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Assessment of Physico-chemical Properties and Water Quality of River Osse, Kogi State

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Abstract: Water is the basis of life and means must be put in place to check its quality for domestic purposes. The river Osse is one of the rivers located in Kabba, Kogi state, and it serves various purposes for the residents of its community. Water samples were collected from 3 stations of Osse river namely; Okoro, Odolu and ABU. These samples were accessed to determine if the water is suitable for domestic purposes. The results of the analyses of the water samples showed that the river had relatively good quality as the dissolved oxygen (DO_2) was within the international and local standards i.e. world health organization (WHO) and Nigeria industrial standards (NIS) respectively. The highest value recorded was 0.60 mg/l at station 1 in August and the lowest value was 0.18 mg/l at the same station in May. The highest mean value for the Nitrate concentration of the river was 36.47 mg/l at station 3 and the lowest was 26.12 mg/l at station 2 and this still falls within the standards laid down. TDS, chloride, alkalinity were in the range of 29-70 mg/l, 3.15-30 mg/l and 16-20 m /l respectively and none was above the limit set down by WHO and NIS. The pH level of all the stations throughout the study ranged from 7.4-7.9 meaning they were also within standards. The BOD highest value was 3 and was also within the tolerance range for pure water. The result shows that the River Osse was within the WHO international standard and not above the standards of the local set limits by NIS. Thus, making the river fit and good for domestic purposes.

Keywords: Water quality, Physico-chemical property, River Osse, Biological Oxygen Demand, Dissolved Oxygen.

INTRODUCTION

Water is an essential natural resource for sustainability of life on earth. Man depends upon inland waters, especially fresh water, for domestic and industrial use. Water is a vital commodity (NBS, 2012) and its sources include rivers, streams, lakes, wells, boreholes, spring etc. Rivers are among the oldest water bodies in the world (Higler, 2012). The monitoring of water quality is needed to provide an overview of water quality and to keep track of trends for long-range of the selected water quality parameters the water quality monitoring is used to detect actual or possible problems for water quality and to find specific causes and to determine the effect of any kind of convective activity nowadays, computer systems offer the opportunity of handling and manipulating databases in many ways that have not been formerly an option that is practical nevertheless, in recent decades, population growth, runoff of sewage from urban areas, and agricultural practices, increases nutrient inputs to the level of their natural occurrence, causing accelerated eutrophication (Choudhary *et al.,* 2010; Zanf *et al.,* 2010; Kuffour and Benjamin, 2014*).*

pH is the scale of intensity of acidity and alkalinity of water and measures the concentration of hydrogen ions. Pure water is very slightly ionized into positively charged hydrogen ions (H+) and negatively charged hydroxide ions (OH–). Water is neutral when the numbers of hydrogen ions and hydroxide ions are equal, hydrogen ion concentration (pH) is the standard measure of how acidic or alkaline a solution is, it is measured on a scale from 0-14. pH of 7 is neutral, pH less than 7 is acidic while pH greater than 7 is basic (Neha Gupta *et al.,* 2013). Hardness is most commonly associated with the ability of water to precipitate soap, water hardness arises due to the presence of cations such as calcium, magnesium and anions such as bicarbonates, chlorides, and sulphides (Makinde *et al*., 2015). The major contributors to water hardness are dissolved calcium and magnesium ions. Conductivity is the ability of water to carry electrical charges, it indicates the presence of ions in the water, changes in conductivity over time may indicate changing water quality, high conductivity could also be as a result of decomposition of organic matter and soil fertilizer (Tongue *et al.,* 2017).

Nitrates are a form of nitrogen, which is found in different forms in terrestrial and aquatic ecosystems, these forms of nitrogen include ammonia, nitrates and nitrites (USEPA, 2014). Nitrate is less toxic than the other forms of nitrogen in the aquatic environment, such as nitrite and ammonia, the nitrate concentration in surface water is normally low, but can reach high levels from agricultural runoff, or from contamination by human or animal wastes (Nahar *et al*., 2016).

