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Heavy Metals in Surface Water, Sediments, Fish and Perwinklesof Lagos Lagoon

[1]O.J. Aderinola, [2]E.O. Clarke, [2]O.M. Olarinmoye, [2]V. Kusemiju and [2] M.A. Anatekhai

[1]Department of Zoology, [2]Department of Fisheries,
Faculty of Science, Lagos State University, Ojo Lagos, Nigeria

Abstract: Lagos Lagoon, covering 700 km^2, is a brackish coastal lagoon, on the Western part of Nigeria (6°26'-37'N; 3°23'-4°20'E) and the largest along the West African coast. The sampling and processes of analyzed samples was carried out as described by American Public Health Association (APHA) and samplings were done between January and June, 2008. The results showed that the concentration of Arsenic (As) (.010±.000) mg/L, Cu (0.197±.144) mg/L, Mn (0.087± .040) mg/L and Zn (0.53± .363) mg/L in surface water were generally low when compared to WHO standard of 2004.On the other hand, Cd, Cr, Pb and Ni were generally high with mean values of 0.354±.297, 0.060±.028, 0.263±.118 and 0.140±.075 mg/L, respectively recommended for marine waters: World Health Organization, 2004. ANOVA test showed that arsenic, nickel and iron are significant at (P< 0.05). This is an indication that they have tendency to bioaccumulate and affect aquatic life. In the sediments however, the mean values were generally low when compared with WHO and FEPA standards. The mean levels of heavy metals in the sediments of Lagos lagoon were generally low and fell within the acceptable limits described by World Health Organization, 2004 and FEPA.The average concentrations for the heavy metals were As, Cd, Ni, Cr, Cu, Fe, Pb, Mn, Zn are 0.083±0.035; 1.150±0.090; 0.867±0.075; 0.618 ±0.193; 0.600±0.272; 19.393±6.649; 0.450±0.598; 2.040±1.049; 0.730±0.337 mg/kg, respectively. Iron, Manganese and Nickel were not defined. When these values are compared with ones recorded for surface water, there is clear evidence that sediments recorded higher values and indication that most of metals were adsorbed to the sediment. In the organisms (*Oreochromis niloticus and Tympanotonus fuscatus Radula)* the shell fish tend to bioaccumulate heavy metals more than the fin fish. The shell fish bioaccumulate these metals namely, Cd (0.555±0.742), Cr (0.066±0.091), Pb (0.675±0.940), Mn (1.4300±1.711) Ni (0.230±0.311) and Zn (1.066±1.1.449) mg/kg, respectively. While the finfish bioaccumulated arsenic, Fe (3.583±0.711) and Cu (0.517±0.004) mg/kg, respectively. There was significant (p=0.05) variation in the elemental concentrations between and within groups.

Key words: Water quality % Bioaccumulation *Oreochromis niloticus* % Anthropogenic % Nigeria

INTRODUCTION

Heavy metals are intrinsic, natural constituents of our environment. They are generally present in small amounts in natural aquatic environments. Apart from the natural sources, several anthropogenic ones also contribute to metal concentrations in the environment. In recent times, industrial activities have raised natural concentrations causing serious environmental problems. The biota that inhabits contaminated sites is generally exposed to very high concentrations of these pollutants [1]. Human may be contaminated by organic and inorganic pollutants associated to aquatic systems by consumption of contaminated fish and other aquatic foods from this environment [2]. This fact is due to the capacity of some aquatic organisms to concentrate heavy metals up to 10^5 times the concentration present in the water [3, 4].

The study of toxic and heavy metals in Lagos lagoon is more important in comparison with other pollutants due to their non bio-degradable nature, accumulative properties and long biological half lives. It is difficult to remove them completely from the environment once they enter into it. With the increased use of a wide variety of metals and petrochemicals in industries coupled with African lifestyle of dumping of wastes around indiscriminately, there is now a greater awareness of toxic metal pollution of the environment. Many of these metals tend to remain in the ecosystem and eventually move from one compartment to the other within the food chain.

Corresponding Author: O.J. Aderinola, Department of Zoology, Faculty of Science, Lagos State University, Ojo Lagos, Nigeria

In addition, there has been proliferation of urban settlements and slum in the city of Lagos resulting in the generation of domestic effluents which combined with the industrial effluents and eventually find their way into the Lagos Lagoon that serves as the ultimate sink for the disposal domestic sewage since the latter part of the 19th century. This will cause physical and chemical changes to the quality of the receiving waters [5-7]. These changes may include increased dissolved nutrients which may result in eutrophication, changes in stream temperatures and bottom characteristics which lead to habitat destruction and alteration of species diversity and the addition of toxic substances which can have either acute or chronic effects on aquatic organisms [7, 8].

