

Bacteriological Assessment of River Lavun, Bida Niger State, Nigeria

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ABSTRACT

The bacteriological quality of water from River Lavun (lower part of River Kaduna), used by the populace of Bida and environ for domestic activities, irrigation and source of aquatic food was investigated. Water samples were collected from three different points along the river for six months. Using standard methods, heterotrophic plate count (HPC), faecal coliform count (FCC) and faecal streptococci counts (FSC) were determined while identification of specific contaminant were done using rapid test kits. Heterotrophic counts ranged from 1.7×10^4 to 8.9×10^4 (cfu/ml). Faecal coliform counts ranged from 2.4×10^2 to 6.8×10^3 (cfu/ml) with relatively lower faecal streptococci counts (8.6×10 to 3.4×10^2 cfu/ml). These counts varied depending on the period, with highest values at the peak of rainy season (September). Forty seven (47) isolates belonging to fifteen bacterial species were identified in the water. Members of the Enterobacteriaceae (91.5%) constituted major contaminants population with *Klebsiella* spp. (46.5%), *Enterobacter* spp (18.6%), *E. coli* (11.6%), *Citrobacter* spp. (9.3%), *Salmonella* spp., *Serratia* spp. (4.7% each), *Shigella* spp. (2.3%), and *Yersinia* spp. (2.3%). Staphylococci species constituted (8.5%) only. Antibigram carried out using disc diffusion technique showed multiple antibiotic resistances among the Enterobacteriaceae of bacterial contaminants but were however susceptible to ciprofloxacin, nitrofurantoin and gentamicin. Staphylococci spp. were generally susceptible to virtually all the antibiotics tested.

Keywords: Bacteriological, Water, River Lavun, Antibigram, Resistance, Heterotrophic.

INTRODUCTION

Water is essential to life, and a satisfactory (adequate, safe and accessible) supply must be available to all WHO¹. The importance of water to man is aptly summarized in the words of Kofi Annan who said: "Access to safe water is a fundamental human need and, therefore,

a basic human right. Contaminated water jeopardizes both the physical and social health of people. It is an affront to human dignity" WHO².

One of the most abundant and readily available source of fresh water to man is River. It is the most important freshwater

source for man. Unfortunately, river waters are polluted by indiscriminate disposal of sewage, untreated industrial waste and plethora of human activities, which affect their physicochemical characteristics and microbiological qualities Koshy and Nayar³. Owing to the large quantity of effluents discharged into receiving rivers, the natural processes of pathogen reduction are inadequate for protection of public health. In addition, industrial wastes that alter the water pH and provide excessive bacterial nutrients often compromise the ability of natural processes to inactivate and destroy pathogens Gerardi and Zimmerman⁴.

Contamination of water is a serious environmental problem as it adversely affects human health and biodiversity in the aquatic ecosystem. The use of indicator bacteria such as faecal coliforms (FC) and faecal streptococci (FS) for assessment of faecal pollution and possible water quality deterioration in fresh water sources is generally recommended APHA⁵.

Currently, coliforms and *E. coli* are of great importance among bacterial indicators used in water quality and health risk definition WHO¹. Pathogens are a serious concern for managers of water resources, because excessive amounts of faecal bacteria in sewage and urban run-offs have been known to indicate risk of pathogen-induced illnesses in humans Adeyinka, John and Akintayo⁶.

River Lavun is the major source of drinking water in Bida and its environs in Niger State. The major occupation of the people around the river is farming. Run-off of fertilizers, pesticides, herbicides and other organic and inorganic materials from agricultural land eventually end up in the river. Other human activities

around the river include fishing, washing, transportation, irrigation and mining. These activities, invariably will impact on the microbiological quality of the river, with attendant health implications on the populace.

