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OCCURRENCE AND DISTRIBUTION OF HEAVY METALS IN SURFACE WATER, SEDIMENT AND SOME AQUATIC ORGANISMS SAMPLED FROM OLOGE LAGOON, AGBARA, LAGOS, NIGERIA

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ABSTRACT: The present study, some heavy metals (Cd, Cr, Cu, Fe, Zn and Pb) were determined in water, sediment and some tissues of *Parachanna obscura, Cardisoma amarantum, Peanus monodon and Helix aspersa* from Ologe Lagoon which is situated in the Agbara Industrial Estate section of Lagos State, Nigeria. This is important because it is open to surrounding industries which deposit their wastes into it. The samplings of the specimens and water matrix were done as describe by American Public Health Association procedure. The samples after treatment were taken to the laboratory for the determination of heavy metal levels in water, sediment and organisms samples by Atomic Absorption Spectrophotometer (AAS) as described by American Public Health Association. The obtained results showed that the average values Alkalinity, BOD Dissolved Oxygen and Fe in water samples were higher than the recommended values for fresh water as stated by W.H.O. Results for levels in water were compared with national and international water quality guidelines. The analysis of heavy metals in sediments indicated that among the six heavy metals tested Fe was maximally accumulated, followed by Zn Cu, Cr, Pb and Cd. The organisms showed bioaccumulation in the following pattern: Fe > Zn > Cu > Cr > Cd > Pb. In the Crab samples, cadmium, chromium, nickel and lead concentrations exceeded the tolerable values provided by international institutions. (Maximum values; Fe - 874.00 mg/g, Cu – 1.71 mg/kg, Pb – 0.02mg/kg, Cd – 0.01mg/kg, Zn – 13.78 mg/kg) and minimum bioaccumulation was recorded in the fish fry (Fe - 135.1mg/kg, Cu 0.45mg/kg, Cr 0.02mg/g, Pb 0.01mg/kg, Cd – 0.01mg/kg, Zn – 3.85mg/kg). The values recorded in this study revealed that apart from Cd, Cr, Pb and Cu the Fe and Zn were present in proportions that calls for concern. And for the rest left, even if their concentrations are not in worrying amounts now, over time the continuous intake into the body of living organisms would result in bio-accumulation of these metals and this may have injurious long term effects on both the environment and the organisms. In light of this study it is reasonable to deduce that fish obtained from Ologe Lagoon is unsafe if it is to be eaten by humans. Baring this discovery, appropriate agencies should be called into action to check these substances as soon as possible.

KEYWORDS: Ologe lagoon, heavy metals, Pollution, Crabs, fish, Prawn, surface water and Sediments.

1 INTRODUCTION

Ologe lagoon is a deep freshwater river along Baadagry Express-way in Lagos, Nigeria. The lagoon is of economic importance to the indigenes of Agbara, Ijanikin and the Agbara Industrial Estate that surround the water. Consequently, the people around the lagoon were able to use the lagoon for various purposes such as fishing, sand mining, and other domestic uses. The lagoon empties into Badagry creek which eventually empties into Lagos lagoon and finally into the Atlantic Ocean. The lagoon receives copious amounts of wastes from industries and abattoirs sited around its course. Industrial discharge structures can release large volumes of effluent containing a variety of potentially harmful substances into the aquatic environment. Metals and other trace elements are common byproducts of industrial processes and as a consequence are anticipated to be components of typical industrial waste streams that may enter the aquatic environment (Kennish

,1998).Although research has shown that disposal of various waste materials into rivers, estuaries, and marine waters is not a modern phenomenon; this practice has been used as a preferred disposal option virtually since the beginning of human civilization (Ludwig and Gould 1988; Islam and Tanaka 2004). Nevertheless, when the full spectrum of emissions from land-based activities is taken into account, the use of coastal waters as a repository for anthropogenic waste has not previously been practiced on as large or intense a global scale as in recent decades (Williams 1996). In Lagos and other mega cities, growing human population densities in coastal communities have manifested a demonstrably adverse effect on aquatic resources. The scientific literature is replete with evidence of inorganic and organic pollutant accumulation in coastal waters from anthropogenic effluents (e.g., Ragsdale and Thorhaug 1980; Tessier et al. 1984; Phelps et al. 1985; Long E et al. 1995; Pastor et al. 1996; Smith et al. 1996; Chapman and Wang 2001; Hare et al. 2001; O'Connor 2002; Robinet and Fenteun 2002; Wurl and Obbard 2004).

Contaminants enter our waterways through two generic vectors: point and nonpoint sources.

