Physicochemical Analyis and Heavy Metal Concentration of Sediments in Four Lakes In Ibadan Metropolis, Southwest, Nigeria.

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ABSTRACT

Lake sediment is a ready sink or reservoir of pollutants including heavy metals. Studies were carried out on the quality of sediments in some lakes in Ibadan to ascertain the extent of pollution. The following lakes were analyzed: Agodi, Awba, Eleyele and IITA lakes. In this regards, four sampling points were selected for each lake and the following parameters were analyzed; % Organic carbon (OC), pH, % Organic Matter (OM), Cation Exchange Capacity (CEC), mechanical properties and heavy metals. The results revealed that CEC ranged from 94.0 meq/100g in Agodi lake to 250 meq/100g in Awba lake , % OC ranged from 0.5 % in IITA to 4.6 % in Awba lake, % OM ranged from 0.9 % in IITA to 8.0 % in Awba lake. The concentration of Cd ion in the lake sediment ranged from 0.1 µg/g in Eleyele to 1.4 µg/g in Agodi lake. Similarly, Pb ion ranged from < 0.01 in IITA to 1.7 µg/g in Agodi lake.The heavy metals data obtained from the study were above the WHO standard for heavy metals in water, which could pose serious threat to human health, water quality and the environment.

Keywords: Sediment, heavy metal, Ibadan, lake water, pollution, environment

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1. INTRODUCTION

INTRODUCTION

The availability of safe and portable source of water in all parts of the world has become global concern over the last few decades (Onnby, 2013; Dada, Ojediran and Abiodun, 2013). Environmental pollution especially lake sediment pollution due to indiscriminate discharge of industrial effluents stand as a risk to worlds water availability. (Anazawa, Kaid, Shinomura, Tomiuasu and Sakamoto, 2004). Sediment pollution is the largest single pollutant of water in Nigeria, but very few people recognize this because they accustomed to seeing muddy rivers, lakes and ponds. Large amounts of sediments in water reduce the visibility and decrease the process of photosynthesis. Suspended sediments cause a high oxygen demand in water and this may reduce dissolved oxygen and affect aquatic life. Sediments also decrease the portability of water and increase the cost of purification. In this regard, sediment pollution is an economic liability (Ellis, White and Warn, 1982).

While water is usually employed as pollution indicator by trace metals, sediments also provides good information on the long-term pollution state of the water body. Sediment refers to sand, stones, mud etc. carried by water and left on the bottom of a lake. Sediment has also been described as a ready sink or reservoir of pollutants including trace metals where they concentrate based on the level of pollution (Mofikoya and Babatunde, 2014).

In this study, it therefore becomes imperative to assess the state and quality of some lakes in Ibadan metropolis by determining their physicochemical properties and heavy metals concentration present in the lake sediments. The pollution of this lake sediment 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. These have affected the quality of the lake sediment over the years, thereby, causing changes in the physical, biological and chemical status of the water.

2. MATERIALS AND METHODS

Fig. 2.1 presents the map of Ibadan, southwest, Nigeria. Four lake sites were sampled; Awba Lake, Agodi Lake, Eleyele Lake and International Institute of Tropical Agriculture (IITA) Lake situated in Ibadan.

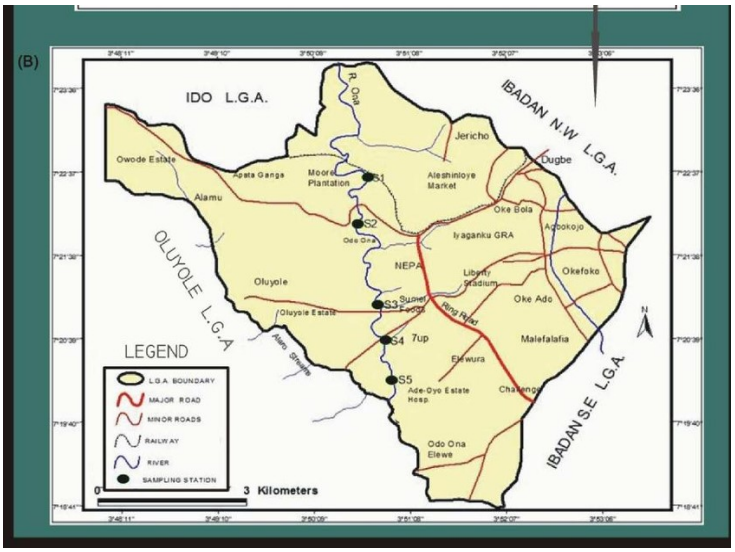

Fig. 2.1: Map of Ibadan, southwest, Nigeria.

2.1 Chemicals and Equipment: All reagents used were of analytical grade and purchased from Nijat Nigeria Limited. Deionized water was used throughout the experiment. The measurement for heavy metals was performed using Perkin Elmer Analyst 400 AAS at Central Science Laboratory, University of Ibadan.

