Physicochemical Qualities of Ogbese River, Ovia North East LGA, Edo State, Nigeria

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Abstract: Ogbese river is the primary source of drinking water for the community's inhabitants. It is located in Ogbese town, Ovia North East Local Government Area of Edo State, Nigeria. This study aimed to evaluate the physicochemical parameters which are of public health significance from Ogbese river in Ovia North East Local Government Area of Edo State, Nigeria. Three sampling points, upstream, midstream, and downstream, were chosen with intervals of 100 meters apart, and water samples were collected against the water current. Samples for physicochemical analyses were collected in sterile clean containers, appropriately labelled, and analyzed using standard analytical methods. The results showed that temperature ranged from 26.00 ±1.00^{0}C - 27.00 ±1.00^{0}C, pH ranged from 6.63 ±0.12 - 8.20 ±0.10, total dissolved solids ranged from 24.83 ±1.53 mg/ml - 156.77 ±16.47 mg/ml and conductivity ranged from 48.00 ±3.00 µS/cm - 224.07 ±166.53 µS/cm respectively. The results of the physicochemical analysis showed that the parameters sampled apart from Temperature and pH values were all below the permissible limit. Concerted efforts should be put in place, by the relevant authorities, to checkmate the public health menance associated, with the consumption of water from Ogbese river, Nigeria.
Key word: Dissolved solids, heavy metals, Ogbese river, public health

INTRODUCTION

Water is one of the most important natural resources which is essential in the life of all living organisms from the simplest plants and microorganisms to the most complex living system known as the human body (WHO, 1991; 2011). Water resources are vital in various aspect of life; human consumption, cultivation of plants, environmental management and economic development (Akhtar *et al.,* 2021). The management of water pollution and water resources, play a vital role at both local, national and international level. This is because the various uses of potable water, affects the quality and quantity of its availability (Ogedengbe and Akinbile, 2004).

Pollution-causing activities have caused severe changes in aquatic environments over the last few decades and have affected the safe use of river water for drinking and other purposes in recent times. Several contaminants pollute the river water hence it is of great concerns in our communities because rivers play a vital role in shaping up the natural, cultural, and economic aspects of any country (Sharma *et al.,* 2020). Contamination of water arises from various human activities (agricultural, industrialization and urbanization) from industrial and residential areas which eventually goes back to the water bodies and results in the water quality degradation as well as outbreak of diseases (Akhtar *et al.,* 2021; Bashir *et al*., 2020).

Ogbese River is about 150 meters from the community. Some of the anthropogenic activities in and around Ogbese river include washing of cars, motor bikes, farm produce, clothes, bathing, open defecation and urination, which are capable of causing deleterious deviation from the standard values of both the physicochemical quality of the river (Olayinka *et al*., 2021). Anthropogenic activities bring almost contamination and subsequent pollution to our varied ecosystems (Bashir *et al*., 2020).

It is noteworthy that, there have been limited reports of public health cases amongst the consumers of water from Ogbese river. Several reasons could be adduced for this, ranging from poor diseases data management system, insignificant number of casualties, acquired immunity over time, natural ability of the river to self – purify amongst other factors, which are not within the scope of this study. However, findings from this study could provide prophylactic measures, whenever there is an incidence of an epidemic associated with the consumption of water from Ogbese River, Nigeria.

MATERIALS AND METHODS

Study area: River Ogbese lies between longitude 5°26' and 6°34' and latitude 6°43'E and 7°17' E. The River runs through Ogbese town, a town which is about five kilometers from Akure, in Akure North Local Government Area of Ondo State, Nigeria. River Ogbese is one of the major perennial rivers in South Western Nigeria. It took its source from Awo Ekiti in Ekiti State. It flows for approximately 22 km from its source to meet River Ose which is 265 km long and discharges into the Atlantic Ocean through an intricate series of creeks and lagoons (Ajakaye *et al*., 2017).

Sample collection: The samples were collected from three sites; upstream midstream and downstream approximately 100 m apart using three sterile 4 l plastic containers labelled A, B and C respectively. The samples in containers were transported to the laboratory within 2 hours with an iced pack.

