Microbial Evaluation and Prevalence of Antibiotic Resistant Isolates in Asa River, Nigeria.

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Abstract

The physico-chemical, microbial qualities and antibiotic resistance pattern of isolated bacteria from different strata of Asa River were evaluated using standard laboratory procedures. The distribution of the bacterial isolates in the water and sediment samples was also presented and Pseudomonas species was the most common bacterial isolate with an occurrence of 53.85 %, followed by Proteus species and Bacillus species with occurrences of 19.23 % each and Flavobacterium species with the least occurrence of 7.69 %. There were various resistance patterns of the isolates to different antibiotics with twenty six (26) isolates showing 100% resistance to Augmetin which was the highest. 25 isolates showed 96.15 % resistance to Amoxicillin and Ceftriazone, 92.31 % resistance to Cotrimoxazole by 24 isolates, 20 isolates showed 76.92 % resistant to Streptomycin, 19 isolates were 73.07 % resistant to Nitrofurantoin, 9 isolates showed 34.61 % resistant to Gentamycin, 8 isolates showed 77 % resistant to Pefloxacin, 7 isolates showed 26. 92 % resistant to Ciprofloxacin and the least 5 isolates showed 19.23 % resistance to Ofloxacin. The commonest resistant patterns were Amoxicillin, Augmentin and Ciprofloxacin (AMX, AUG, CPX). This call for serious concern and attention of both public health and research communities.

Keywords: *Asa River, sediment sample, microbes, anti-biotic.*

Introduction

Considerable concern has been expressed over the prevalence of multiple antibiotic resistant (MAR) bacteria in drinking water sources. The indiscriminate use and subsequent release of residual antibiotics in wastewater is considered an important factor for the emergence, selection and dissemination of antimicrobial resistant bacteria. Microbial resistance to antibiotics and metal ions is a potential health hazard since these traits are generally associated with transmissible plasmids (Tripathi et al., 2011). Several research works have been carried out worldwide to analyze how safe the different water bodies actually are for human consumption and for general usage (Aremu et al., 2011; Duru et al., 2012; Irfan and Shakil, 2012). Akinpelu et al., (2014) analyzed Obere River, Nigeria and detected the presence of pathogenic bacteria especially multiple resistant bacteria. Olayemi et al (2003); Adewoye and Lateef (2004) reported a high bacteria count in Asa River and its tributaries and a strong correlation with the increased degrees of abuse at downstream with mean total and faecal coliform counts ranging from 1.6 x 104 to 1.9 x 107 MPN index 100 ml-1 were recorded.

A study by Tewari et al., (2013) revealed that metal tolerance and antibiotic resistance traits are conjugative plasmid borne, as they could be transferred to sensitive strains through conjugation process. The source of water contamination plays significant role in determining the extent of antimicrobial resistance as contaminating bacteria could come from domestic, wild animals' or human sewage (Sayah et al. 2005). Aremu et al., (2011) presented levels of physicochemical and microbiological parameters in water samples collected from Rivers Doma, Farinruwa and Mada in Nasarawa State, Nigeria. The study further revealed that Rivers Doma and Mada were not safe for drinking based on the microbiological tests carried out on the water samples. Accessibility of Nigerian populace to potable water is an increasing concern, especially when seasonal variations are considered. Dry seasons are much more pertinent with most hand-dug wells already dried up and search for potable water seems unending during the dry season; this has exposed citizens to lots of Sample collection

