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Degradability and Organic Strength of Gross Organic Pollutants In Surface Water of Mini Whuo Stream Obio/Akpor, Rivers State, Nigeria

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ABSTRACT

Water samples were collected from Mini Whou Stream and analyzed for gross organic pollutants and the results was used to evaluate the organic strength of the Stream. The gross organic pollutants studied were dissolved oxygen (DO), biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Dissolved oxygen within the months studied ranged from 5.45±0.15-5.58±0.14mg/L, which were lower than the WHO value for drinking water. Biochemical oxygen demand within the months studied ranged from 36.25±4.47-36.55±3.88mg/L, which was higher than the recommended level for drinking water by WHO. Chemical oxygen within the months studied ranged from 51.82±3.25 – 52.57 mg/L which was above the WHO acceptable level. The organic strength (BOD/COD) of the surface water during the months ranged from 0.69–0.70. The results recorded revealed that the stream was polluted with gross organic pollutants and is therefore not fit for human consumption. The values recorded for organic strength indicated that microbial breakdown of organic matter was very active, which showed that the water of the stream was contaminated with organic pollutants. This should therefore discourage input of organic matter from diffuse sources into the stream.

Keywords: Biological oxygen demand, chemical oxygen demand, dissolved oxygen, gross organic pollutants, organic strength

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INTRODUCTION

Pollution of water bodies has been on the rise as a result of growth in population, urbanization, and industrial activities (Egborge, 1995; Ekaete et al., 2015). The increase in agrarian activities and other systems of production have also added immensely to the pollution of the different water bodies (William and Benson, 2010). Waste materials that originate from both organic and inorganic chemicals are transported by water. This may be through water runoffs, river flows (current) and precipitation, which possibly might have had its origin from agricultural farms, industrial sites and in certain cases, natural factors (Popoola et al., 2014).

Water quality evaluation is the general process of assessing the physical, chemical and biological nature of a given water body. Various water quality indicator markers include Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) (Iyama et al., 2017). Organic pollution and eutrophication indices could be applied to measure the level and degree of water pollution (Liu et al., 2011). Six underlying elements could be recognized as water quality pollution indices, they are; organic, nutrient, physicochemical, weathering, soil leaching and toxic-anthropogenic (Simeonov et al., 2003; Iyama et al., 2020). Investigation has revealed that water quality sources are worse in rivers than in reservoirs (Wang et al., 2009). Water pollution has posed a vigorous task and hazard to human life and the environment which he occupies for and daily make use for survival for some time now (Bu et al., 2009).

The pollution of marine environs with organic matter from both natural and anthropogenic sources is now a matter of urgent and serious concern (Sarfo-Afriyie, 1999). Potential anthropological well-being hazards arise from organisms that cause diseases that thrive and flourish in organic wastes both from plants and animal sources.

Minute to realistic intensities of plant and animal-centered pollution affect the type and nature of water-inhabiting organisms that will be surviving in a waterway or watercourse (Peni et al., 2016; Susilowati et al., 2018). Gross organic pollution characterizes a menace to the continued existence and population of water-dwelling creatures (Hynes, 1960). Even though the subject of pollution from organic substances in household, agricultural and industrial environments has extensively been recognized, yet the normal concerns on the actual control of water pollution take into thoughtfulness the huge metropolitan and additional identified sources and origin of organic matter. The environment has inadequate capacity to hold these pollutants conditional on certain environmental factors. While some ecological systems can hold or carry certain pollutants to a significant level, others could be very susceptible to such negative consequences.

The effect of organic pollutants and contaminants in the aquatic environment is reasonably massive. Through the process of organic matter decay**,** the volume of dissolved oxygen in the water column is usually exhausted by the actions of bacteria. The existence of a great quantity of dissolved oxygen in the water column is needed by water-dwelling organisms (Zhao et al., 2019), like fish and macroinvertebrates, which rely on it for the purposes of respiration (Jouanneau et al., 2014). The importance of this influence is shown by the general practice of using biochemical oxygen demand (BOD) measurement of the water body and wastewater (Goel, 2009). This method is applied for assessing the rate of biodegradation of organic contaminants present in the water body (Prambudy et al., 2019).