It was reported by Akubuenyi, Uttah and Enyi-Idoh⁷ that Bahini River water, India had high total viable count and polluted with pathogenic bacteria. Similarly, drinking water sources of Calabar metropolis, Nigeria has been reported to have high heterotrophic bacteria count and contaminated with disease causing bacteria [8]. This study was undertaken to assess the bacteriological quality of this part of the river, since such information was non-existing before now. Data on the microbiological quality of water from this river will provide information for proper measures for the prevention of disease outbreaks that may occur and institution of management and control measures.

Study Area

The lower part of River Kaduna called River Lavun (also known as River Wuya) passes through Wuya Kpata, near Bida, Lavun Local Government Area of Niger State, North Central Nigeria. It flows into River Niger at Muregi near Pategi in Kwara State, Nigeria. River Lavun forms the eastern border of Lavun Local Government Area. The coordinates of the River Lavun at Wuya Kpata is 9°08'21"N 5°49'57"E.

Fig. 1 shows the schematic diagram of the study area of River Lavun. Samples were collected at three points designated A, B and C. Point A is about 400m before the settlement, Wuya Kpata, and Point C is about 400m after the settlement while Point B is beside the settlement.

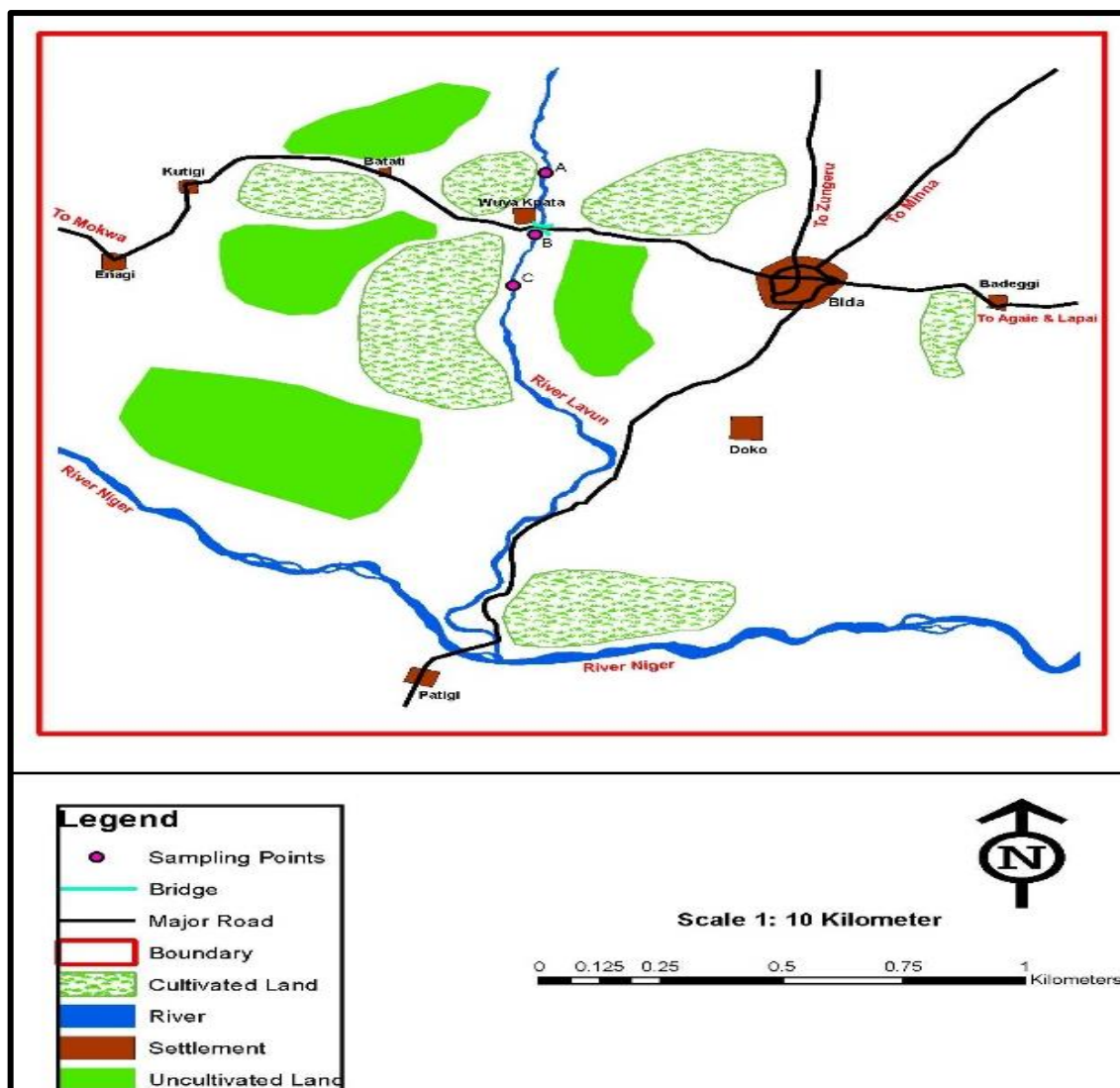


Fig. 1: Map of study area showing sampling points on River Lavun.

MATERIALS AND METHODS

Water sample for Microbiological Analysis

Water samples for microbiological analysis were collected in a sterile amber coloured glass bottle. At each sampling point, the bottle was opened and immediately immersed in the river to a depth of about 30 cm with its mouth facing the water current, filled to three quarters its capacity and quickly stoppered to avoid contamination. The water was then transported on ice to

laboratory. Bacteriological analyses of the samples commenced within three hours of collection of samples. This procedure was repeated for each sample. Samples were collected monthly from April to September, 2014.

Heterotrophic (Standard) Plate Count

