Of the eight sachet water samples investigated, only Clet and Angel sachet water was contaminated with coliforms levels of 13 CFU/100ml and 16CFU/100ml respectively. Eva bottled water was also contaminated with coliform levels of 12CFU/100ml while source borehole from old law faculty was contaminated with faecal coliform. *Staphylococcus aureus and Pseudomonas sp were the most predominant bacteria isolated from food and water samples, respectively. Isolates* were resistant to various commercial antibiotics used in this study. These results are worthy of consideration as the presence of coliform bacteria, and antibiotic resistance potentially pose health hazards to members of the university community and thus calls for strict monitoring and enforcement of regulations on food safety.

Keywords: Food, water, coliform bacteria, antibiotic -resistant, university, community

INTRODUCTION

Antibiotics resistance is a global health concern, and its spread represents a significant health concern globally ((1, 2). Antibiotic resistance in bacteria is not only a clinical issue but also found in several other environments, including food and water (3). In recent years, interest in the prevalence of antibiotic resistant bacteria in both treated and untreated potable water continues to grow. Another challenge is the presence of antibiotic resistant bacteria in food induced by the use of antibiotics during processing. (4,5) is worrisome because the high numbers of antibiotic resistant bacteria in the population are making it increasingly challenging to treat community-acquired infections (6). Coliform bacteria in drinking water and unhygienic prepared and packaged food constitute health risks, and the presence of antibiotics resistant bacteria pose a serious threat to members of the university community. Unsafe drinking water and food are some of the problems associated with developing countries. The lack of proper production infrastructure, poor implementation of strict quality control measures, poor personal hygiene, especially among food handlers, is responsible for the contamination of food and drinking water. Therefore, this research was conducted to assess the bacteriological quality and safety of food and water sold on the campus of Imo State University Owerri.

MATERIAL AND METHODS

Collection of food and water samples

Samples of ready to eat, jollof rice, fried rice, *abacha*, *ukwa*, *moi-moi*, *okpa*, coleslaw, *egusi* soup, vegetable soup, *okro* soup, *garri*, *fufu*, porridge beans, and pottage yam obtained from bukaterias', canteens' and restaurants within the university were analyzedFifteen water samples comprising packaged bottled water (Triumph, Eva, Mangero and Aquafina bottled water), packaged sachet water (Malyn, Grand, Clet, Angel, Feco, Aqua varum, Reni and Florint aqua sachet water) and drinking water sources obtained from the school library, old law faculty, and new law faculty boreholes were also analyzed. . Borehole samples were collected after swabbing the area around tap with 70% alcohol, and then 100ml volume of water was collected into sterile sample containers. Samples were adequately identified with a name tag and sent to the microbiology laboratory at Imo State University within two hours after collection in a cold box containing ice for analysis except for the water samples

Isolation and Enumeration of Bacteria from food samples

Serial dilutions of each food sample were done using 0.1% peptone water. Aliquots of 0.1ml were pour plated on standard plate count agar (Oxoid, UK) and MacConkey agar (Oxoid, UK). Plates were incubated at 37°C for 24 hours and counted using the colony counter. Only colonies growing on plates containing between two to ten colonies were sampled. Purification of isolates was achieved by streaking on plate count and MacConkey agar plates.

Isolation and enumeration of bacteria from water samples

Each Sachet water was aseptically cut opened in the laboratory with scissors swabbed with ethanol. 100 ml of each water sample was filtered through a 0.45µm sterile membrane (Mo Bio Laboratories, Carlsbad, CA, USA). The membrane filter was placed on already sterile solidified media using a sterile forceps. **(7**). Plate count agar, MacConkey agar, eosin methylene blue agar (Lab M, UK) and Thioglycolate citrate bile salt agar (Oxoid, UK) were used for enumeration of aerobic bacteria, coliform, faecal oliform bacteria and *Vibrio* species.. The plates were incubated aerobically for 24hrs at 37^0C

Phenotypic identification

The isolates were preliminarily identified based on their cell morphology. Biochemical tests such as catalase test, oxidase, motility, citrate utilization, vogues Proskauer, methyl red test, indole test, and carbohydrate utilization were alsodone. Gram-stained smears of the isolates were viewed with a phase-contrast microscope (Olympus, Tokyo, Japan). *Staphylococcus* sp and *Enterococcus* sp were confirmed using API Staph (biomerieux, France) and API 20E ((biomerieux, France), respectively. Other isolates were confirmed by 16rSRNA sequencing.