Pollutants of nonpoint source origins tend to enter aquatic systems as relatively diffuse contaminant streams primarily from atmospheric and terrestrial sources. In contrast, point source pollutants generally are introduced via some type of pipe, culvert, or similar outfall structure. These discharge facilities typically are associated with domestic or industrial activities, or in conjunction with collected runoff from roadways and other developed portions of the coastal landscape.

Sediments form a natural buffer and filter system in the material cycles of waters. Sediment in our rivers is an important habitat as well as a main nutrient source for aquatic organisms.

Furthermore, sediments have an impact on ecological quality because of their quality, or their quantity, or both (Stronkhorst et al., 2004). Waters are subject to strong variations of flow rate, substance input and transport, and sedimentation. Sediment analysis is increasingly important in evaluating qualities of the total ecosystem of a body of water, in addition to the water sample analysis practiced for years. In comparison to water testing, sediment testing reflects the long-term quality situation independent of current inputs (Hodson, 1986; Haslam, 1990). In water testing it is not possible to clearly divide between true suspension substances and temporary suspension substances stirred-up from the sediments. Sediment testing is not, or only minimally, affected by other influences.

The suspended and precipitated (non-floating) substances and organic substances in waters are capable of adhering pollutant particles (adsorption). The sediments, both suspended and precipitated substances stored on the water bottom, form a reservoir for many pollutants and trace substances of low solubility and low degree of degradability (Biney et al., 1994; Barbour et al., 1998, 1999). Pollutants are conserved in sediments over long periods of time according to their chemical persistence and the physical-chemical and biochemical characteristics of the substrata. This can also allow conclusions to be drawn regarding sources of contamination.

This work presents the results of our field study, which assessed seasonal and spatial changes in the physico-chemical parameters and nutrient load of pore water of sediments of randomly selected rivers in Ibadan, a metropolitan city in Nigeria

2 The Study Area

The study was carried out on Ologe lagoon in the Agbara Industrial Estate section of Lagos state. The lagoon is supplied on one end by the Owo River and from the other side the waters coming in from Ojo creeks. Due to the level of pollution of the water body most of the rural dwellers are not fishermen or associated artisans, most of the activities going on here involved sand miners. Ologe lagoon is particularly significant in this study because it is surrounded by major companies that produce a wide variety of waste materials.

3 Samples Collection

3.1 Water Samples

The water samples were collected directly from the surface of the lagoon. The water was collected into a clean one litre plastic bottle with tightly a fitted screw lid correlating with standards set by APHA *et al*., 2005. The samples were collected mid-stream at a depth of about 15-20cm below the surface of the water, the sample collected was to be analysed for heavy metals like Lead, Zinc and Cadmium and stored in a refrigerator in the laboratory until all other sample treatment and digestion was completed to prevent decay and disintegration of chemical and biological elements contained within.

3.2 SEDIMENT

The sediment sample was collected from the banks of the lagoon directly into a sample bottle with a plastic screw lid and was also stored in the laboratory refrigerator before it was treated and then the filtrate extracted and packed into a clean plastic sample vial.

3.3 ORGANISMS

The fish, crab and shrimp samples were collected using both round framed and d-framed sediment sieves. Collection had to be done early in the morning when the organisms are closest to the surface of undisturbed water. Most of the samples collected were at their early post-larval stage and as such, organs could not be extracted.

3.4 DIGESTION OF SAMPLES

The obtained specimens (*P. obcura, H. aspersa, P.mondon, C. amaratum* and the soil sediment sample*)* were first weighed and on determination of their weights, 10 gms of each were treated with 10 mils of concentrated nitric acid (HNO_3) and 10mils of concentrated hydrochloric acid (HCL) and the samples were left to digest for two days. The samples, after the digestion were filtered using filter papers and the filtrate were diluted to 25 mils and after which they were poured into sterile, plastic sample containers. The containers were tightly covered and then sent to laboratory for analysis. This exercise was repeated three times to obtain the mean values that were used in this project

4 RESULTS

The result of water quality of Ologe lagoon was as shown in Table 1. That of bioaccumulation in sampled organisms and soil sediment is in table 2

