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DISTRIBUTION OF TRACE METALS IN VERTEBRATE AND INVERTEBRATE SPECIES FROM UBEJI CREEK, SOUTHERN NIGERIA

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ABSTRACT

Trace metals content in water, fishes (Tilapia mariae, Clarias gariepinus), earthworm (Libydrius violaceous) and sediment were determined from Ubeji River using Atomic Absorption Spectrophotometer (AAS). Metals determined were lead, cadmium, zinc, mercury, arsenic, copper and Iron. The results obtained revealed that all the metals were detected. Also, there were variations in metal levels in the samples. Highest Zn level was obtained in all the samples analysed (0.284ppm and 0.284ppm in water, 24.0mg/kg in Clarias gariepinus, 28.8mg/kg in Tilapia mariae, 1.16mg/kg in earthworm and 0.64mg/kg in sediment). The concentrations of trace metals obtained in this study are found to be dangerous. The metal levels in water from Ubeji River are higher than the WHO/FEPA standards for water quality. The concentrations of lead, zinc and copper obtained in the whole body of fishes exceeded the WHO/FEPA set standards for aquatic life. The presence of trace metals found in the sample from Ubeji River is attributed to the proximity of petroleum activity, construction works and other allied companies.

Keywords: Trace metal, Fish, Atomic absorption spectrophotometer.

Contribution/ Originality

This study contributes to the existing knowledge of trace metals in the aquatic ecosystem. It helps resource managers to identify the pollution problems in freshwater bodies and also measure accurately the health status of the water body.

1. INTRODUCTION

Pollution of the aquatic environment by human activities has been considered a major threat to the aquatic organisms including fishes. The agricultural drainage water containing pesticides and fertilizers, effluents of industrial activities and runoffs in addition to sewage effluents supply the water bodies and sediment with huge quantities of inorganic anions and heavy metals [1]. The most anthropogenic sources of metals are industrial, petroleum contamination and sewage disposal [2].

Heavy metal pollution is a reality in Africa but many nations have not yet carried out systematic studies to estimate the impact of the phenomenon. Detailed surveys on accumulation of these pollutants in aquatic ecosystems and evaluations of their impacts on the environment and public health are also lacking [3]. Heavy metal contamination especially mercury toxicity from fish consumption has been reported in other parts of the world [3-5]. Trace metal studies in Nigerian urban fish indicated high levels of lead and cadmium due to accumulation of these metals from contaminated food and polluted environment, which poses great health hazard to consumers [6].

Despite comparatively low industrial activities in Ubeji town, the stream is becoming exposed to unwanted ecological effects of heavy metals due to uncontrolled disposal or poor management of industrial effluent. Other sources of water pollution are surface runoffs from domestic and agricultural activities coupled with vehicular emissions into drainage systems. These drainage systems are connected to the area's stream without being subjected to pretreatment. Studies have shown that some streams around Ubeji are polluted with metal pollutants such as lead, chromium and cadmium. These studies revealed further that wastewater treatment plants in the area do not exist [7]. Wastewaters around these areas are channeled to various streams. Studies on soil samples near major roads in Ubeji have shown relatively high concentrations of heavy metals [8-10]. Consequently, these metals are washed into the area streams, which lead to more pollution.