There is a considerable concern about the human health aspects of metal cycling in polluted coastal and inland waters that are in proximity to large population centers.

Basics of samples of water, sediment and biota from Lagos lagoon is due to many renown scientist such as Ajao [9, 10], Okoye *et al*. [11] had researched this lagoon and came up with the fact that the lagoon is continuously under the effect of pollution by industries around the city. By now one would have thought that the appropriate agencies would have take necessary actions to forestall further pollution. This study showed that a continues increase in levels of heavy metals in Lagos Lagoon. Salient results of these investigations are presented and discussed in this paper.

MATERIALS AND METHODS

The sampling was performed on Lagos lagoon around Ijora axis of the state and was carried out according to APHA (American Public Health Association [12]. In the laboratory 20 grams of muscle tissue was removed with the help of a stainless steel surgery knife and Sample were freeze-dried and ground into a homogenous mixture using a porcelain mortal and pestle.. One gram of sample in triplicate was submitted to a strong acid digestion (HCl + HNO_3 conc. 3:1) in a glass tube block digester. After complete dissolution, the acid was evaporated to almost dryness and dissolved in 0.5N HCl [13]. Metal determination (As, Fe, Cd, Cr, Cu, Mn, Ni, Pb and Zn) was performed with AAS and HPGC and the results expressed in $\mu g.g^{-1}$ of wet weight (w/w).

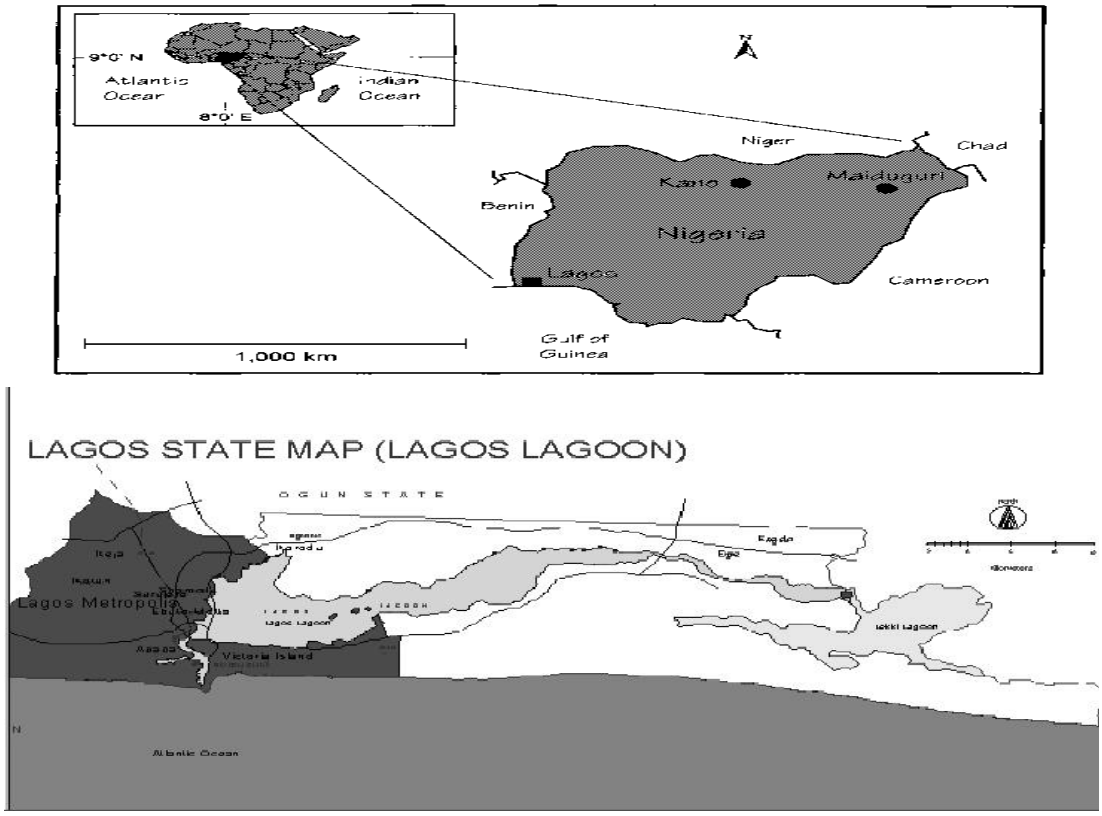

Fig.

Water was sampled using Ruttner-sampler at a depth of 0.5 meter. Sediment samples were taken with core sampler (diameter, 6.4 cm).