Heterotrophic plate count was carried out using the pour-plate method as described by APHA⁹. Ten-fold serial dilutions of the water samples was prepared in sterile water. The 10^{-3} dilution was used. From this, 1 ml

sample was aseptically transferred into labelled sterile Petri-dishes. Aliquots of 15 ml sterile molten Plate Count Agar was then poured into the plates and properly mixed to ensure effective even distribution of the water sample in the agar medium. For each samples, three plates were used and incubated at 37°C for 48 hours. The number of colony forming units were counted and the values multiplied by the dilution factor to obtain the actual microbial levels.

Determination of Faecal Coliform Count

Ten-fold serial dilution of the water sample was prepared in sterile distilled water. The 10^{-2} dilution was used. From this, 1 ml of sample was aseptically transferred to the centre of a prepared Eosine Methylene Blue (E.M.B) agar. Using a sterile rod the water dropped was spread evenly on the agar surface. This was duplicated and the plates were incubated at 44.5°C for 24 hours. Lactose fermenting colonies formed were counted as faecal coliform in cfu/ml and the value multiplied by the dilution factor to get the actual level of the bacteria in each of the water samples collected.

Faecal Streptococci Count

Azide dextrose broth was employed. One in ten dilutions of the samples were made. From these dilutions, 1 ml was aseptically transferred to 9 ml aliquots of sterile Azide dextrose broth and incubated at 37°C. It was examined for turbidity after 24 and 48 hours of incubation. Tube showing growth (turbid) was confirmed by spreading 1.0 ml on Aesculin-azide agar and incubated at 37°C for 24 hours, brownish-black colonies with brown halo indicated the presence of faecal streptococci. This was

confirmed by a negative reaction to catalase test.

The number of colony forming units were counted and the values were multiplied by the dilution factor to calculate the actual microbial levels.

Isolation and Identification of selected Bacteria

One millilitre (1 ml) of water sample was mixed with 9.0 ml of peptone water as pre-enrichment and incubated at 37°C for 24 hours. The 24 hours culture was then streaked on to several selective media: MacConkey Agar, Salmonella-Shigella Agar, E.M.B Agar and Mannitol Salt Agar.