Table 1 Description of the food samples used in the study

Food Type	Description	Method of preparation
jollof rice	Nigeria's most consumed staple food. 'Jollof' rice is a spicy dish, cooked with tomatoes, onions, pepper and various seasonings. It is usually the meal for occasions in every part of Nigeria.	It is made with tomatoes, peppers, fish/meat, onions and several spices with parboiled long grain rice.
fried rice	A variant of jollof rice often served during ceremonies. It is cooked or steamed rice dish, usually stir-fried with soy sauce, egg beat, chopped meat, and vegetables.	Cooked rice is the primary ingredient, with a variety of additional elements such as vegetables, eggs, meat or fish. For extra flavour, onions, shallots, scallions, and garlic are added and fried with cooking oils. Salt, soy sauce, oyster sauce, and many other sauces and spices are usually added.
abacha	A popular dish made with dried shredded cassava. It is consumed in eastern Nigeria. *Abacha* can be eaten as a snack or as a full meal.	For the preparation of *abacha*, matured cassava tubers are harvested, washed, peeled, rewashedand boiled with water until the tubers become soft. The soft tubers are cut into fine slices and soaked for 24 hours to reduce cassava starch and cyanide hydrogen. It is washed and ready for consumption. It can be preserved for the long term by sun drying for 2-3 days.
ukwa	*ukwa* is an exceptional delicacy consumed in South-eastern Nigeria. The seeds can be cooked alone as porridge, or mixed with corn and sorghum **(8).** It can also be separated from the water so that only the seeds could be added with some ingredients.	Matured fruits are allowed to ripen and fall from the large trees that they grow on to remove the seeds from the fruit. From the pulpy fruit, the seed is extracted using flowing water with sand, sponge, and basket made locally. It is washed manually until the husk's slimness is significantly reduced, and sorted to remove shrivelled and infected seeds. . The resulting wholesome seeds are washed with clean water. The seeds are blenched and drained using a sieve and subsequently dehulled **(9)**
moi moi	'moi moi'is a delicious Nigerian food made from ground beans and a mixture of onions, and fresh ground peppers. It is a popular breakfast meal for many Nigerians and usually served with rice during ceremonies.	The beans are soaked in cold water until they are soft enough to remove the delicate outer covering or peel. They are grounded (using a blender) to obtaina fine paste. Salt, dried crayfish, vegetable oil, and other seasonings are usually added. Sometimes sardines, beef, sliced boiled eggs, fish may be added to make it more delicious.
egusi soup	It is a soup thickened with melon seeds. It is one of Nigeria's most famous soups with considerable variation prepared by most tribes and often eaten with dishes such as pounded yams, *garri* or *fufu*	*egusi* is prepared with melon seeds, water and oil. It also contains leafy vegetables (such as the bitter leaf, pumpkin, celosia, and spinach), palm oil, other vegetables (e.g tomatoes and 'okro') , seasonings, and meat.. Chilli peppers, onions, and locust beans are typical seasonings usually addede. Beef, goat, fish, shrimp or crayfish are also commonly used.
coleslaw	Coleslaw popularly referred to as salad in Nigerian parlance, is made from chopped fresh	Carrot, lettuce, tomatoes, cabbage, cucumber, potatoes, and sweet corn are used. Lettuce is cut into thin shreds while the carrot is

