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LIMNOLOGICAL STUDY OF A MAN-MADE LAKE IN IBADAN, NIGERIA

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ABSTRACT

The physico-chemical and trace metal analyses of International Institute of Tropical Agriculture (IITA) main lake in Ibadan were determined in other to assess the current status of pollution. The physico-chemical parameters determined were; dissolved oxygen (DO) by Winkler's titrimetric method; pH with pH meter (Metrohm Hersau E 520) and temperature with the use of a Thermometer (0-100^{0}C). The trace metals (copper and zinc) were analysed using the Atomic Absorbtion Spectophotometer (Unicam Model SP 1900). The range of values obtained for physico-chemical parameters were as follows: DO 0.51-3.0 mg/l, Nitrate 0.12-20.0 mg/l, Phosphate 0-4.50 mg/l, pH 6.60-8.81 and temperature 26.0-29.0^{0}C. The values obtained for trace metals were as follows: copper 0-0.15ppm and zinc 0-0.79 ppm. The values obtained for trace metals and physico-chemical parameters in the water samples of the lake fell below the recommended permissible limits set by Federal Environmental Protection Agency (FEPA) Nigeria and World Health Organization (WHO), the lake was not polluted. However, monitoring should be ensured to avoid pollution.

Keywords: Pollution, Physico-chemical analysis, trace metals, IITA Lake

INTRODUCTION

One of the greatest problems man has today is the issue of water pollution; contamination of streams, lakes, underground water, bays, or oceans by substances harmful to living things. Water is necessary to life on earth. Plants and animals require water that is moderately pure, and they cannot survive if their water is loaded with toxic chemicals or harmful microorganisms. If severe, water pollution can kill large numbers of fish, birds, and other animals, in some cases killing all members of a species in affected areas as reported in the Minamata disease outbreak in Japan-1956 (Jobin, 2005). Pollution makes streams, lakes, and coastal waters unpleasant to look at, to smell, and to swim in. Fish and shellfish harvested from polluted waters may be unsafe to eat. People who ingest polluted water can become ill, and, with prolonged exposure, may develop cancers or bear children with birth defects (Microsft Encarta, 2009).

Water makes about 80% of the living protoplasm and is required as medium for all metabolic reactions taking place in the cell (Brock and Madigan, 1991). As such no living thing, including man can survive without water. Water pollution can result from many human activities. Pollutants from industrial sources may pour out from the outfall pipes of factories or may leak from pipelines and underground storage tanks. Polluted water may flow from mines where the water has leached through mineral-rich rocks or has been contaminated by the chemicals used in processing the ores. Cities and other residential communities {contribute mostly sewage, with traces of household chemicals mixed in. Sometimes industries discharge pollutants into city sewers, increasing the variety of pollutants in municipal areas. Pollutants from agricultural chemicals such as fertilizers, herbicides and pesticides, all contribute to the pollution of water. The IITA main lake is used for domestic, agricultural (irrigation), laboratory and fishing purpose. The water from the Lake is recycled for domestic purpose.

The present study takes into account the current status of pollution in IITA Lake, Ibadan, Nigeria.

MATERIALS AND METHODS

The Study Area (Main Lake)

The Main Lake (also known as IITA Lake) was constructed in 1968. The dam created a lake which is 70 ha. in area and has a depth of 10m The general surrounding of the lake is a thick uncultivated forest along one bank and the experimental agricultural field on the other. The research field receives fertilizer application twice or more per year. The nutrient rich run-off water from these fields makes the lake very fertile and as a result, water weed problems are considerable. A water weed harvester is used routinely which keeps weed problem under control. The cultivated crops in the research farms surrounding the lake include maize, cowpea, cassava and rice. A variety of chemicals are regularly used on them such as herbicides like Grammoxon, Primextra, Paraquat and pesticides like Carbofuran, Actellic etc. NPK and Urea fertilizers are also used.

Fishing activities usually takes place in this lake. Among the fish species present are *Gymnarchus niloticus, Oreochromis niloticus, Lates niloticus, Tilapia zilli, Clarias* spp., *Sarotherodon galileus etc*.

