PHYSICAL AND CHEMICAL SCRUTINY OF OBIZI RIVER IN AWKA SOUTH LOCAL GOVERNMENT AREA OF ANAMBRA STATE, NIGERIA FOR DOMESTIC PURPOSES.

Abstract

Physical and chemical scrutiny of Obizi River in Awka South Local Government Area of Anambra State were analyzed for its pollution level and determined if it will be fit for domestic purposes. It is significant for cooking, drinking, fishing, recreational and other uses. It flows via a channel that may be contaminated by industrial, agricultural, and other anthropogenic activities, limiting its normal uses for cooking, drinking, fishing, recreational and other uses. The parameters analyzed includes Nitrate mg/l, Nitrite mg/l, Magnesium mg/l, Zinc mg/l, TDS mg/l, Hardness mg/l, Sulphate mg/l, Phosphate mg/l, Alkalinity mg/l, Acidity mg/l, Sodium mg/l, BOD mg/l, COD mg/l, TSS mg/l, TS mg/l, OD mg/l, potassium mg/l. The zinc, nitrate component of the samples was measured using a UV VIS spectrophotometric method, Sulphate was determined turbidimetrically by absorption spectrophotometry, magnesium content, total hardness, alkalinity was determined using titration, TDS (mg/L) were determined by Multi-Meter (HI 991300, Hanna Instruments, Romania), potassium and sodium ions were determined by flame photometric method, chemical oxygen demand (COD) was determined photometrically using the SpectroQuant Nova 60 COD cell test (Merck) in the range of 10 – 150 mg/L, biological oxygen demand (BOD) was determined using the OxiDirect BOD system, total suspended solids (TSS) was calculated as the difference between total solids and total dissolved solids, total solids was determined gravimetrically, oxygen demand (OD) was determined in-site using dissolved oxygen meter JENWAY-3405 (Manufacturer: Barloworld Scientific Ltd-England), ascorbic acid method was used to determine phosphates. The parameters were subjected to ANOVA single factor to determine if the results were significant or not and the result of ANOVA showed that it is statistically not signifiacnt. The result of ANOVA concluded that there is no significant difference between the physicochemical characteristics of the water samples because even though most of the physicochemical parameters were under the limit as prescribed by World Health Organization (WHO), Nitrate and OD were above the limit. It was found that most of the physicochemical parameters were within the world health organization (WHO) water quality standards for domestic drinking water and other purposes, except Nitrite and OD which are above world health organization (WHO) limit for domestic drinking water and other purposes and because of that, the quality of water is not good and it is not fit for drinking purpose unless treated.

Keywords: Physical and chemical scrutiny, obizi river, ANOVA, water quality, drinking purpose.

1. INTRODUCTION

Water is one of the most important compounds that constitute the largest part of life on earth. 70.9% of the surface of our planate is covered by water. Of which; 97% of the total water wealth is concentrated in oceans while ice caps comprises 2.4%. Other surface water bodies such as rivers, lakes and ponds constitute 0.6% and 1.6% retained underground (Hirsch et al., 2006). It is the most crucial thing that life can exist on earth and involved for several purposes including drinking, cleaning, dissolving, oxygenating, photo-synthesis, transportation, habitat formation, etc. (WHO, 1992). Drinking water is the second prerequisite for life next to oxygen (Shan e al., 2013). However, majority of the world's population still live without access to healthy water due to continuous contamination with several contaminants such as sewage and industrial effluents (Goel, 2006). The contamination of drinking water with physical and chemical contaminates have been posing serious threats to millions of people across the globe. In both the developing and developed nations, pathogens from contaminated water is recognized as a cause of severe morbidity and mortality of individuals through periodic outbreaks of diarrhoeal diseases (Corso et al., 2003).