	raw cabbage with a salad dressing. It is usually served with rice during ceremonies.	scraped using a grater. Boiled tomatoes, cabbage, sweet corn, and cooked beans are added. Shells are removed from hard-boiled eggs, slic ed thinly using an egg slicer to set aside. Except for the egg, all ingredients are mixed in a large salad bowl in small batches. The ingredients are usually mixed well in a bowl, refrigerated for an hour and served with any salad dressing of choice.
vegetable soup	This a typical Nigerian soup made using leafy vegetables as primary ingredients. Meat, dried fish, periwinkles, stockfish, vegetable oil, and leafy vegetables are other ingredients	The meat and stockfish are washed and cooked while Leafy vegetables are thoroughly rinsed in cold water and cut into separate bowls Palm oil and pepper is added to the cooking meat on fire. It is cooked for 6-10mins until the water dries up. The grounded crayfish and periwinkles are added and allowed to cook for 5mins. Leafy vegetables (waterleaf) are added, stirred and left to cook for 3 minutes.
porridge beans	A Nigerian meal made from a delicious mix of brown/white beans, onions, pepper, salt, and palm oil. It can be cooked with yam, plantain, potatoes or eaten with bread, pap and *garri*	Beans are washed and placed with water in a clean pot and boiled for 5 minutes. The water is drained and rinsed thoroughly once it boils. It is cooked till tender, occasionally adding more water. Chopped onions, pepper, crayfish, and seasoning are added. Palm oil and salt is added and allowed to cook for 5 minutes. Salt is added to taste. The porridge is turned with a wooden spoon and ready for serving.
pottage yam	A delicious meal prepared with yam, meat, fish, crayfish, pepper, salt and onion.	Yam tuber is washed, peeled and cut into tiny pieces, placed in a pot and covered with water. Onions, ground crayfish, pepper allowed to cook for 15 minutes. The pot is covered, and cooking continues until the yam is soft. Palm oil and salt are added. Leafy vegetable of any choice can be added.
okpa	*okpa* is a special Nigerian delicacy that is very popular with the people of eastern Nigeria. It is preparedfrom Bambara nut (*Vigna subterranean*)	First, the nut is grounded, palm oil is added and mixed thoroughly. The flour is then mixed with water until an excellent consistency devoid of any lump develops. Ground crayfish, cube, onions and other seasonings including pepper, garlic, and salt are added. The mixture can be dispensed into plates or any other containers of choice and cooked for 45min.
fufu	*Fufu is* one of Nigerian's popular staple. it is a fermented cassava product and consumed with varieties of soups	Cassava tubers are harvested, washed, peeled and soaked in water to enable fermentation. After fermentation, the fermented pulp is sieved to remove excess starch. Excess water is drained off, and the resulting *fufu* is cooked and pounded for food.
garri	*garri* is widely consumed with soup in Nigeria and other West African countries as a paste made with hot water. It can also be soaked in water and taken with sugar, fried groundnuts, coconut or banana.	Cassava tubers are washed, peeled and grated. The resulting mash is left to ferment for about three days in porous bags. Fermented gruel is placed into an adjustable press machine to remove excess water. It is allowed to dry, sieved and fried using a large clay pot. Sometimes oil is added to make yellow *garri*. It can be preserved for long periods in an airtight and moisture-proof bags.

Genotypic characterization

Extraction of genomic DNA was done using ZR Soil Microbe DNA MiniPrep extraction kit (Zymo Research Corporation, Irvine, CA, USA) without modifications. The integrity and concentration of extracted DNA were confirmed with 1.5% agarose gel electrophoresis and Nanodrop spectrophotometer (3300) respectively before PCR. However, only four isolates were sequenced.

16S rRNA Sequencing Method

16S rRNA gene PCR amplification and sequencing were performed by Inqaba Biotech, South Africa using the primers 27F and 1492R. The PCR reaction was performed with 20nm of genomic DNA as the template in a 30µl reaction mixture by using OneTaq Quick-Load 2X Master Mix (Biolab, USA) as follows: activation of Taq polymerase at 95°C for 3 minutes, 30 cycles of 95 °C for 1 minute, 50 °C and 68 °C for 1minute each were performed, finishing with a 10-minute step at 68 °C. The Sequencing reaction was done using a PRISM Big Dye Terminator v3.1 Cycle Amplified PCR product was sequenced using ABI Prism 3730xl DNA analyzer (Applied Biosystems, Foster City, CA).

Phylogenetic Analysis

DNA sequence analysis were performed using standard procedures and contiguous sequence reads were obtained using Bioedit software package and subsequently aligned using CLUSTAL (version: 1.2.4). The 16S rRNA gene sequences of bacteria isolated from this study were compared with sequences in the GenBank using the Basic Local Alignment Search Tool (**10**) for nucleotide sequences

Antibiotic Susceptibility Test

Antibiotic susceptibility test of isolates was evaluated using the disc diffusion method of Kirby-Bauer. Eleven commercial antibiotic disks (Abtek, UK) including ofloxacin (10mcg), erythromycin (10mcg), ciprofloxacin (10mcg), augmentin (30mcg), gentamycin (10mcg), ceftazidime (30mcg), nitrofurantoin (10mcg), cefuroxime (30mcg), ceftriaxone (30mcg), cefixime (30mcg) and cloxacillin (30mcg) were used for the susceptibility profile on Mueller Hilton agar (Oxoid, UK). Antibiogram of each isolate was determined by measuring inhibition zones and comparing them to the interpretative chart of the Clinical and Laboratory Standards Institute (**11**). All studies were performed in duplicates, and the average values were taken.