Biochemical Tests

The following general biochemical tests were carried out according to the methods described by Cheesbrough¹⁰.

a. Catalase test

This test was carried out to differentiate between a catalase enzyme-producing bacterium such as *Staphylococcus* and non-catalase enzyme producing bacteria such as *Streptococcus*.

Two (2 ml) of 3% hydrogen peroxide solution was measured and transferred into test tube. Using a sterile glass rod, several colonies of the test organisms were removed and immersed in the hydrogen peroxide solution. Immediate bubbling in the tube shows a positive catalase test.

b. Coagulase test

This test was used to differentiate coagulase-producing *Staphylococcus* from the non-producing ones. A drop of distilled water was placed on each end of a clean slide. Colonies of the test organisms were emulsified in each of the drops to make two thick suspensions. A loopful fresh human plasma was added to one of the suspension, and mixed gently.

Clumping of the organisms within 10 minutes indicates a positive coagulase test.

c. Oxidase test

Oxidase test strip (Oxoid, England) was used. This test was used to differentiate between oxidase-positive and oxidase-negative bacteria. Several colonies of the test organisms were robbed on the strip using sterile glass rod. Formation of purple colouration within 5 seconds indicates a positive oxidase test.

Identification of the Oxidase-Negative Enterobacteriaceae Family using Microbact GNB 12E

The Microbact GNB 12E test strip is an identification system for Enterobacteriaceae that are oxidase-negative, nitrate-positive and glucose-fermenting Gram Negative Bacilli (GNB). It uses the ability of the isolates to ferment 12 sugars. The sugars included Inositol, Sorbitol, Rhamnose, Sucrose, Lactose, Arabinose, Adonitol, Raffinose, Glucose, Maltose, Dulcitol and Xylose. Organism identification is based on pH change and substrate utilization.

Using oxidase negative organism, 1 to 2 colonies were picked and emulsified in 3 ml of sterile saline solution. This was mixed thoroughly to prepare homogenous suspension. Sterile micropipette was used to take 100 µl of the bacteria suspension to fill each well. Wells 1, 2 and 3 were overlaid with 2 drops of sterile mineral oil and plate was then incubated at 37°C for 24 hours.

At the end of the incubation period, two drops of Kovac's reagent, one drop each of VP1 and VP11 and one drop of TDA were added to wells 8, 10 and 12 respectively before taking the readings. Colour changes of all the wells were compared with the standard colour chart provided by the manufacturer and

number grade assigned to each well. Four digit coding of the sum of the positive results was then imputed into the Microbact Computer Aided Identification Package which interpreted the results by identifying the likely organisms with percentage share of the probability.

Identification of Staphylococci species using Microbact Staphylococcal 12S

This is based upon conventional identification system using a combination of sugar utilization and colorimetric enzyme detection substrate. Microbact Staphylococcal 12S can identify both coagulase- positive and coagulase-negative organisms. It is used in the identification of Gram-positive cocci, non-motile, non-spore forming, and catalase-positive facultative anaerobes. It has 12 tests. The organism identification is based on pH change and substrate utilization. Using the 24 hour pure culture of the organism to be identified, 2- 5 colonies were picked and emulsified in 3 ml of *Staphylococcus* suspending medium. This was mixed thoroughly to prepare homogenous suspension and sterile micropipette was used to transfer 100 µl of the bacterial suspension to fill each well. The well no 7 was overlaid with 2 drops of mineral oil. It was then incubated at 37°C for 24 hours.

After the incubation 1 drop of Fast Blue reagent was added to well No.12 and the colour changes of all the wells were converted to numerical code which were then entered into Microbact Computer Aided Identification Package software for identification.