Many people in the developing world lack access to a safe water supply (Gonçalves et al., 2019). Globally, progress towards access to safe drinking water has accelerated under the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) (World Health Organization et al., 2015; UNESCO et al., 2019). It is reported that between 2000 and 2015 global population using improved water resources rose from 81% to 89% (UNESCO et al., 2019). However, lack of access to secure adequate drinking water remains a global issue. In 2015 alone 29 % of the global population (2.6 billion individuals) did not access improved drinking water sources, whereas 844 million people still lacked access and 144 million individuals were fetching drinking water from lakes and rivers (UNESCO et al., 2019, WHO. 2015; WHO/UNICEF,2019). Of the 144 million individuals who were sourcing drinking water from ponds, rivers, and lakes, 58% lived in sub-Saharan Africa (UNESCO et al., 2019). Sub-Saharan Africa is reported to have made little progress towards improving access to improved drinking water with just 43% of its population currently having access to improved resources (WHO et al., 2015; Mkwate et al., 2017).

In addition, water sources including rivers, springs, wells and underground water sources have increasingly become polluted with municipal sewage, industrial waste, industrial toxics, heavy metals, fertilizers, chemicals, radioactive substances, land sediment and so on (Bartram and Balance, 1996). Physicochemical parameters such as turbidity, pH, temperature, nitrate and others with respect to water quality are widely accepted as other critical water quality parameters describing the quality of drinking water. In the country, over 60% of the communicable diseases are assumed to be caused by poor environmental health conditions that emerged from unsafe and inadequate drinking water supply besides from poor hygienic and sanitation practices (MOH, 2007).

Consequently number of cases of water borne diseases has been seen which a cause of health hazards. An understanding of water chemistry is the bases of the knowledge of the multidimensional aspect of aquatic environmental chemistry which involves the source, composition, reactions and transportation of water. The quality of water is of vital concern for the mankind since it is directly linked with human welfare .It is a matter of history that facial pollution of drinking water caused water-borne diseases UNICEF and WHO. (2008).

The WHO Guidelines for Drinking Water Quality (GDWQ) describes the need to protect public health through the adoption of a water safety plan (WSP). It establishes general guidelines for drinking water quality providing a common point of reference for all nations to determine the safe level of drinking water. This necessitates proper protection of water supply from contamination and the need for regular surveillance of water resources. Thus, physical and chemical scrutiny of obizi water is imperative to minimize such contaminations and ensures continuous supplies of healthy water to the people of awka south local government area of anambra state, Nigeria.

2. STUDY AREA

Description of study area

Anambra state is a state in the south-eastern nigeria. The capital and seat of government is awka. The state's theme is "light of the nation". Boundaries are formed by delta state to the west, imo state and river state to the south, enugu state to the east, and kogi state to the north. Anambra state is located between Latitudes 5° 45´ and 6°46´ N and Longitude 6°31E´ and 7° 03´E and covers an estimated land area of 4887 km^2. Anambra state has a tropical climate with annual average temperature and rainfall of 27°C and 1828 mm respectively. According to the last population census of 2016, the state has a projected population of about 5,527,800. Awka is located within the latitude of 6.333̊ N and longitude of 7.000̊ E and falls within the rainforest climatic region with 33^0C as its mean annual temperature and between 1,400 mm in the north to 2,500 mm in the South as its average annual rainfall. It covers an area of 613 SQ.KM with 15% Highland and 21% plainland. It experiences two seasons in the year, which are the rainy season and the dry season. The rainy season falls between march and september while the dry season is between november and april for about 4-5 months (Onwuka et al, 2012). It is a typical savanna covered with grass.

