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Research Article

Physico-chemical and Bacteriological Assessement of Oyibo River in Ehime Mbano, Imo State

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Abstract

The physico-chemical and bacteriological assessement of Oyibo river, Ehime Mbano, was carried out between 2011 and 2012. Considering the communities that make use of this river for different purposes, water samples were collected from four different sampling points along the river and subjected to physico-chemical and bacteriological analyses. Pour plate method was adopted to determine total heterotrophic bacteria, and membrane filtration technique, for total coliforms and *E. coli* counts. Standard procedures for water analysis by APHA were adopted for the determination of physical and chemical parameters. Atomic Absorption Spectrophptometer (AAS) was used to analyze for heavy metals. The average values of total heterotrophic bacteria were 5.8×10^3 cfu/ml and 1.51×10^3 cfu/ml for rainy and dry seasons respectively. Average values for total coliforms and *E. coli* counts were 33.75 cfu/100ml and 6 cfu/100ml for rainy season, and 17.38 cfu/100ml and 4 cfu/100ml for dry season. Bacterial isolates included *E. coli*, *Salmonella spp, Lactobacilli spp, Klebsiella spp, Staphylococcus spp, Proteus spp*, and *Pseudomonas spp*. In all the water samples, the pH values ranged from 6.04 – 6.52. Average values of total hardness for rainy and dry seasons were 5.90mg/l and 5. 43mg/l respectively. The concentrations of nitrate, phosphate, chloride, and sulphate ranged from 0.00 – 16.40mg/l; 0.01 – 1.24mg/l; 0.13 – 0.35mg/l; 0.00 – 15.95mg/l respectively. Average COD, BOD and DO values were 5.63mg/l, 2.07mg/l, and 3.17mg/l in dry season, and 9.24mg/l, 1.77mg/l, and 4.26mg/l in rainy season. The values of heavy metals during the rains were within the range of 0.0008ppm – 1.5605ppm, but 0.0001ppm – 0.0339ppm, in dry season. There were no significant differences in some bacteriological and chemical properties with season, but the physical parameters such as depth, flow rate, pH, and turbidity were, at $p < 0.05$. The study revealed that Oyibo River is not safe for drinking (inasmuch as it serves as source of drinking water for some communities), unless subjected to appropriate treatment.

Keywords: Physico-chemical, Bacteriological, Assessement, Oyibo, River

Introduction

The quality of any water body is governed by its physico-chemical, bacteriological and heavy metal factors. The monitoring of physico-chemical characteristics of a water body is vital for both long term and short term evaluation of its quality. Lakes, rivers and streams have important multi-usage components, such as sources of drinking water, irrigation, fishery and energy production (Iscen *et al.*, 2008). Increase in human population, industrialization, intensive agricultural practices and discharges of massive amount of wastewater into the rivers and streams have resulted in deterioration of water quality (Herschy, 1999). The impact of these anthropogenic activities has been so extensive that the water bodies have lost their self-purification capacity to a large extent (Sood *et al.*, 2008). The physical and chemical characteristics of water bodies affect the biological species composition, abundance, productivity, and

physiological conditions of aquatic organisms (Bagenal, 1978). In Nigeria, studies on the physico-chemical quality of water Reports by Food and Agricultural Organisation (FAO) of U.S.A revealed that in African countries, particularly Nigeria, water-related diseases caused by microbes such as viruses, bacteria, etc had been interfering with basic human development (FAO, 2007), resulting to serious outbreak of diseases such as cholera, typhoid, etc.

Degradation of water quality is more severe in the four States in Nigeria where about 80 percent of the nation's industries are located; Lagos, Rivers, Kano and Kaduna States. A study by Umeh *et al* (2004) showed that people of Kastina-Ala in Benue State were affected by urinary Schistosomiasis due to increase in water pollution index. Olaoye and Onilude (2009) have documented varying levels of microbial contaminations of drinking water in parts of western Nigeria. There have been recorded cases of heavy metals poisoning (e.g Lead, Cadmium, Zinc, Copper, Arsenic, etc) through drinking water in Nigeria (Esoka & Umaro, 2004; Eniola *et al*., 2010). These have continued to pose threats on health and economic development in the country (Ajibade, 2004; Olayinka and Alo, 2004; Adekunle *et al*., 2007; Adeyemi *et al*., 2008; Mustapha, 2008; Adewolu *et al*., 2009).

