Journal of Forestry Research and Management. Vol. 18(2).41-48; 2021, ISSN 0189-8418

www.jfrm.org.ng

PHYSICOCHEMICAL AND BACTERIOLOGICAL STUDY OF ABAYI MBASA RIVER, ABIA STATE, NIGERIA

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ABSTRACT

Contaminated surface water supply causes various water-related diseases, hence there is need to assess state of the physical, chemical and bacteriological characteristics of some river in order to ascertain the level of their quality. This studytherefore assessedthe water quality of Abayi Mbasa River in Ugwunagbo LGA of Abia State. Water samples were collected at three pointsrepresenting points of sand dredging (A), human domestic activities (B), and downstream (C) and analyzed for physicochemicaland bacteriological properties according to standard procedures. Results show variations in the water quality between the three sample points. The temperature varied between 31°C and 32°C and was higher at the sand dredging point. pH varied between 5.33 and 5.77 while the turbidity was in the range of 7.14 - 15.07 NTU. Electrical conductivity, total solids, and soluble solids were above the acceptable limits by WHO. Chemical properties show that hardness ranged from 27.13 to 34.77. Calcium was between 19.23-24.17mg/l, Magnesium 4.40-8.10mg/l, Iron 1.42-3.15mg/l. Lead was above the WHO limits with levels of 0.13 mg/l while Arsenic fall with the limit being less than 0.05mg/l. The radicals NO_3, SO_4, and PO_4 were all within the acceptable limit.Biochemical oxygen demand (BOD) varies from 4.10-4.73mg/L,chemical oxygen demand(COD) 32.27-40.80mg/l. Total viable count of bacteria ranged between 26.67×10^7 to 32.67×10^7CFU/ml, while the most probable number of coliforms was between 2.67-6.33 MPN/100 ml. There were seven bacteria species isolated and identified as being prevalent. Proteus, Bacillus, Staphylococcus, and pseudomonas had 100% occurrence, while Salmonella, and Streptococcus species varied between 33.3% and 66.7%.

Keywords: Abayi Mbasa River, Bacteria, Downstream, Sand dredging.

Introduction

In most rural communities in developing countries, surface water (rivers, streams, and lakes) has been the most available water source for domestic purposes (Ubuoh and Uchendu, 2018; Bwire*et al.,* 2020).Water from these sources is contaminated with domestic, agricultural, industrial, municipal waste, agricultural runoff, and accidental spillage thatare likely to cause water-related diseases (Ibeneme *et al.*, 2014).According to the United Nations, more than five million people die annually from diseases caused by unsafe drinking water and lack of sanitation(Higler, 2012, Ajala*et al.*, 2020).

Contaminated surface water supply causes various water-related diseases, including typhoid, hepatitis, cholera,andguinea worm (Adentunde and Odowon, 2010). In some places, streams are used as lavatory;hence there are concentrations of human excrement. Livestock regularly drinking water in streams; therefore, animal faeces are frequently found in such surface waters. Also,some food items are cleanedin these waters,peopleswimming in these streams sometimes swallow some of this polluted water (Adekole *et al.*, 2008).

In an urban environment, sewage discharge isasignificant component of water pollution, and this contributes to oxygen demand and nutrient increment, thereby promoting the growth of toxic algae, thus decreasing the oxygen for other aquatic life(Ojekunle, 2000). Good knowledge of the water quality in our rural communities will help determine possible water-borne infections the people may face and proffer mitigations against such health problems (Yerima *et al.*, 2008).Abayi Mbasa River is subjected to domestic and municipal waste pollution because of poor enforcement of water pollution control laws and regulations. Runoff from soil used for farming and soil mining activities also contributes to river water quality degradation (Prerna*et al.*, 2020). This research work is essential because Abayi Mbasa river is the only stable source of water within the study area as there is a limited presence of potable waters(Ugwu and Wakara, 2012)

This study aim to assess the physicochemical and microbiological properties of the Abayi Mbasa river. This study will enlighten urban inhabitants on the consequences of dumping waste into rivers and the health and environmental implications of such activities, thereby creating awareness of the need to improve waste management practices in Abayi, Ugwunagbo municipality.Contaminated water is linked to transmission of diseases such as cholera, diarrhoea, dysentery, hepatitis A, typhoid, and polio. Absent, inadequate, or inappropriately managed water and sanitation services expose individuals to preventable health risks (Bwire *et al.*, 2020)