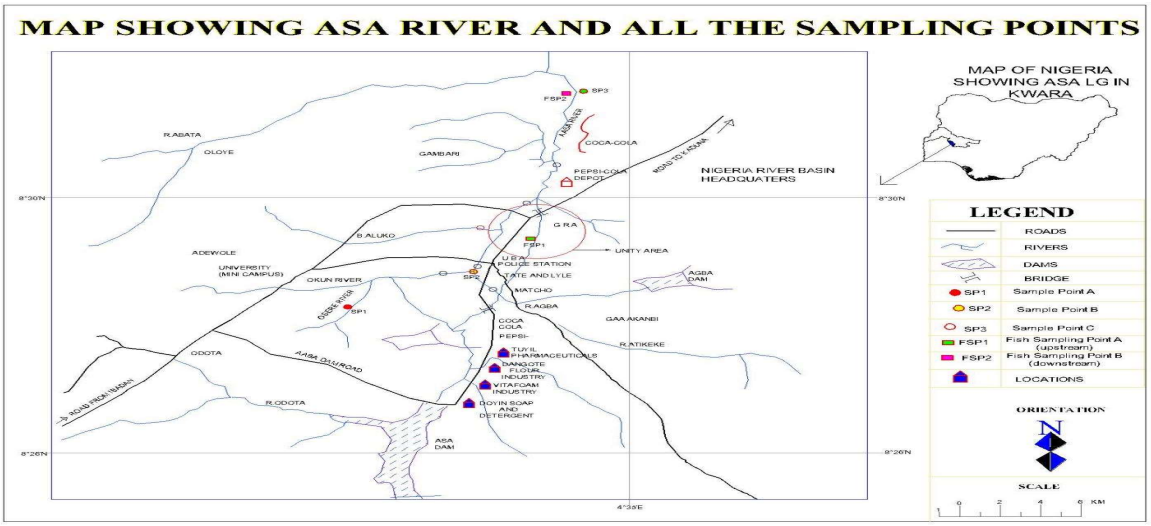
Water and sediment samples were collected monthly from Asa River at three designated points; A, B and C for a period of twenty-four months using composite method of sampling. Four hundred and forty-two water and sediment samples were collected from the sampling points along the river course during the rainy and dry seasons of the two sampling years. The sampling sites were selected based on consultations with the local authorities and a water assessment monitoring group, who claimed to have identified the river as having poor water quality due to usage for domestic activities by the populace of the metropolis. From each sampling sites, grab water samples were collected in replicates into 5 L sterile plastic bottles with screw caps from 30 cm below the water surface and transported on ice to the laboratory for analyzes within 4 hours of collection. Sediment samples were collected in replicates from the same points where water samples were collected using fabricated bottom grabber. Sediment was collected only when it has not rained for about 3 to 4 days prior sampling. unquantifiable hazards.

Asa River is a major river of economic, agricultural and environmental significance in Ilorin—the capital city of Kwara State, Nigeria. The river receives effluents from industries located along its course, apart from domestic wastes and other activities carried out along it that contribute to its pollution. It was also reported that the major identified source of pollution of Asa River was direct runoff of effluents from the industries (Adekunle and Eniola, 2008). Moreover, it was pointed out that the river is subject to high level of eutrophication due to the organic matter and industrial effluents discharged into it (Eletal et al., 2005). This informed the need to evaluate the impact of pollution on the river segment and its aquatic biota. A study of this kind has not been carried out on the river. River is solely dependent upon by most nearby dwellers and it as well supplies the basic water needs of the Ilorin city and its environs. Asa River originates from Oyo state and flows through Ilorin in a South-North direction forming a dividing boundary between Eastern and Western Ilorin (Ibrahim et al., 2013). In a quest to assess its potability, monitor and keep the river under close surveillance, a lot of research work has been done to assess its sanitary status (Adewoye, 2013; Ahaneku and Animashaun, 2013 and Ibrahim et al., 2013). This present study evaluates the river physic-chemical and microbiological characteristics based on seasonal variations and then try to assay the sediment of the river body if it could serve as a source of persistent contamination.

MATERIALS AND METHODS

Description of Study Site

The study was conducted on the Asa River segment at the exit of the industrial estate around Unity Road, Ilorin, North Central Nigeria (8° 28′ N, 4° 38′ E to 8° 31′ N, 4° 40′ E). the sampling sites are as presented in Figure 1.



Sample collection

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Water Quality Evaluation

Water samples for analysis were collected into new high-density polyethylene terephthalate (PET) screw-capped containers of 1.5 L capacity. The PET containers and stoppers were thoroughly washed with distilled water three times and once with the water meant for sampling before collection according to the description of Khan et al., (2012) and Dahunsi et al., (2014). At each site, one bottle was filled with water without acid (for microbial analysis) while the other bottle was filled with the water from the same point and acidified with a few drops of 5% Nitric acid (HNO_3) to stop the activities of microorganisms and was later used for metal analysis. The water samples were transported to the Central Research Laboratory in Ladoke Akintola University of Technology, Nigeria and kept in a refrigerator at 4 °C. Physical parameters including pH (HI 9024-C, Hanna Instruments, Smithfield, RI, USA), temperature (HI 98517, Hanna Instrument), salinity (HI 19311, Hanna Instrument), electrical conductivity (HI 2315, Hanna Instr.), and total dissolved solids (TDS) (VSI 22, VSI Electronics Private Limited, Punjab, India) were analyzed in- situ using the hand digital meters that are mentioned above. Dissolved oxygen of the samples was analyzed using the azide modification of Winkler's method (APHA, 2012). As described in APHA (2012) standard methods, chloride was determined by titration while the Ultraviolet spectrophotometer screening