Physicochemical analysis: The physicochemical properties of the river water samples were determined using standard methods for analysis of water. The parameters determined were: temperature, which was determined *in-situ* using an infra-red thermometer. A portion of the water sample was used for determination of pH and electrical conductivity of the water. pH metre (model 300408.1, Denver Instrument Company, Bohemia, New York, USA) was calibrated using millesimal buffers of pH 4.0, and 7.0 before taking the measurements. The electrical conductivity of the samples was determined on site using a multi-parameter analyzer (Hach model C0150). Total Dissolved Solids and total suspended solid were determined using multiparameter analyzer (Hach model C0150). Turbidity was determined by pouring twenty-five milliliters (25ml) of water sample into the cuvette and read at zero in the spectrophotometer at 450 nm. Dissolved Oxygen, Biological Oxygen Demand and Chemical Oxygen Demand were determined using the method described by APHA (1999). Determination of sulphate concentration was carried out using the turbidometric method. Concentration of phosphate in the water samples was determined by the molybdenum blue method. Ammonium nitrate was determined by indophenol method involving oxidation with sodium hypochlorite and phenol solution. Colour was determined using atomic absorption spectrophotometer (AAS) (Perkin Elmer Analyst 200). FME (1991); WHO (1991); AOAC (2000).

RESULTS

Physicochemical parameters of water samples

Table 1 shows the physicochemical parameters of Ogbese river water at different months of sampling. The findings revealed that temperature had a range of 26.00 ± 1.00^0C – 27.00 ± 1.00^0C, pH ranged from 6.63 ± 0.12 – 8.20 ± 0.10, total dissolved solids had a range of 24.83 ± 1.53 – 156.77 ± 16.47 mg/ml. The conductivity ranged from 48.00 ± 3.00 - 224.07 ± 166.53 µS/cm, while alkalinity had a range of 11.33 ± 1.53 – 17.33 ± 1.15. The dissolved oxygen and biochemical oxygen demand ranged from 0.73 ± 0.06 – 0.83 ± 0.32 mg/l and 1.37 ± 0.21 – 1.73 ± 0.15 mg/l respectively, while the chemical oxygen demand values ranged from 31.33 ± 3.06 – 45.00 ± 3.00 mg/l. The temperature and pH were within the Nigerian Standard of Drinking Water Quality (NSDWQ) permissible limits of 25^0C – 30^0C and 6.5 – 8.5 respectively. The total dissolved solids, conductivity and alkalinity were significantly below the NSDWQ permissible limits of 500 mg/ml, 1000 µS/cm and 100 respectively.

Physicochemical parameters in terms of dissolved nutrients of Ogbese River

Table 2 shows the physicochemical parameters in terms of dissolved nutrients of Ogbese River over the months of sampling. The findings revealed that nitrate content had a range of values from 1.18 ± 0.10 – 1.40 ± 0.10 mg/ml, phosphate ranged from

0.42 ± 0.04 - 0.64 ± 0.04 mg/ml. The sulphate content ranged from 3.67 ± 1.15– 4.00 ± 0.00 mg/ml. These parameters were significantly below the NSDWQ permissible limits of 50 mg/ml for nitrate and phosphate and 100 mg/ml for sulphate.

Heavy metal content of Ogbese River

Table 3 shows the physicochemical parameters in terms of the heavy metal content of Ogbese River over the months of sampling. The result revealed that lead and cadmium were below detectable limits. However, zinc had a range of values from 0.33 ± 0.05 (mg/ml) – 0.37 ± 0.10 (mg/ml). The chromium content ranged from 0, 03 ± 0.00 (mg/ml) – 0.07 ± 0.02 (mg/ml). The zinc and chromium were significantly below the NSDWQ permissible limits of 3 mg/ml.