Study Area: The Lagos Lagoon(6°22'-6°38'N/2°48'-4°36'E) lie behind the barrier beach and extend for 210 km along the coast. Lagos Lagoon is connected by a long narrow navigable channel with Cotonou Lagoon in Benin Republic. The lagoon is more than 50 km long and 3 to 13 km wide, separated from the Atlantic Ocean by a long sand spit 2 to 5 km wide, which has swampy margins on the lagoon side.

Lagos Lagoon empties into the Atlantic via Lagos Harbour, a main channel through the heart of the city, 0.5 km to 1 km wide and 10 km long (Fig. 1).

Three sediment replicate samples from each site were combined. Water and sediment samples were collected from the same location where the fish and periwinkles were collected. The results are as shown below.

RESULTS

The concentration of As (0.01000±0.000000) mg/l, Cu (0.19667±0.143643) mg/l, Mn (0.08667± 0.040415) mg/l and Zn (0.52667± 0.363501) mg/l in surface water were generally low when compared to WHO standard of 2004. On the other hand, Cd, Cr, Pb and Ni were generally high with mean values of 0.35433±.297433, 0.06033±0.027934, 0.26333±0.116762 and 0.14000±0.075498 mg/l, respectively recommended for near shore waters [14, 15]. The high concentration levels of these heavy metals could be attributed to anthropogenic sources arising from solid and liquid wastes discharged by cottage industries located in the area.

The mean levels of heavy metals in the sediments of Lagos lagoon results showed that concentration of the metals were generally low and fell within the acceptable limits described by EEPA [14]1998 and WHO [15].The average concentrations for the metals As, Cd, Ni, Cr, Cu, Fe, Pb, Mn, Zn are 0.08333±0.035119; 1.15000±0.090000; 0.86667±0.075498;0.61800±0.192720;0.60000±0.272213; 19.39333±6.649100; 0.45000±0.598080; 2.04000±1.049190; 0.73000±0.337194 mg/kg, respectively (Table 1).

In the organisms (*Oreochromis niloticus and Tympanotonus fuscatus Radula)* the shell fish tend to bioaccumulate heavy metals more than the fin fish. The shell fish bioaccumulated these metals namely, Cd (0.55500±0.742), Cr (0.06600±0.0905), Pb (0.67500±0.940), Mn (1.4300±1.711) Ni (0.2300±0.311) and zn (1.06550±1.1.449) mg/kg, respectively. While the finfish bioaccumulated arsenic, Fe (3.58300±0.711) and Cu (0.51700±0.0042) mg/kg, respectively. This is an indication that shell fish has the capacity much more

Table 1: Concentration of metals in water, sediments and tested organisms

		Lagoon surface water (Mg/L)	Sediment (Mg/Kg)	Fish (Mg/Kg)	Periwinkles (Mg/Kg)
Arsenic (Mg/L)	Mean	.01	.08	.36	.01
	Std. Dev	.00	.04	.42	.00
Cadmium (Mg/L	Mean	.35	1.15	.27	.56
	Std. Dev	.30	.09	.00	.74
Chromium (Mg/L)	Mean	.06	.62	.01	.07
	Std. Dev	.03	.19	.00	.09
Cupper (Mg/L)	Mean	.20	.60	.52	.38
	Std. Dev	.14	.27	.00	.39
Iron (Mg/L)	Mean	1.41	19.39	3.58	2.63
	Std. Dev	.42	6.65	.71	2.07
Lead (Mg/L)	Mean	.26	.45	.06	.68
	Std. Dev	.12	.60	.00	.94
Manganese (Mg/L)	Mean	.09	2.04	.14	1.43
	Std. Dev	.04	1.05	.00	1.71
Nickel (Mg/L)	Mean	.14	.87	.01	.23
	Std. Dev	.08	.26	.00	.31
Zinc (Mg/L)	Mean	.53	.73	.08	1.07
	Std. Dev	.36	.34	.00	1.45