Antibiotic Susceptibility Testing

Standardized culture of the same turbidity with 0.5 MacFarland was streaked on to the surface of dried

Mueller-Hinton agar in such a way as to ensure an even spread with sterile non-toxic cotton swab. The antibiotic discs under test were placed firmly on the surface of the agar using sterile forceps. The plates were allowed to stand for an hour to enable the antibiotics to diffuse into the agar. The plates were then incubated at 37°C for 18 hours. After the incubation, the plates were examined for the zones of inhibition, which were measured in millimeter using metric ruler.

The result was interpreted using the interpretation criteria published by European Committee on Antimicrobial Susceptibility Testing, EUCAST¹¹. The isolates were reported as sensitive (S), intermediate (I) and resistant (R) to the various antibiotics depending on the sizes of the zones of inhibition.

The multiple antibiotic resistance (MAR) index was computed as the number of antibiotic(s) to which the organism is resistant divided by the total number of antibiotics tested Krumperman¹² and Paul *et al.*¹³.

Bacteriological Analysis of River Lavun Water Samples

Heterotrophic plate count (HPC), faecal coliform count (FCC) and faecal streptococci count (FSC) of the water samples are presented in Tab. 1, 2 and 3. In April which is the beginning of rainy season, HPC was 4.23, 4.38 and 4.48 at point A, B and C respectively. FSC at these points were lower than the HPC but more than FCC. HPC was higher at point C compared to FCC and FSC that were highest for the month at point A. However in September, these values are considerably higher. HPC was $1.7 \pm 0.3 \times 10^4$, $2.4 \pm 0.5 \times 10^4$ and $3.0 \pm 0.2 \times 10^4$ at point A, B and C respectively.

A comparison of the HPC, FCC and FSC at the different points in April and September showed that though there were slight increases or decreases, the differences were not really statistically significant at $p=0.05$. The values of the three indices increased with increasing rainfall, with highest values in September. This trend was irrespective of the sampling points. The faecal coliform and faecal streptococci values showed substantial increase by as much as 80% from the month of April to September, 2014.

RESULTS

Table 1: Heterotrophic (Standard) Plate Count (cfu/ml) of River Lavun

Month	Points		
	A	B	C
April	$1.7 \pm 0.3 \times 10^4$	$2.4 \pm 0.5 \times 10^4$	$3.0 \pm 0.2 \times 10^4$
May	$5.0 \pm 1.1 \times 10^4$	$8.0 \pm 0.7 \times 10^4$	$9.0 \pm 0.3 \times 10^4$
June	$7.0 \pm 1.2 \times 10^4$	$9.6 \pm 1.5 \times 10^4$	$9.8 \pm 1.8 \times 10^4$
July	$2.6 \pm 0.3 \times 10^4$	$3.0 \pm 0.1 \times 10^5$	$3.5 \pm 0.8 \times 10^5$
August	$1.6 \pm 0.3 \times 10^5$	$4.6 \pm 0.7 \times 10^5$	$5.2 \pm 0.5 \times 10^5$
September	$4.4 \pm 1.4 \times 10^5$	$6.1 \pm 0.3 \times 10^5$	$8.9 \pm 0.8 \times 10^5$

Table 2: Faecal Coliform Count (cfu/ml) of River Lavun

Month	Points		
	A	B	C
April	$4.2 \pm 0.2 \times 10^2$	$3.6 \pm 0.7 \times 10^2$	$2.7 \pm 0.5 \times 10^2$
May	$2.4 \pm 0.7 \times 10^2$	$5.6 \pm 0.2 \times 10^2$	$7.1 \pm 0.5 \times 10^2$
June	$5.2 \pm 0.3 \times 10^2$	$4.6 \pm 0.1 \times 10^3$	$7.8 \pm 0.3 \times 10^2$
July	$2.5 \pm 0.5 \times 10^3$	$4.7 \pm 0.6 \times 10^3$	$3.0 \pm 0.1 \times 10^3$
August	$3.3 \pm 0.2 \times 10^3$	$5.0 \pm 0.5 \times 10^3$	$4.8 \pm 0.4 \times 10^3$
September	$4.6 \pm 0.3 \times 10^3$	$7.0 \pm 0.7 \times 10^3$	$6.8 \pm 0.4 \times 10^3$