Table 1: Physicochemical properties of Ogbese river water sampled from January to March, 2019

Parameters	January	February	March	NSDWQ	WHO
Temperature (°C)	26.00±1.00[a]	27.00±1.00[a]	26.00±1.00 [a]	25-30	-
pH	6.63±0.12[a]	8.20±0.10[b]	6.70±0.00[a]	6.5-8.5	6.8-7.5
Suspended solid (mg/l)	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	3	0.02
Turbidity	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	5	5
Total dissolved solid(mg/l)	24.83±1.53[a]	156.77±116.47[a]	25.17±0.58[a]	500	5
Total solid (mg/l)	24.83±1.53[a]	156.77±116.47[a]	25.17±0.58[a]	-	5
Conductivity (µS/cm)	48.00±3.00[a]	224.07±166.53[a]	59.33±1.15[a]	1000	100
Alkalinity	15.00±3.00[ab]	11.33±1.53[a]	17.33±1.15[b]	100	8.2
DO (mg/l)	0.77±0.15[a]	0.83±0.32[a]	0.73±0.06[a]	-	10
BOD (mg/l)	1.37±0.21[a]	1.40±0.36[a]	1.73±0.15[a]	-	10
COD (mg/l)	31.33±3.06[a]	34.67±10.69[a]	45.00±3.00[a]	-	10

Same alphabets across rows indicate no significant difference ($p>0.05$)

Keys: DO = dissolved oxygen BOD = biological oxygen demand, COD = Chemical oxygen demand, pH = potential of hydrogen, ^{0}C = degree Celsius, NSDWQ = Nigeria Standard for Drinking Water Quality, WHO = World Health Organization.

Table 2: Physicochemical parameters of dissolved nutrients sampled from January to March, 2019

Parameters	January	February	March	NSDWQ	WHO
Nitrate	1.18±0.10a	1.36±0.54a	1.40±0.10a	50	0.02
Phosphate	0.48±0.06a	0.42±0.04a	0.64±0.04b	-	0.05
Sulphate	4.00±0.00a	3.67±1.15a	3.67±1.15a	100	0.05

Same alphabets across rows indicate no significant difference ($p>0.05$)

Keys: NSDWQ = Nigeria Standard for Drinking Water Quality, WHO = World Health Organization.

Table 3: Physicochemical parameters of heavy metals sampled from January to March, 2019

Parameters	January	February	March	NSDWQ	WHO
Lead	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.01	0.001
Cadmium	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.003	0.001
Zinc	0.33±0.05a	0.37±0.10a	0.35±0.03a	3	0.005
Chromium	0.06±0.01a	0.03±0.00a	0.07±0.02a	-	0.001

Same alphabets across rows indicate no significant difference ($p>0.05$)

Keys: NSDWQ = Nigeria Standard for Drinking Water Quality, WHO = World Health Organization.

DISCUSSION

It is the collective responsibility of every stakeholder, to ensure that the quality of the source of potable water, is deliberately maintained in order to sustain its continuous availability. The situation becomes even more critical, as human population and activities grow around the surface water, especially if it is the major source of water to the entire community (Ogedengbe and Akinbile, 2004).

The temperature of Ogbese River obtained in this study ranged between 26^0–27^0C. A similar range of temperature was reported by Pang *et al.* (2017). The variation in the temperature of surface waters, is capable of converting carbon (iv) oxide to oxygen and availability of more oxygen, can consequently enhance the growth rate of aerobic (Pang *et al.,* 2017).

The findings of the Total Dissolved Solids recorded ranged between 24.83 – 156.77 mg/l and it was significantly at variant with the findings of Zhang *et al.* (2017), who recorded a much higher TDS range of values. This difference in TDS value, may have been due to two mutually inclusive factors, which are seasonal variation and volume of water. During the rainy season, the volume of the river water increases, which may cause a decrease in the TDS value. Conversely, during the dry season or early rainy season, the volume of the river water decreases and there is a corresponding increase in TDS values. An increase in the total dissolved solids of surface water, has been reported to proportionately cause an increase in the overall salinity of the environment. Consequently, the high salinity of the environment may ultimately result to cell death or plasmolysis (Zhang *et al.*, 2017). Low TDS values were recorded in this study, the conductivity value of this study ranged from 48.00 ± 3.00 µS/cm–224.07 ± 166.53 µS/cm. These values were at variant with the study of Gadhia *et al*. (2012) as well as Akinbile and Omoruyi (2018), who separately reported a relatively, lower and higher electrical conductivity mean ± SD values of 32.27 ± 4.84 µS/cm and 1102.75 ± 414.53 µS/cm respectively, during the dry season. Generally, the electrical conductivity of a water body depends on the volume of water, which is influenced by amount of rainfall and the temperature. The higher the temperature and lower the volume of water, the lesser the electrical conductivity. This is because the level of ionization is relatively higher, when the surface temperature of the river is high and the volume of water is low Gadhia *et al*. (2012). Therefore, the variations in one or both of these factors, may have significantly accounted for the differences observed, in the values of electrical conductivity. The findings of the turbidity of Ogbese River, recorded in this study was quite high.