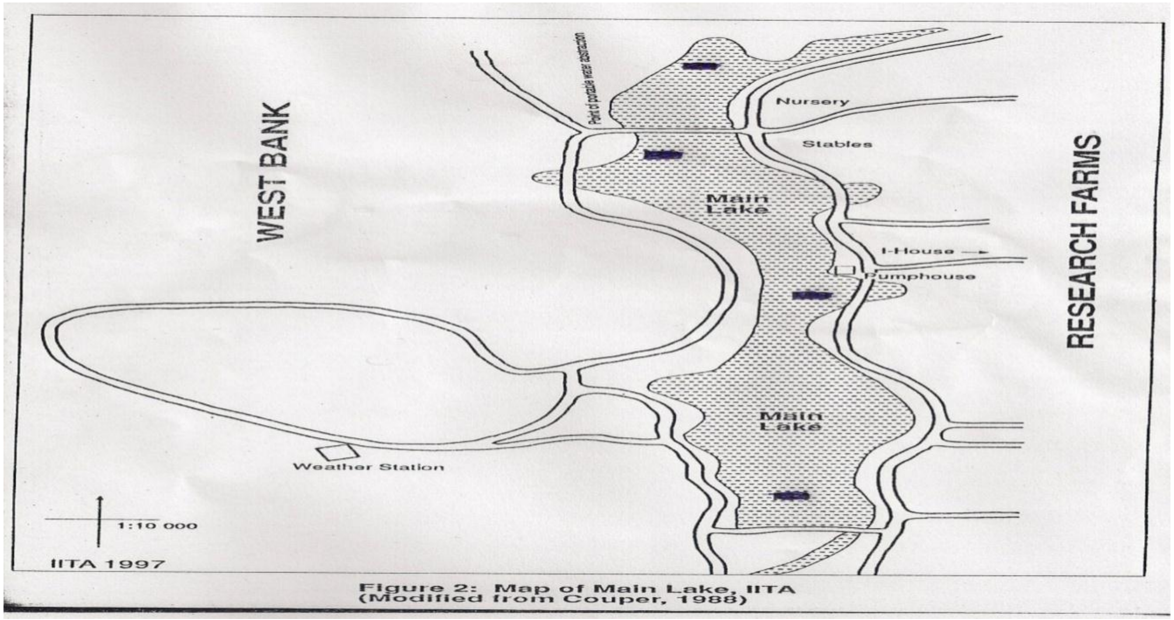

Figure 1: Map of IITA Lake

Source: Couper, 1988

Sampling

Water samples were collected from the lake weekly for twelve weeks between 9am and 12pm.

Sampling for physico-chemical parameters

The containers used for the collection of sample were washed and rinsed thoroughly with clean water as described by Mombeshora *et al.*, (1981). All the containers used for collection were plastic. Each container was filled with water when dipped into it. The temperature of the water surface at each site was measured with a mercury-in-glass (0-100^{0}C) thermometer.

Dissolved oxygen sampling was carried out. Samples collected were without air bubbles both in the water and containers. Samples were then fixed on the spot with Winkler's solution A and B.

other parameter sampled was nitrate. All the samples were taken to the laboratory for analysis. Samples were also analysed for heavy metals by the AAS according to standard methods by APHA (1992). Analysis of Variance (ANOVA) was used in all cases for mean metal level and physico-chemical parameter comparisons at 5% level of significance.

RESULTS AND DISCUSSION

The physico-chemical parameters recorded in IITA Lake are presented in Figure 2 and Table 1. The highest weekly temperature value for the entire lake was 29.0^{o}C in the 1st and 2nd week (May) while the lowest was recorded in the 12th week (26.5 ^{o}C). Temperature determination is important because of its effect on other physical phenomenon like dissolved oxygen, reduction in solubility of gases and amplification of tastes and odours. The temperature values analysed were within the maximum permissible limits (Table 2). Doughari *et al*., (2007) reported an increase in temperature (29^{0}C) in their work at Gudu stream, Abuja. DO ranges was from 0.51- 3.05mg/l. DO levels was highest in the 5th and 10th week. DO is very crucial for survival of aquatic organisms and it is also used to evaluate the degree of freshness of a river (Fakayode, 2005). The IITA main lake had no plankton, due to the fact that weeds were always removed from the water surface. This may be one of the reasons why the DO level is not high.