method was used in the determination of the major anions using a UV spectrophotometer (DR 2800, HACH, Washington, USA) (Khan et al., 2012 and Dahunsi et al., 2014). In order to ensure reliability and reproducibility, blank, standard and pre-analyzed samples were analyzed after every 10 samples (Dahunsi et al., 2014). Metal analysis was done with the aid of an atomic absorption spectrophotometer (AAS) (Sens AA 3000, GBC, Australia) using the method in APHA (2012).

Microbiological analysis

Microbiological analysis was initiated soon after sample collection. The total colony counts of bacteria in the water samples were determined by the pour plate method using nutrient agar (Oxoid). The water samples were serially diluted with sterile distilled water and 0.2 ml of a thousandth fold dilution was used to inoculate nutrient agar plates in triplicate, then incubated at 37 ^{0}C. The total colony count was determined by multiplying the average plate count per ml by the dilution factor used and expressed as the colony forming units per ml of the samples (Nwachukwu, 2000). 1g of each sediment sample was weighed into about 9 ml of distilled water 10 ml and homogenized by vigorous shaking to prepare an elutriate needed for the microbiological analysis. The total colony counts of bacteria in the simulated sediment samples were determined by the pour plate method using nutrient agar (oxoid). The prepared elutriate were serially diluted with sterile distilled water and 0.5 ml of a thousandth fold dilution was used to inoculate the plate in triplicate. The plates were incubated at 37 ^{0}C for 48 hrs. The total colony counts were determined by multiplying the average plate count per ml by the dilution factor used and expressed as the colony forming units per ml of the samples (Nwachukwu, 2000).

Feacal Coliform Test and Isolation of Microorganisms from Water Samples

The three-tube procedure using lactose broth was used for the detection of coliforms and determination of the Most Probable Number (MPN). 0.1, 1.0 and 10 ml of each sample (water and sediment sample) were used to inoculate the lactose broth in five replicates using the McCrady table following standard methods (APHA, 1992).

For the detection of fecal coliform bacteria, production of acid and gas reflected through the colour change of the indicator incorporated into the lactose broth and accumulation of gas in the inverted Durham tube inserted in the broth, was taken as positive indication (D' Auriac et al., 2000). Tubes showing positive results were cultured in MacConkey broth and incubated at 37 ^{0}C for 48 hours. These tubes were plated on Eosin-Methylene Blue (EMB) agar and incubated. Colonies grown on EMB plates were selected and finally identified on the basis of morphological and biochemical characteristics for the isolation of Escherichia coli (APHA, 1992).

At the end of incubation, distinct colonies of bacteria were subculture to obtain pure cultures. They were then subjected to routine primary and biochemical tests. The isolates were identified based on the schemes and description of Bergey's methods (Buchanan and Gibbons, 1974). The colonies were recognized on plates based on morphological features such as pigmentation and shape of colony.

Anitibiotic Sensitivity Test

All the isolated strains of bacteria from the sediment samples were tested for their sensitivity to antibiotics using a disc diffusion method (Bauer et al., 1996). It was investigated using GBMTS discs (Abtek Biologists Ltd) containing Gram positive discs (25 µg Augmentin, 5µg Ofloxacin, 10 µg Treptomycin, 30 µg Chloramphenicol, 30 µg Ceftriazone, 10 µg Gentamycin, 5 µg Pefloxacin, 25 µg Cotrimoxazole, 10 µg Ciprofloxacin, 5 µg Erythromycin) and negative (30 µg Augmentin, 30 µg Ceftriazone, 200 µg Nitrofuranton, 10 µg Gentamycin, 25 µg Cotrimozazole, 5 µg Ofloxacin, 25 µg Amoxycillin, 10 µg

Ciprofloxacin, 30 µg Tetracyclin and 5 µg Pefloxacin). The commercial antibiotic discs were placed on nutrient agar plates previously seeded with an 18 h-broth culture of the test organisms. The plates were incubated at 37 ^{0}C for 48 h, after which the zones of inhibition were examined, measured and interpreted accordingly (Chortyk, et al., 1993).