Throughout the period of sampling and analysis, the values obtained were 0.00± 0.00 NTU. Firstly, it was significantly below the NSDWQ permissible limit of 5 NTU. Secondly and comparatively, while Gadhia *et al*. (2012) recorded a relatively high mean value of 152 ± 48.28 NTU; Borthakur and Singh (2020), reported a mean turbidity value of 29.35 ± 2.01 NTU. Turbidity is the degree of transparency or light penetration and scattering of a water body. Therefore, several factors may influence the turbidity of a water body including the concentration and presence of suspended organic and inorganic materials such as planktons and other microscopic organisms, silt, clay and so on. In addition, tidal waves, decayed organic material and algal bloom may also negatively impact the turbidity of a water body (Davies-Colley and Smith, 2007; Bilotta and Brazier, 2008).

The alkalinity values recorded in this study ranged between 11.33 ± 3.00 – 17.33 ± 1.15. This was relatively higher than that reported by Idowu *et al*. (2020), who recorded a mean ± SD alkalinity value of 10.3 ± 1.7. This variation in values recorded may be due to the volume of water and the concentration of bicarbonates and other salts dissolved in the water.

The dissolved oxygen of Ogbese River in this study, had a range of values from 0.73 ± 0.06 mg/l – 0.83 ± 0.32 mg/l. Dissolved oxygen was not detected (ND), in the findings of Okoya *et al*. (2016). The values obtained in this study were significantly lower, than that obtained from the findings of Akinbile and Omoruyi (2018), who reported dissolved oxygen values ranging from 4.70 – 16.00 mg/l and a mean ± SD value of 10.23 ± 3.70 mg/l. Meanwhile, Idowu *et al*. (2020), recorded yet a higher dissolved oxygen values ranging from 22.5 – 25.2 mg/l from four (4) sampling sites and a mean value of 23.5 mg/l. The variation in the amount of dissolved oxygen from the various findings and this study are due to several factors. For instance, the higher the photosynthetic activities in the river, the lower the temperature, the higher the amount of dissolved oxygen. The higher the temperature, the lower the amount of dissolved oxygen. In addition, low salinity cumulative effect of tidal waves/wind velocity, may also increase the amount of dissolved oxygen Gadhia *et al*. (2012). The biochemical dissolved oxygen (BOD) recorded in this study ranged from 1.37 ± 0.21 mg/l – 1.73 ± 0.15 mg/l. In their separate findings, Okoye *et al.* (2016) reported a much higher mean ± SD BOD value of 23.50 ± 0.71, while Borthakur and Singh (2020), reported values ranging from 2.00 – 28.00 mg/l and a mean ± SD value of 13.29 ± 5.74 mg/l. Again, the variations in these BOD values, may be due to several factors including the temperature, pH, types and presence of aerobic organism, organic and inorganic materials (Gadhia *et al*., 2012).

Generally, there is a direct correlation between DO and BOD levels of a water body. The chemical oxygen demand (COD) values recorded in this study ranged from 31.33 ± 3.06 mg/l – 45.00 ± 3.00 mg/l. Borthakur and Singh (2020), reported similar range of COD values 18.00 – 49.00 mg/l and a mean ± SD value of 35.70 ± 7.63 mg/l in their findings, during the dry season of their study. Gadhia *et al*. (2012) reported a much higher COD value of 118.00 ± 31.72 mg/l, during the pre – monsoon (dry) season of their study. In their assertion, COD is in indication of the level of organic matter contamination and decomposition. Such pollutants could either be of domestic or industrial source.