Table 1: Water quality of Ologe lagoon

S/N	PARAMETERS	Water	W.H.O. Standard
1	pH @ 25°C	7.52	6.0 – 9.0
2	Conductivity, úS/cm	95.3	2500
3	TSS, mg/l	7	<100
4	TDS ,mg/l	49.0	1250
5	Salinity, ppt	0.11	
6	Acidity, mg/l	6.9	>6.0
7	Alkalinity, mg/l	12.8	<9.0
8	Total Hardness, mg/l	8.22	750
9	DO, mg/l	4.1	>3.0
10	BOD5, mg/l	4	<1
11	COD, mg/l	10.1	25
12	Chloride, mg/l	28.8	175
13	Nitrate, mg/l	0.88	3.0
14	Sulphate, mg/l	2.1	625
15	Phosphate, mg/l	0.32	0.25
16	Calcium, mg/l	2.50	750
17	Magnesium, mg/l	0.45	0.2
18	Zinc, mg/l	0.041	2.0
19	Iron, mg/l	0.091	5.0
20	Copper, mg/l	< 0.001	0.2
21	Cadmium (mg/l)	< 0.001	0.01
22	Lead (mg/l)	< 0.001	0.05
23	Chromium (mg/l)	< 0.001	0.05
24	Manganese (mg/l)	0.014	0.05

Table 2: Results of heavy metals bioaccumulation in organisms and soil sediment of Ologe lagoon

	Analysed Samples					
PARAMETER	Crab	Helix	Fish	Prawn	Sand	W.H.O. Standard
Iron (mg/kg)	874.00	600.35	135.1	523.813	420.75	15 mg/kg
Copper (mg/kg)	1.71	1.18	0.45	1.66	0.35	2 mg/kg
Chromium(mg/kg)	0.08	0.06	0.02	0.07	0.01	0.001 mg/kg
Lead (mg/kg)	0.02	0.03	0.01	0.03	0.02	0.005 mg/kg
Cadmium (mg/kg)	0.01	0.01	0.01	0.01	0.01	0.005 mg/kg
Zinc (mg/kg)	13.78	15.63	3.85	24.23	7.55	17mg/kg

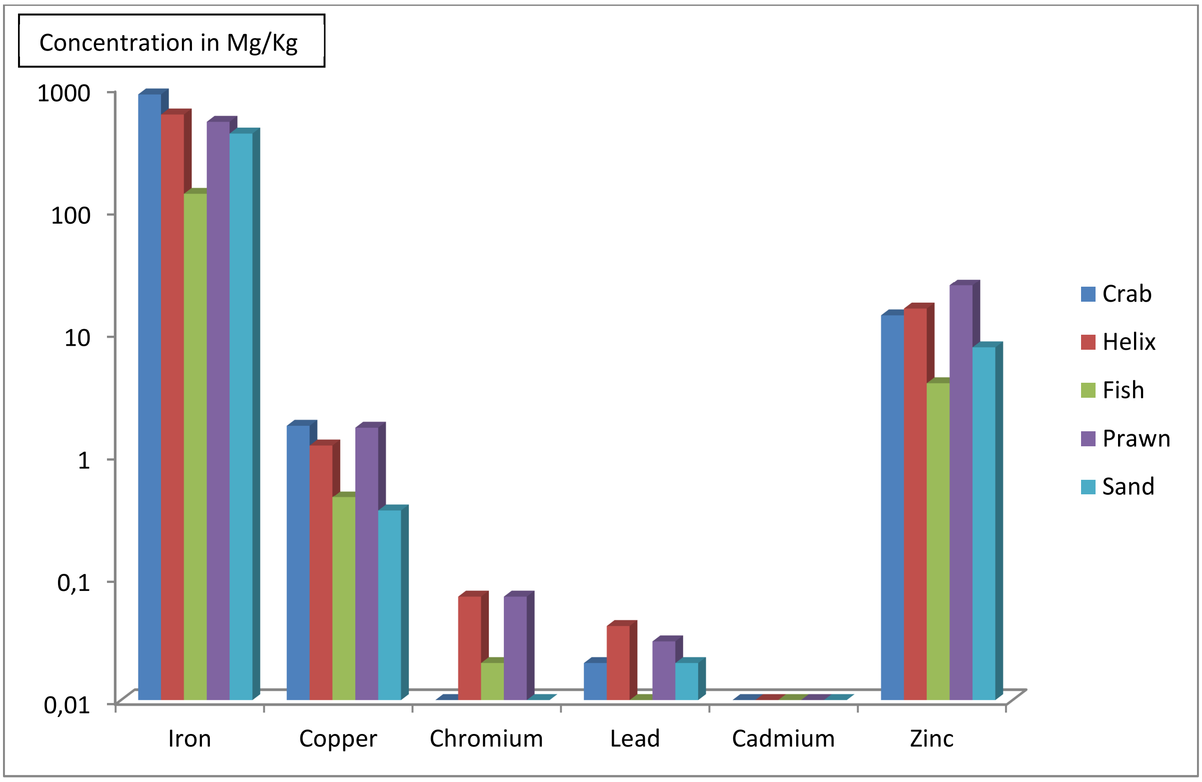

Figure 1: Concentration of heavy metals in the organisms and soil collected from Ologe lagoon