Even though significant research in recent years is focused on describing the range of contamination by private and pharmaceuticals preservation of good water environments, there are certain customary issues of gross organic pollution such as chemical oxygen demand and biochemical oxygen demand (Harwood, 2014). To decrease the effects of these pollutants requires that the sources and origin of their input must be known. This could be realized by using both biological and chemical environmental markers (Prambudy et al., 2019; Zhao et al., 2019).

It is therefore vital, imperative and useful that an all-inclusive investigation be carried out on the evaluation of pollution degree from water bodies, putting into account parameters that offer the overall assessments of the pollution levels of the water bodies.

This study was therefore undertaken to examine the concentrations of gross organic pollutants (DO, BOD and COD) and organic strength (degradability) of water from Mini Whuo Stream Obio/Akpor, Rivers State, Nigeria.

MATERIALS AND METHODS

Water samples were collected in the early hours of the day with amber-coloured bottles and corked under water. The samples were collected between the months of April to October 2021. The samples were instantly put into an ice-cooled container and then moved immediately to the laboratory for determination and analysis**.** In the laboratory, the modified Winkler-azide method (APHA, 2005) was employed to evaluate the quantity of oxygen that was dissolved in the water. Manganese sulphate of 2 cm^3 by volume was put into the water and about 2 cm^3 of alkali iodide-azide reagent was then added. The mixture was properly shaken together vigorously and a precipitate was formed. 2 cm^3 of sulphuric acid was added to the sample mixture and constantly mixed by overturning the container numerous times. The agitated sample mixture was kept for about eight hours, and 203 cm^3 of the sample mixture was placed in a conical flask and then reacted with sodium thiosulphate solution until a straw with yellow colour was observed. 2 cm^3 volume of starch was added to the conical flask that contained a starch indicator. The colour was changed to blue. The sample was then titrated with starch until a colourless solution was formed and the dissolved oxygen present in the sample was calculated using the equation;

Dissolved Oxygen (DO) =

$$\frac{Volume\ of\ Sodium\ thiosulphate\ x\ 0.2\ x\ 1000}{Volume\ of\ sample\ Taken}$$

Biochemical oxygen demand (BOD) was determined on the same water sample that was initially analyzed for DO with the improved Winkler-azide method (APHA, 2005). The water samples initially examined for DO were preserved in a BOD incubator (a dark cupboard) at 20 ^oC for five days. On the fifth day, the samples were examined again for DO. The result recorded was deducted from that of the original DO obtained and the difference is recorded as BOD_5. Chemical oxygen demand (COD) was examined using the method of APHA (2005). Two separate tubes containing the water sample and distilled water respectively were filled to a volume of 2.5 cm^3. The distilled water sample is the blank. The addition of potassium dichromate (1.5 cm^3) was made separately into each of the different tubes and 3.5 cm^3 of Sulphuric acid was then added to the tubes and were then sealed. The different tubes were separately put into a COD digester that was operated at 150 ^oC for 2hrs. The digest was allowed to cool at room temperature after 2 hours and the contents was then transferred into a conical flask. Addition of two drops of ferroin indicator was put into the contents in the flasks and were titrated separately against a freshly prepared ferrous ammonium sulphate. The titration was concluded when a reddish-brown colour was observed and the level of COD was then calculated using the equation;

Chemical Oxygen Demand (COD) = $\frac{A-B\ x\ N\ x\ S\ x\ 1000}{Volume\ of\ Sample\ Taken}$

Where;

Table 1: Concentrations of Gross Organic Parameters in Water Samples of the Rumuokoro, Eliozu and Rukpokwu axis of the Mini Whuo Stream in April.

Parameters	Stations/Locations			Mean Concentration	WHO Limit
	Rumuokoro	Rukpokwu	Eliozu		
Dissolved Oxygen (DO) mg/L	5.30	5.65	5.40	5.45±0.15	10mg/L
Biochemical Oxygen Demand (BOD)	42.50	31.60	36.25	36.78±4.47	10 mg/L
Chemical Oxygen demand (COD) mg/L	56.60	48.90	50.80	52.10±3.28	40 mg/L
Organic Strength	0.75	0.65	0.71	0.70±0.04	-

Table 2: Concentrations of Gross Organic Parameters in Water Samples of the Rumuokoro, Eliozu and Rukpokwu axis of the Mini Whuo Stream June.