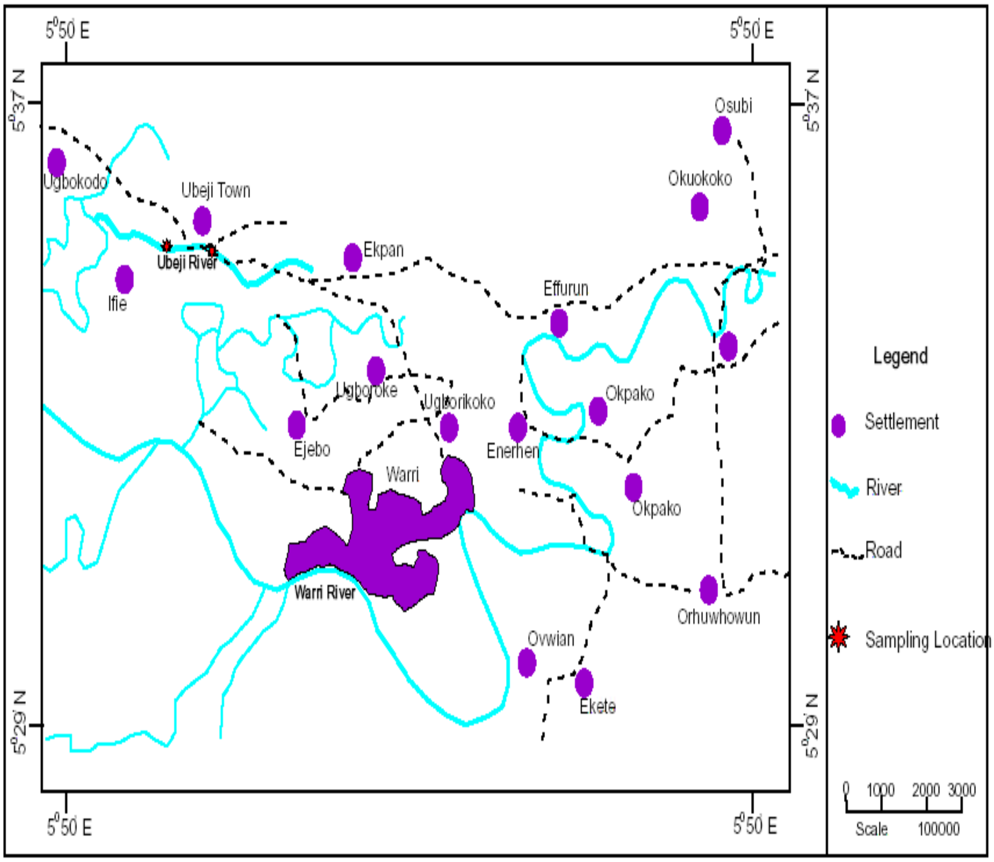
This work aimed to investigate (*i*) the distribution of trace metals in fish and earthworm in Ubeji River, (*ii*) find the source of pollution, (*iii*) find the concentration of pollutants in fish, earthworm and sediment in Ubeji River and, (*iv*) find out if the levels of pollutants are dangerous to man and aquatic life.

2. MATERIAL AND METHOD

2.1. Sampling Area

Ubeji River (fig. 1) is a tropical shallow freshwater body with a depth ranged from 40 to 178m. The area of the river reached about 345km^2 and drains into Warri River. Ubeji River is a subject to huge inputs of anthropogenic nutrients discharge, sewage and agricultural runoff. The inhabitants of Ubeji are from all works; therefore, it is necessary that Ubeji River as the receiving end of all waste both domestic and industrial waste might be polluted. There is no doubt that pollution can impact negatively on the aquatic life, hence the need for this study.

Figure-1. Map showing the study location



2.2. Sample Collection

Samples were collected from Ubeji River in triplicates. Samples collected are water, *Tilapia mariae*, *Clarias gariepinus*, earthworm (*Libyodrilus voilaceous*) and sediment during day time in January 2013. Water was collected with clean polyethylene bottles followed by addition of 5ml concentrated HNO_3 to maintain the pH of the water. Fish and earthworm samples were collected in plastic buckets containing the river water. Sediments obtained from the side of the river were placed in plastic container. All chemicals and reagents used in this procedure were of analytical grade (AR). Heavy metal concentrations for fish, earthworm, water and sediments were determined using Buck Scientific Atomic Absorption Spectrophotometer Model 200A.