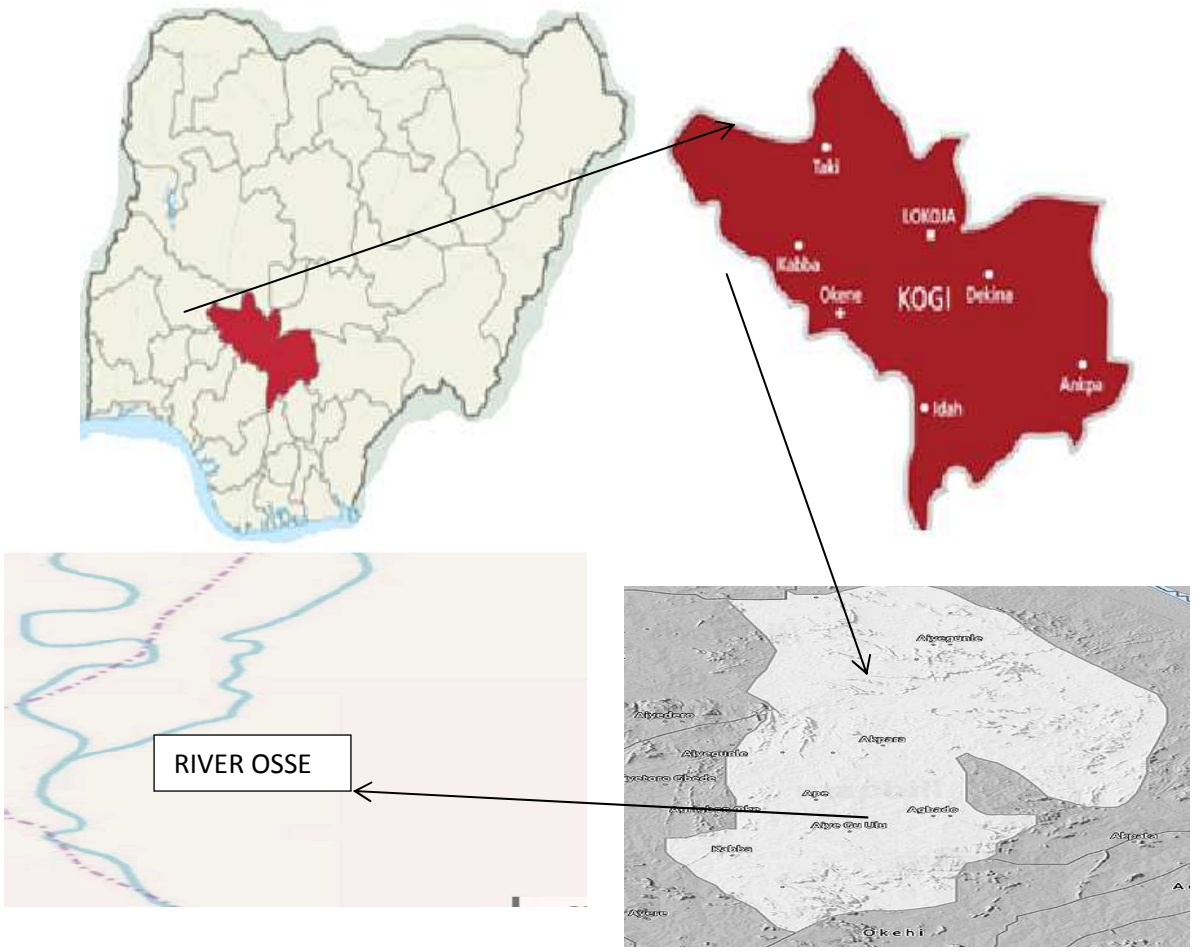
Biological Oxygen Demand is the measure of the oxygen required by microorganisms while breaking down organic matter, it has been used as a measure of the amount of organic materialism an aquatic solution which support the growth of microorganism (Deepak and Sangeeta, 2017). Nowara *et al.* (2013) discovered in his study that the river Turag showed higher BOD concentration in all seasons due to the presence of comparatively more organic waste in the river water, saying BOD of a river increases as organic waste increases.

The objective of the study is to investigate the suitability of the river for domestic uses, through physico-chemical analysis.