2.2 Sample Collection: The sediment samples were collected from four different points of each lake using grab sampler and transferring into a polythene bag for further analysis.

2.3 Sample Treatment: The samples were air-dried for several days, grinded and sieved through 2mm mesh sieve.

2.4 Method of Analysis: The following physicochemical parameters and heavy metals were analysed; pH, CEC, %OC, %OM, mechanical properties, heavy metals are; Lead, Chromium, Cadmium and Copper using American Standard Method for Examination for Wastewater (APHA, 2005).

3. RESULTS AND DISCUSSION

3.1 Physicochemical Parameters of the Sediments

3.1.1 pH. The mean pH values obtained for all the lake sediment were in the range of 5.13-6.13. This is an indication that the sediments were slightly acidic as presented in Table 3.1. Awba lake had the highest pH mean value; this may be attributed to the chemicals discharged into the lake from the laboratories. Table 3.2 showed that there was a significant difference in the pH of all the lake sediment samples.

3.1.2 Percentage Organic Carbon. The quality of organic carbon present was dependent on the adequacy of aeration stability of the soil structure, its ability to absorb and retain water and its capacity to supply nitrogen, phosphorus and other elements to growing plant. The mean obtained for all the sediment samples are as stated in Table 3.1. From analysis of variance (Table 3.2) showed that there was a significant difference in the level of organic carbon in all the lake sediment sampled.

3.1.3 Percentage Organic Matter. Soil organic matter values are used to estimate potential soil nitrogen mineralization, pesticides management and crop production management. The mean value of sediment obtained for all lake sediments were between 0.98-7.97 % as shown in Table 3.1. From (Table 3.2), it can be concluded that, there was a significant difference in all the lake sediment sampled.

3.1.4 Cation Exchange Capacity. The mean value obtained for Agodi sediment was recorded as 93.5±6.86 meq/100g with values ranging from 86.0–102 meq/100g as presented in Table 3.1. Awba sediment had a mean value of CEC recorded as 250 ± 13.5 meq/100g, the values ranged from 238–269 meq/100g. Eleyele sediment had a mean value of 104±2.94 meq/100g. From the analysis of variance (Table 3.2), the result showed that there was a significant different in the level of CEC between all the lake sediment sampled.

3.1.5 Mechanical Properties. The sizes ranges for sediments are as follows; sand- 0.05-2.0 mm, slit was between the ranges of 0.05-0.002mm and clay had a value of >0.002 mm. The mean value for percentage sand and silt from Table 3.1 showed that the particle sizes of the sediment were higher than the required size. Percentage clay was within the standard range stated. There was a significant difference in the level of %clay, %sand and %silt for all the lake sediment sampled.

Table 3.1: Characteristics of Lake Sediment Samples

Parameter/ Characteristics	AGODI	AWBA	ELEYELE	IITA
CATION EXCHANGE CAPACITY (meq/100g)				
MEAN	94	250	100	220
S.D	6.9	14	2.9	3.9
RANGE	87.0-102	238-269	102-107	218-227
pH				
MEAN	5.3	5.1	6.1	5.7
S.D	0.03	0.1	6.1	0.1
RANGE	5.29-5.35	5.10-5.20	6.1-6.20	5.70-5.80
% ORGANIC CARBON				
MEAN	1.9	4.6	2.2	0.5
S.D	0.3	0.2	0.2	0.03
RANGE	1.62-2.24	4.36-4.82	1.98-2.41	0.49-0.56
%ORGANIC MATTER				
MEAN	3.2	8.0	3.9	0.9
S.D	0.3	0.3	0.3	0.1
RANGE	1.62-2.24	3.80-4.17	3.80-4.17	0.85-0.97
% CLAY				
MEAN	0.7	1.1	1.1	8.0
S.D	0.01	1.10	0.01	0.01
RANGE	0.68-0.70	1.03-1.06	1.04-1.06	7.99-8.82
% SAND				
MEAN	27	1.2	1.9	88
S.D	0.8	0.1	0.3	0.1
RANGE	25.7-27.6	1.04-1.35	1.64-2.25	88.0-88.2

Table 3.2: Analysis of Variance of the Physico-Chemical Parameters of Sediment

Parameters	Source of Variations	Sum of squares	Degrees of freedom squares	Mean	F-ratio	Significance
pH	BG WG	2.609 0.045	3 12	0.870 0.004	234	0.00
Cation Exchange Capacity	BG WG	76755.688 75.750	3 12	25585.229 63.063	406	0.00
% Organic Carbon	BG WG	34.247 0.426	3 12	11.416 0.036	321	0.00
% Organic Matter	BG WG	103.398 3 0.896	34.466 12	461 0.75	0.00	
% Sand	BG WG	1646.537 2.097	3 12	548.846 0.175	314	0.00
% Clay	BG WG	150.213 0.001	3 12	50.071 0.000	445	0.00
% Silt	BG WG	1794.672 2.074	3 12	598.224 0.173	346	0.00