Table 3: Faecal Streptococci Count Plate (cfu/ml) of River Lavun

Month	Points		
	A	B	C
April	$8.6 \pm 0.1 \times 10^1$	$5.1 \pm 0.3 \times 10^1$	$3.7 \pm 0.2 \times 10^1$
May	$8.9 \pm 0.4 \times 10^1$	$7.7 \pm 1.1 \times 10^1$	$7.9 \pm 0.8 \times 10^1$
June	$9.3 \pm 0.6 \times 10^1$	$7.4 \pm 0.1 \times 10^1$	$8.6 \pm 0.1 \times 10^1$
July	$1.7 \pm 1.2 \times 10^2$	$1.5 \pm 0.7 \times 10^2$	$1.3 \pm 1.1 \times 10^2$
August	$2.1 \pm 1.1 \times 10^2$	$1.6 \pm 0.8 \times 10^2$	$1.9 \pm 1.2 \times 10^2$
September	$5.7 \pm 1.9 \times 10^2$	$2.5 \pm 1.6 \times 10^2$	$3.4 \pm 0.7 \times 10^2$

Distribution of Isolates in Water

Forty seven (47) isolates belonging to fifteen bacterial species (Table 4) were identified in the water samples and mostly belong to eight genera in the Enterobacteriaceae Family. Of these Enterobacteriaceae, *Klebsiella* spp constituted the most (42.5 %), followed

by *Enterobacter* spp (17.0 %) and *E. coli* (10.6%). Other less frequently isolated Enterobacteriaceae organisms belonged to *Shigella*, *Salmonella*, *Citrobacter*, *Serratia* and *Yersinia* spp. *Staphylococci* spp which constituted 8.5 % were the only Gram positive bacteria isolated and identified.

Table 4: Distribution of bacteria Isolates from water samples collected from River Lavun

Organism	Frequency (n)	Percentage (%)
<i>Enterobacter gergoviae</i>	5	10.6
<i>Enterobacter cloacae</i>	2	4.3
<i>Enterobacter agglomerans</i>	1	2.1
<i>Serratia marcescens</i>	2	4.3
<i>Citrobacter freundii</i>	3	6.4
<i>Citrobacter diversus</i>	1	2.1
<i>Klebsiella pneumoniae</i>	19	40.4
<i>Klebsiella oxytoca</i>	1	2.1
<i>Escherichia coli</i>	5	10.6
<i>Salmonella</i> sp	2	4.3
<i>Shigella sonnei</i>	1	2.1
<i>Yersinia enterocolitica</i>	1	2.1
<i>Staphylococcus aureus</i>	2	4.3
<i>Staphylococcus saprophyticus</i>	1	2.1
<i>Staphylococcus simulans</i>	1	2.1
Total	47	10

Antibiotic Susceptibility Profiles of the Isolates

The results of the antibiotic susceptibility tests of the isolates are presented in Tables 5. The susceptibility profiles of the Enterobacteriaceae isolates show that majority of the organisms were susceptible to the inhibitory activities of gentamicin, nitrofurantoin, ciprofloxacin, chloramphenicol and co-trimoxazole. Except with erythromycin, *Citrobacter* spp. were susceptible to all the antibiotics tested. Resistance to the Tetracyclines, Erythromycin and penicillins (ampicillin and amoxicillin-clavulanate) was relatively high

especially with *Enterobacter*, *Salmonella* and *Serratia* isolates, while moderate resistance was exhibited by the isolates against cefuroxime (a cephalosporin) and co-trimoxazole.