RESULTS AND DISCUSSION

Enumeration of bacteria from food samples

Food contamination by pathogenic microorganisms is a global issue and predisposes humans to vary degrees of health challenges. Food handling is one of the major problems associated with foodborne diseases worldwide, particularly in developed countries with a high prevalence of foodborne diseases **(12).**

In this study, bacterial load was adopted as a measure of the microbial quality of food served to the university community. The result shows that the total aerobic and coliform count for fried rice and *fufu* was acceptable. Total aerobic count for other food products except for fried rice, *garri* and *fufu* were higher than the recommended standard value (Table 2). According to International Commission for Microbiological Specifications for Foods **(13)** and **(14**), ready–to–eat foods between 0 - 10^3 CFU/g is considered acceptable; 10^4 – 10^5 CFU/g is tolerable, and 10^6 CFU/ml and above is unacceptable. Abnormal bacteria count in vended food samples in Nigeria have been previously reported **(12,15,16,17)**. The poor hygienic practices of the vendors, the sanitary condition of the environment and, the quality of the materials used for cooking may be responsible for this high count. Also, the consumption of food samples such as *abacha* and coleslaw without any form of heating to reduce microbial contaminants, may have counted for high bacteria counts associated with the food products. Furthermore, the ingredients added during the preparation of *abacha* such as *ugba*, and vegetables if contaminated also add to the high counts recorded by the food sample. The method of serving customers could also lead to contamination. Generally, humans are the primary agents of food contamination. Hands, fingers, clothing, hair, accessories and other internal factors such as breath, saliva and wound can contribute to contamination (18,19,20)

Also, the level of sanitary conditions of the utensils used in food preparation, packaging materials, the environment, exposure of food to air and personal hygiene of the vendors, may have contributed to the high bacteria counts. According to **(12)** the practice of washing and rinsing plates and cutleries in the same water bowls several times, without changing the water has been found to contribute to high bacteria count. Since most bacteria are carried in aerosols by dust and air, food exposed to air and dust at the point of sale may also lead to an increase in bacterial counts **(21).**

Enumeration of bacteria from water samples

Drinking water samples from Imo State University were also analyzed to determine the safety and quality of the water sources. Amongst the eight sachet water samples investigated, only 'clet' and angel sachet water were contaminated with coliforms levels of 13 CFU/100ml and 16 CFU/100ml, respectively (Table 3). These values are above the WHO permissible maximal level of 10 CFU/100ml of total coliform that is acceptable for human consumption **(22).** The identification of coliforms in sachet water can be attributed to factors including the source of raw water, hygienic practices encountered during processing, and inadequate storage under unhygienic and high-temperature conditions.

Identification of bacteria isolates from food and water samples

Staphylococcus sp and *Enterococcus* sp were confirmed using API Staph (biomerieux, France), and API 20E ((biomerieux, France) respectively. Other isolates were confirmed by 16rSRNA sequencing. Sequence data have been submitted to GenBank under accession numbers: MT250934- MT250937. Enterococcus spp, *Staphylococcus aureus* and *Acinetobacter baumanii* MT250935 were isolated from food samples while *Klebsiella pneumonia* MT250934, *Pseudomonas* sp MT250936, Enterobacter sp MT250937 were isolated from water samples (Table 4). *Staphylococcus aureus* was the most predominant isolate while Acinetobacter baumannii MT250935 was the least isolate from food samples. Since food is an excellent medium for microbial growth, it could be suggested that some of the food samples did not favour the growth of *Acinetobacter* due to the food spices used during the preparation. The isolation of pathogenic bacteria from these food samples is of utmost public health implication as these organisms cause varying degrees of ill health. As a normal flora in the human skin, nasal cavity and throat of healthy individuals, *Staphylococcus aureus* can gain access to the food chain due to poor hygiene of the vendors. *Staphylococcus aureus* can produce a disease-causing toxin if allowed to grow in foods (23). According to (24**)** Staphylococcus aureus is the most predominant agent of foodborne diseases. Enterococcus species which dominates the gastrointestinal tract of warm-blooded animals can cause gastroenteritis, diarrhoea, urinary tract infections, endocarditis, and meningitis. Strains of Acinetobacter