RESULTS

Physico-Chemical and Microbial Characteristics of Water and Sediment Samples

The total counts of heterotrophic bacteria in the water samples taken from the three sampling points ranged from 5.08 × 10^5 to 6.96 × 10^5 Cfu at Point A; 5.91× 10^5 to 7.96 × 10^5 Cfu at Point B and 6.00 × 10^5 to 8.15× 10^5 Cfu at Point C. The mean monthly values of microbial load of water samples were significantly different (P<0.05) across the sampling points. The highest values were found at points B and C during the rainy season. The water samples from all the sampling points were also noted to have high Coliform Bacilli with high most probable number (MPN) of ≥1800 as prescribed by the coliform index. High microbial load was generally significant during the rainy season of the year than what was observed in the dry season. A total number of twenty one (21) bacteria species belonging to nine different genera were isolated and identified in various water samples. Point A also recorded the highest number of heterotrophic bacteria with a total number of 20, followed by points B and C with 17 each. Pseudomonas and Staphylococcus species were the most common isolates with an occurrence of 19.05% each, followed by Bacillus species and Enterobacteria species with 14.29% each, Proteus species and Micrococcus species has an occurrence of 9.52% each, Escherichia species, Klebsiella species and Sarcina species have an occurrence of 4.76% each (Figur 1). The colony count in the sediment sample were in the order of 10^7, and these ranged between 20.26 × 10^7 to 38.75 × 10^7 Cfu at (Point A; 60.07 × 10^7 to 88.00 × 10^7 Cfu at Point B and 40.08 × 10^7 to 76.45 × 10^7 Cfu at Point C. The highest value of 90.07 × 10^5 was obtained from point B which is the discharging point of industrial effluents, followed by point C which is the downstream where both points A and B drains. The mean monthly values of microbial load of sediment samples were significantly different (P<0.05) across the three sampling points. The microbial load was noted to be in the order of B>C>A. Also, all the sediment samples contained high coliform count, with MPN of ≥1800. The observed high microbial load was generally significant during rainy season than dry season. A total number of 14 bacterial isolates belonging to four families were identified, Pseudomonas species was the most common isolate with an occurrence of 53.85%, followed by Proteus species and Bacillus species with occurrences of (19.23%) each and Flavobacterium species with the least occurrence of 7.69%.

Twenty six (26) isolates showed 100 % resistance to Augmetin which was the highest. Twenty-five isolates showed 96.15 % resistance to Amoxicillin and Ceftriazone, 92.31 % resistance to Cotrimoxazole by 24 isolates, 20 isolates were 76.92 % resistant to Streptomycin, 19 isolates were 73.07 % resistant to Nitrofurantoin, 9 isolates were 34.61 % resistant to Gentamycin, 8 isolates were 77 % resistant to Pefloxacin, 7 isolates were 26. 92 % resistant to Ciprofloxacin and the least 5 isolates showed 19.23 % resistance to Ofloxacin. The commonest resistant patterns were Amoxicillin, Augmentin and Ciprofloxacin (AMX, AUG, CPX) which occurred in all isolates.

DISCUSSION

The mean temperature values obtained across all the sampling sites were not significantly (p<0.05) different, thus falling within the ambient temperature range (0 - 30^{0}C) of Nigeria Industrial Standard (2007) and World Health Organization (2011) for good surface water according to Chapman, (1996). It however could provide a favorable

environment needed for the optimal proliferation of most of the bacteria isolated from the water in this study most of which are enteric bacteria which usually grows at temperature range (20 °C and 32 °C). Generally, the variation in water temperature obtained in this work is a direct reflection of low depth of the water bodies and the irregular slow movement which does not ensured a complete mixing of the entire water phase. This observation agreed with the submission of Ajao, (1990) and Oyewo, (1998) on the temperature profile of Lagos Lagoon. This is also in line with the temperature range of 24.5 °C to 31.5 °C reported by Fagade and Olaniyan (1994) from Asa River. There were significant differences between the three values obtained for the three sampling sites and between the two seasons of the year.