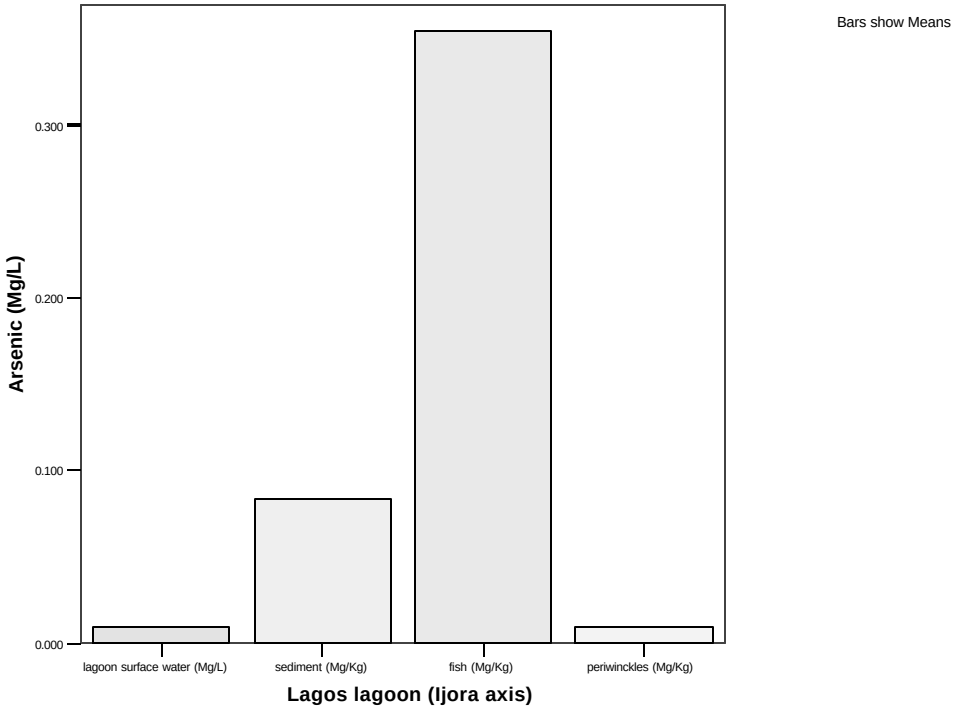

Fig.1: Variations in concentration of arsenic in lagoon surface water, sediments, fish and periwinkles from Lagos lagoon

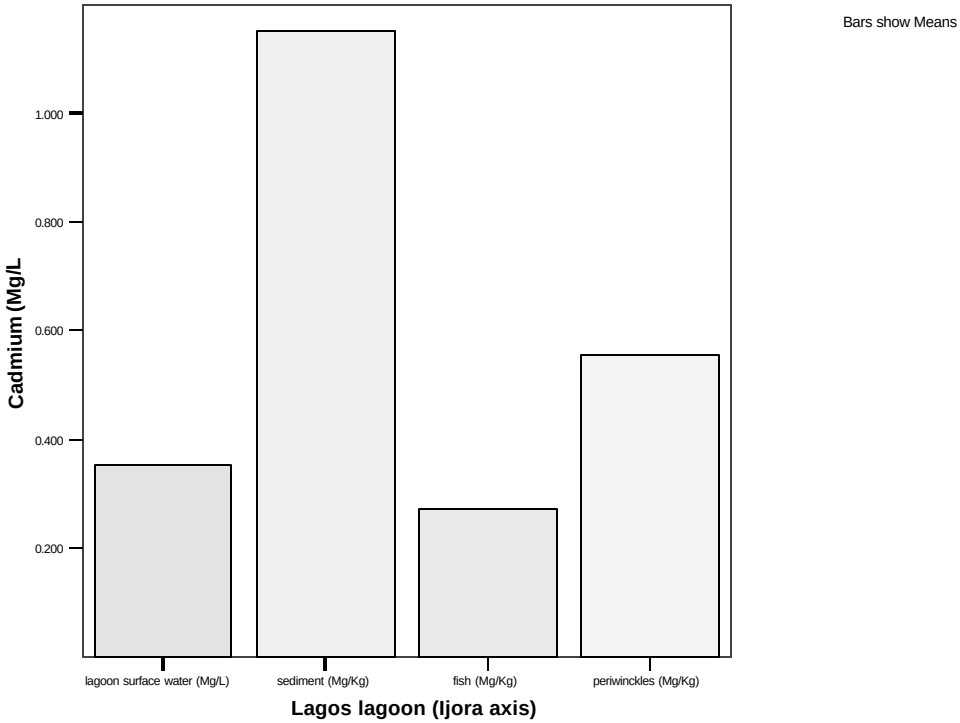

Fig. 2: Variations in concentration of cadmium in lagoon surface water, sediments, fish and periwinkles from Lagos lagoon