The result of the water quality of Ologe lagoon as indicated in table 1 showed that with the exception of alkalinity, dissolved oxygen and biological oxygen demands, the other parameters were within the acceptable limit of World Health Organization. This is an indication that the water quality of Ologe lagoon may at any period of the year depart from good quality condition to poor condition. This may have ecological effects on the organisms that are denizen in that ecosystem

With regards to the bioaccumulation study of the habitat, result showed that of all the stated elements, iron stood out most notably with overwhelming figure across all the samples analysed (Iron (mg/Kg); Crab – 874.0, Helix - 600.3582, Fish – 135.1, Shrimp – 523.813, Sand – 420.75) . The rest of which were below significant levels.

Looking at the organisms one by one, the result showed that different organisms bioaccumulat metals differently. In the case of fish species which is *Parachanna obscura,* the organism bio-accumulated the least on the average, the levels are given as thus; iron 135.1; copper 0.45; chromium 0.07; lead – 0.04; cadmium – 0.02; and zinc 3.85.

In the crab, *Cardisoma amarantuma* bioaccumulated the highest concentration of metals, the values are given as thus in mg/kg; Iron – 874.0, Copper – 1.72, Chromium 0.08, Lead – 0.02, Cadmium - 0.01, Zinc – 13.78. The rest had values that were below significant and even detectable levels.

5 DISCUSSION

The concentrations of the detected heavy metals in surface water of Ologe Lagoon, sediment and the living organisms obtained from the site are shown on the tables 1, 2 and 3 above The highest significantly being Iron all round, with a maximum value in sand (420.75mg/kg) and in the living organism samples the highest values came in *Cardisoma amarantuma* (874mg/kg) and least in *Parachanna obscura* (135.1mg/kg). The least represented of the heavy metals was Lead with maximum values in the soil sediment (0.02mg/kg), *Helix aspersa* (0.04mg/kg) and least in *P. obscura* (0.01mg/Kg). others with intermediate positions are Copper with maximum concentration in *C. amarantum* (1.71mg/kg), and minimum in *P .obscura* (0.45mg/kg), Chromium, maximum concentration (0.08mg/kg) in *C. amarantum* and minimum in *P. obscura* (0.015mg/g), Cadmium had a maximum of 0.01mg/kg in *P. monodon* and minimum of 0.01mg/kg in *P. obscura.* and finally, Zinc which had the second highest level of bioaccumulation after iron had its maximum values in *P. monodon* (247.24mg/kg) and minimum in *P. obscura* (3.85mg/g).

From the data available it is reasonable to deduce that the most significant bioaccumulation is obviously iron and least from cadmium which would be both environment and health wise insignificant as the values are well below the WHO standards of environmental exposure.

The level of bioaccumulation of iron and zinc most probably come from the fact that most of the organisms affected in one way or the other are bottom dwellers organisms. It can be seen that the sediment sample contained high levels of metals than the surface water indicating that there have been source of metals from the urban or industrial waste water and of course sediment is a sink of heavy metal pollutant. Since most animals get most if their food from the soil they reside within and in trying to feed they ingest sizable amounts of sand along with that probably explains the high concentrations of these metals in the systems of organisms like *C. amarantum* and *P. monodon.* The concentrations of these two heavy metals are most alarming. Iron, for instance has a value over sixty times the WHO recommended standard (Table 2).

Zinc is essential for the normal functioning of the cell including protein synthesis, carbohydrate metabolism, cell growth and cell division. Concentration of Zn in *Helix aspersa and C. amarantum* were found to be 13.78 and 815.63 mg/Kg respectively. A normal body contains 1.4 to 2.3 gm of zinc and it is present in all body cells. Recommended daily dietary intake of zinc is about 15 mg (Dara, 1993). Excessive intake of Zinc can have long term effects whereas the deficiency syndrome manifests itself by retardation of growth, anorexia, lesions of skin and appendages, impaired development and function of reproductive organs. In view of this the estimated concentrations of metals in vegetables under investigation do not cause health hazards for consumers.

Lead which is particularly injurious to the health of man, and usually enters the body of man from drinking contaminated water has above acceptable levels in *P. monodon*, *H. aspersa*, and *C. amarantum*, and their resulting concentrations are reasonably proportional to the amount of lead in the water. The lead pollution in the environment could be traced to industrial production processes and their emissions, road traffic with leaded petrol, the smoke and dust emissions of coal and gas-fired power stations, the laying of lead sheets by roofers as well as the use of paints and anti-rust agents .This is similar to the report of Nriagu and Coker, (1980) and (Ramamoorthy and Rust, 1978).