The pH values recorded in this work are indicative of good water quality which was within the acceptable limits (WHO, 2011). The high values of pH (7.92±0.06 and 7.56±0.05) recorded at sampling sites B and C respectively could have been due to the influx of industrial effluent and the synergistic effects of these effluents on the water bodies. A slight alkaline pH value recorded may be due to the alkaline treatment given to the effluents before discharging into the river (Amao, 1998). This agreed with the submission of Adebayo and Adediran (2005), that influx of effluent in alkaline form into water could affect the pH. The fluctuations observed in the surface pH indicated the buffering capacity of total alkalinity, high water volume, and greater water retentions. Good buffering capacity of total alkalinity may have been the reason why pH was in neutral or moderate alkaline medium during the rainy season and for most part of this study. Using the pH as a water quality index, Asa River and its tributaries has good water quality with the mean pH of 7.13, 7.92 and 7.56 for point A, B and C respectively; most natural waters have pH between 6.5 and 8.5 (Tepe et al., 2005). Such pH values will also allow the survival of aquatic organisms and its use as drinking water. In this present situation, the maximum pH of 7.80 ± 0.06 was recorded in the dry season and this may be linked to the decreased volume of water by evaporation; the minimum value of 7.50 ± 0.10 obtained during the rainy season may be attributed to shorter day length and decrease in photosynthetic activity (Salve and Hiware, 2006).

High total solids observed in sites B and C during the dry season, could also be as a result of influx of effluents from industrial premises, thereby bringing about increase in the level of conducting ions, electrical conductivities and turbidity of the affected water bodies. It could also be due to siltation, deterioration and heavy precipitation. These observations agreed with the findings of Ayoola and Kuton (2009) on Lagos Lagoon in Nigeria. The BOD recorded in sites B and C could be as a results of accumulation patterns of organic materials due to organic pollution which may eventually results in reduction of oxygen content; and that when organic matter is abnormally high in an aquatic phase, the biological oxygen demand level reduces and this may eventually disrupt the behavioral responses of the organisms and reduces the fitness of a natural population of fish, this observation conformed with the reports of Adewoye et al., (2005) and Ayoola and Kuton, (2009). Lower values of dissolved oxygen (3.21±0.50 at site A; 1.99±0.06 and 3.00±0.41) below the 6.0 recommended level of (WHO, 2011) in this work attributs to the fact that, the river is grossly polluted with chemical pollutants. Ayoola and Kuton (2009) reported that the desired range for the culture of warm water fish is 5 mgl^{-1} and above but not more than 12 mgl^{-1}. The continuous influx of industrial discharge into the water might likely support the growth of aquatic weeds and formation of flocks on the surface of the water, hence a reduction in the dissolution of oxygen into water. Morrison et al., (2001) however stressed that the depletion of dissolved oxygen in a water body could be due to common practice of dumping of wastes into such water body. Virtually all metals

analyzed in water and sediment samples were found to be bellow and within the permissible limit of WHO, (2011) and NIS, (2007) but their additive effects must not be under-estimated as they tends to form different compounds within the aquatic phase.

The index of microbial load (10^5) and (10^7) is high and evidently pronounced in water and sediment samples respectively from Asa River. The comparative analysis of the microbial load indicates that more bacterial were encountered in all the three points in the order of B>C>A. The same trend was noticed during the dry and rainy seasons, though more bacteria were encountered in the rainy season than what was recorded for the dry season. Geometric increase in bacteria counts recorded in Asa River and its tributaries correlated conveniently with the degree of organic pollution of the river as shown previously by low dissolved oxygen and high Biological Oxygen Demand (BOD) (Olayemi, 1990). It is also a reflection of high inputs of organic and inorganic nutrients into these water bodies as observed in this study.

The increase in nutrient level, river flow and aeration that characterizes the rainy season enhances aerobic decomposition of organic matter, hence increment in microbial load. It is significant that the high total bacterial counts for both seasons conformed to the unsanitary status of the river. Though the results of identification of bacterial isolates revealed that some of them are of no sanitary importance, they may nevertheless be directly involved in the deterioration of the aesthetics value of the river e. g. Bacillus app. or its economic importance. Pseudomonas and Micrococcus spp. are often found to be associated with fish spoilage and other aquatic products like oysters, mussels and clams (Olayemi, 1990).