MATERIAL AND METHODOLOGY

Study Area

Kabba is located in Kogi State, in the north central zone of Nigeria with coordinates: 7°30'N 6°42'E, sharing boundary with Ondo State to the west, Abuja to the north, Nassarawa state to the north east, Benue state to the east, Enugu state to the south east, Anambra state to the south, Edo state to the south west, Ekiti state to the west, Kwara state to the west, Niger state to the north (the only state in Nigeria which shares boundary with ten states). River Osse is located in Kabba in Kogi state. It's coordinate are 6°9'0"N and 5°18'0"E in DMS (degrees minutes seconds) its UTM position is GG58 and its joint operation graphics reference is NB31-08. The standard time zone for River Osse is UTC/GMT +1 (Figure 1).



1: Map of Nigeria showing Kogi state and the course of river Osse in Kabba.

Sampling Techniques and Preparation of Samples

Sampling procedure

The sampling was carried out for four months, from May 2018 to August 2018. Water samples were collected monthly from the site using 1L plastic container (Before sampling, the containers were cleaned and washed with detergent solution and treated with 5% nitric acid (HNO_3) over night and rinsed properly) for three different stations namely station 1 (upstream), station 2 (middle course) and station 3 (downstream) for the four months of the experiment and taken to the laboratory for the test on the physio-chemical properties. Station 2 is 2 km from station 1 and station 3 is 3 km from station 2.

Measurement of physico-chemical parameters

Water samples for physico-chemical analyses were collected monthly for four consecutive months (May 2018 – August 2018) at the three sampling stations (Okoro, ABU and Odolu). The experiment took place in two phases, which was the in-situ (on field) and ex-situ (outside field).

In-situ experiment

In-situ phase of the experiment includes unstable parameter which can alter within a short period or are influenced easily or can only be determined on the field, such parameters include pH and water temperature which were determined using Hanna multimeter (APHA, 2014).

Ex-situ experiment

The water samples were taken using sampling bottles, previously rinsed with station water and transferred to labelled plastic containers. They were then stored at 4°C in cold ice during transport to the laboratory and analysed within 24 hours as recommended by the standards (Elshemy and Mean, 2011; APHA, 2014). The following parameters were determined ex-situ in the laboratory: Nitrate, Alkalinity, Biochemical Oxygen demand, Chlorine, Conductivity, Total Dissolved Solids and Dissolved Oxygen.

Data Analysis

Data obtained from physical and chemical measurements were statistically analysed for variance using the Microsoft excel 16.00 (Microsoft inc., USA) software package. The mean values were compared with the water quality criteria of the World Health Organization (WHO) and Nigeria Industrial Standard (NIS). Microsoft excel was used for graphical presentation.

RESULTS AND DISCUSSION

Physical Properties

pH

The pH values of samples taken at each station during the period of experiment were measured and presented in Table 1. It was observed from the table that the mean value of the pH for stations 1 and 2 (Okoro and ABU) was a little bit different to that observed at the station 3 (Odolu) The variation of the pH value recorded maybe due to the volume of water as at the time of collecting the samples and also the high and low value of pH may be due to the presence of contaminant across the rivers.

Table 1 shows high pH observed at station 1 during the first month may also be as a result of increase in fresh water emptying into the river, which is in agreement with Makinde *et al.,* 2015 in his study of Orugbo creek. The pH observed did not at any point exceed the standards (6.5-8.5) given by WHO (2014) and Nigeria industrial standard (2017).

Table 1: pH level for the three stations during the four month of study

Month	stations			Standards	
	1 (okoro)	2 (ABU)	3 (Odolu)	WHO (2014)	NIS (2017)
May	7.4	7.6	7.9	6.5-8.5	6.5-8.5
June	7.9	7.7	7.8		
July	7.5	7.4	7.5		
August	7.5	7.6	7.4		
Mean	7.58	7.58	7.65		

Conductivity

The values of conductivity measured in the three stations range from 17.0 µs/cm to 41.99 µs/cm (Figure 2). The lowest mean conductivity value recorded was 19.74 µs/cm at station 2 and the highest mean value was 24.97 µs/cm at station 1.