BG- Between Groups
WG- Within Groups

3.2. Heavy Metal Analysis in the Sediment

The concentration of trace metals in the sediments collected from the lake under study is presented in Table 3.3. The concentration of Cadmium ion was found to be highest in Agodi lake (1.4 µg/g) in all the lake sampled. Awba lake presented the highest mean concentration of Lead ion (13 µg/g) in all the lakes sampled. The level of Copper ion concentration was highest in Awba and Agodi lake (11 µg/g). Awba lake presented the highest mean concentration of Chromium in all the lake sampled, with a value of 40 µg/g. The analysis of variance as shown in Table 3.4 reveals that there was no significant difference between the four heavy metal concentrations in all the lake sediment sampled. The results reveals that the mean concentration values of the metals in the lake sediment sampled were higher than the WHO standard as shown in Table 3.5. This indicates that, metals discharged into lake water settles at the bottom of the water, which is the sediment, implying that as the concentration of the heavy metals in the sediments increases, the concentration in the water also increases appreciably.

Table 3.3: Metal concentrations (µg/g) in sediments samples

METALS/ SAMPLE CODE	AGODI	AWBA	ELEYELE	IITA
CADMIUM				
MEAN	1.4	0.6	0.1	0.9
STD. DEV.	0.4	0.1	0.02	0.1
RANGE	1.06-1.96	0.66-0.52	0.09-0.13	0.72-0.94
LEAD				
MEAN	1.7	13	6.4	<0.01
STD. DEV.	2.5	1.2	0.3	0.01
RANGE	13.9-19-9	11.3-14.2	6.03-6.80	0.01-0.01
COPPER				
MEAN	11	11	6.5	6.5
STD. DEV.	4.2	1.8	0.63	0.14
RANGE	9.30-12.2	9.40-13.6	5.93-7.41	6.43-6.72
CHROMIUM				
MEAN	15	40	0.01	<0.01
STD. DEV.	3.6	3.4	<0.01	0.01
RANGE	10.6-19.4	36.2-44.4	<0.01-0.01	0-0.01

Table 3.4: Analysis of variance data of the metals concentration in water and sediment

Parameters	Source of Variations	Sum of squares	Degrees of freedom	squares	Mean	F-ratio	Significance
Cd Sediment	BG	3.178	3		1.059	24.3	0.000
	WG	0.523	12		0.004		
Pb Sediment	BG	679.767	3	226.589	127	0.000	
	WG	21.428	12		1.786		
Cu Sediment	BG	80.733	3		26.911	21.2	0.000
	WG	15.226	12		1.269		
Cr Sediment	BG	3905.389	3		26.911	210	0.000
	WG	74.561	12		6.213		

Table 3.5: WHO standards for heavy metals in water

Metal	Prescribed Limit(mg/L)
Cadmium	0.005
Chromium	0.05
Lead	0.05
Copper	0.05

Source: Mofikoya and Babatunde (2014).

4. CONCLUSION

The results of the analysis showed that the physico-chemical parameters of sediment in all the lakes sampled had no significant difference in the levels of parameters studied. The data obtained from the study of the heavy metals in the sediments of the four lake water sampled were above the WHO standard for heavy metals in water. IITA lake showed the lowest concentration of all the metals while Agodi and Awba lake had the highest concentration of heavy metals in the sediments. The levels of heavy metals determined in sediments were higher than the prescribed limit for water by WHO. These implies that as the concentration of the metals in the sediments increases, the concentration in the water also increases appreciably. Hence, posing serious threat to human health, water quality and the environment.

With respect to the findings of this research, it is recommended that;

- 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.
- Government should enlighten the public on the relevance of proper environmental practices through education and public awareness.

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REFERENCES

1. Anazawa, K., Kaid, V., Shinomura, Y., Tomiuasu, T. and Sakamoto, H. (2004). Heavy Metal Distribution in River Waters and Sediment around Firely Village, Shikoku, Japan. *Application of Multivariate Analysis. Analytical Science, 20:79-84.*
2. Dada, A. O., Ojediran, J. O. and Abiodun, P. O. (2013). Sorption of Pb^{2+} from aqueous unto modified rice husk: Isotherm studies. *Advances in Physical Chemistry,* 2013**:**1-6. Article ID 842425,http://dx.doi.org/10.1155/2013/842425.
3. Ellis, K. V., White, G. and Warn, A. E. (1989). Surface water pollution and its Control. Macmillan Press, London.
4. Mofikoya, A. I. and Babatunde, D. D. (2014). Concentration of trace metals in water and sediments of four streams in Abeokuta, Ogun state, Nigeria. *International Journal of Science Education,* 5(1): 1-7.
5. Onnby, L. (2013). Water treatment using cryogel-based adsorbents: Targeting environmental pollutants at low concentrations. Ph. D Thesis, Facaulty of Engineering, Lund University, Sweden.
6. Standard Methods (2005). Standard Methods for the examination of water and waste water (21st Editions). American Public Health Association (APHA), AWWA Washington DC, 150-200.