Results obtained in this work conforms with the submission of Olayemi, (1994) and Adewoye, (2007) on River Asa, except that the microbial index recorded in this study were slightly higher than the previous reports and this may be attributed to the continuous increase in the number of industries that empties their wastes into these water bodies and as well as increase in domestic and agricultural discharges. Similar results were obtained in the study of polluted Oba River that was exposed to both human and agricultural wastes (Bakare et al., 2003) with a microbial load in the order of 10^4. The authors reported that the samples collected in December to February had lower colony counts probably because they were collected in the dry season when there was little or no land run-off, and some sanitary measures were observed around the river (Bakare et al., 2003). While in the other months, the total colony counts were higher for both saprophytic and parasitic bacteria due to land run-off which washed soil, vegetation and domestic wastes into the rivers (Olayemi, 1994).

Eniola and Olayemi (1999); Eniola, (2001) and Adewoye, (2007) reported that the physicochemical characteristics of the water samples from Asa River led to the richness of point B and C in nitrate, phosphate and sulphate than the points A. It can therefore be deduced that high microbial load recorded in point B and C might not be unconnected to the abundance of nutrients and organic load, the muddy and humid nature of the sediment which enhances a long term sink for divalent metals and thereby create large surface area for pollutant persistency. Thus, effluent discharged at these points (point B and C) was capable of enhancing growth of microorganisms in the river. These also support the submission of Chukwura and Okpokwasili, (1997) that the washing of wastes into water bodies during rainy season encourages an outbreak of microbial loads.

The high bacteria isolates recorded in point A is an indication that the point is exposed to non-point pollution such as run-off from agricultural and human wastes. The presence of fecal coliform and E. coli in all the water samples indicated that the river is not free from human fecal materials. Thus, it is highly probable that Asa river is exposed to both point and non-point pollution, which can

impair the natural population within the ecosystem, by selectively encouraging the development of those aerobic microorganisms which can degrade all or some of the added materials (Okafor, 1985).

High bacterial isolates recorded at upstream (point A) which is a point that does not receive industrial effluents agreed with the findings of Eniola and Olayemi (1999); Eniola (2001) and Olayemi et al., (2003) that a total number of sixteen and twenty bacterial species were isolated from points B & C respectively and then reported that effluent-free water body i.e point A had more bacterial isolates than effluent containing water bodies. Akpata (1990) however, submitted that effluents normally increase the count of bacteria in any water body but appeared to cause a decrease in the number of heterotrophic bacteria.

It is not unusual to obtain higher microbial load in the rainy season than dry season. The isolation of a number of bacterial genera known to be pathogenic call for a serious concern. Specifically, Escherichia.coli, Staphyloccocus aureus, Bacillus subtilis, Staphyloccocus spp., Pseudomonas species, Klebsiella spp, Enterobacter spp., Proteus spp., Micrococcus sp. and so on, were encountered in water and sediment samples. Health problem associated with these organisms can cause tastes and odour problems thereby affecting the aesthetic properties of water and this conveniently conform to the submission of WHO (1984) and Akaninwor et al., (2007). The high coliform counts in this work are very undesirable and this suggests that human or animal sewage forms a significant portion of the domestic pollutants in the river.

The results also demonstrated that the sediment samples from these sampling points were heavily populated with pathogenic microorganisms such as Pseudomonas spp., Proteus spp., Bacillus spp. and Flavobacterium spp. The fecal nature of these microbial populations has been confirmed through the isolation of multiple antibiotic resistant E. coli. The higher populations of these isolates were recorded from points B and C which receives effluents from the industrial premises and this may be attributed to the muddy and humid nature of the bed sediment that allows persistence of such divalent metals that enhances the growth of these microorganisms. The most worrisome situation in this study is the antibiotic resistance pattern demonstrated by most bacteria isolates from the sediment samples with resistance pattern above 50% in ten different antibiotics used. Such high level of resistance is a serious challenge to public health and the people in the area, who consume fishes from such contaminated bodies of water. Ayandiran et al., (2014) also noted that Obere River in Nigeria is polluted with antibiotic resistant microorganisms.

Resistant bacteria may be present because of the application of antibiotics in fish or because of selection by the antibiotics present in sediments. High antibiotic load in sediments in concentration sufficiently potent to inhibit the growth of bacteria were reported for aquaculture. Resistance organism has been isolated from a numbers of natural and man-made environments. In natural environment, resistant organisms can be indigenous or introduced through natural or anthropogenic courses.