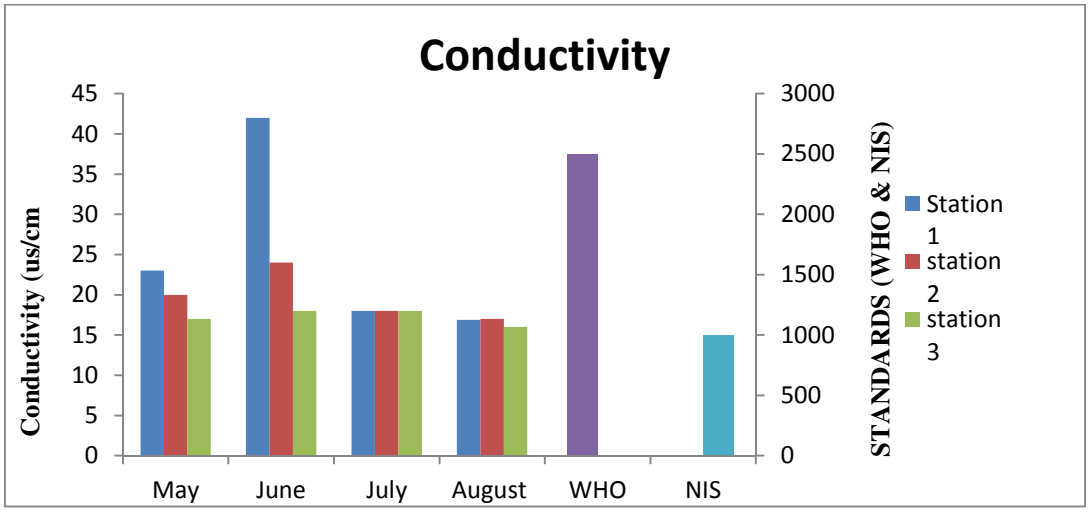


Figure 2: Bar chart comparing the conductivity of the stations for four months

Highest conductivity was recorded in station 1 in the second month of the study (Figure 2). The average mean of the three stations during the study was 20.65 us/cm. The conductivity when compared with World Health Organisation (WHO) standard and Nigeria Industrial Standard (NIS) shows the water is of good quality as WHO standard is 2500 us/cm and NIS limit is 1000 us/cm. The conductivity value which ranged from 17.0 us/cm to 41.99 us/cm (Figure 2) indicates that the water is fresh water as reported by Makinde *et al.,* 2015 in his study of Warri River, where he classified water below 1000 us/cm as fresh water. The difference in the values could be as a result of the presence of fertilizer or organic matter in the river at that particular time, it could also be as a result of high evapotranspiration rate, leading to high conductivity, this is also in corroboration with Akinrotimi *et al.,* 2015.

Hardness

Hardness value measured ranged from 75.0 mg/l $caco_3$ to 152 mg/l $CaCO_3$, (Figure 3). The highest value recorded was 152 mg/l $CaCO_3$ at station 1 in the first month of study (May) and the lowest value was 75 mg/l $CaCO_3$ at the third month (July) in station 2.

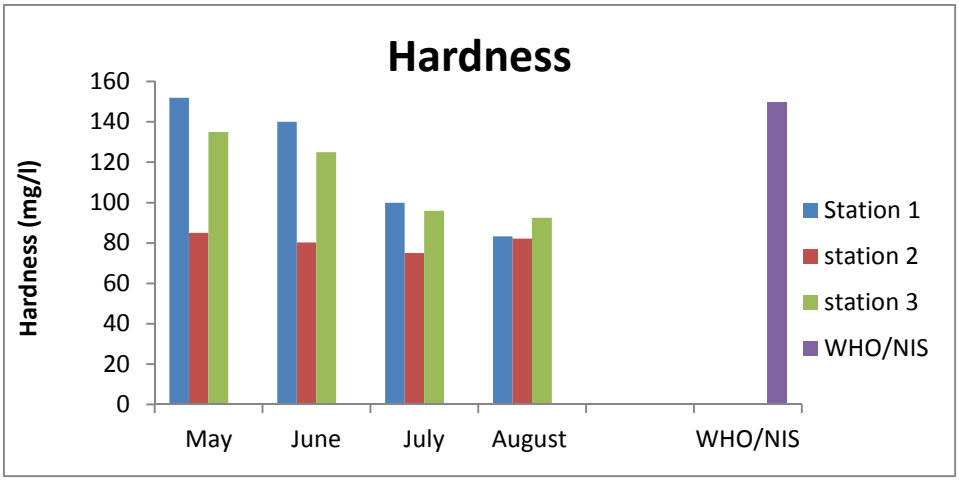


Figure 3: Bar chart comparing the hardness values of the stations for four months