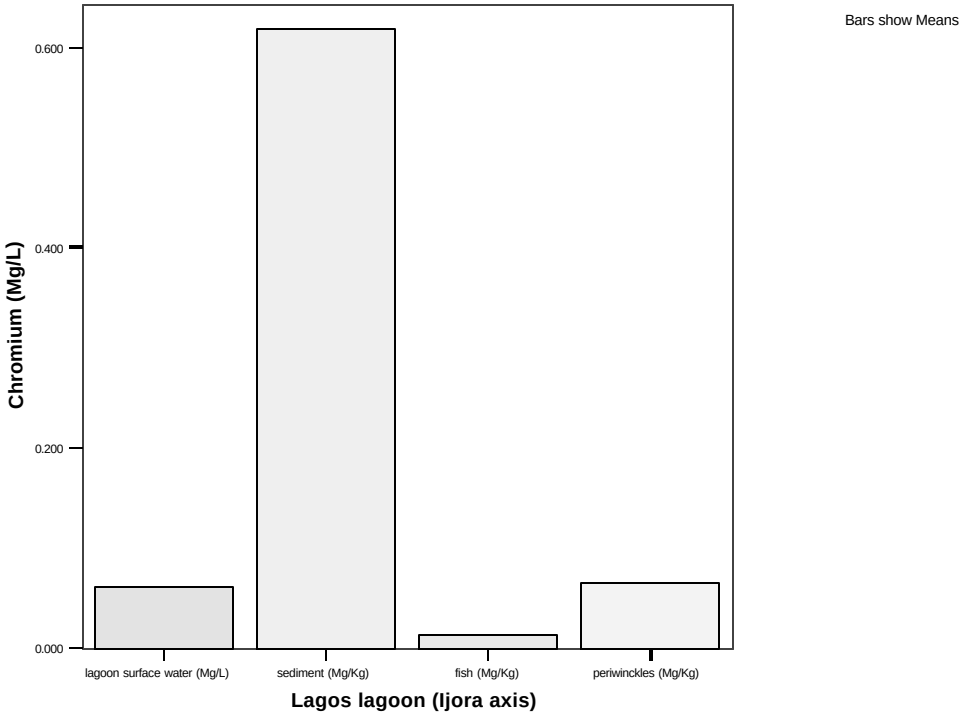

Fig. 3: Variations in concentration of chromium in lagoon surface water, sediments, fish and periwinkles from Lagos lagoon

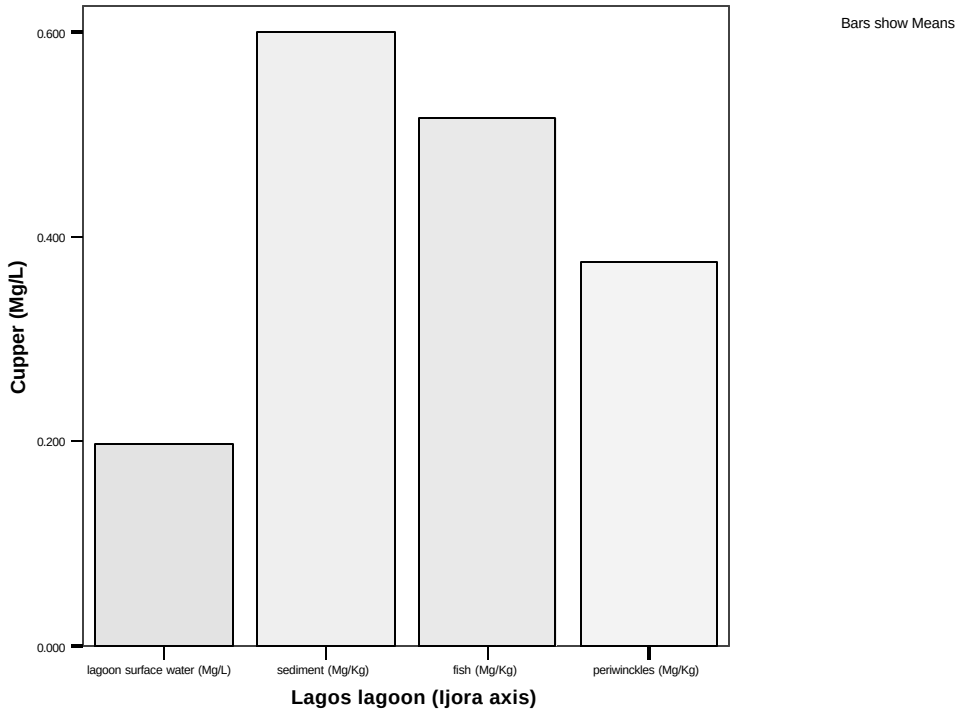

Fig. 4: Variations in concentration of copper in lagoon surface water, sediments, fish and periwinkles from Lagos lagoon