Many rural and some urban dwellers in Nigeria depend on surface water (eg rivers and streams) for their daily water supply (Okereke & Nnoli, 2010). However, some of these water sources are under pollution threat, yet they have not been properly investigated. Among such rivers is Oyibo river in former Oyibo Local Government Developement Centre in Ehime Mbano, Imo State. The river cuts across more than four communities which the people depend on for their drinking water supply as well as laundry, irrigation, fishing and recreational activities, etc. These activities no doubt, directly or indirectly impact on the river water quality, hence the interest to investigate its quality status.

Materials and Methods

Water sample collection

Four water samples were collected in duplicates using $1dm^3$ sterile bottles from four different sampling locations guided by where human, and other sundry activities were spotted across the communities through which the river transverses. Samples were collected during and after the rains between August, 2011 and January, 2012 at different locations: Ibeafor Umunumo (samples A1 & A2), Umuezeala Nzerem (samples B1 & B2), Umueze Umunumo (samples C1 & C2), and Oparaocha (samples D1 & D2).

Laboratory analyses

Bacteriological investigations were carried out on the water samples; total microbial load of the water samples was determined using pour plate as reported by Pelczar *et al* (1993); the total coliform count and *E.coli* counts were determined using membrane filtration technique. Biochemical tests were carried out on the isolates for proper characterization. Depth of the river was determined using long metal meter-rule diped at different points at a given sampling location and average values recorded. The flow rate of the river was determined using float method. Concentrations of heavy metals were determined using atomic absorption spectrophotometer (AAS) at different wavelengths. Standard procedures for the determination of DO, BOD, COD and other basic water parameters were adopted using APHA methods

Results

As shown in Table 1, the average total heterotrophic bacteria ranged from 7.6×10^2 - 1.89×10^3CFU/ml. Average total coliform counts and faecal coliforms counts were 33.7 CFU/100ml, and 6.0 CFU/100ml; 17.4 CFU/100ml and 4.0 CFU/100ml, for rainy and dry seasons respectively. Some of the isolates were micro-organisms of public health concern in our drinking water supply, which included *Klebsiella spp*, *Staphylococcus*, *Lactobacilli*, *Escherichia coli*, *Pseudomonas spp*, and *Proteus spp* as shown in Table 2.

The results of physical and chemical parameters obtained from the analyses during rainy season are presented in Table 3. The pH values ranged between 6.04 – 6.52 while average depth was 186.50cm, with highest depth of 360.00cm recorded at Umueze Umunumo, and least (50.00cm), at Oparaocha. Flow rate of the river was highest (40.16m/s) at Umuezeala Nzerem and lowest (10.36m/s) at Oparaocha. Average value of hardness was 5.43mg/l. Conductivity was highest in water samples collected at Oparaocha (sample D) with value of 39.60μS/cm, and lowest (21.70μS/cm) in samples collected at Ibeafor Umunumo (sample A).

Table 1: Microbial population of water samples from Oyibo River

Season	**Samples**	**TMC (Cfu/ml)**	**TCC (Cfu/ml)**	**TFCC (Cfu/100ml)**
Rain	A1	7.6×10^2	45.0	4
	B1	1.56×10^3	49.0	13
	C1	1.28×10^3	22.0	5
	D1	9.8×10^2	19.0	2
	Average	**5.8×10^3**	**33.75**	**6**
Dry	A2	1.89×10^3	30.5	9
	B2	1.62×10^3	18.0	4
	C2	1.37×10^3	9.0	2
	D2	1.14×10^3	12.0	1
	Average	**1.51×10^3**	**17.38**	**4**

Key:

TMC**:** Total microbial count; TCC: Total coliforms count; TFCC: Total fecal coliform count .
Samples A1 & 2: Water samples collected from Ibeafor Umunumo during rainy and dry seasons respectively.
Samples B1 & 2: Water samples collected from Umuezeala Nzerem during rainy and dry seasons respectively.
Samples C1 & 2: Water samples collected from Umueze Umunumo during rainy and dry seasons respectively.
Samples D1 & 2: Water samples collected from Oparaocha during rainy and dry seasons respectively.