Parameters	Stations/Locations			Mean Concentration	WHO Limit
	Rumuokoro	Rukpokwu	Eliozu		
Dissolved Oxygen (DO) mg/L	5.40	5.75	5.60	5.58±0.14	10mg/L
Biochemical Oxygen Demand (BOD)	41.60	30.96	37.05	36.54±4.36	10 mg/L
Chemical Oxygen demand (COD) mg/L	55.90	47.96	51.60	51.82±3.25	40 mg/L
Organic Strength	0.74	0.65	0.72	0.70±0.04	-

Table 3: Concentrations of Gross Organic Parameters in Water Samples of the Rumuokoro, Eliozu and Rukpokwu axis of the Mini Whuo Stream in August.

Parameters	Stations/Locations			Mean Concentration	WHO Limit
	Rumuokoro	Rukpokwu	Eliozu		
Dissolved Oxygen (DO) mg/L	5.34	5.75	5.38	5.49±0.18	10mg/L
Biochemical Oxygen Demand (BOD) (mg/L)	41.65	32.26	35.75	36.55±3.88	10 mg/L
Chemical Oxygen demand (COD) mg/L	56.80	49.80	51.10	52.57±3.04	40 mg/L
Organic Strength	0.73	0.65	0.70	0.69±0.03	-

A is the volume of ferrous ammonium sulphate for blank solution, B is the volume of ferrous ammonium sulphate for the sample, N is concentration of ferrous ammonium sulphate and V is sample volume.

The organic strength of the Mini Whuo water samples were analyzed and determined using the method

adopted and described by Kurniawan et al (2006) and Agbozu et al (2015), using the equation;

$$\text{Organic Strength (OS)} = \frac{BOD\,5}{COD}$$

This ratio was originally formulated to observe variations and fluctuations that will arise due to the biodegradation of leachates (Agbozu et al., 2015). However, it could also be useful in monitoring the levels and degree of organic degradation in a slow-moving water environments such as rivers, streams and creeks, where wastes are directly discharged into it. When the ratios calculated falls between the values of 0.4 - 0.6, it indicates the presence of a very high degree of biodegradation in the aquatic ecosystem and also shows high input and influence of organic materials into the water body, but when the values fall between the ranges of 0.05-0.2; it indicated low degree of biodegradable matter/materials.

RESULTS AND DISCUSSION

The results obtained for the different gross organic parameters in the Mini Whuo stream are shown Tables in 1 to 4 and the mean concentrations of the gross organic parameters during the four months period of investigation are graphically represented in Figure 1.

Dissolved Oxygen (DO)

The values of DO observed in this investigation ranged between 5.30-5.95mg/L in the water column of the stream within the months of study. The average values observed for DO in the stream during the months of the investigation was between 5.45±0.15mg/L-5.59±0.25mg/L. The mean concentration of DO for all the

Table 4: Concentrations of Gross Organic Parameters in Water Samples of the Rumuokoro, Eliozu and Rukpokwu axis of the Mini Whuo Stream in October.

Parameters	Stations/Locations			Mean Concentration	WHO Limit
	Rumuokoro	Rukpokwu	Eliozu		
Dissolved Oxygen (DO) mg/L	5.39	5.95	5.44	5.59±0.25	10mg/L
Biochemical Oxygen Demand (BOD)	42.15	33.10	35.88	37.04±3.79	10 mg/L
Chemical Oxygen demand (COD) mg/L	59.00	50.20	52.21	53.80±3.77	40 mg/L
Organic Strength	0.71	0.66	0.69	0.69±0.02	-

