POLLUTION INDEX OF SOME LAKES IN IBADAN METROPOLIS, OYO STATE, NIGERIA

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ABSTRACT

Lake water is a sink for different waste discharge and effluents; hence it is a good indicator of environmental pollution. Studies were carried out on the quality of some lake water in Ibadan to ascertain the extent of pollution. The following lakes were sampled and analyzed; Agodi, Awba, Eleyele and IITA lakes. In this regards, four sampling points were selected for each lake and the following parameters were analyzed; temperature, pH, total solids, total dissolved solids, total suspended solids, oil and grease, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, alkalinity, total hardness, nitrate, chloride, ammonia, sulphate and phosphate using standard analytical methods. The results of the analyses showed that the pH of the lake water ranged from 8.0±0.02 to 8.3±0.05. Other values of range are: Total Solids - 330±26 to 730±51mg/L; DO-1.93±0.06 to 7.64±0.46mgO_2/L; BOD – 5.7±0.4 to 11±1.0mgO_2/L; COD - 130±5.3 to 160±9.2mgO_2/L; Total hardness - 99±2.2 to 160±3.7mg $CaCO_3$/L. The results of the analyses indicate that most of the physico-chemical parameters of the water sample were within the WHO and Federal Environmental Protection Agency (FEPA) maximum permissible limits for drinking water. They are not high enough to be hazardous.

Keywords: Lake Water, Pollution, Environment, Biochemical Oxygen Demand, Wastewater

INTRODUCTION

The availability of safe and portable source of water in all parts of the world is a problem. Over 600 million people have no access to clean water (Onnby, 2013). Environmental pollution, especially lake water pollution stands as a risk to the world water availability (Anazawa et al, 2004).

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The principal contaminants of surface water are: suspended solids, biodegradable organics, pathogenic organisms, and heavy metals and dissolved organics. Sources of lake water pollutants are industrial effluents discharged into water bodies like, fertilizer run off, oil spillage, agricultural effluents from animal husbandry etc. (Oketola, 2000).

Surface water is most vulnerable to pollution due to its quick accessibility for disposal of pollutants and waste. Generally, surface water quality is influenced by anthropogenic activities and natural process (Jarvie et al, 1998). Erosion, climate change, agricultural land use, sewage discharge, thermal discharges are also sources of lake water pollution (Mahvi et al, 2003).

Several impacts associated with surface water pollution could be reduction of dissolved oxygen due to discharge of effluent into surface waters, presence of pathogen causing cholera, diarrhea, dysentery, hepatitis etc, killing of aquatic organisms due to toxic chemicals in effluents and thermal discharges. (Tchobanoglous, 1992).

Ibadan has different lakes situated within the metropolis. For this study, four lakes were sampled, the Awba lake, situated in University of Ibadan, International Institute of Tropical Agriculture (IITA) lake, situated in the IITA premises, Eleyele lake situated along the Polytechnic Ibadan road and Agodi lake, situated along Mokola in Ibadan. To a large extent the Lake water is polluted, due to increase in population and urbanization of Ibadan city. Lake water pollution in Ibadan is as a result of human activities, which includes sewage disposal, domestic waste, toxic contamination through heavy metals and pesticides, runoff from agriculture and urbanization and air pollution, which have affected the quality of the lake water in Ibadan over the years. As a result of this, there are changes in the physical, biological and chemical status of the water.

In view of the above-mentioned pollution problems of the lakes in Ibadan metropolis, the present study was carried out with the objectives of ascertaining the pollutional level of the lake water by determining the physicochemical properties and level of heavy metals present in the lake water and also to compare the findings with the WHO and FEPA standards for drinking water.

MATERIALS AND METHODS

Four lake sites in Ibadan were sampled; Awba Lake, Agodi lake, Eleyele Lake and International Institute of Tropical Agriculture (IITA) Lake.