Table 2: Culture, morphology/biochemical identification of isolates

Morphology	**Gram staining**	**Catalase**	**Motility**	**Coagulase**	**Oxidase**	**shapes**	**glucose**	**maltose**	**Lactose**	**Sucrose**	**Presumate organism**
Creamy, raised smooth edge	+	+	-	+	-	Cocci	A/G	-/-	-/-	-/-	*Staphylococcus*
Round, large colonies with raised surface	+	+	-	-	-	Bacilli	A/-	A/G	A/G	-	*Lactobacillus*
Pink convex colonies with smooth edge	-	-	-	-	-	Rods	A/G	A/G	A/G	A/-	*Escherichia coli*
Creamy colonies with entire edge	-	+	-	+	-	Rods	A/G	A/G	A/G	A/G	*Klebsiella spp*
Flat, irregular colonies	-	+	-	-	-	Rods	A/G	A/G	-/-	A/G	*Proteus spp*
Creamy, irregular edge colony on nutrient agar	-	+	+	-	+	Rods	A/-	A/-	A/-	A/-	*Pseudomonas spp*

Key: + Positive result; - Negative result

Table 3: Average values of physico-chemical parameters of Oyibo river during rainy season

Parameters	**Sample A1**	**Sample B1**	**Sample C1**	**Sample D1**	**Average**
pH	6.52	6.37	6.39	6.04	6.33
Conductivity (µS/cm)	21.70	24.40	26.10	39.60	27.95
Sulphate (mg/l)	15.95	4.77	0.00	3.78	6.13
Bicarbonate (mg/l)	29.16	22.68	22.66	19.44	23.49
COD (mg/l)	13.00	8.13	10.51	5.32	9.24
Hardness (mg/l)	4.40	5.60	5.70	6.00	5.43
TSS (mg/l)	62.00	20.00	8.00	0.01	22.50
TDS (mg/l)	21.90	17.20	2.00	19.00	15.03
BOD (mg/l)	4.03	2.91	3.83	1.77	3.14
Nitrate (mg/l)	0.31	0.22	0.17	0.21	0.23
Dissolved oxygen (mg/l)	4.72	4.06	4.75	3.49	4.26
Turbidity (NTU)	88.00	29.52	5.70	2.43	31.41
Chloride (mg/l)	0.15	0.23	0.20	0.24	0.21
*Depth (cm)	94.00	242.00	360.00	50.00	186.50
*Flow rate (m/s)	20.49	40.16	30.50	10.36	25.38
Phosphate (mg/l)	0.01	0.09	0.01	0.07	0.05
Lead (ppm)	1.839	2.172	2.230	< 0.001	1.5605
Arsenic (ppm)	<0.001	<0.0001	<0.001	<0.001	0.0008
Cadmium (ppm)	0.012	0.0338	0.017	<0.001	0.0045
Nickel (ppm)	0.037	0.0072	0.108	<0.001	0.0383
Mercury (ppm)	0.010	0.0008	0.002	<0.001	0.0035

***** Depth and Flow rate were determined at locations where water samples were collected

Table 4: Average values of physico-chemical parameters of oyibo river during dry season.

Parameters	**Sample A2**	**Sample B2**	**Sample C2**	**Sample D2**	**Average**
pH	6.50	6.21	6.39	6.29	6.35
Conductivity (µS/cm)	19.50	19.30	22.20	19.40	20.10
Sulphate(mg/l)	12.83	9.05	15.54	12.83	12.56
Bicarbonate (mg/l)	35.64	38.88	38.88	32.40	36.45
COD (mg/l)	5.60	5.53	5.78	5.59	5.63
Hardness (mg/l)	5.20	5.59	6.40	6.40	5.90
TSS (mg/l)	5.00	7.00	16.00	4.00	8.00
TDS (mg/l)	10.00	11.40	1.22	0.00	5.66
BOD (mg/l)	1.88	2.03	2.25	2.11	2.07
Nitrate (mg/l)	0.50	0.00	16.40	9.20	6.53
DO (mg/l)	2.70	3.20	3.54	3.24	3.17
Turbidity (NTU)	7.71	8.22	6.83	4.93	6.92
Chloride (mg/l)	0.13	0.35	0.31	0.30	0.27
*Depth (cm)	54.00	97.00	118.00	65.00	83.50
*Flow rate (m/s)	31.84	19.63	30.64	15.38	24.37
Phosphate (mg/l)	1.08	1.24	0.23	0.86	0.85
Lead (ppm)	0.0172	0.0155	0.1028	<0.0001	0.0339
Arsenic (ppm)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium (ppm)	0.0146	0.0338	0.0493	0.0261	0.0310
Nickel (ppm)	0.0117	0.0072	0.0103	0.0017	0.0077
Mercury (ppm)	0.0014	0.0008	0.0022	<0.0001	0.0011

***** Depth and Flow rate were determined at locations where water samples were collected

Average values of COD, BOD, and DO were 9.24mg/l, 3.14mg/l, and 4.26mg/l respectively. The results for concentrations of nitrate, phosphate, chloride, and sulphate ranged from 0.17 – 00.31mg/l, 0.01- 0.09mg/l, 0.15 – 0.24mg/l, and 0.00 – 15.95mg/l respectively. The average values of heavy metal were within the range of 0.0008 – 1.5605ppm.