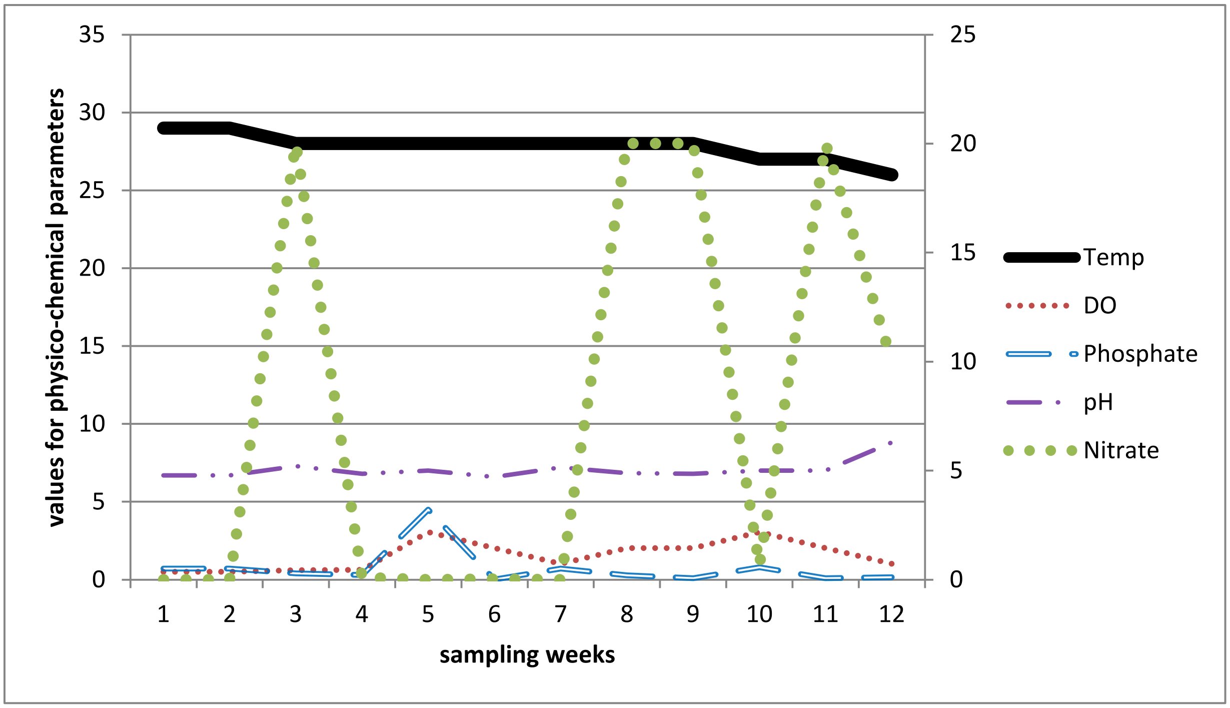

Figure 2: Variations of physico-chemical analysis in IITA Lake

Table 1: Results of Physico-chemical Parameters of IITA Lake

Weeks	DO	Nitrate	Phosphate	pH	Temperature
1	0.46±0.08a	1.01±0.01a	0.75±0.07a	6.71±0.01a	28.50±0.71a
2	1.01±0.01a	1.01±0.01a	0.65±0.07a	6.71±0.01a	28.50±0.71a
3	0.61±0.01a	20.05±0.07a	0.45±0.07a	7.32±0.02a	28.00±0.00a
4	0.61±0.01a	0.15±0.07a	0.31±0.01a	6.75±0.00a	28.00±0.00a
5	3.03±0.06a	0.00±0.00a	4.50±0.01a	7.05±0.07a	28.50±0.71a
6	2.02±0.02[a]	12.60±0.01a	0.03±0.1a	6.55±0.71a	28.50±0.71a
7	1.01±0.01a	0.01±0.01a	0.75±0.07a	7.25±0.07a	28.50±0.71a
8	2.02±0.02a	20.01±0.01a	0.29±0.01a	6.82±0.02a	28.50±0.71a