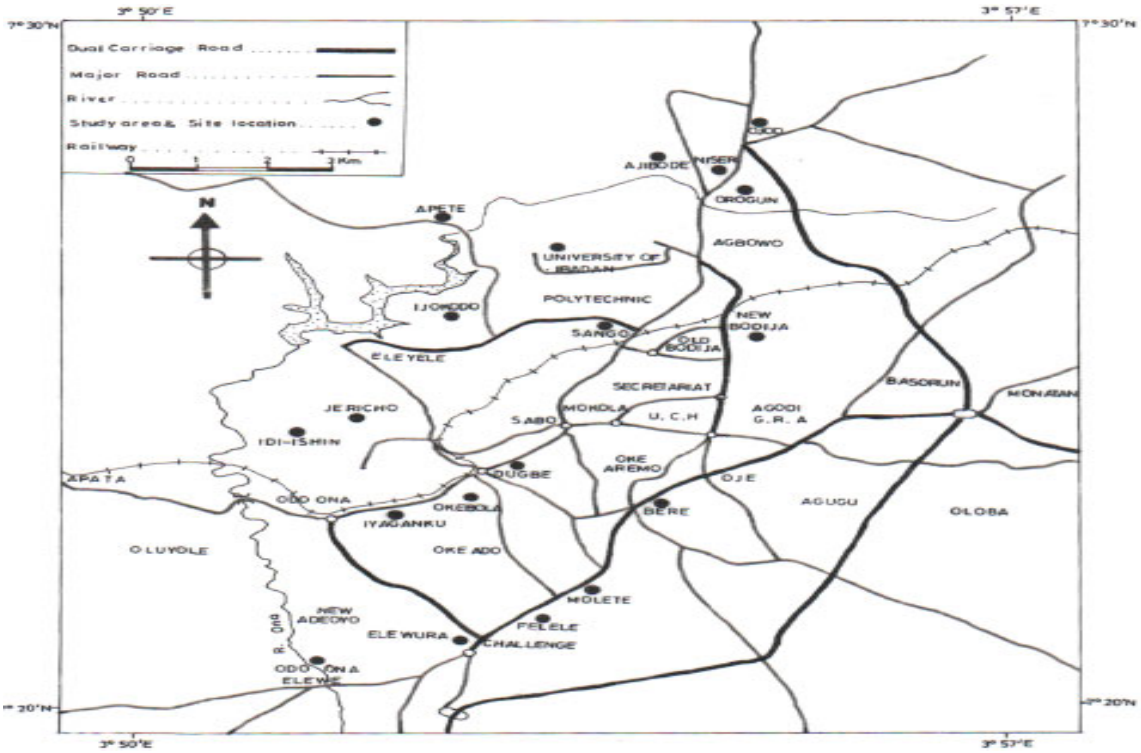

Fig 1: Map of Ibadan showing the Locations of the Lakes

The Awba Lake is situated behind the faculty of science in University of Ibadan. Maximum depth of the water is 28ft., effluents from the faculty like laboratory chemicals, sewages and hostel waste are discharged into the lake thereby polluting it. The lake is surrounded with vegetation's and water hyacinths plants growing around it. Eleyele Lake is located along Olagoke Akintola/Eleyele express roads. The maximum depth of the lake is about 45ft., human activities like bathing, boating, washing and fishing takes place in the water. The International Institute of Tropical agriculture (IITA) Lake is situated in the IITA premises. The maximum depth of the water is about 33ft. The lake is surrounded with thick vegetation, water hyacinths and shrubs. The Agodi Lake is situated along Queen Elizabeth way in Ibadan. Maximum depth of the water is 25ft., effluents from the residential area like, sewages are discharged into the lake, polluting the water.

SAMPLES COLLECTION

Four different sampling points were chosen from each Lake in Ibadan for the water sample. Discrete grab samples were collected manually by dipping the sample bottles gently into the center of the water (Nekhavhambe et al., 2014). Water samples needed for the physicochemical parameters were determined; Samples for physical parameter were collected with 1 litre plastic bottles. Samples for oil and grease determination were collected with 250ml amber bottles. Samples for COD were collected with 1 litre plastic bottles Samples for dissolved oxygen determination were collected with 250ml BOD bottles and the oxygen fixed immediately on the field using manganeous sulphate solution and strong alkali-azide regent. The samples was filled to the brim to prevent atmospheric oxygen from the surface of water and the reagents prevent loss of DO prevent in the water. All were preserved in the refrigerator at 4 ^{0}C (ALPHA, 2005).