The values varied significantly and difference of 77 mg/l was recorded (Figure 3). A mean value of 103.8 mg/l was recorded which classify the water as a medium hard water when compared with world health organization standard (WHO). The highest value recorded (152 mg/l) showed that the water was very hard at station 1 in the first month (May) as it was 2 mg/l higher than medium hard (as classified by WHO) which may be due to weathering of Calcium and Magnesium rich rocks in the area, as reported by Etim *et al.*, (2013).

Alkalinity

The value of alkalinity recorded in this study ranged from 16 to 20.0 mg/l (Table 2). The lowest mean value (17.75 mg/l) was recorded in station 2 and the highest mean value (18.75 mg/l) was recorded in station 3.

Table 2: Alkalinity value for the three stations during the four month of study

Month	stations			Standards	
	1 (okoro)	2 (ABU)	3 (Odolu)	WHO (2014)	NIS (2017)
May	17	18	16	100-200	-
June	19	16	18		
July	18	20	20		
August	18	17	21		
mean	18	17.75	18.75		

The highest value for alkalinity recorded was 21 mg/l (Table 2) and the lowest value recorded was 16 mg/l in June and May at station 2 and 3 respectively (Table 2). The mean value of the alkalinity was 18.16 mg/l is below the permissible level given by WHO (100- 120 mg/l) and therefore does not pose any challenge.

Total dissolved solids (TDS)

The total dissolved solids (TDS) values recorded in the study, ranged from 29 to 70 mg/l (Table 3). The TDS value was found to be highest (70 mg/l) in station 1 at the second month of study (June) and found lowest (29 mg/l) in the same station at August (Table 3).

Table 3: Total dissolved solids values for the three stations during the four month of study

Month	stations			Standards	
	1 (okoro)	2 (ABU)	3 (Odolu)	WHO (2014)	NIS (2017)
May	45	40	30	600	600
June	70	40	30		
July	30	30	30		
August	29	30	31		
mean	43.5	35	30.25		

The highest mean value was at station 1 (43.5 mg/l) and the lowest mean was at station 3 (30.25 mg/l). Station 1 shows the highest mean value of 43.5 mg/l, this could be as a result of more runoff in the area (Makinde *et al.,* 2015). The average mean of the three stations was 36.25 mg/l which is below the permissible limit given by world health organisation (WHO) and Nigeria industrial standard (NIS) of 600 mg/l. Station 1, though not above the WHO standards had the highest mean value, might also be as result of more human activities in the area like water carrying particles from the block industry very close to the station, similar occurrence was reported by Deepak and Sanqeeta, 2017 and Tonque *et al*., 2017.

Water temperature

The water temperature recorded in the study ranged between 27.2^{0}C and 30℃ (Table 6). The lowest temperature was recorded in station 2 (27.2℃) at the month August and the highest 30℃ both at stations 1 and 3 at May and August respectively (Figure 4).

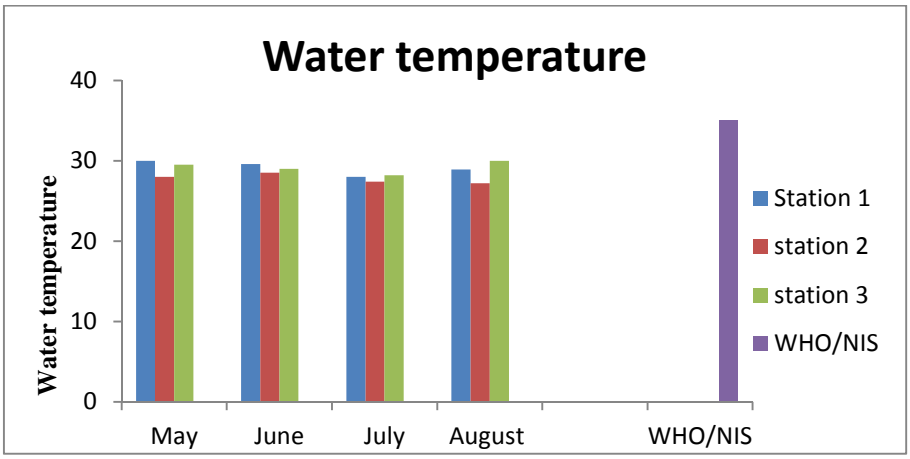


Figure 4: Bar chart comparing the water temperature of the stations for four months