9	2.02±0.02a	20.05±0.07a	0.15±0.07a	6.85±0.07a	28.50±0.71a
10	3.02±0.02a	0.63±0.04a	0.75±0.06a	7.0±0.71a	27.50±0.71a
11	2.02±0.02a	20.05±0.07a	0.10±0.00a	7.05±0.07a	27.50±0.71a
12	1.01±0.01a	10.01±0.01a	0.13±0.04a	8.81±0.01a	26.50±0.71a

Means with the same alphabet along the rows are NOT significantly different at 0.05 probability level (Duncan's Test).

Nitrate concentrations ranged from 0-20.0mg/l and very high (compared to other weeks) in weeks 3, 8, 9 and 11. Seepage of fertilizer used on the farms of IITA research farms into the lakes may have contributed to the high levels of nitrate recorded in them. Nitrate from fertilizers is not a health hazard, but when converted into nitrite, as is often the case in soils, it becomes a significant hazard. Nitrate, if leached to potable water supply is however a hazard (Amadi, 1991). Human intake of nitrate in food and drinking water is one of the current environmental issues associated with agriculture. Nitrites can produce a serious condition in fish called "brown blood disease." Nitrites also react directly with hemoglobin in human blood and other warm-blooded animals to produce methemoglobin. Methemoglobin destroys the ability of red blood cells to transport oxygen. This condition is especially serious in babies under three months of age. It causes a condition known as methemoglobinemia or "blue baby" disease. Water with nitrite levels exceeding 1.0 mg/l should not be used for feeding babies. High concentration of nitrates (> 100mg/l) in water may also result in the formation of nitro-5-amines in the stomach. Nitro-5-amines have caused stomach cancer (gastrointestinal cancer) in animal experiments (Mason, 1991).

Table 2: Standards For Water Quality: Drinking Water

PARAMETER	AWBA	MAX. Permissible limit standard for drinking water
Temperature (^{0}c)	26-31.0	20-33.0
DO (mg/l)	1.02-6.1	6.80
Nitrate (mg/l)	10.12-14.81	20.0
Phosphate (mg/l)	4.78-9.78	>6.1
pH	8.10-8.81	6.0-9.0
Copper (ppm)	0.01-0.08	2.0
Zinc (ppm)	0-0.79	<1.0

FME (2001)

Phosphate ranged from 0-4.50 mg/l with highest concentration recorded in week 5. Biney, (1990) noticed a similar case in his studies of some fresh waters and coastal ecosystems in Ghana that phosphate levels were very low. Man-made lakes act as sedimentation tanks for the suspended sediments of their feeder rivers (Symoen *et al*., 1981). This process may also remove some of the inorganic phosphorus before the waters are discharged Midstream. Peak pH value of 8.81mg/l was observed in the 12th week. This corroborates with findings of Doughari *et al*. (2007) that reported a pH of 7.04 at Gudu stream, Abuja.

Trace Metals: The trace metals analyzed for were copper and zinc. The weekly variations in concentrations of these metals are illustrated in Table 3 and Figure 3. Copper concentrations ranged from 0-0.15 ppm.