2.3. Determination of Heavy Metals in *Tilapia Mariae, Clarias Gariepinus and Libyodrilus Voilaceous*

Tilapia mariae, *Clarias gariepinus* and *Libyodrilus voilaceous* samples were collected and packed in plastic bags, which were kept in cooler box. Samples were kept frozen pending analysis. Samples were dried at 105°C and blended. 2g of the sample was ashed at 550°C overnight in a muffle furnace. Ashed samples were then transferred quantitatively to 100ml glass (Pyrex) beaker. Crucibles used for ashing were washed with 25ml of 20% nitric acid (HNO_3) solution as part of qualitative transferring. The washouts were added to the ashed samples in a beaker and then warmed in fume hood just up to boiling. The solution was left to cool and then filtered using gravity into a 50ml volumetric flask and made to the mark with distilled water [11]. Samples were run on Atomic Absorption Spectrophotometer.

2.4. Determination of Heavy Metals in Water Samples

Ubeji River water samples were collected in 1-litre plastic bottles. Water sample was collected from the points where fish was found. 1ml concentrated nitric acid (HNO_3) was added to each sample. Samples were digested in nitric acid and filtered. The filtrate was diluted to the mark in 100ml volumetric flask with distilled water [12]. Heavy metal concentrations were determined using Buck Scientific AAS.

2.5. Determination of Heavy Metals in Sediment

Sediment samples were collected in plastic bags. Samples were collected from the points where fish was found. Samples were air dried and grinded using Ritsch electric grinder (model: RM 100). Samples were then sieved in 2mm sieve. 10ml of concentrated nitric acid was added to 2g of the sample and refluxed in a 100ml beaker for 45 minutes, and then evaporated to dryness. 5ml of 3:1 HCl and HNO_3 (aqua regia) was added to dry sample and then filtered [13, 14]. Buck Scientific AAS was used to determine concentrations of heavy metals.

3. RESULTS AND DISCUSSION

In recent times, Ubeji River has been subjected to a lot of anthropogenic pollutants capable of impairing the healthy status of the river. The result of the analysis carried out on water samples, fish, earthworm and sediments are shown in the figures below. Water samples are represented in ppm while sediment, fish and earthworm are in mg/kg dry weight. Metal concentrations in water were found in the following order: Zn > Cu > Pb > Fe > As > Cd > Hg in location I, whereas they follow the order of Zn > Cu > Pb > Fe > As > Cd > Hg in location II (see fig. 2).

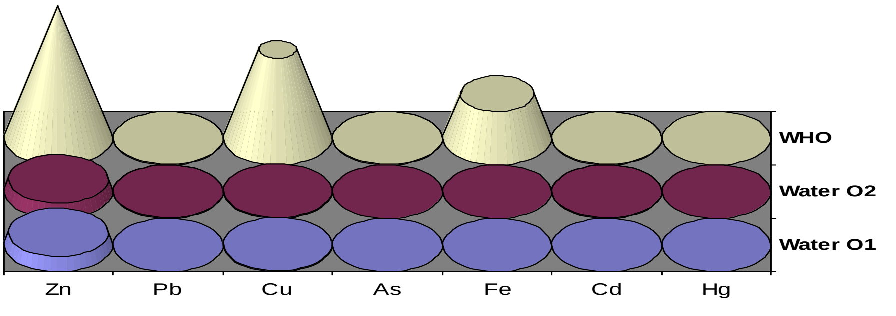
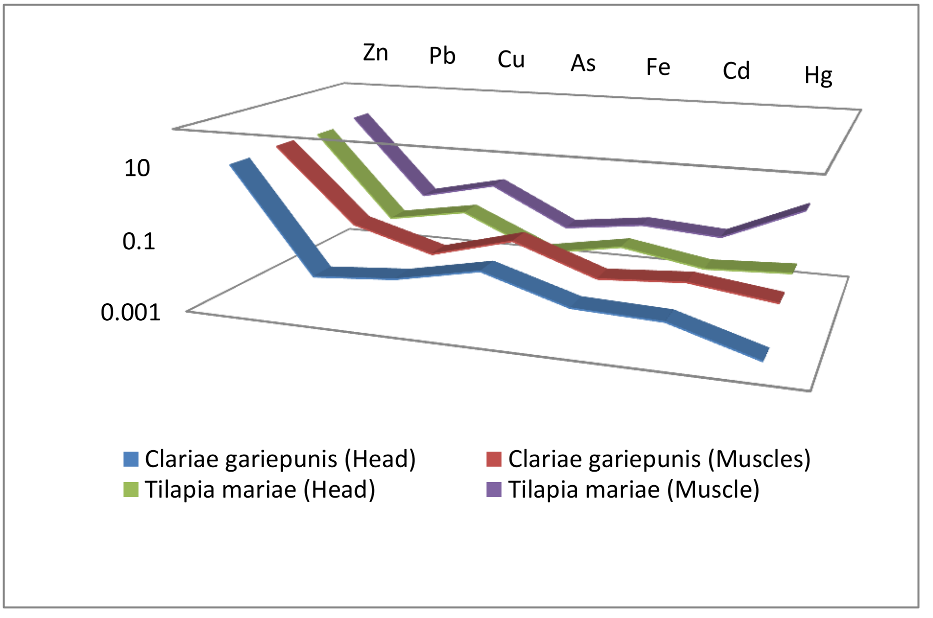