The levels of concentration of cadmium and chromium are also very low due to the low concentrations in the environment and as seen from the tables the values represented are well below the slated standards and there may not be any reason to worry. But continuous exposure over time would result in the organisms bio-accumulating amounts of chromium or cadmium which may be well over the ambient environmental concentration and detrimental effects may follow subsequently. Chromium is selectively accumulated in liver and kidney. It has been reported to interfere with enzymatic sulphur uptake of cells affecting the lungs, liver and kidney (Lawrence et al., 1993). Concentration of chromium and cadmium were found in the range of 0.1–0.8 Mg/Kg. Chromium and cadmium do not apparently pose a health threat in view of its concentration levels in the organisms investigated. Looking through this perspective one would tempted to say they are safe for human consumption. However at long run , it may pose a danger top the consumers due to gradual bioaccumulation along the food chain.

Copper has its values well rep[resented in the series but like cadmium and chromium, the level of concentration of within the tissues of these tested organisms were well, below the slated standards and as such may not constitute any cause for worry if the concentration do not increase. Copper is an essential element widely distributed and always present in food, animal livers, which are the major contributor to dietary exposure to copper, various shellfish and some dry materials. It is necessary for normal biological activities of amino-oxides and tyrosinase enzymes. Tyrosinase is required for the catalytic conversion of tyrosine to melanin, the vital pigment located beneath the skin, which protects the skin from dangerous radiation. Concentration of Cu in these vegetables was recorded in the range of 0.35 – 31.71 mg/Kg. A daily dietary intake of 2 to 3 mg of copper is recommended for human adults (Dara, 1993). Ingestion of 15-75 mg of copper causes gastrointestinal disorders. Excessive intake of copper may cause heamolysis, hepatotoxic and nephrotoxic effects.Continuous ingestion of copper from food induces chronic copper poisoning in man.

With regard to the water quality parameters in table 1. The high level of total BOD, low dissolved oxygen content recorded in the study could be an indication of the deteriorating water quality and probably resulted from the discharges of industrial and domestic wastes into the lagoon through the land based anthropogenic inputs and other sources. Similarly, Ajao and Fagade, (1990); Akpata et al; (1993), recorded, high biochemical oxygen demand, low dissolved oxygen content and heavy microbial load at organically polluted sites in the Lagos Lagoon.

A decrease in the dissolved oxygen levels is usually an indication of an entry of some organic pollutant.Concentrations below 5 mg/l may adversely affect function and survival of biological communities and below 2 mg/l can lead to death of most fishes (Water Quality Assessments, 1996). Behaviorally, fish may avoid low dissolved oxygen conditions by physically moving out of an area. Finally, low oxygen levels can also increase toxicity of contaminants to anadromous fish, including ammonia, zinc, lead, and copper (Colt *et al* 1979, Davis 1975).

6 CONCLUSSION

Most of these metals especially iron; zinc and copper in reasonable dosages are significant to human diet as they are necessary to complete biochemical and metabolic path ways and are also important in tissue formation. Iron which is an essential part of the haemoglobin which is essential in transportation of oxygen via blood cannot be nutritionally overemphasised, especially in parts of the world like Africa where people content with diseases that cause loss of blood and anaemia in extreme cases and cause deaths as much as 25million in only children yearly as reported by the World Health Organisation. Even as the important as it may seem excessive intake of iron leads to a medical condition known as hemochromatosis which results from over deposition of iron in the tissue and organs of the body which may be expressed in humans with symptoms that include fatigue, chronic body pains and in very extreme cases affected individuals may suddenly drop dead. Zinc is also important in normal functioning of the nervous system as well as magnesium which helps in bone formation, copper which also aids in formation of blood and transportation of oxygen. The rest of the metals have not been documented to have any positive effects on the metabolism of human.

As the means of exposure to these metals is through the lagoon, where sometimes people use water from this source for a range of domestic activities and sometimes drinking these metals may enter into their system either through direct means or indirectly by deposition or reaction with free chemical radicals which may subsequently find their way into the body systems of these unsuspecting individuals. Feeding on organisms from this water body also is a source of exposure and the stated disease conditions may arise and in cases where organisms obtained for commercial purposes, a larger number other than those that stay around these areas may be exposed to the toxic effects of these substances and morbidity if not mortality may be recorded without seemingly justifiable causes. Consequently, the appropriate agencies must stand up and do their duties such as creation of awareness and protection of our waterways from pollutions and the offenders should be brought to books

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