For the dissolved nutrients, the amount of nitrate concentration recorded in this study ranged between 1.18 ± 0.10 mg/l – 1.40 ± 0.10 mg/l. These values were significantly lower than the findings of Okoye *et al*. (2016), who recorded a mean ± SD value of 17.00 ± 0.01 mg/l, during the dry season of their sampling. Conversely, Borthakur and Singh (2020), reported a range of nitrate values of 0.01 – 0.03 mg/l and a mean ± SD value of 0.51 ± 0.063 mg/l, which were significantly lower than that obtained from this study. The variation in the concentration of dissolved nitrates in the river, is determined by the amount of nitrogenous salts either from decayed organic matter, increase in phytoplankton excretory products, and reduction of nitrates and oxidation of ammonia as well as recycling of inorganic fertilizers, run off from neighboring farms (Gadhia *et al*., 2012). The dissolved phosphate levels recorded in this study had a range of 0.42 ± 0.04 mg/l – 0.64 ± 0.04 mg/l. These values were at variance with the findings of Borthakur and Singh (2020), who reported a low dissolved phosphate range of 0.02 – 0.09 and a mean ± SD value of 0.34 ± 0, 47 mg/l. High phosphate levels of surface waters, have been implicated as a major cause of algal bloom and excessive growth of aquatic plants, which can influence the turbidity. Considering the low phosphate levels of Ogbese river, from different findings, it tends to establish a correlation between the low phosphate levels and the low turbidity in NTU reported so far. The dissolved sulphate in Ogbese river recorded in this study ranged between 3.67 ± 1.15 mg/l – 4.00 ± 0.00 mg/l. These values were within the range of the findings of Okoye *et al.* (2016) who reported a dissolved sulphate values ranging from 0.01 – 26.00 mg/l, at 9 different sampling sites.

In the case of heavy metals, lead and cadmium were not detected in this study. This finding was in agreement with the study done by Elsherief *et al.* (2014) who also reported that lead was not detected in their study, especially during the dry season. However, while the amount of cadmium was not mentioned by Enabulele *et al.* (2022), it was detected in trace amounts at all the points (from upper to lower stream) throughout the month of February and only at the lower stream in the month of March (Olayinka *et al*., 2021). The values for the amount of zinc obtained in this study, ranged from 0.33 ± 0.05 mg/l – 0.37 ± 0.10 mg/l. Although Fronsolet *et al*. (2008), detected zinc from their findings, the values obtained were not only in trace amounts, but significantly lower than that reported in this study. The values of chromium obtained in this study, were in trace amounts and they ranged from 0.03 ± 0.00 – 0.07 mg/l. It was however, not detected by Elsherief *et al.* (2014) throughout the period of their study, except once with a value of 0.010 ± 0.000 mg/l, at the lower stream in the month of February.

The presence of heavy metals in water exerts a great impact on both the water and the sediments as well. As heavy metal persists in the environment, it results to bioaccumulation and a higher degree of toxicity to all forms of life. Comparatively, the level of their concentration in sediments, over time is much more than in the water. A more worrisome characteristic feature of heavy metals is, their non – biodegradability, which makes them relatively very lethal both within and outside a living system, from microscopic to the most complex, which is the human body (Olayinka-Olagunju *et al.,* 2022). Bioaccumulation and biomagnification of heavy metals, within edible aquatic life form like fishes, crabs, and prawns and so on, have been reported to be highly carcinogenic (Yadev *et al.,* 2008). Untreated chemical effluents from industries, waste water from washing of car and motor bike exhausts inside the river as well as mixing of crude oil contaminated water with fresh water are the commonly implicated sources of heavy metal contamination of surface water like Ogbese River Olawusi *et al*. (2014).

CONCLUSION

Ogbese river is a major source of water for both domestic, agricultural and other purposes. Seasonal variation and changes in the volume of water, coupled with other mechanisms, by which the river self- purify itself are ineffectual to maintain the portability of the water. This is against the backdrop that, findings from this research, has reiterated the negative impact of natural and anthropogenic processes on the contamination of Ogbese river. The water must be properly treated to meet NSDWQ or WHO physicochemical permissible limits before consumption.

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