Materials and Method

The Study Area

The research was carried out in Ugwunagbo LGA of Abia State.The area lies between latitude 5°07¹N and 7°23¹E and longitude 5°117¹N and 7°367¹E. The mean maximum and minimum temperatures recorded were38.2°C and 20.7°C, respectively.Relative humidity ranges between 60 – 85%. The area lies within the sub-equatorial, sub-humid region with March to October as the rainy season and November to February as the dry season. The annual average rainfall is about 2200 mm.Ugwunagbo LGA has an area of 108 km^2 and apopulation of 111,800 (NPC, 2016).The people of Ugwunagbo depends mainly on farming, and there are several abattoir sites, and they dispose of their waste in the river (Nnenna, 2013).

Sample Collection and Analysis

Water samples were collected during the rainy seasonat three points representing points of sand dredging (A), human domestic activities (B), and downstream (C). Sampling was done by a complete immersion technique and corking underwater as described byClaaasen (1982). Samplescollected were kept in ice packed containers and transported to the laboratory for analysis.Physical properties were determined according to the standard methods described by APHA (1999). The temperature of the water sample was determined in situ using a Celsius thermometer, Total titratable acidity was determined by the alkaline titration method, Total solid was determined according to the gravimetric method ofClaaasen (1982),totalhardness(mg/l) was determined using APHA (1999) as described by(Okeke and Adina, 2013). The determination of heavy metals in the water samples was done using atomic absorption spectrophotometryaccording to the method described by Cheesbrough (2005).Turbidity was determined by in-situ measurement using a ranch laboratory turbidimeter, electrical conductivity was determined by direct reading using a conductivity meter. Nitrate ions in the water were determined spectrophotometrically using the phenol-sulphuric acid colourimetric method. Phosphate was determined using the vanadomalayaitecolourimetric method. Sulphate ions in the water were determined by turbidimetricgravimetry.BOD was determined using the titrimetric method (APHA, 1999). The microbiological analysis of the sampleswas determined using the methods of the international commission on the microbiological specification of foods, as reported by Chukwu (2008). The pour plate technique was used to determine the plate count (total viable count);the coliform count was determined using the multiple tube fermentation method (Cheesbrough, 2005).Data obtained were subjected to statistical analysis. Test for significant differences were carried outusing Analysis of Variance (ANOVA).

Results

The physical properties of the Abayi Mbasa river are shown in table 1. The temperature ranged from 31 - 32°C. The highest temperature (32°C) was recorded at the sand dredging site, while the downstream recorded the lowest temperature (31°C). The pH ranged from 5.33-5.77. the highest pH (5.77) was recorded at location B, where human domestic activities were observed, while the lowest pH (5.33) was recorded at the sand dredging site. Total Solids ranged from 543.33-683.00 mg/l, with the highest value of TS (683.00) recorded at the human domestic activities sample point while the lowest value of TS (543.33) was recorded at the downstream.

Electrical conductivity ranged from 120.53-151.30 µS/cm, with the highest EC (151.30) recorded at the human domestic activities sample point, while the lowest EC (120.53) was recorded at the sand dredging site. Turbidity values ranged from 7.14-15.07 NTU, with the highest value (15.07) recorded at the sand dredging site, while the lowest value (7.14) was recorded at the downstream.There was a significant difference ($P<0.05$) between the characteristic of the river in places where there are human activities, (location A and B), and the river at the other location (C) (non-human activities).

Table 1: Physical properties of Abayi Mbasa river

	Temp(°C)	**pH**	**TS (mg/l)**	**TDS (mg/l)**	**TSS (mg/l)**	**EC(mS/cm)**	**Turbidity(NTU)**
A	$32.00\pm^{b}0.00$	$5.33\pm^{a}0.06$	$619.33\pm^{b}2.31$	$410.67\pm^{a}4.16$	$208.67\pm^{c}3.06$	$120.53\pm^{a}8.27$	$15.07\pm^{c}1.27$
B	$31.67\pm^{b}0.58$	$5.77\pm^{b}0.06$	$683.00\pm^{c}20.22$	$576.33\pm^{c}24.13$	$106.67\pm^{b}4.73$	$151.30\pm^{b}4.95$	$9.09\pm^{b}0.25$
C	$31.00\pm^{a}0.00$	$5.37\pm^{a}0.06$	$543.33\pm^{b}11.02$	$472.00\pm^{b}10.39$	$71.33\pm^{a}5.03$	$140.40\pm^{b}1.04$	$7.14\pm^{a}0.25$

Results are expressed as means ±SD. Figures with different superscriptsdown the column are significantly different ($P<0.05$).