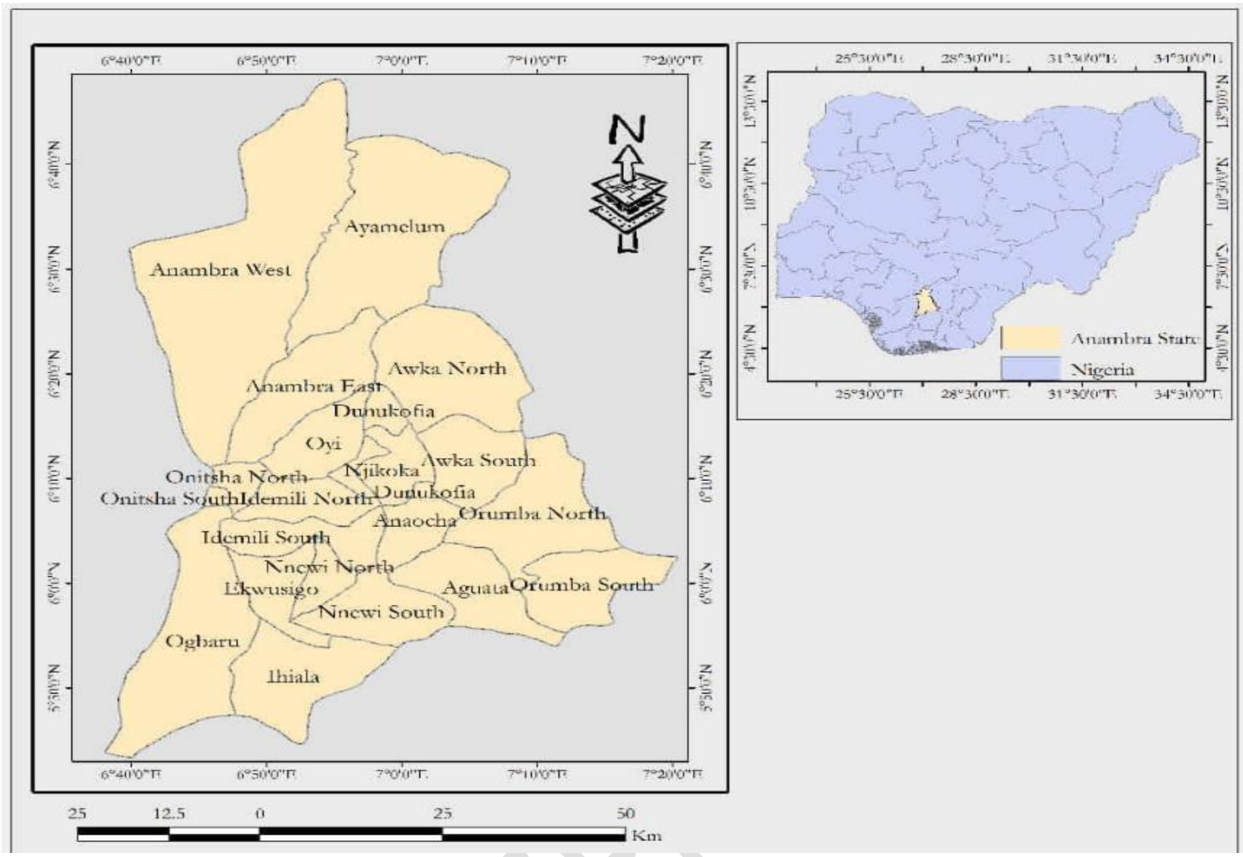

Figure 1: Map of the Study Area

3. MATERIAL AND METHOD

Water for physico-chemical analysis were aseptically collected from obizi river in awka south local government area of anambra state using 250ml sampling bottles (screw capped), according to the procedure described by APHA (1985). A total of three samples were collected, which includes the upstream, located approximately 800m upstream of the effluents discharge entry point from domestic and agricultural waste into the river. Effluents entry point, this site is located in the downstream of the first site at effluent entry point. The site is where effluents discharge from domestic and agricultural waste of inhabitants of the community is discharged into the river. Downstream, this site is located at about 700m downstream from the discharge entry point. The samples were collected in the morning hour. The sample was placed on ice in a cooler to maintain temperature of the water samples during transportation to springboard laboratory for analysis. The water sample was collected in rainy season (July). The sample was analyzed within 24 hours of collection. Where analysis is delayed, sample was refrigerated at 4^0C. All glass wares used for the collection of water sample were sterilized in an autoclave at 120^0C for 15 minutes. The parameters analyzed includes includes nitrate mg/l, nitrite mg/l, magnesium mg/l, zinc mg/l, tds mg/l, hardness mg/l, sulphate mg/l, phosphate mg/l, alkalinity mg/l, acidity mg/l, sodium mg/l, bod mg/l, cod mg/l, tss mg/l, ts mg/l, od mg/l, potassium mg/l.

The data obtained were subjected to statistical analysis using ANOVA Single-Factor to determine if there are significant differences between the parameters and world health organization (WHO 2018) recommended limit.