Table 3: Results of Duncan's Test for Trace metal in IITA Lake

Week	Copper	Zinc
1	0.03±0.01b	0.00±0.00a
2	0.03±0.01a	0.00±0.00a
3	0.01±0.01a	0.19±0.01a

4	0.01±0.01a	0.00±0.01a
5	0.00±0.00a	0.00±0.00a
6	0.00±0.00a	0.00±0.00a
7	0.00±0.00a	0.00±0.00a
8	0.00±0.00a	1.05±0.01a
9	0.00±0.00a	1.07±0.01a
10	0.00±0.00a	1.05±0.01a
11	0.17±0.02a	0.00±0.00a
12	0.00±0.00a	0.00±0.00a

Means with the same alphabet along the rows are NOT significantly different at 0.05 probability level (Duncan's Test)

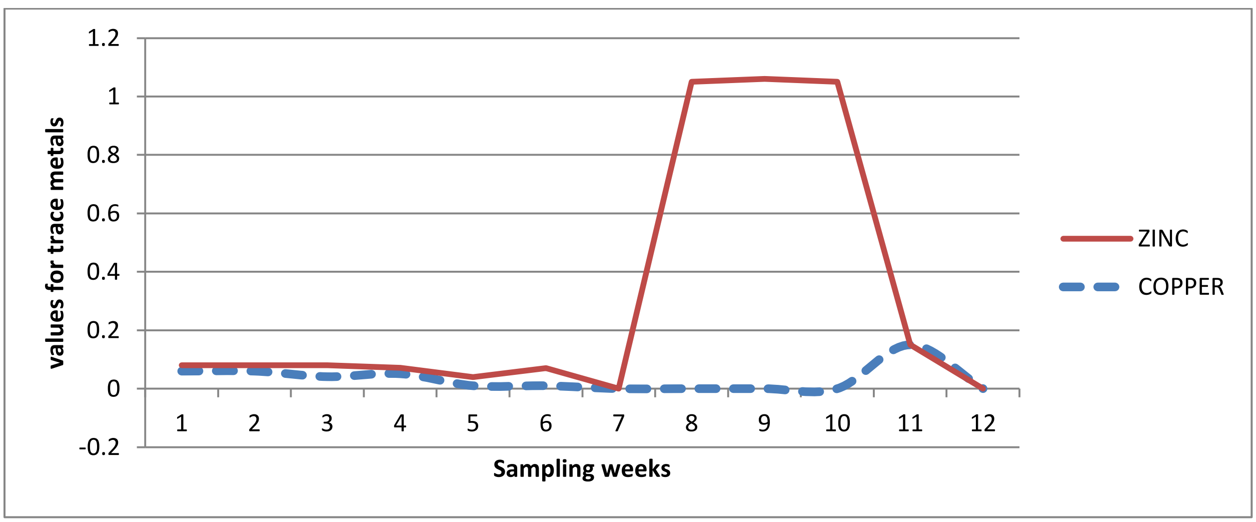

Fig 3: weekly variations of copper and zinc in IITA Lake

The results obtained from this study showed that both the physico-chemical parameters and trace metals analyses fell within the standards for water quality. Another reason which could have resulted to decrease in values of both the physico-chemical parameters and trace metals analysed might have been the presence of the following aquatic plants which are known for their phytoremediation ability.

Phytoremediation is the use of green plants to remove pollutants from the environment or to render them harmless. Phytoremediation takes advantage of the fact that a living plant can be considered a solar-driven pump, which can extract and concentrate particular elements from the environment. The plants include; Water hyacinth *(Eichhornia crassipes),* water lettus (*Pistias stratiostes*) and water lily (*Nymphaea lotus)*. Usman *et a.,l* (2002) showed that *Nymphaea lotus* has high potential for selective uptake of Lead and Zinc faster than for Iron. Ogunlade ,(1996) reported that water hyacinth has the ability to remove nutrients and heavy metals from aquatic environments. Okunowo and Ogunkanmi (2010) showed that the water hyacinth can phytoremediate metals such as Potassium, Sodium, Zinc, Lead, Iron, Cadmium, Magnesium, Copper and Calcium. Water hyacinth has been reported to bioaccumulate some of these metals (Upadhyay and Tripathi, 2007).

CONCLUSION

The values obtained in the IITA Lake fell below the International standards for drinking water (FME, 2001). This could mean that some control measures were put in place. This study has shown that the water samples meet the WHO limits for the trace metals and the physico- chemical properties. This means that the water is not polluted. However, regular monitoring should be ensured by the authorities concerned to prevent the Lake from being polluted.

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