Klebsiella spp from water samples were found to be highly resistant to Ampicillin, amoxicillin-clavulanate, tetracycline, erythromycin and cefuroxime but susceptible to inhibitory action of nitrofurantoin, gentamicin, ciprofloxacin, co-trimoxazole and chloramphenicol. The isolated *Staphylococcus* spp. were generally susceptible to most of the antibiotics tested.

Table 5: Antibiotic Resistance Profiles of selected Enterobacteriaceae Bacteria Isolated from River Lavun.

Antibiotics	Percentage Resistant (%)						
	Entr. sp (n=8)	Citr. sp (n=4)	Serr. sp (n=2)	Kleb. sp (n=20)	E. coli (n=5)	Salm. sp (n=2)	Staph. sp (n=4)
Ampicill	75.00	25.00	100.00	90.00	60.00	50.00	0.00
Amox./Clav	75.00	25.00	100.00	65.00	0.00	50.00	0.00
Nitrofurantoin	0.00	0.00	0.00	5.00	0.00	0.00	25.00
Gentamicin	25.00	0.00	50.00	15.00	0.00	0.00	25.00
Ciprofloxacin	0.00	0.00	0.00	20.00	0.00	0.00	0.00
Tetracyclin	75.00	25.00	100.00	75.00	80.00	50.00	0.00
Erythromycin	87.50	50.00	100.00	90.00	80.00	100.00	0.00
SMZ/TMP	0.00	25.00	0.00	30.00	60.00	50.00	0.00
Cefuroxime	50.00	25.00	100.00	60.00	0.00	50.00	0.00
Chloramphenicol	0.00	25.00	0.00	5.00	20.00	50.00	0.00

Amox. / Clav. : Amoxicillin / Clavulanic acid combination

SMZ/TMP: Sulphamethoxazole trimethoprim combination

Entr. = *Enterobacter* Citr. = *Citrobacter* Serr. = *Serratia*,

Kleb. = *Klebsiella* Salm. = *Salmonella*

Determination of MAR Index

MAR indices presented in Table 6 shows that most of the isolates are resistant to several drugs, and also resistant to two or more classes of the antibiotics tested. The

highest MAR index of 0.7 were observed with *Klebsiella* spp. In contrast, none of the *Staphylococci* isolates is multiple drug resistant.

Table 6: MARI of bacteria isolates from water and fish samples collected from River Lavun.

MARI	No. of organisms with MARI value							
	Entr. sp. (n=8)	Citr. sp. (n=4)	Serr. sp. (n=2)	Kleb. sp. (n=20)	E.coli. sp.(n=5)	Salm. sp.(n=2)	Staph. sp. (n=4)	Percentage Ratio
0.0	0	0	0	1	1	0	3	11.11
0.1	2	2	0	1	0	0	0	11.11
0.2	0	0	0	2	1	1	1	11.11
0.3	2	0	0	4	1	0	0	15.56
0.4	3	2	1	4	1	0	0	24.44
0.5	0	0	0	0	0	0	0	0.00
0.6	1	0	1	3	1	1	0	15.56
0.7	0	0	0	5	0	0	0	11.11

MARI: Multiple Antibiotic Resistance Index

Entr. = *Enterobacter*

Citr. = *Citrobacter*

Serr. = *Serratia*

Kleb. = *Klebsiella*

Salm. = *Salmonella*

Shig. = *Shigella*

Staph. = *Staphylococcus*

DISCUSSION

Rivers are natural sources of water which usually have their qualities altered through anthropogenic activities (such as farming, fishing, transportation and recreation) on or around, or due to agricultural land runoffs, industrial effluents and municipal waste water discharges.