Table 2 Mean bacterial count (CFU/g) of food samples

Food samples	**Total aerobic count**	**Coliform count**
moi-moi	2.0×10^{6}	$1.5x10^{5}$
pottage yam	$4.0x10^{5}$	NG
porridge beans	$3.0x10^{6}$	$1.0x10^{4}$
Jollof rice	$4.0x10^{5}$	NG
a*bacha*	$2.8x10^{7}$	$1.0x10^{5}$
fried rice	$1.2x10^{3}$	NG
okpa	$2.1x10^{6}$	$5.5x10^{4}$
garri	$4.0x10^{4}$	$1.0x10^{2}$
fufu	$1.8x10^{3}$	NG
okro soup	$2.5x10^{6}$	$1.5x10^{5}$
egusi soup	$3.0x10^{6}$	$5.0x10^{4}$
vegetable soup	$1.0x10^{6}$	$4.2x10^{4}$
coleslaw	$2.5x10^{7}$	$5.6x10^{4}$
ukwa	$5.0x10^{5}$	NG

Key:NG = No growth

Table 3: Mean bacterial count (CFU/100 ml) in drinking water samples

Water samples	Total aerobic count	Total coliform	Faecal coliform	Vibro count
Triump bottled water	40	NG	NG	NG
Eva bottled water	60	12	NG	NG
Mangero bottled water	20	NG	NG	NG
Aquafina bottled water	60	NG	NG	NG
Malyn sachet water	40	6	NG	NG
Grand sachet water	50	8	NG	NG
Clet sachet water	52	13	2	NG
Angel sachet water	60	16	NG	NG
Feco sachet water	50	5	NG	NG
Aqua varum sachet water	50	NG	NG	NG
Reni sachet water	40	NG	NG	NG
Florint aquza sachet water	30	NG	NG	NG
Borehole from library	43	7	NG	NG
Borehole from old law faculty	60	2	1	NG
Borehole from new law faculty	3	NG	NG	NG

Key: NG = No growth

such as Acinetobacter baumanii cause bloody diarrhoea and hemolytic uremic syndrome. The isolation of *Enterobacter* sp, *Klebsiella pneumonia* and *Pseudomonas* sp from the water samples agree with the findings of (**25).** (**26)** also isolated *Staphylococcus, Enterobacter*, *Salmonella, Klebsiella* and *Shigella* species, *Escherichia coli, Citrobacter, Pseudomonas, Streptococcus and Micrococcus* species from sachet water. Bottled water is typical of good quality for drinking, but if not adequately protected during bottling and transit, it could be contaminated. The result of the bacteria count of drinking samples shows that Eva bottled water was the only contaminated sample with a total coliform count of 11CFU/100ML **(27-29)** have reported coliform contamination of bottled water in Nigeria. (**30**) also reported similar contamination of bottled water samples in Egypt. This contamination could be due to extended storage of processed bottled water under conditions that support the growth of coliform bacteria (**31).** Poor manufacturing practices, illiteracy and poor hygiene practices of the vendors are other possible reasons for coliform contamination of bottled water (**26**). Result also shows that source borehole water from old law faculty was contaminated. This contamination may have been caused by seepage from the plumbing system. **33-37** reported contamination of borehole water samples from their respective works

Table 4: Percentage Occurence of bacteria isolates from food and water samples

Isolates	Food samples	Drinking water samples	Total **(%)**
Enterococcus sp	14	0	14(20)
Staphylococcus aureus	18	0	18 (25.71)
Acinetobacter baumanii MT250935	4	0	4 (5.71)
Klebsiella pneumonia MT250934	0	9	9 (12.86)
Pseudomonas sp MT250936	0	15	15 (21.43)
Enterobacter sp MT250937	0	10	10 (14.29)
Total			70 (100)

Antibiotic susceptibility pattern of bacterial isolates from food and water samples

Antibiogram result revealed a varying degree of resistance by the bacterial isolates. *Acinetobacter baumanii* MT250935 isolated from food samples showed maximum resistance (100%) against ceftazidime, cefuroxime, and cefixime. *Enterococcus* sp also from food sample showed 100% resistance to cefuroxime and 78.6% *to* ceftazidime. *Klebsiella pnuemoniae* MT250934 isolated from drinking water samples recorded 90% resistance to ceftazidime and 77.8% to Cefuroxime. *Pseudomonas* sp MT250936 showed 86.7% and 73/3% to gentamycin and ofloxacin, respectively (Table 5). **15** and **38** reported high similar antibiotic spectra against enteric pathogens isolated from food samples. Multiple antibiotic resistance of bacteria from ready to eat meat has also been reported **(**1**5,39-40)**