However, during dry season as shown in Table 4, the pH values ranged between 6.29 - 6.50 while average depth was 83.50cm with highest depth of 118.00cm recorded at Umueze umunumo, and least (54.00cm), at Ibeafor Umunumo. Flow rate of the river was highest (31.84m/s) at Ibeafor Umunumo and lowest (15.38m/s) at Oparaocha. Electrical conductivity, bicarbonate, hardness, and turbidity showed average values of 20.10µS/cm, 36.45mg/l, 5.90mg/l, and 6.92 NTU respectively. The values of sulphate, nitrate, chloride, and phosphate ranged between 9.05 – 15.54mg/l, 0.00 – 16.40mg/l, 0.13 – 0.35mg/l, and 0.23 – 1.24mg/l respectively. The average values of heavy metals ranged between <0.0001 - 0.0339ppm.

Discussion

Of most of the rivers studied in Nigeria, varying levels of organic and inorganic contaminations have been implicated which invariably encourages growth of different species of micro-organisms (Obasi *et al*., 2006). The microbial load of the studied river may be associated with organic or inorganic contaminations inasmuch as bacterial load recorded was relatively low. Also the bacteriological assessment showed isolation of organisms of public health concern which included *Staphylococcus spp*, *Escherichia coli*, *Klebsiella spp*, *Pseudomonas spp*, *Lactobacillus*, *Proteus spp.* The presence of *E.coli* was indeed indicative of other pathogens isolated among which are the heterotrophic aerobic bacteria, which are predominantly faecal coliforms, possibly from human or animal excreta (Anazoo and Ibe, 2005; Blum *et al*, 1987). *Staphylococcus spp*, being normal flora of the skin, may be from swimmers and other users since the river serves as source of drinking water, recreational activities, fishing, fermenting of cassava, etc for people of the communities. According to Okereke & Nnoli (2010a), about18.8 – 75.0% of the populace across Imo State make use of river water. *Pseudomonas spp* could be as a result of Oxygen depletion while *Bacillus spp* may be from the mode of collection. *Klebsiella spp* may be attributed to run-off from soil which agrees with the findings of Anazoo and Ibe (2005).

The results showed that concentration of heavy metals in the samples analysed were within permissible limit except Lead which recorded an average of 1.5605ppm in rainy season and 0.0339 in dry season. This differed from the findings of Okereke and Nnoli (2010b) who obtained lower values in some rivers studied in Eastern Imo State. Contamination can occur by the use of pesticides, fertilizers and more so, the proximity of the river to major roads across the communities, avails motorist and motorbyke operators the opportunity to wash cars and motorcycles at the river, which may be a contributory factors to the level of Lead recorded. Consumption of such water endangers the liver, placenta, brains, bones, kidney, as they are target organs.

Surface water and shallow wells are generally known to be affected by flooding, effluent discharges, and infiltration. The variation pattern of some physical properties of the river such as turbidity, which was higher during the rains, may not be far from the above assertion. This is synonymous with the reports of Imoobe and Oboh (2003).

The river depth and flow rate varied with season and location. The variations in depth are usually associated with the rainfall pattern of the drainage basin (Anyanwu, 2012), topographical factors, and other seasonal streams entering the river at different points. The average DO in the surface water samples of study in dry season was 3.17 mg/l; which may adversely affect fish catch by local fishermen, since DO of 4 mg/l and above can support aquatic life (Bangenal, 1978). The average values of dissolved Oxygen (DO) varied with season as higher values were recorded during the rains though the overall values were relatively low compared to other rivers studied in some parts of Nigeria (Aisien *et al*., 2010; Eniola *et al*., 2010). The low level of DO of surface water samples may be attributed to agricultural and organic wastes pollution.

Conclusion

The physico-chemical parameters and the levels of some heavy metals of Oyibo River as observed from this study are within the acceptable limits of World Health Organisation guidelines for drinking water. The

bacterial load of river however, is above the permissible limit hence water from Oyibo River cannot be classified as good or fit for drinking.

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