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RESEARCH ARTICLE

ASSESSMENT OF WATER QUALITY OF OGBESE RIVER IN OVIA NORTH-EAST LOCAL GOVERNMENT AREA OF EDO STATE, NIGERIA

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ABSTRACT

The pollution of Ogbese River in Ovia North-East L.G.A. of Edo State, Nigeria was studied. Parameters like pH, temperature, electrical conductivity, colour, odour, chlorides, nitrates, phosphates and heavy metal ions such as lead, chromium, zinc etc, were analyzed. Also various techniques such as titrimetric methods, atomic absorption spectrophotometry were employed in the determination of these ions. The results show that most of the pollution indices of the water samples analyzed indicate that the Ogbese River water falls within the acceptable range for natural waters according to the World Health Organisation (WHO, 2006) standards. However, the Ogbese River water falls short of potable water on account of high presence of coliforms bacteria found in the river water. Defecations of human, wild animals and runoffs from agricultural farmlands are believed to be the source of the coliforms bacteria.

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INTRODUCTION

The threats from pollutants in water supplies have been under searchlight for some time now because of the various adverse effects of the pollutants (Ogunlaja *et al.*, 2007; Yadav *et al.*, 2011). The effluents from industries, domestic wastes and sewage from homes, agricultural wastes contain contaminants which end up as run offs into rivers and pollutes the water. Such contaminants include mercury, chromium, lead, arsenic, copper, phosphates, nitrates etc (Isreal 2000; Kazuo 2001; Wang 2003; Demirel 2004 and Orjiekwe *et al.*, 2006). One major problem in developing countries is shortage of adequate potable water, especially in the rural communities that depend on streams, rivers, ponds and streams as chief source of drinking water. Anthropogenic factors have been identified as major source of pollution of water bodies (Liven 2005; Phiri *et al.*, 2005; Raccine 2005 and Kumar *et al.*, 2013). Nigeria, as a major producer of oil in the world has been suffering from severe environmental pollution, especially in the Niger Delta region where virtually all her oil production takes place. Concerns over the biological effects of increasing oil spillage on rivers, estuaries, fish ponds and other water bodies are mounting. Effective means of cleaning-up these spills have been sought after in order to reduce some of the harmful effects of spillage in the environment.

In one of our previous paper, we reported on the water quality index assessment of Evedonede and Ovia Rivers in Ovia North-East Local Government Area of Edo State, Nigeria (Orjiekwe *et al.*, 2006). Most pollution indices measured are far above the limits approved by WHO for clean, safe and potable water. Moreover, pathogenic organisms such as Coli forms, Pseudomonas, Vibrio, Samonella and Shigella spp. were confirmed present in the river waters. This has obvious great health implications for the rural dwellers. In the present study, efforts have been made to provide an insight into the concentration levels of contaminants in Ogbese River which serve as major source of water supply to the neighbouring rural communities. The study will be useful to governments at local, state and national levels as well as to other agencies concerned with environmental health and well being of rural dwellers.

MATERIALS AND METHODS

The Ogbesse River water samples were collected with clean plastic bottles for analysis in the Analytical Chemistry Laboratory. The map of the sampling area which is Ogbesse town located within Ovia North-East LGA of Edo State, Nigeria is shown Figures 1 and 2. The physicochemical parameters and microbiological studies were determined by standard methods as reported extensively in one of our previous papers (Orjiekwe *et al.*, 2006). Briefly, the measurements include:

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Metal	Al	Cd	Cr	Cu	Fe	Pb	Mn	Hg	K	Na	Zn	As
Spect	Hach	AAS	AAS	AAS	Hach	AAS	AAS	AAS	AAS	AAS	AAS	AAS
λ (nm)	535	228.8	357.9	324.7	510	283.3	279.5	253.7	536.9	535.6	213.9	257.9

HACH spectrophotometer. Titrimetric methods was employed in the determination of Ca^{2+} and Mg^{2+} at controlled pH values. Initially, the river water samples were titrated with EDTA to determine the total content of Ca^{2+} and Mg^{2+} ions using Eriochrome black as indicator. For the determination of Mg^{2+} ions alone, the Ca^{2+} ions was first precipitated as its oxalate and removed by filtration. Thereafter, the river water samples were titrated with EDTA using Eriochrome Black indicator. The solution changed from wine red to blue at the end point.

Chlorides

In the determination of chlorides, the mercuric nitrate method was used. Chloride ions reacted with mercuric ions to form a highly stable complex, which was titrated with a standard solution of mercuric salt. The end point was determined by a diphenylcarbazone indicator, which formed a blue violet complex with an excess of mercuric ions.