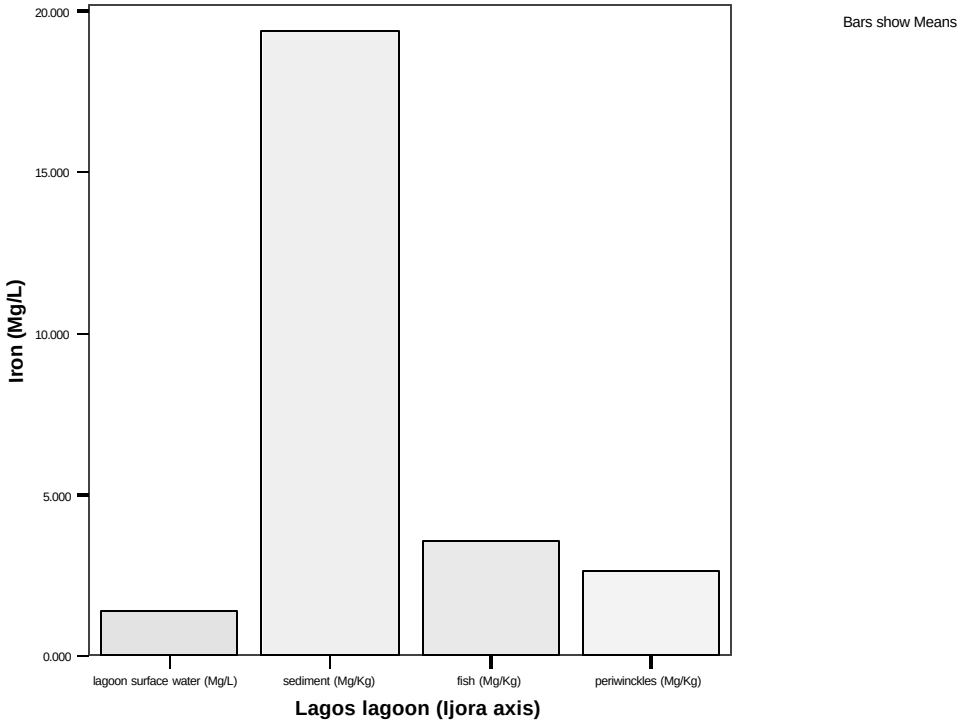

Fig. 5: Variations in concentration of iron in lagoon surface water, sediments, fish and periwinkles from Lagos lagoon

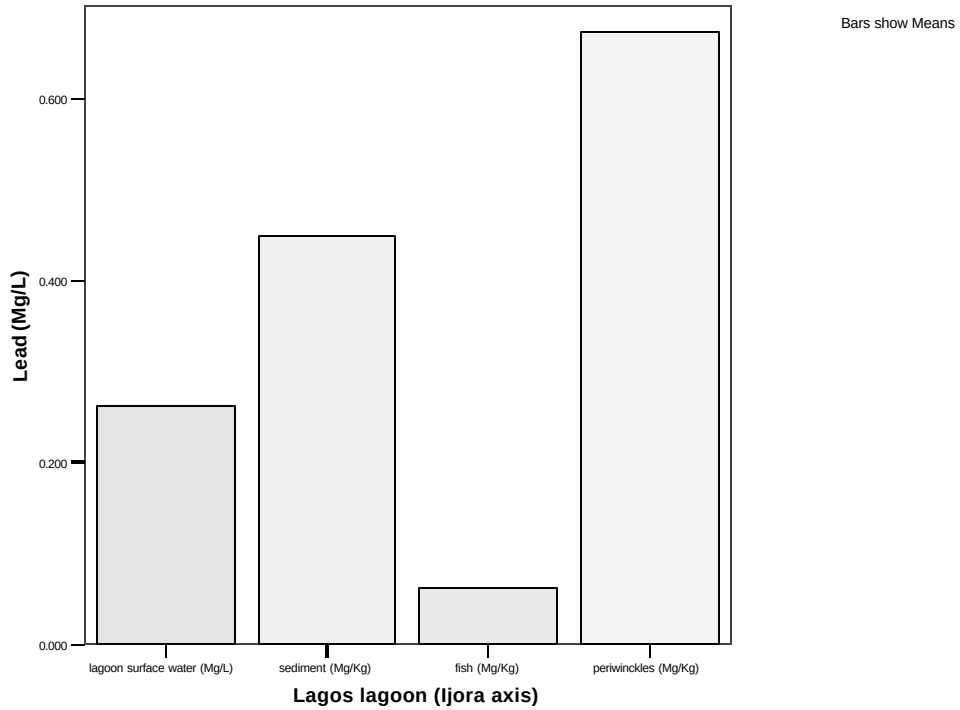

Fig. 6: Variations in concentration of lead in lagoon surface water, sediments, fish and periwinkles from Lagos lagoon