The biological analysis of the Abayi Mbasa river is shown in table 2. The BOD rangedfrom 4.10-4.73, which indicates that the waters all conform to the minimum limit of BOD for surface water (5.0mg/l). Similarly, the COD ranged from 32.27-40.80mg/l. Both the BOD and COD were highest at location B, where human activities werefor domestic water use.The result shows there are significant differences between the water from different locations.

Table 2: Biologica properties of Abayi Mbasa river

	BOD(mg/l)	COD(mg/l)	TVCx10^7 (CFU)	Coliform (MPN)
A	$4.33\pm^{b}0.06$	$32.27\pm^{a}0.95$	$32.67\pm^{b}3.51$	$6.33\pm^{b}1.15$
B	$4.73\pm^{c}0.12$	$40.80\pm^{c}0.87$	$26.67\pm^{a}1.15$	$2.67\pm^{a}0.58$
C	$4.10\pm^{a}0.10$	$37.47\pm^{b}0.92$	$32.33\pm^{b}2.30$	$3.33\pm^{a}0.58$

Results are expressed as means ± SD. Figures with different superscripts down the column are significantly different (P<0.05). TVC is Total viable count

The chemical composition of the Abayi Mbasa river is shown in table 3. The water hardness rangedfrom 27.13-34.77mg/l and was highest in the water where there are human domestic activities such as swimming, washing, drinking. The lowest value was at the point where sand dredging activities occur. Calcium and magnesium were both higher in sample B, where there is a human domestic activity, with the values of 24.17mg/l and 10.93mg/l, respectively.

Table 3: Chemical properties of Abayi Mbasa river

	Hardness	Ca (mg/l)	Mg (mg/l)	NO_3 (mg/l)	PO_4 (mg/l)	SO_4 (mg/l)	Fe (mg/l)	Pb (mg/l)	As (mg/l)	Zn (mg/l)
A	$27.13\pm^{a}1.09$	$19.80\pm^{a}1.37$	$7.33\pm^{a}1.91$	$12.03\pm^{b}0.92$	$38.47\pm^{a}0.12$	$324.50\pm^{c}2.07$	$1.42\pm^{a}0.06$	$0.13\pm^{a}0.01$	$0.03\pm^{a}0.01$	$0.55\pm^{a}0.02$
B	$34.77\pm^{b}5.05$	$24.17\pm^{b}1.28$	$10.93\pm^{a}4.40$	$8.67\pm^{a}0.04$	$28.80\pm^{a}2.23$	$219.30\pm^{a}2.95$	$3.15\pm^{b}0.01$	$0.39\pm^{b}0.03$	$0.05\pm^{b}0.01$	$0.45\pm^{a}0.01$
C	$27.33\pm^{a}0.92$	$19.23\pm^{a}0.29$	$8.10\pm^{a}0.81$	$9.65\pm^{a}0.40$	$47.07\pm^{a}29.22$	$258.80\pm^{b}15.91$	$1.43\pm^{a}0.06$	$0.14\pm^{a}0.02$	$0.03\pm^{a}0.01$	$0.49\pm^{b}0.01$

Results are expressed as means ± SD. Figures with different superscripts down the column are significantly different (P<0.05).

The occurrence of bacteria isolates in the Abayi Mbasa river is shown in table 4. The results show variations in the occurrence of the organisms. Staphylococcus, Proteus, Bacillus, and Pseudomonas were present in all the water samples (100%). Other isolates and their respective occurrence were *E. coli* (66.7%), Salmonella (33.3%), and Streptococcus (66.7%).