SAMPLE RECORD

During the sampling, relevant information concerning the lakes and the surrounding were recorded. These include the ambient temperature (28oC), date of sampling (31st of June, 2016) and (12th of August, 2016) time of sample (11.00am-6.00pm) and (9.00am-4.00pm) respectively. Season of sampling (wet season).

METHODS OF ANALYSIS

The physicochemical parameters analyzed were: pH, temperature, total solids, total dissolved solids, total suspended solids, oil and grease, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, sulphate, nitrate, phosphate, ammonia, chloride, alkalinity and total hardness were determined using American Standard Method for Examination for Wastewater (APHA, 2005)

RESULTS AND DISCUSSION

The results of the characteristic composition of the lake water are as shown in Table 1.1. The appearance of the lake water sampled were generally turbid and the odours not so offensive.

The pH values were within 6.5 – 9.2, which is the range for WHO maximum permissible limits for drinking water. No high pH value exceeding water criteria was found in all the lake waters sampled Table 1.1 gives the mean values of the lake water sampled. The pH values were between the ranges of 7.96 – 8.27 for all lake water sampled. Agodi water had a high value of pH and these may be due to the

chemicals discharged into the water from the laboratory. From table 1.2 the analysis of variance showed that there was a significant difference between the lake water sampled.

The range values of the temperature were between 27.0 – 29.5. Higher temperature values were obtained mainly in the afternoon between the hours of 1.00pm and 4pm, the results showed that IITA water had the highest value of temperature. From Appendix 1, there was a significant difference in the values of temperature obtained for the lake water sampled.

The results obtained from total solid, total suspended solid and total dissolved solid were higher than the WHO standards. The high level of total suspended solid in IITA were indication of settlable and partially dissolved domestic waste from the surroundings. High TDS is due to run-off from the industrial waste water (Moresco et al., 2012).

The level of dissolved oxygen for all the lake water sampled showed the presence of dissolved oxygen. The results show that Agodi and IITA water at 1.99mg/L and 1.93mg/L respectively were slightly polluted, while Awba and Eleyele water at 5.48mg/L and 7.64mg/L respectively were of acceptable quality. This may be due to the presence of water hyacinth and pastia grasses growing around the IITA and Agodi water.

Eleyele water had the highest value of BOD and this may attributed to the composition of waste in the water i.e. presence of organic matter, since the water is situated close to a much commercialized environment. Analysis of variance table 1.2 showed that there was a significant difference in the value of BOD in all the lake water sampled.

High values obtained for COD for all lake water sampled, it's an indication of oxygen used by biodegradable and non-biodegradable organic matter present in agricultural run-off and industrial wastes discharged into the lake (APHA, 2005). From analysis of variance (Table 1.2) there was a significant difference between the lake water sampled in the COD levels.

All the mean values for alkalinity were within the FEPA permissible criteria for drinking water 30 – 500mg/L. The results showed that all lake water sampled were low in alkalinity and this may be due to low level of alkaline substances discharged into the water. From analysis of variance

(1.2) there was a significant difference between the lake water sampled in the alkalinity levels.

The mean value of the total hardness at all points sampled for each lake water were much lower than WHO maximum permissible limit for drinking water which is 500mg/L. The qualitative classification of water according to hardness by (Tchobanoglous, 1992) showed that the four lake water sampled can be classified as being moderately hard. These may be attributed to low level of carbonate in all the lake water sampled. Ca an Mg causes total hardness in natural water and it is classified as carbonate hardness which is associated with carbonate and bicarbonate ions and non-bicarbonate ions associated with other anions such as chloride and sulphate. (Table 1.2) shows that there was significant difference in the level of total hardness for all the lake water sampled.

From table 1.1 the results showed that the mean values of calcium ion present for all four lake water sampled were below the WHO limits for drinking water, which is 200mg/L, while the mean values of magnesium ion present in all the lake water were below WHO maximum permissible limits for drinking water which is 150mg/L$CaCO_3$.

The mean level of oil and grease in the sampled water showed that all the samples had some quantity of oil in it and this may be attributed to the type of activities that takes place in the water bodies like chemicals etc. Presence oil and grease in water makes it unfit for consumption, fish poisoning and finally death of organisms in the water leading to low fish productivity. (APHA, 1999). The results showed a consistent range values in the four lakes sampled.