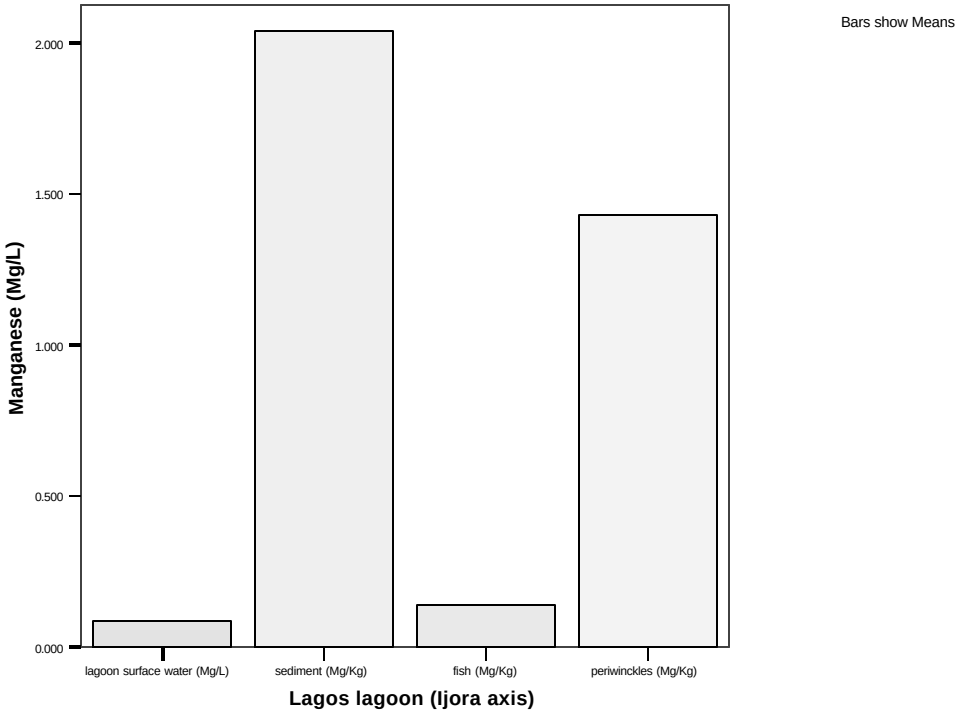

Fig. 7: Variations in concentration of manganese in lagoon surface water, sediments, fish and periwinkles from Lagos lagoon

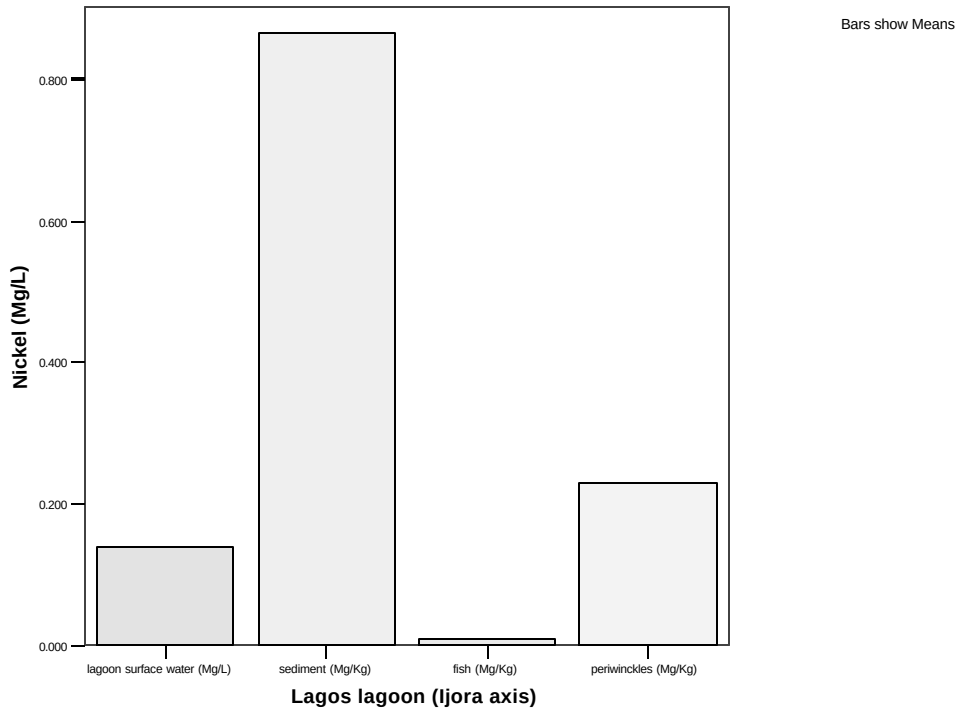

Fig. 8: Variations in concentration of nickel in lagoon surface water, sediments, fish and periwinkles from Lagos lagoon