Figure 2: Trace metal concentration in water (ppm) from Ubeji River

Figure-3. Trace metal concentration (head and muscle) mg/kg dry weigh from Ubeji River in fish parts



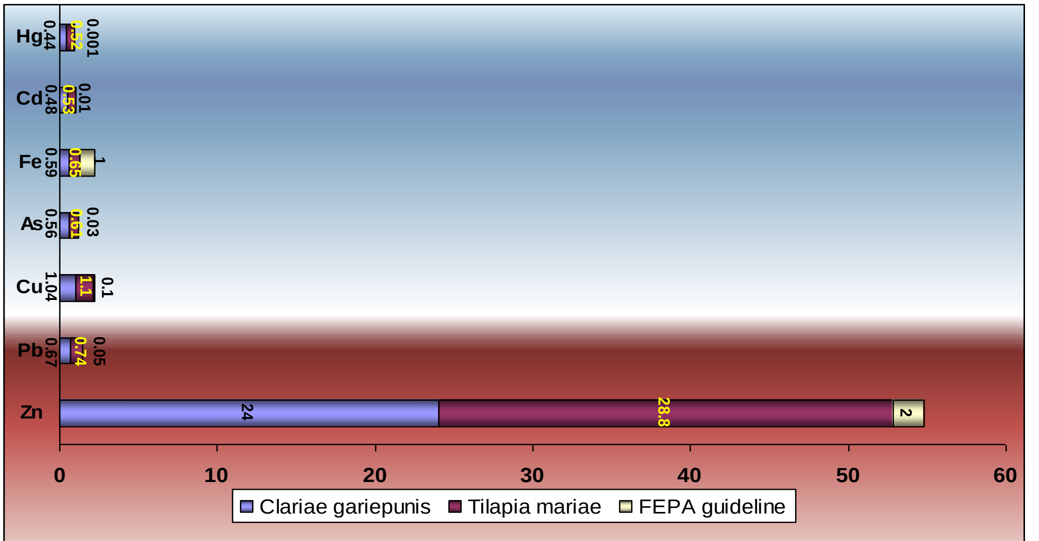


Figure 4: Trace metal concentration in fish (whole body) mg/kg dry weight from Ubeji River