There was low level of nitrate in all the lake water sampled. The mean levels of Nitrate in all sampled points of the four lakes were lower than the desirable levels of drinking water as recommended by WHO which is 45mg/L. the low level of total nitrogen indicates that the four lake water sampled was unpolluted. The vales for all the lakes sampled were between 0.66 – 1.17mg/L. From analysis of variance (Table 1.1), showed that there was a significant difference in the level of nitrate in all the lake water sampled.

There was slightly high level of phosphate in all the lake water sampled. The mean levels of phosphate in all the four sampled points of each lake were slightly higher than the desirable levels of drinking water as recommended by FEPA (1988), which is within 0.01 – 0.03mg/L. The

high level of phosphate indicates that the water is polluted. This can be attributed to the discharge of detergent as domestic waste (Balal et al., 2015).

The mean levels of sulphate in all the lake water sampled were within the maximum permissible limit for drinking water by WHO and FEPA, which is 400 and 250mg/L respectively. From table 1.1 the results showed that the values of sulphate in all lake water sampled were almost of the same value ranging from 0.02 – 0.04mg/L. The presence of sulphate in water indicates pollution. (Adegbenro and Osibanjo, 2012). Table 1.1 showed that there was a significant difference in the concentration of sulphate in all the lake water sampled.

For chloride the results of all the lake water sampled showed that the samples were within the permissible limit of 600 and 2.5mg/L by WHO and FEPA respectively. The low level of chloride in this study might be due to dilution by rainfall since sampling and analysis were done during the wet season. From the analysis of variance (Table 1.1) the result showed that there was a significant difference between all the lake water sampled for chloride concentration.

Table 1.1: Characteristics of Lake Water Samples

CHARACTERISTICS	AGODI	AWBA	ELEYELE	IITA
ALKALINITY (mg/L)				
MEAN	74	69	67	62
S.D	2.2	8.3	1.7	0.1
RANGE	72.0 – 77.0	61.4 – 81.0	66.0 – 69.7	61.4 – 63.3
BOD mg/L				
MEAN	5.7	6.9	11	6.4
S.D	0.4	0.3	1.0	0.1
RANGE	5.12 – 5.99	6.54 – 7.21	9.90 – 12.1	6.34 – 6.51
COD mg/L				
MEAN	150	145	158	125
S.D	2.1	6.3	9.2	5.3
RANGE	147 – 152	139 – 152	149 – 170	120 – 132
CHLORIDE mg/L				
MEAN	20	27	25	2.0
S.D	1.8	2.0	0.2	0.7
RANGE	18.8 – 22.0	24.9 – 28.8	24.8 – 25.2	18.8 – 20.4
DISSOLVED OXYGEN (mg/L)				
MEAN	2.0	6.5	7.6	1.9
S.D	0.3	0.4	0.5	0.1
RANGE	0.2 – 22.0	5.96 – 6.93	6.99 – 8.01	1.88 – 2.01
NITRATE (mg/L)				
MEAN	0.7	1.3	0.9	1.1
S.D	0.03	0.1	0.02	0.04
RANGE	0.66 – 0.73	1.17 – 1.39	0.89 – 0.94	1.07 – 1.16