4. RESULTS AND DISCUSSION

Table 1: Result of the Water Analysis

S/N	PARAMETER	SAMPLE A CONC.	SAMPLE B CONC.	SAMPLE C CONC.	WHO
1	Nitrate mg/l	4.544	6.895	2.565	10
2	Nitrite mg/l	0.01	0.05	0.02	0.02
3	Magnesium mg/l	0.889	0.895	0.902	2.0
4	Zinc mg/l	0.053	0.065	0.003	5.0
5	TDS mg/l	122.33	103.82	74	500
6	Hardness mg/l	28	28	24	100
7	Sulphate mg/l	56.47	64.39	45.78	100
8	Phosphate mg/l	7.488	6.93	4.899	100
9	Alkalinity mg/l	132.55	103.37	87.78	200
10	Acidity mg/l	74.93	75.65	45.89	100
11	Sodium mg/l	0.140	0.153	0.163	200
12	BOD mg/l	56.65	67.87	56.89	100
13	COD mg/l	102.44	75.86	103.89	200
14	TSS mg/l	4.00	3.22	7.32	500
15	TS mg/l	12.633	10.74	81.32	500
16	OD mg/l	43	55	56.43	10
17	Potassium mg/l	7.933	7.355	5.474	10

Nitrate:

Nitrate concentrations in this study area varied in the ranged from 2.565 mg/l to 6.895 mg/l shown in figure 2, with sample A having 4.544 mg/l, sample B having 6.895 mg/l and sample C having 2.565 mg/l. All the water samples from different locations were found to be in the acceptable range of value prescribed by WHO. Nitrate is produced by autotrophic nitrobacter combining oxygen with nitrite on the walls of river. The presence of nitrate in rivers are caused by surface run off, washing activities, leaching of nitrate into the river, sewage, usage of fertilizers and other wastes rich in nitrates and recorded lowest nitrate value because of algal assimilation. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Nitrite:

Nitrate concentrations in this study area varied in the ranged from 0.01mg/l to 0.05mg/l shown in figure 2, with sample A having 0.01mg/l, sample B having 0.05mg/l and sample C having 0.02mg/l. All the water samples from different locations were found to be in the acceptable range of value prescribed by WHO except sample B having 0.05mg/l which is higher than the prescribed limit by WHO. However, the maximum concentration was recorded at point B, and decrease downstream. The presence of nitrite in rivers is caused by agricultural chemicals, nitrogen containing chemical, industrial and municipal effluent including sewage which is rich in ammonia, which in turn can lead to increased nitrites concentration, commercial fertilizers and naturally from mineral rocks decomposition. The presence of nitrite is indicated by the increase in the concentration of nitrate ion. High level of nitrite in river water may indicate pollution. Nitrite is a good source of nutrients for plants but at high pH and high ammonia, the toxicity effect of nitrite is increased. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Magnesium:

Magnesium concentrations in this study area varied in the ranged from 0.889 mg/l to 0.902 mg/l shown in figure 2, with sample A having 0.889 mg/l, sample B having 0.895 mg/l and sample C having 0.902 mg/l. All the water samples from different locations were found to be in the acceptable range of value prescribed by WHO. All the recorded values lies below the WHO maximum allowable limits for drinking purpose. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Zinc :

Zinc concentrations in this study area varied in the ranged from 0.003 to 0.065 mg/l shown in figure 2, with sample A having 0.053 mg/l, sample B having 0.065 mg/l and sample C having 0.003 mg/l. All the water samples from different locations were found to be in the acceptable range of value prescribed by WHO. The presence of zinc in rivers is caused by dissolution of zinc from water distribution pipes and as such has affected the quality of water consumed by households. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Total Dissolved Solid:

TDS concentrations in this study area varied in the ranged from 74 mg/l to 122.33 mg/l shown in figure 3, with sample A having 122.33 mg/l, sample B having 103.82 mg/l and sample C having 74 mg/l. All the water samples from different locations were found to be in the acceptable range of value prescribed by WHO. TDS consist of inorganic salts and dissolved materials and the samples contain dissolved solids in levels that don't threaten human lives. The higher value obtained in sample A may be due to leaching of soil and minimum value obtained in sample C may be due to settling of silt. This is in accordance with study done by Ehiagbonare and Ogunrinde (2010) and Gayathri et al. (2013). One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Hardness:

Hardness of water in this study area varied in the ranged from 24 mg/l to 28 mg/l shown in figure 3, with sample A having 28 mg/l, sample B having 28 mg/l and sample C having 24 mg/l. All the water samples from different locations were found to be in the acceptable range of value prescribed by WHO. Hardness of water is the parameter used to describe the effect of dissolved minerals by high levels of Calcium (Ca^{2+}) or magnesium (Mg^{2+}) cation present in water samples (Saidu and Gimba, 2019). The presence of hardness in water is caused by high soap consumption during water use for domestic washing and cleaning (WHO, 2011). One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Sulphate:

The sulphate content in all the water samples was low from 45.78 – 64.39mg/l as shown in figure 3, with sample A having 56.47 mg/l, sample B having 64.39 mg/l and sample C having 45.78 mg/l. All the water samples from different locations fell within the WHO permissible limits for drinking water. Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals (Manivaskam , 2005). Discharge of industrial wastes and domestic sewage tends to increase its concentration. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Phosphate:

The Phosphate content in all the water samples was low from 4.899 – 7.488 mg/l as shown in figure 3, with sample A having 7.488mg/l, sample B having 6.93mg/l and sample C having 4.899 mg/l. All the values obtained from different locations were by far less than the WHO permissible limits for drinking purpose. High phosphate content may be due to rain, surface water runoff, agriculture run off, man's domestic washing and cleaning activity could have also contributed to the inorganic phosphate content. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Alkalinity:

The alkalinity content in all the water samples was low from 87.78 – 132.55mg/l as shown in figure 4, with sample A having 132.55 mg/l, sample B having 103.37 mg/l and sample C having 87.78mg/l. All the values obtained from different locations were by far less than the WHO permissible limits for drinking purpose. High alkalinity content may be due to increase in bicarbonates in the water. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Acidity:

Acidity of water in this study area varied in the ranged from 45.89mg/l to 75.65 mg/l shown in figure 4, with sample A having 74.93 mg/l, sample B having 75.65mg/l and sample C having

45.89 mg/l. All the water samples from different locations were found to be in the acceptable range of value prescribed by WHO. The presence of acidity in rivers is caused by industrial pollution, chemical dumps, power plants, confined animal feeding operation and landfills. Acidity has a pH of 6.5 or less. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Sodium content:

Sodium content of water in this study area varied in the ranged from 0.140 mg/l to 0.163mg/l shown in figure 4, with sample A having 0.140 mg/l, sample B having 0.153 mg/l and sample C having 0.163 mg/l. All the water samples from different locations were below the WHO permissible standard for drinking purpose and do not pose danger to human consumption. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Biochemical oxygen demand:

BOD content of water in this study area varied in the ranged from 56.65 mg/l to 67.87 mg/l shown in figure 4, with sample A having 56.65 mg/l, sample B having 67.87 mg/l and sample C having 56.89 mg/l. All the water samples from different locations were below the WHO permissible standard for drinking purpose. Biological Oxygen Demand (BOD) is the amount of oxygen to be used by bacteria to decompose organic matter present within the samples under aerobic conditions. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Chemical oxygen demand:

Chemical oxygen demand content of water in this study area varied in the ranged from 75.86 mg/l to 103.89 mg/l shown in figure 5, with sample A having 102.44 mg/l, sample B having 75.86 mg/l and sample C having 103.89 mg/l. All the water samples from different locations were below the WHO permissible standard for drinking purpose. COD is another important parameter of water quality assessment. High COD concentration might be due to the use of detergents from the domestic washing of clothes and urine of cattle. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Total Suspended Solid:

The TSS content of water in this study area varied in the ranged from 3.22 mg/l to 7.32 mg/l shown in figure 5, with sample A having 4.00 mg/l, sample B having 3.22 mg/l and sample C having 7.32 mg/l. All the water samples from different locations were far below the WHO permissible standard for drinking purpose. The total suspended solids are composed of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium, manganese, organic matter, salt and other particles. The effect of presence of total suspended solids is the turbidity due to silt and organic matter (Mahananda et al., 2005). One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Total Solid:

TS concentrations in this study area varied in the ranged from 10.74 mg/l to 81.32 mg/l shown in figure 5, with sample A having 12.633 mg/l, sample B having 10.74 mg/l and sample C having 81.32 mg/l. All the water samples from different locations were found to be in the acceptable limit of value prescribed by WHO. Higher values of total solids are mainly due to the presence of silt and clay particles in the river water. The higher amount of total solids in sample C, is due to run off from many bathing ghats, municipality solid garbage dump and other wastages. One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Oxygen demand:

Oxygen demand concentrations in this study area varied in the ranged from 43 mg/l to 56.43mg/l shown in figure 5, with sample A having 43 mg/l, sample B having 55 mg/l and sample C having 56.43 mg/l. All the water samples from different locations were found to be above the acceptable limit of value prescribed by WHO. Oxygen demand is the measure of the amount of gaseous oxygen dissolved in an aqueous solution and is expressed in terms of percentage saturation. The tolerance limit for inland surface waters used as raw water and bathing ghat is 3 mg/l, the tolerance limit for sustaining aquatic life is 4 mg/L whereas tolerance limit for drinking purposes it is 10 mg/l (WHO, 2015). One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Potassium:

Potassium concentrations in this study area varied in the ranged from 5.474 mg/l to 7.933 mg/l shown in figure 5, with sample A having 7.933 mg/l, sample B having 7.355 mg/l and sample C having 5.474 mg/l. All the water samples from different locations were found to be in the acceptable limit of value prescribed by WHO. Comparatively the maximum value was recorded at sample A, even though all the recorded values lie within WHO standard guidelines for drinking purpose (10 mg/l). The major source of potassium in natural fresh water is weathering of rocks but the quantities increase in the polluted water due to disposal of waste water (James, 2000). One-way analysis of variance (ANOVA) in table 5, also showed that the means were not statistically significant at $p<0.05$ and not recommended for drinking purposes.

Table 2: ANOVA TABLE FOR SAMPLING POINT A

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	17	654.06	38.47412	2051.584

Column 2	0	0	#DIV/0!	#DIV/0!
Column 3	0	0	#DIV/0!	#DIV/0!

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0	2	0	0	1	3.738892
Within Groups	32825.35	14	2344.668			
Total	32825.35	16				

Table 3: ANOVA TABLE FOR THE SAMPLING POINT B

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	17	610.263	35.89782	1492.007
Column 2	0	0	#DIV/0!	#DIV/0!
Column 3	0	0	#DIV/0!	#DIV/0!

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0	2	0	0	1	3.738892
Within Groups	23872.12	14	1705.151			
Total	23872.12	16				

Table 4: ANOVA TABLE FOR THE SAMPLING POINT C

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	17	597.326	35.13682	1307.047
Column 2	0	0	#DIV/0!	#DIV/0!
Column 3	0	0	#DIV/0!	#DIV/0!

ANOVA

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	0	2	0	0	1	3.738892
Within Groups	20912.75	14	1493.768			
Total	20912.75	16				

Table 5: ANOVA TABLE FOR THE THREE SAMPLING POINTS

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	17	654.06	38.47412	2051.584
Column 2	17	610.263	35.89782	1492.007
Column 3	17	597.326	35.13682	1307.047

ANOVA

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	104.0057	2	52.00284	0.032162	0.96837	3.190727
Within Groups	77610.21	48	1616.879			
Total	77714.22	50				