The temperature values showed slight variation form each other, the highest mean value recorded was at station 3 (29.18℃) and the lowest mean value recorded was at station 2 (27.78℃). The mean value of the three stations was 28.7℃ which is lower than the permissible limit given by WHO (World Health Organization) of 25℃ to 35℃.

Chemical Properties

Dissolved oxygen (DO_2)

The Dissolved Oxygen (DO_2) values recorded during the study varied from 0.18 to 0.60 mg/l (Table 4). Station 1 recorded the highest value of DO (0.60 mg/l) and the lowest value of 0.18 mg/l.

Table 4: Dissolved oxygen value for the three stations during the four month of study

Month	stations			Standards	
	1 (okoro)	2 (ABU)	3 (Odolu)	WHO (2014)	NIS (2017)
May	30	28	29.5	-	-
June	29.6	28.5	29		
July	28	27.4	28.2		
August	28.9	27.2	30		
mean	0.39	0.37	0.35		

The mean values of the stations recorded were; 0.39 mg/l, 0.37 mg/l and 0.35 mg/l (stations 1, 2 and 3 respectively). The average mean of the dissolved oxygen (DO_2) for the three station was 0.37 mg/l, which indicate high presence of organic matter and gives the reason for low aquatic organisms in the river, dissolved oxygen (DO_2) does not have effect on drinking quality of water rather on the aquatic habitat in the river (Togue *et al.,* 2017). DO_2 below 1 mg/l retards the growth of aquatic organisms, which is in collaboration with Deepak *et al.,* 2017.

Nitrate

The values of nitrate recorded ranged between 18.42 mg/l to 41.38 mg/l (Figure 5). Station 3 recorded the highest value of nitrate (41.38 mg/l) during the second month of study (June) while the lowest value was recorded in station 2 in the month of May (Figure 5)

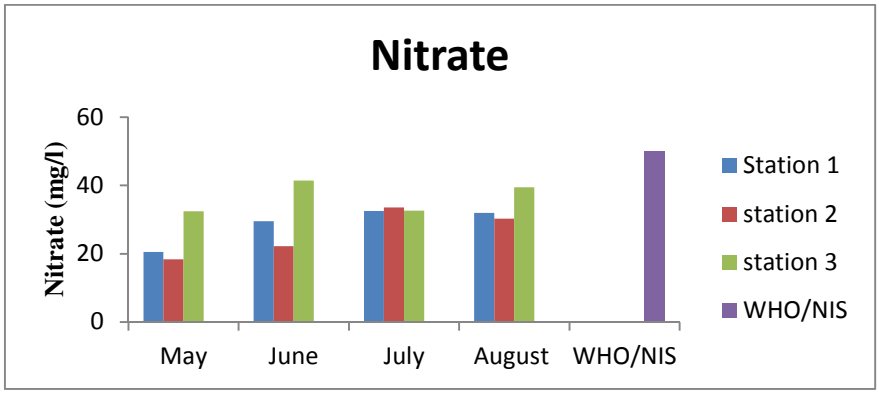


Figure 5: Bar chart comparing the nitrate level of the stations for four months

The highest mean recorded was at station 3 (36.47 mg/l), this indicates the level of micronutrients present in the river, which could be as a result of nitrate containing fertilizer used for the growth of crop plantation done close to river, this agrees with Ftsum *et al.* ,2014. The average mean was 30.4 mg/l which means the river did not in any point during the study go neither above the world health organization standard nor above the Nigeria Industrial Standard (both 50 mg/l).