The microbiological data obtained from this study clearly showed high heterotrophic, faecal coliform and faecal streptococci counts in the river. The lower counts in the early part of the rainy season was expected due to the fact that as rainfall becomes heavy and frequent, more pollutants (municipal, agricultural land runoff and stagnant ponds) find their way into the river

through drainage and flooding. This trend has also been reported by Agbabiaka and Olayiwola¹⁴. Similarly, Oyeleke and Istifanus¹⁵ had also observed that rainy months recorded the highest counts of pollutants in the various sampling points on river Kaduna. The heterotrophic and coliform levels obtained in this study are in agreement with the findings of Tytler¹⁶, Olatunji *et al.*¹⁷ and Neils *et al.*¹⁸. The relatively high counts of heterotrophic and faecal coliform obtained at point B might be due to additional contamination arising from washing, bathing, and swimming activities being carried out by the populace near this point. This is in agreement with the reports of Ibiene *et al.*¹⁹ and Gensberger *et al.*²⁰ who reported high heterotrophic counts of the river waters studied.

The FC/FS ratio obtained in this study was much above 4.0, an indication of human pollution. Also, APHA⁹ reported that FC/FS ratio greater than 4.0 implies contamination arising mostly from human activity while values less than 1.5 indicate contamination from non-human sources such as domestic animals. The populace around this river lack modern toilets and as such excrete on the land directly which are often washed into the river. These results are in agreement with those of Khalid, Khadhum and Seba²¹ on Tigris River, Baghdad Province.

Distribution of isolates in this study which showed that members of Enterobacteriaceae constituted 91.5% of the total bacteria, the rest being staphylococci, is in agreement with that of Tytler¹⁶ who reported 62.4% of Enterobacteriaceae and 19.1% of *Staphylococcus*. This high prevalence of Enterobacteriaceae is also in line with the work of Gensberger *et al.*²⁰ and Olaniyan *et al.*²².

A study of the isolates indicated that a high proportion of them are pathogenic. Similar findings were reported by Oyeleke and Istifanus¹⁵; Raji and Ibrahim²³ on their works on River Kaduna and drinking water respectively.

Commonly used antibiotics such as ampicillin, tetracycline, and erythromycin are relatively ineffective others such as quinolones, chloramphenicol and nitrofurantoin are effective alternatives.

Salmonella and *Klebsiella* spp. from water samples were resistant to 70% of the antibiotics tested followed by *Serratia* and *Enterobacter* spp. which were resistant to 60% and 50% by *E. coli*. Raji and Ibrahim²³ reported higher resistant values in a study carried out on River Niger, North Central Nigeria: *Escherichia coli* isolates were resistant to 80% of the test antibiotics.

Most Enterobacteriaceae isolates from the water samples are multiple antibiotic resistant, MAR. Unfortunately, 68.1% of the isolates had MAR index to be 0.3 and above, implying that the study area is associated as potential source of infectious outbreak. The highest MAR index of 0.7 was seen with the *Klebsiella* isolates, a worrying development as *Klebsiella* isolates is a well-known pathogen. Effective management of infection that may arise from this organism is thus a problem.

These findings are also in agreement with those reported by Tytler¹⁶ on River Kaduna, Northern Nigeria which reported that 58.6% of the Enterobacteriaceae isolates were MAR.

Contaminated drinking water and food are major sources of enteric pathogens, causing several waterborne disease outbreaks. Consumption of the water with presence of antibiotic-resistant bacteria is a major public health concern as antibiotic-resistant bacteria could be transferred to humans,

contributing to the spread and persistence of antibiotic-resistant bacteria in environments Olayiwola and Adedokun²⁵. Presence of multiple antibiotic resistant enteric bacteria isolates from aquatic environment has also been reported by Mervat *et al.*²⁶, who investigated antimicrobial resistance profiles of Enterobacteriaceae isolated from Rosetta Branch of River Nile, Egypt.

CONCLUSION

River Lavun is microbiologically polluted and therefore unsafe for drinking without adequate treatment.

A high number of the isolates particularly the Enterobacteriaceae were multiple drug resistant with attendant health implication. Commonly used antibiotics such as ampicillin, tetracycline, and erythromycin are relatively ineffective others such as quinolones, chloramphenicol and nitrofurantoin are effective alternatives.

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