Nitrate

The cadmium reduction method was employed for nitrate determination. Nitrate was reduced to nitrite when a sample was passed through amalgamated cadmium granules.

Nitrite

A spectrophotometer equipped with 10mm cell, adjusted to a wavelength of 540nm was used to determine the nitrite concentration of the river water samples.

Phosphates

A Hach spectrophotometer equipped with 10mm cell, adjusted to a wavelength of 575 nm was used to determine phosphate concentration.

Sulphates

In the determination of sulphates in the river water samples, sulphate was precipitated as barium sulphate in hot hydrochloric acid medium by addition of barium chloride.

Dissolved Oxygen (DO)

The iodometric method was employed for the determination of dissolved oxygen. A solution of manganous salt was added to the sample followed by sodium hydroxide. The manganese hydroxide revert to a divalent state with liberation of iodine equivalent. The iodine was then titrated with a standard solution of sodium thiosulphate.

Biochemical Oxygen Demand (BOD)

The BOD is an empirical test used to estimate the relative oxygen requirements of waste waters, effluents and polluted water bodies. The dilution test was applied skillfully in the BOD determination of the river water samples. The dissolved oxygen content of the river water samples was determined before and after incubation for five days at 20°C.

Chemical Oxygen Demand (COD)

The dichromate method which is the reference method for COD determination was used. The river water samples were boiled under reflux with potassium dichromate and silver sulphate in strong sulfuric acid. Parts of the dichromate was reduced by organic matter and the remainder was titrated with ferrous sulphate. The solution changed from its previous blue-green to reddish brown colour when the end point was reached.

Microbiological Studies

Culture Media and Chemicals

Mc Conkey agar and lactose sugar

Methods

Each container of the river water sample was shaken properly and 1ml sample volume was then obtained in a test tube in triplicate. These were diluted appropriately and plated on Mc conkey agar for coli forms determination. The plates were incubated at 37°C for 48 hours. All procedures were carried out in an aseptic screen and repeated three times. The total coli forms load was counted and subsequently isolated and confirmed using the lactose sugar test. A positive gas or acid production at the end of incubation period is an indication of the presence of coli forms bacteria.

Statistical Analysis

Statistical analysis on the data obtained was performed with ANOVA method using WHO, FMEV and DPR limits as standards.

RESULTS

Table 1 shows the result of the physicochemical properties and microbiological studies of water samples collected from Ogbese River in Ovia North East L.G.A. of Edo State, Nigeria in comparison with the recommended limits by three regulatory bodies namely: World Health Organisation (WHO), Federal Ministry of Environment (FMEV), Nigeria and Department of Petroleum Resources (DPR), Nigeria. The temperature values for the river water fell within the acceptable limit of 27°C - 35°C for both upstream and downstream regions. The pH was in the range of 6.70 - 6.73 for both upstream and downstream regions. Electrical conductivity was 138 – 139 $\mu\text{S}/\text{cm}$ which is low compared to FMEV limit of 10,000 $\mu\text{S}/\text{cm}$. The conductivity of the water samples were due to dissolved ions in them. The range for total suspended solid was 1.33 - 1.6 mg/L compared with FMEV limit of 30 mg/L. Ogbese River had a hardness value of 22.43 mg/L as against 100 mg/L limit recommended by WHO. The dissolved oxygen, (DO), a measure of how much the river water samples is saturated with oxygen is in the range of 4.2-

Table1. Result of Physicochemical Properties and Microbiological studies of Ogbese River Water, Edo State, Nigeria