pH				
MEAN	8.0	8.3	8.3	8.3
S.D	0.02	0.05	0.04	0.03
RANGE	7.96 – 8.00	8.25 – 9.38	8.25 – 8.35	8.24 – 8.29
PHOSPHATE (mg/L)				
MEAN	0.1	0.1	0.1	0.1
S.D	0.01	0.06	0.02	0.01
RANGE	0.09 – 0.11	0.09 – 0.2	0.08 – 0.12	0.06 – 0.07
SULPHATE (mg/L)				
MEAN	0.02	0.03	0.03	0.02
S.D	0.11	0.01	0.01	0.01
RANGE	0.02 – 0.03	0.02 – 0.04	0.02 – 0.04	0.02 – 0.03
TOTAL HARDNESS ($mg/LCaCO_3$)				
MEAN	160	124	99	110
S.D	3.7	5.1	2.2	2.1
RANGE	155 – 160	120 – 131	96.7 – 102	108-113
CALCIUM HARDNESS ($mg/LCaCO_3$)				
MEAN	100	95	68	63
S.D	4.6	3.0	5.1	1.2
RANGE	94.2 – 105	67.7 – 74.0	60.4 – 71.0	61.0 – 63.9
MAGNESIUM HARDNESS ($mg/LCaCO_3$)				
MEAN	48	53	31	48
S.D	2.8	1.0	7.1	1.1
RANGE	44.8 – 50.7	52.2 – 54.3	41.6 – 25.7	41.6.25.7
OIL/GREASE (mg/L)				
MEAN	2.7	2.0	1.3	2.0
S.D	0.5	0.1	0.1	0.6
RANGE	2.0 – 3.00	1.89 – 2.09	1.17 – 140	1.74 – 2.12
TDS (mg/L)				
MEAN	220	180	190	160
S.D	18	7.3	13	11
RANGE	198 – 240	169 – 186	188 – 203	141 – 164
TS (mg/L)				
MEAN	330	360	340	730
S.D	26	17	9.8	51
RANGE	300 – 363	339 – 379	329 – 352	748 – 756
TSS (mg/L)				
MEAN	110	180	150	570
S.D	9.2	8.4	19	40
RANGE	100 – 124	170 – 190	118 – 164	508 – 592
AMMONIA (mg/L)				
MEAN	0.5	0.1	0.4	0.3
S.D	0.1	0.03	0.01	0.02
RANGE	0.49 – 0.59	0.08 – 0.14	0.89 – 0.94	0.28 – 0.33
TEMPERATURE $^{o}C.$				
MEAN	28	28	28	30
S.D	0.2	0.3	0.1	0.3
RANGE	27.5 – 27.9	28.0 – 28.5	27.0 – 28.0	29.5 – 30.0

COD-Chemical Oxygen Demand TDS-Total Dissolved Solid TS-Total Solid
BOD-Biochemical Oxygen Demand TSS-Total Suspended Solid

Table 1.2: Analysis of Variance Data of Physicochemical Parameters of Lake Water

Parameters	Source of variations	Sum of squares	Degrees of freedom	Mean square	F-ratio	Significance
Temperature	BG WG	9.303 0.475	3 12	3.101 0.040	78.3	0.00
pH	BG WG	0.295 0.018	3 12	0.098 0.002	65.4	0.00
Dissolved Oxygen	BG WG	109.7	3 12	36.596 0.504	72.7	0.00
Biochemical Oxygen Demand	BG WG	72.051 3.687	3 12	24.017 0.307	78.2	0.00
Chemical Oxygen Demand	BG WG	2427.688	3 12	809.229 39.063	20.7	0.00
Total Solids	BG WG	443706.7 111112.250	3 12	147902.29 926.021	160	0.00
Total Dissolved Solids	BG WG	15086.250 1633.500	3 12	5028.750 136.125	36.9	0.00
Total Suspended Solids	BG WG	460909.3 7032.500	3 12	153636.417 586.042	262	0.00
Nitrate	BG WG	0.756 0.037	3 12	0.252 0.003	82.1	0.00
Chloride	BG WG	139.967 23.323	3 12	46.656 1.944	24.0	0.00
Phosphate	BG WG	0.008 0.017	3 12	0.003 0.001	1.75	0.21
Total Hardness	BG WG	7398.742 145.386	3 12	2466.247 12.114	204	0.00
Calcium Hardness	BG WG	3357.540 171.590	3 12	119.180 14.299	78.3	0.00
Magnesium hardness	BG WG	1168.935 193.215	3 12	389.645 16.101	24.2	0.00
Sulphate	BG WG	0.001 0.000	3 12	0.000 0.000	6.29	0.00
Alkalinity	BG WG	280.442 231.313	3 12	93.481 19.276	4.85	0.02
Ammonia	BG WG	0.379 0.012	3 12	0.126 0.001	131	0.00
Oil & Grease	BG WG	4.045 0.805	3 12	1.348 0.067	20.1	0.00

BG ------- Between Groups
WG------- Within Groups

CONCLUSION

The result of the analyses indicates that most of the physico-chemical parameters of the water samples were within the WHO and Federal Environmental Protection Agency (FEPA) maximum permissible limit for drinking water. They are not high enough to be hazardous. Proper examination should always be carried out on the lake waters at regular intervals to avoid contamination of the lakes which can eventually be harmful to man and its environment.

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