Chloride

The chloride values recorded varied between 3.15 mg/l and 24.0 mg/l (Table 5). The lowest value of chloride recorded during the study was at station 3 in the month May (3.15 mg/l) and the highest value recorded was 24.0 mg/l at station 2 in May (Table 5).

Table 5: Chloride Value for the three Stations during the four month of study

Month	stations			STANDARDS	
	1 (okoro)	2 (ABU)	3 (Odolu)	WHO (2014)	NIS (2017)
May	17	24	3.15	250	250
June	17.75	13	2		
July	3.55	3.55	8.88		
August	5.6	4	9		
mean	10.98	11.14	5.76		

The reason for low chloride at some point may be due to the high activity rate of organisms and their ability to generally use up the chloride in the water (Etim *et al.,* 2013). The mean value for the three stations during the study period (May to August) was 9.29 mg/l, the highest mean was at station 2 (11.11 mg/l) and the lowest mean was at station 3 (5.76 mg/l), after comparing the average mean with the world health organization standard and the Nigeria industrial standard it was seen that the chloride level did not go above the permissible limit set down of 250 mg/l.

Biological Oxygen Demand (BOD)

The values of the Biological Oxygen Demand (BOD) ranged from 1.24 to 3.0 mg/l. The highest value of BOD was recorded in station 3 in May (3.0 mg/l) and the lowest value was at July at station 1 (Figure 6).

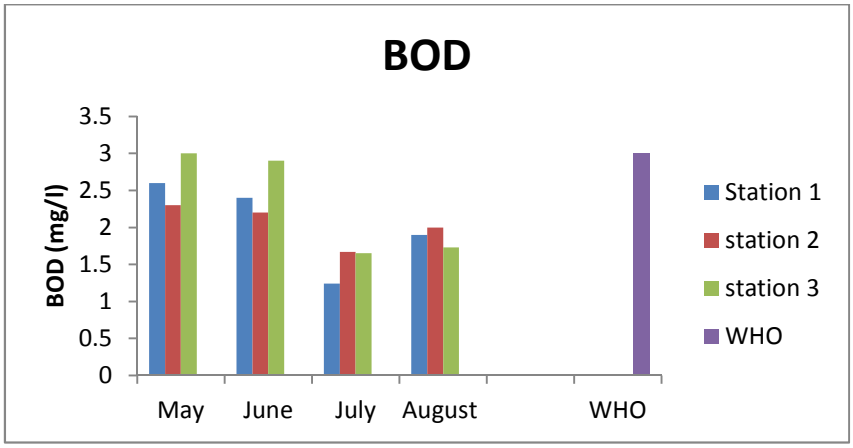


Figure 6: Bar chart comparing the BOD of the stations for four months.

The increase in BOD level in station 3 (Figure 6) may be due to the introduction of organic matter (Togue *et al.,* 2017). The highest mean value for the stations was recorded in station 3 (2.32 mg/l), the average mean value for the three stations during the study period was 2.13 mg/l. After the average mean (2.13 mg/l) has been compared to the world health organization standard (3.0 mg/l), it was found to be below the permissible limit for drinking water.

CONCLUSIONS

Quality water is a key to healthy living. The Osse River was analysed to determine if the river is fit for domestic usage. This was done by carrying out laboratory tests on the samples collected from three different stations namely; Okoro, ABU and Odolu. The result obtained from the analysis showed that most of the physical and chemical properties of the river that were tested fell within the range of the water quality standards as laid down by World Health Organization (WHO) and Nigeria Industrial Standard (NIS). When pH is concerned, the mean pH of station 1 was 7.58, station 2 was 7.58, and station 3 was 7.65, with all these values falling within the range of WHO and NIS standards. The nitrate values of the three stations (28.59. 26.13 and 36.47 for Okoro, ABU, and Odolu respectively) were found to be less than 50 mg/l which means they're still within the permissible level set down by WHO and NIS for domestic usage. All other parameters such as BOD, conductivity, alkalinity, water temperature, chloride and total dissolved solids were also within the permissible laid down standards of water. Therefore, it can be concluded that the River Osse, at this moment is very suitable for domestic usage and will continue to satisfy the water demand of Kabba, provided that the river is well-guarded against agents of pollution.

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