Ten patterns of multiple drug resistance among the bacterial isolates were obtained and are consistent with the results of other researchers (Adewoye and Lateef, 2004; Lateef, 2004). The level of resistance of the bacterial isolates was highest amongst those from the Pseudomonas species with (53.85%) followed by both Bacillus species and Proteus species with (19.23%) each and the least level of resistance was observed in the Flavobacterium species with (7.69%). This may be traced to the muddy and humid nature of the sediment which allows persistence of such chemical pollutants over time. This may also be connected to the fact that strains of the same microorganism isolated from different sampling points may exhibits diverse level of

resistance as a way of surviving the contaminated environment.

Adewoye and Lateef (2004) obtained different levels of resistance for strains of bacterial isolates obtained from different organs of Clarias gariepinus exposed to varying concentrations of an industrial effluent; Likewise, Lateef (2004) obtained diverse levels of resistance strains of bacterial isolates from a pharmaceutical effluent. Multiple drug-resistances are an extremely serious public problem (Prescott et al., 1990) and it has been found to be associated with the outbreak of major epidemics throughout the world. Thus, the multiple drug-resistances shown by these bacterial isolates are worrisome because of the public health implications. Therefore, handling and consumption of such aquatic foods such as fish from this kind of contaminated water bodies can expose the handler and consumer to certain risks either from the water or from any aquatic sample of fish themselves. The fact that the exposure is highly locally concentrated has to be considered critical.

Chemical substances used in industrial, agricultural and domestic premises can enter sediments directly from the water without undergoing any kind of purification process. Some investigations have demonstrated the presence of antibiotics crippled extensively in fish farming in sediments. In view of this, measures to avoid the release of harmful substances should be incorporated in the design, apparition maintenance and management of industrial plants to prevent and control industrial pollution from the onset, as this will yield both economic and environmental benefits.

Human carriers introduced these pathogens into the river and the subsequent population bloom as a result of effluent discharged into the rivers. This becomes worrisome as it affects the quality of the water, apart from the fact that users of the water can easily get infected by these human pathogens, the aquatic life forms particularly the fishes can also be adversely affected which when enter into an active food chain, man is always at the receiving end. Though not all members of known pathogens of fishes were isolated in this study, so, it is not correct to state that the fishes are not affected by those isolated. This is because research on bacteriology of fishes in relation to water pollution is rarely undertaken in this part of the world and this may also be the main reason for which etiological agents of different fresh water fish, diseases are not described yet (Boon and Huisman, 1996). The results of the microbiological analyses of Asa River and its two tributaries investigated, have shown that all the surrounding industries, both local and domestics operation units stands the major source of environmental pollution through the discharge of effluents into these water bodies. Elevated levels of these pollution indicators when compared with an effluent free water bodies would invariably affects the tastes, smell, appearance and aesthetic properties of the water or could pose a potential health hazards of varying degrees of various life forms, which depends on the water for domestic and recreational purposes.

Therefore, base on the above microbial pollution indexes recorded in this water body, it is important to embark on proper assessment of general quality of major edible fish species, most especially the benthic dwellers, such as Clarias gariepinus which is the predominant species cultured in Asa River and in most Nigeria water bodies.

CONCLUSION

This project evaluated the prevalence of antimicrobial resistant isolates from various strata of Asa river in Ilorin Kwara state Nigeria. The authors used standard techniques for sample collection and analysis while they used the pour plate technique for microbiological assay and the disc diffusion technique for antibiotics sensitivity testing. Our findings indicated a significant difference in the mean monthly bioburden of the water samples across the various strata

with P<0.05, with the highest values found at points B and C during the rainy season.

High Coliform Bacilli count with high most probable number (MPN) of ≥1800 was also observed across the strata, suggesting fecal contamination. We isolated twenty one (21) different bacteria species including Pseudomonas, Staphylococcus species, Bacillus species, Enterobacteria species, Proteus species, Micrococcus species, Escherichia species, Klebsiella species etc. and also reported resistance of some of the isolates to some antibiotics and concluded that the commonest resistant patterns were Amoxicillin, Augmentin and Ciprofloxacin (AMX, AUG, CPX) which occurred in all isolates.

Majority of the populace in most developing countries including Nigeria lack access to municipal water supply, therefore depending on rivers streams etc. The authors, using Asa river as a case study, highlighted the dangers associated with usage of such water source, as a result of pollution resulting from industrial effluent and poor sanitary practices. The authors decided to collect samples both during low tide (dry season) and high tide (rainy season), we therefore advice policy makers to advice against usage of the river water for drinking, cooking and other domestic purposes.

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