Parameter measured	Units	1	2	DPR Limit	FMEV	WHO limit	Method
<i>Sample ID</i>		1A	1B				
<i>Temp.</i>	°C	27	27	30	35	27	EPA 79
<i>pH</i>		6.73	6.70	6.5-8.5	6.0-9.0	6.5-8.0	ASTM D1293-95
<i>EC</i>	µS	238	139	10000	10000	N/A	ASTM D1125-95
<i>TSS</i>	mg/L	1.33	1.6	50	30	N/A	ASTM D1868
<i>TDS</i>	mg/L	71.8	72.3	2000	2000	1000	ASTM D1868
<i>Turbidity</i>	NTU	5.20	5.90	15	30	5	ASTM D1889-94
<i>Hardness</i>	mg/L	22.43	22.43			100	ASTM D1126-69B
<i>Colour</i>		Odourless	Colourless				
<i>Odour</i>		Odourless	Odourless				
<i>DO</i>	mg/L	4.2	4.6	>4.0	>4.0	6.2	APHA-507 5e
<i>BOD</i>	mg/L	3.4	4.5	125	50	6	APHA-507
<i>COD</i>	mg/L	39.3	41.5	125	40	40	ASTM D1252-95
<i>HCO₃⁻</i>	mg/L	35	42.7			N/A	ASTM D1067-92(1996)
<i>CO₃²⁻</i>	mg/L	ND	ND				ASTM D1067-92(1996)
<i>CN⁻</i>	mg/L	ND	ND				ASTM D3026
<i>Ca²⁺</i>	mg/L	5.77	4.49			75	ASTM D511-93A(1998)
<i>Mg²⁺</i>	mg/L	1.86	2.62			50	ASTM D511-93A(1998)
<i>SO₄²⁻</i>	mg/L	0.33	0.66			400	APHA 427 C
<i>PO₄³⁻</i>	mg/L	5.904	23.266	N/A	N/A	0.26	ASTM D515-88
<i>NO₃⁻</i>	mg/L	ND	ND			50	ASTM D3867
<i>NO₂⁻</i>	mg/L	ND	ND				ASTM D3867
<i>S²⁻</i>	mg/L	ND	ND				ASTM 427 C
<i>Zn</i>	mg/L	0.028	0.035			5	APHA 301 A
<i>Cu</i>	mg/L	0.013	0.022			1	APHA 301 A
<i>Pb</i>	mg/L	0.009	0.01			0.05	APHA 301 A
<i>Ni</i>	mg/L	0.003	0.004			N/A	APHA 301 A
<i>Cr</i>	mg/L	ND	ND			0.05	ASTM D1687-84(A)
<i>Mn</i>	mg/L	0.155	0.368			0.1	APHA 301 A
<i>Fe</i>	mg/L	0.37	0.48			0.3	APHA 301 A
<i>Cd</i>	mg/L	ND	ND			0.005	APHA 301 A
<i>As</i>	mg/L	ND	ND			0.05	APHA 301 A
<i>Al</i>	mg/L	ND	ND			0.2	APHA 301 A
<i>Coliforms count</i>	cfu/ml	2.5 x 10 ⁵	2.6 x 10 ⁶			10cfu/100ml	EPA-600/8-017,1978

4.6 mg/L which is within the range of 4.0 – 6.0 mg/L recommended by DPR, FMEV and WHO. Biological Oxygen Demand (BOD) was in the range of 3.4 – 4.5 mg/L compared to WHO limit of 6.0. Chemical Oxygen Demand (COD) was in the range of 39.3 – 41.5 mg/L compared to 40 mg/L limit recommended by WHO. Phosphate concentration was in the range 5.904 mg/L (upstream) to 23.266 mg/L (downstream) compared with WHO limit of 0.26 mg/L which suggests a high concentration of phosphates in the Ogbese River water. Nitrate, nitrite and sulphides were not detected in the water samples. Aluminum and heavy metals such as chromium, cadmium and arsenic were also not detected in the river water samples. Even the heavy metals present such as zinc, copper and lead are within WHO recommended limit. Coliform bacterial count values were extremely high ranging from 250,000 cfu/ml – 2600000 cfu/ml as against 10 cfu / 100ml WHO recommended limit.

DISCUSSION

The physicochemical characteristics of the water samples collected from Ogbese River are presented in Table 1. The value obtained for each parameter is the mean of three replicate readings. Two sampling points were chosen separated by a distance of one kilometer. One is upstream and the other downstream. Temperature measurements are one of the most important factors as the degree of hotness or coldness of the river water body affects the aquatic organisms (Nicholas, 2005). The temperature of the Ogbese River water samples collected was found to be 27°C which is within the acceptable range by the World Health Organisation, (WHO, 2001; 2006).

The normal desirable level for temperature as stipulated by the WHO and FMEV (Federal Ministry of Environment) is within the range of 27-35°C. The pH range of the river water samples (6.70 – 6.73) fell within the acceptable range of 6.0 – 8.0 prescribed by DPR, FMEV and WHO although it lies slightly on the acidic side. The river water may however be regarded as being neutral (Fakayode, 2005). The pH is a very important factor for determining the quality of the river water because it controls the solubility and availability of mineral nutrients and heavy metals to aquatic organisms (Fakayode, 2005).