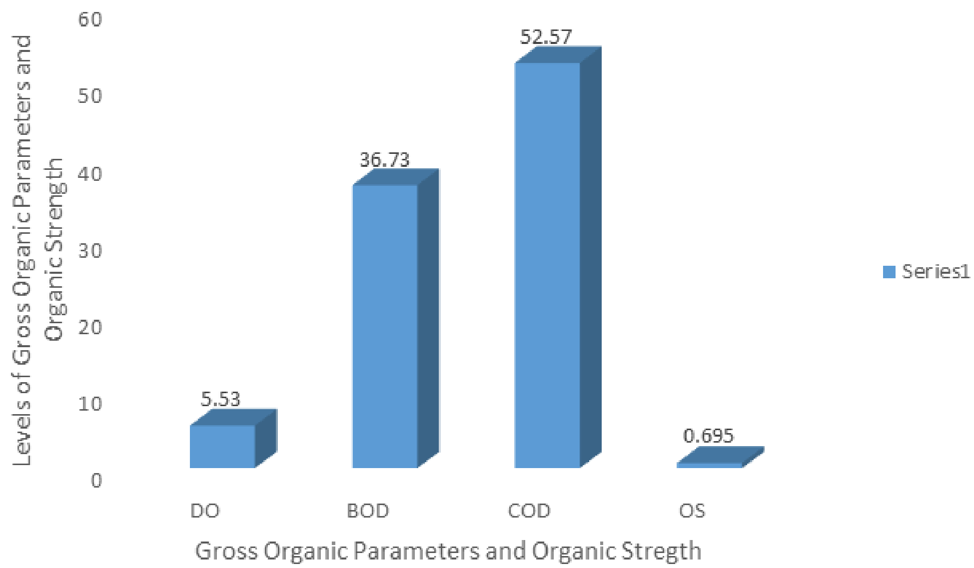

Figure 1: Mean Concentrations of Gross Organic Parameters and Organic Strength during the Months of Investigation in the Mini Whuo Stream.

months was 5.53±0.18mg/L. The lowest value was obtained in April while the highest value was recorded in October. The values obtained within the months were lower than the value of 10mg/L recommended by WHO for water to be used domestically. The low availability of DO may be ascribed to the refuse in the stream, the muddy nature and the semi-stagnant nature of the stream which do not allow effective mixing of oxygen in the water body. The possibility that there might be much microbial activities within the stream which may lead to the high consumption of the available oxygen within the system, and also the overtaken of major parts of the stream by grasses might be responsible for the low content of DO since air is not allowed to directly come in contact with the surface of the water. The dissolved oxygen value recorded in this study was within the same range or slightly higher than that reported by Edori et al. (2019) in water samples collected from the Silver River which varied from 4.0 to 5.4 mg/L. DO is an important parameter in water analysis based on the fact that life in aquatic environments is a function of its availability. The observed and recorded values of DO in the present work corroborates the findings of Edori and Nna (2018), in a polluted water environment, but it is at variance with the study of Iyama et al. (2019), in Sagbama Creeks. DO is used to develop information on the nature, level and degree of bacterial activity, photosynthetic characteristics, the quantity of nutrients and the ability of fishes to endure and live in that environment (Premlata, 2009). Temperature is also a key factor that governs the quantity of dissolved oxygen that exists in water. High-temperature causes a reduction in the available DO and helps in promoting increase in microbial activities, growth and development (Kataria et al., 1996).

Biochemical Oxygen Demand (BOD)

The values of BOD observed in this study was in the range of 30.96-42.50mg/L in the water column of the stream within the months of study. The average values observed for BOD in the stream during the months of investigation was between 36.54±4.36-37.04±3.79±mg/L. The mean concentration of BOD for all the months was 36.73±4.13mg/L. The lowest value recorded was in June while the highest value was in April. These values obtained were higher than the 10mg/L maximum concentration required by WHO for water necessary for drinking and other domestic uses. The BOD values obtained in this study are higher than the value recorded by Edori and Nna (2018) at discharge points of the New Calabar River of 4.920 mg/L. The values obtained in this study is lower than that which was observed by Yapo et al. (2012) from wastewater in Abijan, which was 14500 mg/L. BOD is used in expressing the degree of contamination of water by organic matter. It is the amount or quantity of oxygen that is dissolved in the water column that is desirable or essential for biochemical oxidation, disintegration or breakdown of organic and some inorganic materials by micro-organism (Sawyer et al., 1994). It is used in evaluating the amount of pollution in surface and ground waters wherever there is a discharge of domestic and industrial effluents (De, 2003). Although the WHO acceptable maximum requisite concentration for BOD in water is 10.0 mg/L, nevertheless 1.0 mg/L is utmost and appropriate for domestic intake. BOD values of 5.0 mg/L and above gives serious uncertainty on the usability and portability of that water due to the possibilities of high presence of bio-organisms.