Table 5: Percentage resistance of bacteria isolates from food and water samples

		Isolates					
Antibiotics		1	2	3	4	5	6
CAZ	S (%)	3(21.4)	8(44.4)	0(0)	5(33.3)	6(60)	8(44.4)
	R (%)	11(78.6)	10(55.6)	9(100)	10(66.7)	4(40)	4(100)
CRX	S (%)	0(0)	5(27.8)	2(22.2)	6(40)	5(50)	0(0)
	R (%)	14(100)	13(72.2)	7(77.8)	9(60)	5(50)	4(100)
GEN	S (%)	6(42.9)	9(50)	5(55.6)	13(86.7)	8(80)	0(0)
	R (%)	8(57.1)	9(50)	4(44.4)	2(13.3)	2(20)	4(100)
CXM	S (%)	ND	ND	3(33.3)	8(53.3)	0(0)	0(0)
	R (%)	ND	ND	6(66.7)	7(46.7)	10(100)	4(100)
CTR	S (%)	9(64.3)	9(50)	ND	ND	ND	ND
	R (%)	5(35.7)	9(50)	ND	ND	ND	ND
OFL	S (%)	2(14.3)	6(33.3)	9(100)	11(73.3)	10(100)	0(0)
	R (%)	12(85.7)	12(66.7)	0(0)	4(26.7)	0(0)	4(100)
AUG	S (%)	7(50)	11(61.1)	3(33.3)	6(40)	6(60)	1(25)
	R (%)	7(50)	7(38.9)	6(66.7)	9(60)	4(40)	3(75)
ERY	S (%)	4(28.6)	8(44.4)	ND	ND	ND	ND
	R (%)	10(71.4)	10(55.6)	ND	ND	ND	ND
CXC	S (%)	5(35.7)	6(33.3)	ND	ND	ND	ND
	R (%)	9(64.3)	12(66.7)	ND	ND	ND	ND
CPR	S (%)	ND	ND	9(100)	10(66.7)	8(80)	0(0)
	R (%)	ND	ND	0(0)	5(33.3)	2(20)	4(100)
NIT	S (%)	ND	ND	5(55.6)	4(26.7)	10(100)	0(0)
	R (%)	ND	ND	4(44.4)	11(73.3)	0(0)	4(100)

Key: 1 = *Enterococcus* species, 2 = *Staphylococcus aureus*, 3 = *Klebsiella pneumoniae*, 4 = *Pseudomonas aeruginosa*, 5 = *Enterobacter aerogenes*, 6 = *Acinetobacter baumanii*

S = Number sensitive, R = Number resistant, ND = Not detected CAZ = Ceftazidine, CRX= Cefuroxime, GEN = Gentamycin, CXM = Cefixime, CTR=ceftriaxone OFL = Ofloxacin, AUG = Augmentin, ERY = Erythromycin, CXC= Cloxacillin, CPR = Ciprofloxacin, NIT = Nitrofurantion.

41 reported multiple resistance from *pseudomonas* sp isolated from drinking water samples in New Dehli. **42** reported 100% resistance to Ampicillin and Cloxacillin from *Escherichia coli*, *Pseudomonas sp*, *Klebsiella* sp, and *Enterococcus* sp isolated from drinking water sources in Akungba Akoko, Nigeria. *Staphylococcus spp, Streptococcus sp, Klebsiella sp, Pseudomonas sp and Salmonella sp* isolated from different drinking water samples in Afikpo, Sotheastern Nigeria was found to be completely resistant to cephalothin, tetracycline, penicillin G, oxytetracycline, cefotaxim and cefuroxime **(37).** Resistance of isolates to various antibiotics observed in this study may be due in part to multiple factors such as excessive use of antibiotics and mechanisms of drug resistance

exhibited by the bacterial isolates. Other factors such as enzyme inactivation, removal of the efflux pump and alteration of target receptors may also play a part in bacteria resistance **(43)**

CONCLUSION

This study reports for the first time, bacteria contamination in both food and drinking water sold within the campus of Imo State University Owerri, as indicated by high aerobic and coliform bacteria counts. This contamination represents a significant potential health risk. The study also revealed a high spectrum of resistance by the isolated pathogens to commonly prescribed antibiotics. Therefore, we recommend that the management of the University take appropriate measures in educating and training food operators in the campus on adequate food production and processing techniques to prevent contamination and transmission of foodborne disease. The study also recommends the surveillance of antimicrobial resistance on foodborne pathogens on the university campus.

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Conflict of interest
The authors declare that there is no conflict of interest.
Data availability
Bacteria Sequence data generated from this study have been deposited to GenBank under accession MT250934-MT250937.

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