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Trends in Trace Metal Burdens in Sediment, Fish Species and Filtered Water of Igbede River, Lagos, Nigeria

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Abstract: Trends in trace metal burdens in surface sediment, fish species (*Galeoides decadactylus*) and filtered water of Igbede river, Lagos were assessed weekly in November, 2003. Levels of selected metals (Cu, Cd, Zn, Pb, Cr, Mn and Fe) were determined in the acid digests of the samples and the result showed that sediment retained more than 70% of the trace metals while the metal levels were more in the biota than the filtered water samples. Comparative statistical analyses of the mean levels also revealed that the distribution of the metals in the samples investigated followed the order Fe > Zn > Mn > Pb > Cu > Cr > Cd for sediment; Fe > Zn > Pb> Mn > Cu > Cd > Cr for *Galeoides decadactylus* and Fe > Cr > Cu > Mn > Pb > Cd > Zn for filtered water, respectively. Metal levels varied from sample to sample. Cr was not detected in the fish species neither was Zn detected in the filtered water samples. The results, however, fell within tolerable limits stipulated by World Health Organization (WHO).

Key words: Trace metals, sediment, *Galeoides decadactylus*, filtered water, Igbede river

INTRODUCTION

Rivers are major sources of water supply to man for his various activities. Trace metals gain access into rivers from natural and anthropogenic sources. Their introduction into the environment by anthropogenic activities is well documented (Duzgoren-Aydin *et al*., 2006; Florea and Busselberg, 2006). Trace metals are non-degradable and tend to persist in the environment. The fate of these metals in the aquatic system is significant due to their impact on the ecosystem. Trace metals can be accommodated in three basic reservoirs: water, biota and sediment. Sediments are repositories for physical and biological debris and sinks for a wide variety of contaminants (Hung and Hsu, 2004). Many commercial species and food chain organisms spend a major portion of their life cycles living in or on aquatic sediments hence providing a pathway for these contaminants to be consumed by higher aquatic life and humans (Eja *et al*., 2003). Many trace metals are biologically essential playing important roles as oligoelements but all are potentially toxic to biota and humans above certain threshold concentrations. Several studies have reported the accumulation of these metals in tissues of aquatic biota from contaminated areas (Yilmaz, 2005; Asuquo *et al*., 2004; Riba *et al*., 2003). Toxic trace metals are readily transferred in the food web of the ecosystem into the diet of fishers and small mammals. Metals may affect cells by acting on the cell membrane or interfering with cytoplasmic or nuclear functions after entry into the cell. For instance, accumulation of lead and cadmium in the human body results in brain and kidney damages (Jarup, 2003). Lead contamination leads to metabolic interference, central and nervous system toxicity while cadmium causes skeletal illnesses, high blood pressure and sterility among males.

Many aquatic fauna species could be used as indicators of levels of trace metals in aquatic ecosystems. The commonly used bio-indicators of metal pollution are fishes including *Galeoides decadactylus* which are available in Igbede river. The trace concentration of metals in filtered water column gives an indication of the water quality. Toxic metals are in dynamic equilibrium with pore water and the overlying water column and have pathways that are primarily associated with sediment substrates (Udosen and Benson, 2006). Trace metal burdens in sediment, biota and pelagic column are important indicators of the pollution status of an aquatic environment. Thus, continuous monitoring is essential for detecting and assessing metal pollution. The objective of this study was to assess and document trends in metal burdens in surface sediment, galeoides deacdactylus and filtered water of Igbede river, Lagos, Nigeria especially as substantial quantities of trace metals are known to be transported by major rivers and creeks adjourning it.

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MATERIALS AND METHODS

Surface sediments (top 10 cm layer), fish species (*Galeoides decadactylus*) and bottom water were collected from Igbede river located within Ojo Local Government of Lagos State, Nigeria. Sediments were collected weekly from four different points in November 2003 with a stainless steel grab sampler and mixed together to give composite samples. Samples were sieved through a 500 μm mesh and allowed to stand in polyethylene bags. Subsequently, the supernatant was decanted carefully to prevent loss of sediment. After decantation, the sediment was stirred with a plastic spatula and stored in a polyethylene bag prior to determination. 1.0 g of the remaining wet sediment was digested with 20 cm^3 1:1 HNO_3 and H_2O_2 on a hot plate maintained at 100°C inside a fume hood until white fume was evolved. The resulting digest was cooled, filtered and made up to the mark in a 25 cm^3 standard flask with deionized water.

Fish species, *Galeoides decadactylus*, were collected, rinsed with deionized water and frozen at 0°C. The samples were subsequently defrozen and rinsed with deionized water prior to sample preparation. 10 g fresh weights were taken and homogenized in a previously cleaned polyethylene plastic and digested with 20 cm^3 1:1 concentrated HNO_3 and H_2O_2 on a thermostated hot plate maintained at 100°C inside a fume hood until white fume emanated from the solution. The resulting digest was cooled, filtered and made up to the mark in a 25 cm^3 standard flask with deionized water.

For the filtered water sample, a 50 cm^3 amount of the decanted supernatant was filtered through a 0.45 μm membrane filter and treated with 20 cm^3 concentrated HNO_3. It was maintained at 100°C on a hot plate inside a fume hood. The resulting digest was cooled, filtered into a 25 cm^3 standard flask and made up to the mark with deionized water (Blust *et al*., 1988; Aukley and Schubaner-Berigan, 1994).