Turbidity is a measure of clarity of the river water. The higher the measured TSS and TDS in the water, the higher is the turbidity and the converse is also true. The Ogbese River water is colourless, odourless with slight astringent taste because the values of turbidity (5.20 -5.90 NTU), total suspended solids, TSS (1.33-1.60 mg/L), Total Dissolved Solids, TDS (71.8 – 72.3 mg/L), hardness (22.43 mg/L) and electrical conductivity ,EC (138-139 µS) are very low and lie within allowable limits recommended by FMEV, DPR and WHO. The slight astringent taste has been attributed to the dissolved ions, especially iron in the river water. The iron concentration in the river water exceeded WHO standard of 0.3mg/L. The hydrolysis of ferric ion in water affected the pH making it slightly acidic as indicated by the pH (Orjiekwe *et al.*, 2006). Nitrates and nitrite are notorious alga nutrients. The fact that nitrates and nitrite were not detected in the river water samples rules out the possibility of excessive algae growth from sewage and industrial discharges nearby. This observation corroborates with the BOD and COD values which are within allowable limits recommended by FMEV, DPR and WHO.

The nitrate level for Ogbese River is in sharp contrast to that observed elsewhere (Ogbeigbu 2002; Ano *et al.* 2008 and Thomas *et al.* 2011). According to Ogbeigbu (2002), pollution from organic sources from a brewery plant nearby affected negatively the growth and feeding habits of fishes in Ikpoba River, Benin city. Similarly, Ano *et al.* (2008) observed that population density, urbanization and industrialization are largely responsible for the high level of nitrate ions in underground water from Abia state which far exceeded the WHO limits. Similarly, Thomas *et al.* (2011) reported that the high concentration levels for nitrate observed in well water from Eloor industrial area of India which exceeded the WHO guidelines are largely due to pollution from industrial effluents from industries in the area. Phosphate concentration was in the range 5.904 mg/L (upstream) and 23.266 mg/L (downstream) which are high compared with WHO limit of 0.26 mg/L. The high phosphate values and the disparity between the upstream and downstream values have been attributed to the indiscriminate use of linear alkylbenzene sulphonate-bearing detergents and soaps during laundry and bathing activities witnessed by the river banks (Orjiekwe *et al.*, 2006; Kana, 2004). Sulphate concentration in the river samples tested was low and within allowable limits (Odukoya, 2002). The heavy metals, chromium, cadmium and arsenic were not detected in the Ogbese river water samples while zinc, copper and lead are present within the allowable limits recommended by WHO for safe drinking water (WHO, 2001; 2006).

This implies that the river water is free from heavy toxic metals that have been implicated elsewhere in various forms of cancer (Odokun, 2000; Ideriah, 2001; Wang, 2003; Orjiekwe *et al.*, 2006). Total coli forms bacterial count is utilized as a microbial measure of drinking water quality, largely because they are easy to detect and enumerate in water. The coliforms bacterial count values in the Ogbese river water are extremely high ranging from 2.5×10^5 cfu/ml for upstream to 2.6×10^6 cfu/ml for downstream as against 10cfu/100ml recommended by WHO for potable water (WHO, 2006). Therefore, the Ogbese River water is not fit for drinking on account of the coli forms bacterial count. Faecal contamination from human, wild animals and runoffs from domestic homes and agricultural farmlands have been ascribed as the source of the coliforms bacteria in the river water (Orjiekwe *et al.*, 2006). Similarly, Nhapi, (2001) reported that sewage discharges into Marimba River, Zimbabwe is largely responsible for high nitrate level and coliforms bacterial count in the River. The statistical analysis indicate that apart from phosphates, iron and coliforms, most pollution indices measured for Ogbese River water are relatively within the allowable limits compared with our previous study on Evedonedo and Ovia Rivers (Orjiekwe *et al.*, 2006).

Conclusion

The Ogbese River water is not fit as drinking water on account of the coli forms bacterial count and the phosphate content, even though most of the other pollution indices fall within the allowable limits by DPR, FMEV and WHO. This obviously have great health implication for the rural dwellers that depend mostly on the river water for drinking, washing and other domestic uses. The Ogbese River water are to a large extent virtually free from toxic heavy trace metals such as cadmium, arsenic, lead and chromium which are cancerous.

Governments at Federal, State and Local government areas and even Non-governmental Agencies and International bodies are enjoined to sink functional boreholes for the rural dwellers to discourage them from using the Ogbese River as drinking water. Also, conscious efforts through awareness campaign should be made to educate the local rural dwellers on the scourge and inherent danger of drinking the Ogbese River water.

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