Table 4: Total occurrence of bacteria isolates in Abayi Mbasa River

	Staph	E. coli	Salmonella	Proteus	Bacillus	Pseudomonas	Streptococcus
A	+	+	+	+	+	+	+
B	+	-	-	+	+	+	-
C	+	+	-	+	+	+	+
Total	3	3	3	3	3	3	3
No of +ve	3	2	1	3	3	3	2
%Occurrence	100	66.7	33.3	100	100	100	66.7

Discussion

The temperature was highest (32°C) at location A where sand dredging activities are frequently carried out. According to Obi and Okocha, (2007), the temperature of a river is critical because it affects and controls many activities and reactions. The pH was in the range of 5.33 to 5.77 and was lowest on the sand dredging activity. The water pH in all the locations failed to meet the standards level of 6.5 - 8.5 (Prerna *et al*., 2020). Total solid was above the permissible level of 500mg/l (Abdel-Satar*et al*., 2017) as its highest value of 683.00mg/l was recorded in location B, where there are multiple human activities, especially domestics. Total solid is the sum of suspended solids (TSS) and dissolved solids (TDS). The high total solid and subsequently high suspended solids were reflected in the turbidity level, which was in the range of 7.14 to 15.07, at location A where sand dredging takes place. The pulling out of sand from the waterbed to the surface and away to the vessels results in soil particles' suspension, leadingto high turbidity (Ibeneme *et al*., 2014). The turbidity of 15.07 was found to be at the threshold limit (15 NTU).

Calcium and magnesium, and hardness all fell within the permissible limits of the World Health Organization (WHO, 2006). It was also observed that the magnesium level does not show a significant difference ($P<0.05$) within the sample locations. The sulphate, phosphate, and Nitrate levels all varied between the water from different locations. Nitrate was in the range of 8.67mg/l to 12.03mg/l and was highest in sand dredging water and least in the water where the human domestic activity is high; this is in tandem with the study of Busico*et al*. (2019). Phosphate was in the range of 28.08mg/l to 47mg/l, while sulphate was in the range of 219mg/l to 324mg/l and was highest in the sand dredging area.

From the species of bacteria isolated in the water, there are established pathogens with a history of causing different diseases to humans and animals. *E. coli* is an enteric bacterium that has been associated with diarrhoea and dysentery, while Salmonella is known to be responsible for typhoid fever (Sang *et al*., 2012). Streptococcus species are associated with respiratory tract infection, while Staphylococcus are known pathogens (Cheesbrough, 2005).

The mean total viable count of the bacteria in the river ranges from26.67×10^7CFU/ml to 32.67×10^7 CFU/ml. Bacteria load varied significantly between different locations. The amount of coliform in the water was at the threshold, 3.33 MPN/100ml at the downstream but 6.33 MPN/100ml at the sand dredging sampling point. The total heterotrophic bacteria count and the coliform estimation results fell belowtheWHO,(2006) standards. The result shows that the microbiological status of the river water was poor. The relativelylow biological quality of the river in the study area was attributed to the anthropogenic activities. Therefore, the river water is not suitable for drinking without treatment(Okeke and Adina, 2013)

Heavy metal in the river water was found to vary significantly and mostly with values above the set minimum limits by World regulatory bodies. Lead was in the range of 0.13mg/l to 0.39mg/l, above the WHO 0.05mg/l set standard (Ibeneme *et al.,* 2014). Arsenic level ranges from 0.01-0.05 mg/l, which fell within the acceptable level for surface water. Similarly, the iron content was low (1.42-3.15mg/l), which is the threshold of the 3.0mg/l limit.The above chemical composition of the river water shows that the riverdoes not measure up with the minimum acceptablesurface water criteria. This was attributed to pollution of the water from various surfaces and its courses, according toUgwu and Wakara (2012). While rivers are the most important freshwater source to man, rivers are being polluted by indiscriminate sewage disposal, industrial wastes, and many human activities that affect their physicochemical and biological characteristics. As shown in this study, the poor quality of the river wateris a severe environmental problem. The heavy metals high concentration could accumulate in aquatic organisms such as fish, which indirectly affect humans through the food chain (Vaishali and Punita, 2010).Also, it is reported that water quality dependsmainly on the chemical composition, which is often modified by natural and anthropogenic sources (Verma*et al.*, 2011; Khatri and Tyagi, 2015).

Conclusion

From this study it could be concluded that there is significant difference in the physicochemical and biological composition of the Abayi Mbasa river waters at the different sample points. The physical properties varied between the sand dredging point and the point used for domestic activities and from the downstream water outside these areas. The BOD and COD were higher in the domestic point while the microbial load wasbeyond acceptable limits. The water was slightly acidic; all locations have high turbidity occasioned by high total, dissolved and suspended solids. The microbial quality was low, and the flora harboured many different bacteria species. Abayi Mbasa river water users, especially domestics, are exposed to potential infection dangerswith these pathogenic bacteria. This study recommends that the water should be treated where possible before use.

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