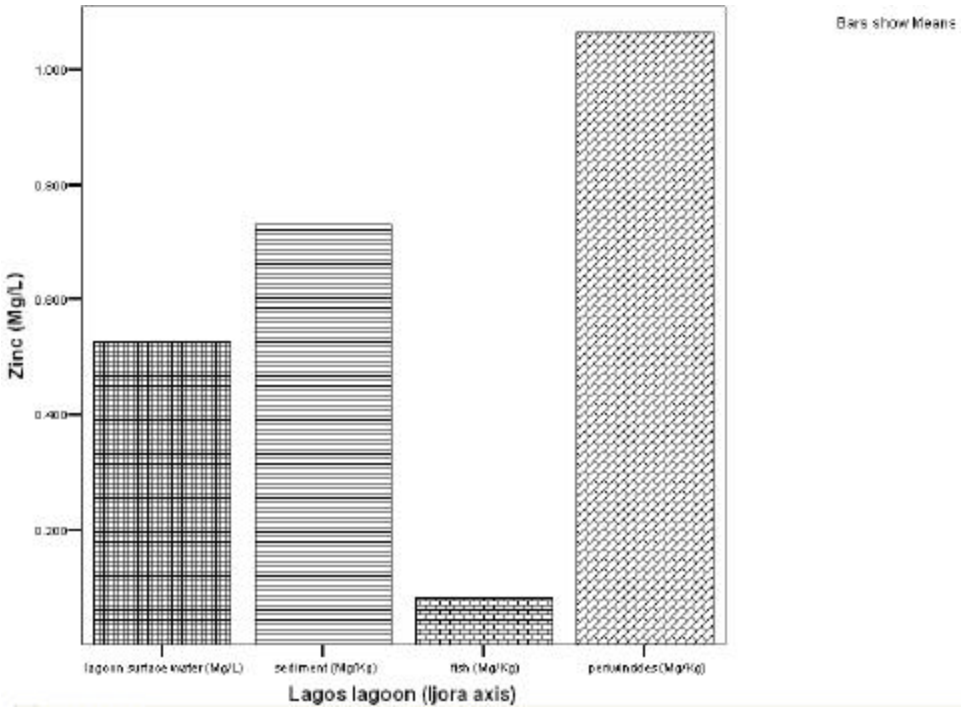

Fig. 9: Variations in concentration of zinc in lagoon surface water, sediments, fish and periwinkles from Lagos lagoon

than finfish in accumulation of heavy metals in their body and consumers that are not careful may ingest such toxics when large numbers of this fish is consumed.

DISCUSSION

Lagos lagoon has been subjected to contaminating materials, capable of initiating the impairment of the water quality. The present investigations has revealed the concentration of certain heavy metals such as Cd, Cr, Pb and Ni and were generally high with mean values of 0.35433±0.297433, 0.06033±0.027934, 0.26333±0.116762 and 0.14000±0.075498 mg/l, respectively when compared with recommended values for marine waters [14, 15]. These values in the surface water could be adduced to anthropogenic activities going on around the lagoon because of its closeness to urban area and high population of people around the place. This is similar to the report of Adeniyi *etal*. [16] 2007 based on their research at Agboyi creek segment near the lagoon with higher surrounding human population density recorded higher levels of metals in sediments and water samples.

The metal levels in sediments were higher than those in the lagoon surface water and organisms. Animals are known to take up and accumulate heavy metals from contaminated soils [17-20], hence detection in animals samples was not surprising.

This study has confirmed that sediments are important hosts for toxic metals. It has been shown that sediment permit the detection of heavy metals that may be either absent or in low concentration in the water column. As presented, the concentrations of heavy metals studied in the surface water, *Oreochromis niloticus and Tympanotonus fuscatus Radula* samples were relatively low but the concentrations in the sediments may be elevated. The occurrence of enhanced concentrations of heavy metals in coastal sediments such as that obtained from Lagos lagoon can be a good indication of maninduced pollution rather than by natural enrichment through geological weathering.

Although levels of Cd (0.555±0.742), Cr (0.067±0.0905), Pb (0.675±0.940), were within the normal range in minimum allowable in diet of man however, continual consumption could lead to accumulation with adverse health implications since Cd has been linked to renal diseases and cancer [21]. Metals from lagoon surface water could be a contributing source to the levels in animals hence continual assessment is highly essential.

Of all the metal examined, Iron was found to be the most abundant metal in Lagos lagoon with an average value of 482± 8.866 mg/kg in sediment. This is excepted because it has been reported that in Iron occurs at high levels in Nigeria soil [22-24].

The average concentrations of metals determined in the two organisms (shellfish species *Tympanotonus fuscatus Radula* and *Oreochromis niloticus*) were within limits not considered to be a cause for toxicological concern WHO [15] however, the concern is higher values recorded in shell fish that are more than that of the fish. If this continues unabated could jeopardize the brighter future of shell fish industries. The bottom line here is the fact that commission regulations for metals currently apply only to the potentially hazardous elements such as cadmium, lead and mercury. The Committee on Medical Aspects of Food and Nutrition Policy (COMA), the Committee on Toxicology of Chemicals in Food, Consumer Products and the Environment (COT) and the EU Scientific Committee for Food (SCF) have issued advice on intake of the other heavy metals listed.

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