Instrumental calibration was carried out prior to metal determination by using standard solutions of metal ion prepared from their salts. Commercial analar grade 1000 mg kg^{-1} stock solutions of Cu^{2+}, Cd^{2+}, Zn^{2+}, Pb^{2+}, Cr^{2+}, Mn^{2+} and Fe^{2+} were diluted in 25 cm^3 standard flask and made up to the mark with deionized water to obtain working standard solutions of 2.0, 3.0 and 4.0 mg kg^{-1} of each metal ion.

Cu, Cd, Zn, Pb, Cr, Mn and Fe levels in surface sediment, galeoides decadactylus and filtered water were measured on a UNICAM 969 Atomic Absorption Spectrometer (AAS) Solar with deuterium background corrector.

RESULTS AND DISCUSSION

Trends in trace metal burdens in all the samples investigated during the period showed weekly variations. Metal levels varied from sample to sample. The results obtained revealed that sediment retained more than 70% of the metals while the metal levels were more in the biota than the filtered bottom water samples. Statistical analyses of the mean levels indicated that the distribution of the metals in the samples followed the order Fe > Zn > Mn > Pb > Cu > Cr > Cd for sediment; Fe > Zn > Pb > Mn > Cu > Cd > Cr for *Galeoides decadactylus* and Fe > Cr > Cu > Mn > Pb > Cd > Zn for the pelagic samples (Table 1). The relation between metal concentrations in pelagic column and biota may have been observed due to differences in the metal complexation capacities of water as past workers had suggested (Al-Abdali *et al*., 1996).

Fe recorded the highest concentration levels in all the samples assessed. Studies of the transport of trace metals by major rivers in the world indicate that substantial quantities of Fe are transported daily and associated with suspended sediments in these rivers (Clark, 1986). Since Igbede river is adjourning to Lagos lagoon, it may have been enriched with Fe as a result of transportation. The amount of Fe found in the fish species could be attributed to Fe rich haemoglobin and secondarily to the suspended particulates that might have been ingested along with its food. Fe is more of dietary supplement than a pollutant. A knowledge of the forms in which Fe is made available to aquatic species provides information on its vulnerability and establishes a relationship between Fe in the sediment, fish and water.

Trace metals produce unhealthy effects in organisms when approved threshold values are exceeded. Trace metal concentrations in aquatic fauna are often proportional to the levels in the aquatic environment in which the fauna resides (Akueshi *et al*., 2003). Fish absorbs metal through ingestion of contaminated food or by absorption in the gills from where they are transferred to higher organisms including man. The guts of the fish species, *Galeoides decadactylus*, were not purged prior to analysis. This may be one of the reasons for the high variation in metal content as trace metals in the gut of aquatic animals can present a high percentage of the total quantity (Sager and Pusco, 1991). Cr was not detected in the fish species neither was Zn detected in the filtered water during the investigation. Cu and Zn showed identical variation in the mean values recorded for the samples. It has been reported that organic matter influences the bioavailability or toxicity of Cu and Zn to sediment ingesting fish species (Giesy and Hoke, 1989). A consistent relationship was found between Cd in fish and

Table 1: Trends in trace metal burdens in sediment, fish species (*Galeoides decadactylus*) and filtered water of igbede river in November, 2003

Trace metals (μg g^{-1})		Cu	Cd	Zn	Pb	Cr	Mn	Fe
Sediment	Min.	6.16	0.25	49.28	0.70	10.59	17.96	1,492.33
	Max.	10.38	0.89	53.35	16.95	11.24	21.78	1,990.57
	Mean±SD	7.65±1.91	0.45±0.39	51.85±1.81	8.98±6.64	5.46±6.31	15.11±10.20	1,633.42±238.78
	95% CI of Mean	7.65±3.04	0.45±0.62	51.85±2.88	8.98±10.56	5.46±10.04	15.11±16.23	1,633.42±379.90
Galeoides decadactylus	Min.	0.17	0.03	2.44	1.45	ND	0.60	4.68
	Max.	0.61	0.12	7.82	2.82	ND	2.01	23.14
	Mean±SD	0.45±0.24	0.08±0.04	5.41±2.73	1.92±0.78	ND	1.33±0.70	11.49±10.13
	95% CI of Mean	0.45±0.60	0.08±0.10	5.41±6.79	1.92±1.94	ND	1.33±1.74	11.49±25.20
Filtered water	Min.	0.12	0.03	ND	0.04	0.23	0.02	0.65
	Max.	0.15	0.06	ND	0.17	0.66	0.18	0.81
	Mean±SD	0.14±0.01	0.05±0.01	ND	0.07±0.06	0.29±0.22	0.09±0.08	0.72±0.07
	95% CI of Mean	0.14±0.01	0.05±0.01	ND	0.07±0.09	0.29±0.35	0.09±0.13	0.72±0.11

Cd in sediment and water just as there was a strong correlation between Pb in the samples. The availability of Pb to fish specie correlated with the amount present in sediment. The levels of Cr and Mn followed different patterns in the samples while the level of Mn in the fish was higher than that of Cr.

This study is a novel research work and the findings showed that the aquatic environment is not stressed as the trace metal content in the samples investigated were within tolerable boundaries set by World Health Organization (Clark, 1986). It is, however, necessary to carry out researches in other biota in the ecosystem to discover trends in trace metal burdens in them.

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