Chemical Oxygen demand (COD)

The values of COD observed in this study was in the range of 47.96-59.00mg/L in the water column of the stream within the months of study. The average values observed for COD in the stream during the months of investigation was between 51.82±3.25-53.80±3.77mg/L. The mean concentration of COD for all the months was 52.57±3.34mg/L. The lowest value recorded was in June while the highest value was in October. These values recorded were far above the 10mg/L required maximum level necessary and accepted by WHO for domestic water useful for drinking and other domestic works. The values of COD recorded in the Mini Whuo stream was higher than those observed by Edori and Marcus (2021) in the Okamini Stream, in Port Harcourt, Rivers State, Nigeria, those recorded by Edori and Nna (2018) in surface water at points effluents are being discharged into the New Calabar River and also that recorded by Edori (2020) in Onyima Creek, Rivers State, Nigeria. COD equally is a degree of the level of organic matter and pollutants or pollution in water environment. The chemical oxidation of organic material present in the water setting needs a certain level of dissolved oxygen that should be present. It is the measure of dissolved oxygen that is used to attain the required oxidation in the system known as COD (Sharma and Walia, 2017; Edori et al., 2019). COD like BOD is important in the confirmation of the environmental and health status of any surface water before supply for usage. COD gives facts on the concentration or content of oxidizable organic components that might be responsible for river or water pollution. The redox potential of any water body requires a certain quantity or volume of oxygen in it that can efficiently oxidize the organic matter existing in it. The amount of oxygen that is essential in the process of oxidation is referred to as COD (Sharma and Walia, 2017). COD is a noteworthy factor of importance in environmental health assessment which is a valuable tool in the determination of the usefulness and potability of water.

Organic Strength

The values of organic strength observed in this study were in the range of 0.65-0.75 in the water column of the stream within the months of the study. The average values observed for organic strength in the stream during the months the investigation was between 0.69±0.02-0.7±0.04. The mean concentration of organic strength for all the months was 0.695±0.03. The lowest value recorded was in June while the highest value was in October. The occurrence of organic matter in water is characterized according to the level of biodegradation. Usually, organic strength is a tool used in describing the level to which organic matter has been degraded and also provides information on the ratio of BOD to COD within the system (Agbozu et al., 2015). A drop or reduction in the level of BOD5 describes a two-factor effect viz. decrease in the available level of organic waste products and higher degradation of organic materials or matter by microbes (Krug and Ham, 1995; Edori and Marcus, 2021). The concentration of COD will drop continuously if there arises no additional input of organic matter as the biodegradation of organic components remains within the system (Ehrig, 1989). Reliable and constant monitoring of the quantity of BOD5/COD will enable the monitoring of alterations as a result of bio-disintegration of wastewater or contaminated aquatic environments. The disparities in the relationships of BOD5/COD are useful measures in predicting the condition of the contaminated water in consideration of organic pollutants or contaminants. When the ratio of BOD_5/ COD falls between the range of 0.4 to 0.6, it is an indication of active degradation of organic matter, but a lower range of ratios between 0.05 to 0.2, is an indication of low occurrence of organic matter or low degree of degradation which is a drastic reduction which comes as a result of most of the degradation and oxidation process coming to a conclusive end (Agbozu et al., 2015). The values observed in this work revealed that the Mini Whuo stream is at the active end of the degradation of organic matter.

CONCLUSION

The study on gross organic matter and organic strength of the Mini Whuo Stream revealed that the stream is polluted with organic matter. The values obtained all showed that the water was below the requirement of

WHO for domestic and other usages. Observations at different points or locations within the stream revealed different levels of anthropogenic influence and input sources. The results recorded showed higher values of BOD and COD. The organic strength of the stream showed an active aquatic environment with serious disintegration of organic matter due to microbial activities. Therefore, efforts ought to be geared towards combating organic matter contribution sources like the fish farm, waste dumpsites, abattoir and other sources such as domestic and industrial effluents that are discharged into the stream on regular basis.

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