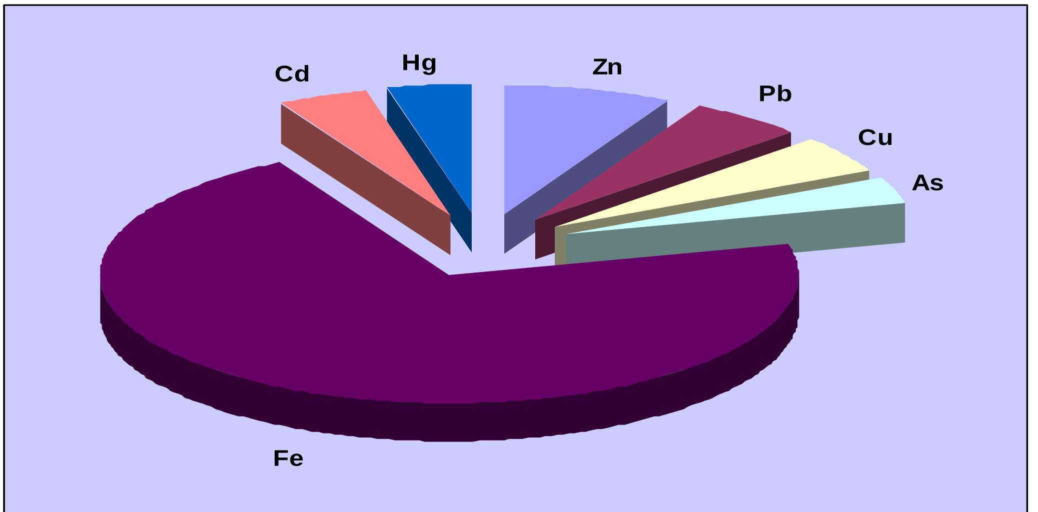


Figure 5: Trace metal concentration in earthworm (Libydrilus violaceous) mg/kg dry weight from Ubeji River

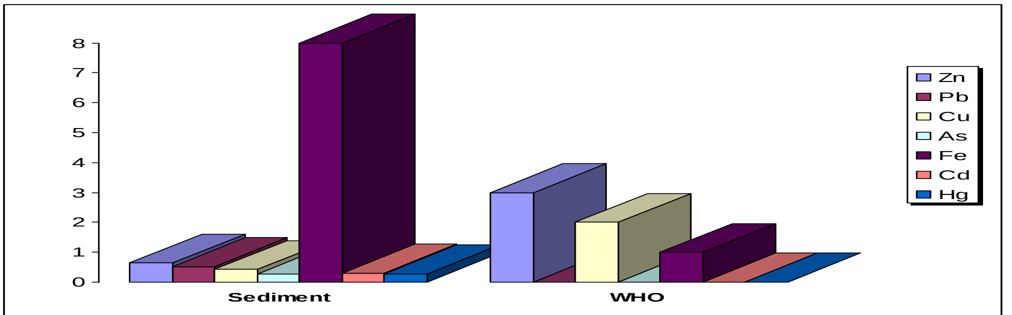


Figure 6: Trace metal concentration in sediment mg/kg dry weight from Ubeji River

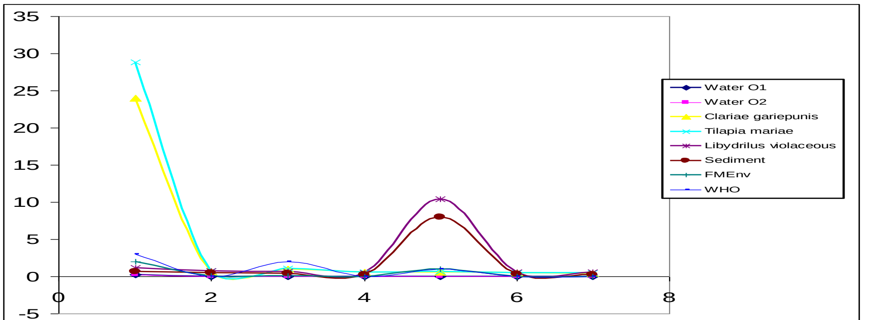


Figure 7: Trace metal concentration in all samples

The result obtained in this study revealed that trace metals analysed in the water samples are present except mercury (Hg) which was in low concentration. The level of trace metals detected can be attributed to some chemicals that are used by the petrochemical and other allied industries which find their way into the water system. It is also attributed to high concentration of vehicles in this zone due to the numerous car parking lots that discharge (leak) fuel and contaminated engine oil into the environment. Mercury levels were elevated in fish and earthworm. Highest Hg level were obtained in earthworm (*Libydrilus violaceous*).