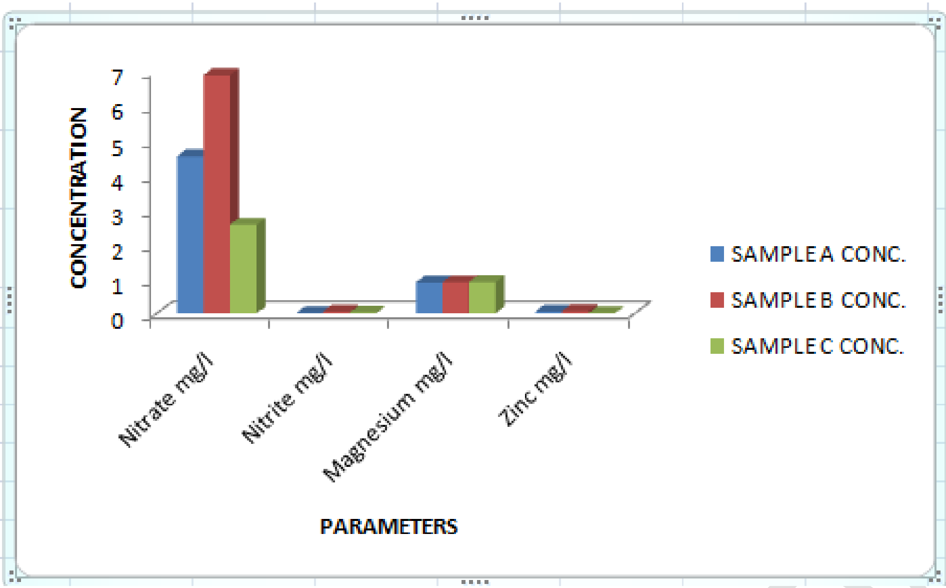

Figure 2: Nitrate, Nitrite, Magnesium and Zinc of the water samples

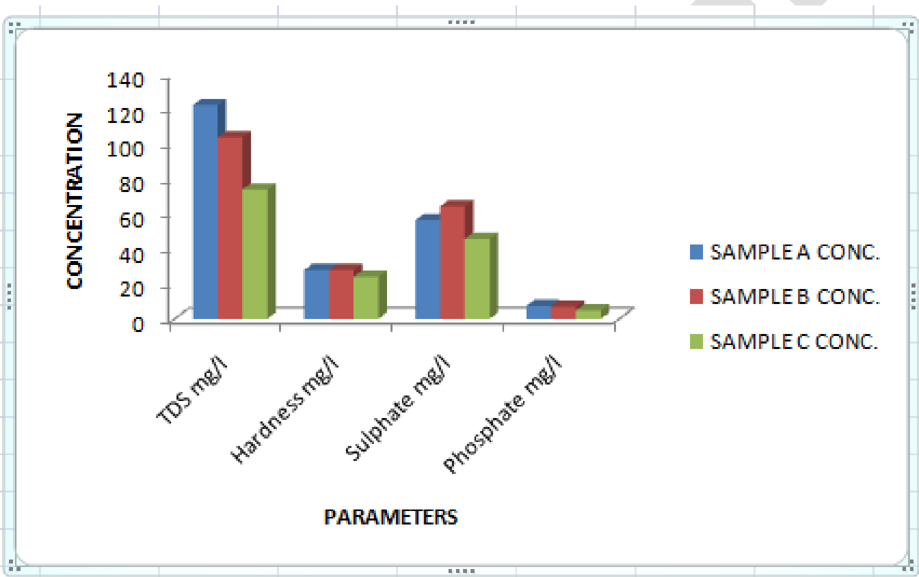

Figure 3: TDS, Hardness, Sulphate and Phosphate of the water samples

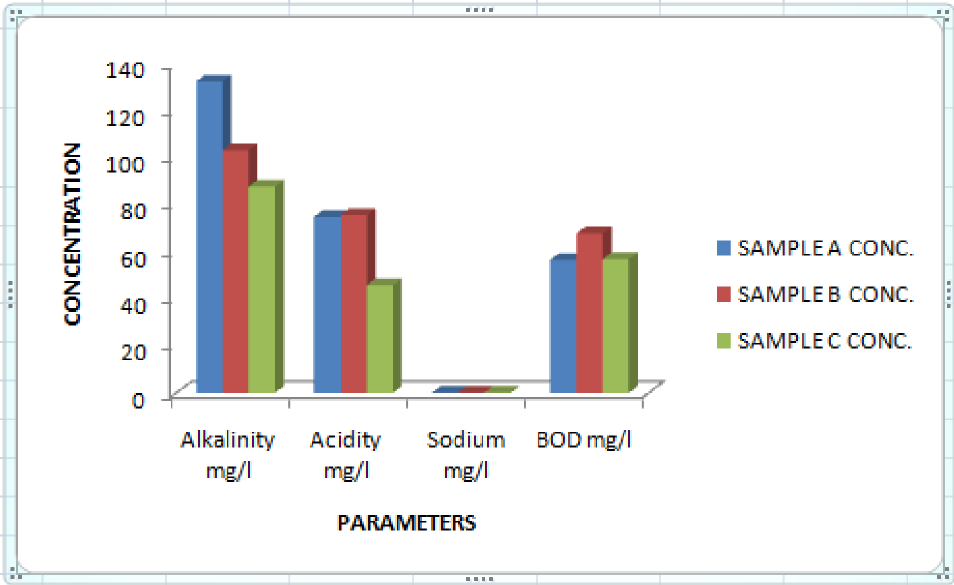

Figure 4: Alkalinity, Acidity, Sodium and BOD of the water samples

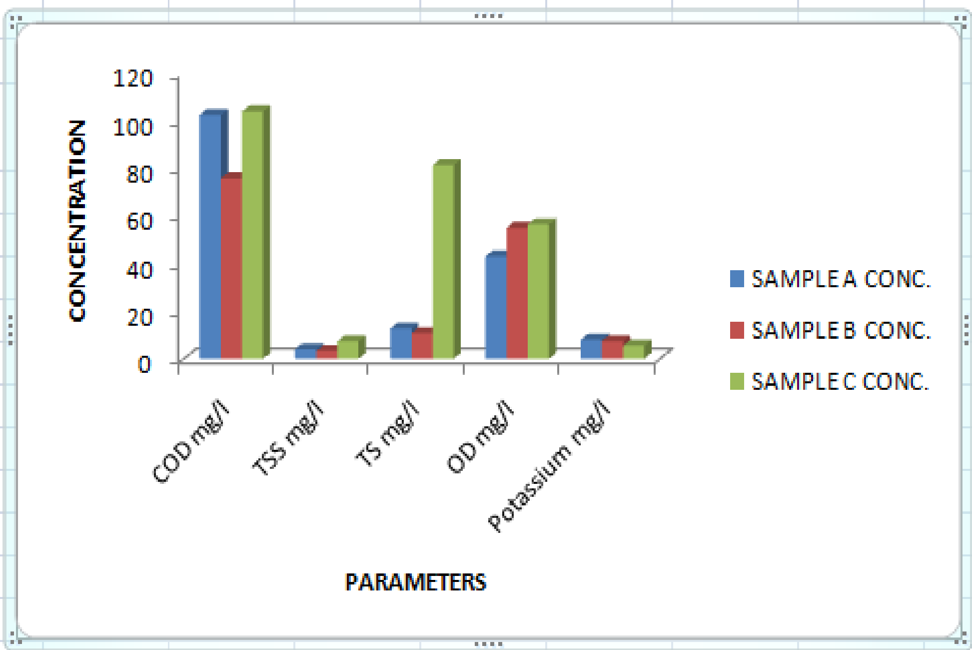

Figure 5: COD, TSS, TS, OD and Potassium of the water samples

CONCLUSION

The Obizi River is one of the most important River in Awka-South Local Government Area of Anambra State that is feeding the city in many ways. It also contain all kinds of garbage. From the beginning the importance of the river was very much and increasing day by day. But at present that river is under pollution. Like other rivers in the city its water quality is losing day by day. The result obtained during study was compared with WHO standards, and from it, it was discovered that even though most of the water parameters fell within the tolerance limit prescribed by WHO, some parameters like OD and nitrite were above the limit. The result of ANOVA also concluded that there is no significant difference between the physicochemical characteristics of the water samples. In addition, the results showed that the water is certainly unfit for drinking and other domestic purposes without any form of treatment.

Recommendation

i. It is very much necessary to conduct more research on this river to determine the microbial load.

ii. It is very much necessary to create awareness among the people about the danger of consuming the polluted water without treatment.

iii. Government should as a matter of urgency, take immediate mechanism in order to control increment of contaminants getting into water bodies and also revise their water treatment process.

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