Zinc (Zn) and copper (Cu) levels obtained from the water are above the maximum allowable values of World Health Organization [15] guidelines for drinking water (portable water). The levels were elevated in fish parts and earthworm; this may be attributed to bioaccumulation of the metal from runoff and effluents discharged into the water body via food chain. Trace metal analysis of the flesh of the fishes showed that it contained toxic metals like Pb, Zn, Fe, Cu and As which may be attributed to both aquatic and terrestrial food chains which are capable of accumulating certain environmental contaminants up to toxic concentration as mentioned by Sinha, et al. [11]. The level of metals in the muscle of *Clarias gariepinus* was higher than those of the head. The level of metals in *Tilapia mariae's* muscle exceeded those obtained in the head, this is due to the susceptibility of individual tissue of metal uptake which varies considerably. Thus, there is variation in value of trace metals obtained in the fish parts. The level of Zn in fish is higher than those obtained in earthworm. Also, Zn level obtained in earthworm is higher than that contained in the sediment. The total trace metal contents examined except Hg was found to exceed the allowed grading of the Federal Ministry of Environment [16] and World Health Organization [15]. This may be due to bioaccumulation of these metals in the earthworm through uptake of metals from the sediment and surrounding debris. The concentration of Zn in river water is higher than other metals obtained in the same water (0.281ppm and 0.284ppm) as shown in figure 2. This is attributed to the high levels of zinc in fish and earthworm due to bioaccumulation which may be due to the high rate of input of this metal into the environment.

The concentration of iron (Fe), cadmium (Cd), arsenic (As) and lead (Pb) in the fish and earthworm exceeded those found in water; this is traceable to bioaccumulation of metals in the body of the fish. The presence of high concentration of these metals is alarming to health risk [17, 18]. Highest zinc levels were found in fish. Also, zinc levels in earthworm were also high. The high uptake of trace metals in fishes from Ubeji River are attributed to effluent discharged from refinery, construction works, automobile workshop and other petroleum industries. The elevated value of lead (Pb), zinc (Zn), iron (Fe) and copper may pose danger to both human and aquatic lives. An increase in concentration of Pb can damage the gill tissue, which may lead to decrease in respiration rates and loss of gill oxygen uptake [19], thereby reducing the productivity of fish. Lead can cause many health problems, especially in kidneys, brain and in the reproductive system. It can also lower the fisheries product of marine lives.

Therefore, zinc, lead, iron and copper concentrations in the river should be closely monitored regularly so as to prevent bioaccumulation in the body through food chain. Since the level of cadmium and mercury are relatively very low in the water, it therefore points that, it is discharge through runoff and leaching of soil surface containing deposits of cadmium and mercury.

4. CONCLUSION

Trace metal analysed in water, fish, earthworm and sediment revealed that there were variations in level of metals. Mercury which has a low concentration in water has a higher concentration in fish and earthworm. The metal values obtained in the head and muscle of fishes and earthworm were elevated. These elevated levels of metals may cause harm to aquatic life. These high levels of metal may be attributed to effluent discharged from industries such as petroleum, construction works and other allied industries from the upstream. The concentrations of zinc, lead, copper and iron obtained in this study were higher than the recommended standards by WHO and FMEnv. The results obtained from Ubeji River indicate pollution. The pollution status of these trace metals is alarming since the difference between the results obtained and recommended standards are comparatively high.

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