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Determination of Heavy Metals in *Tilapia mossambicuis* Fish, Associated Water and Sediment from Ureje Dam in South-Western Nigeria

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Abstract: The concentration of heavy metals (zinc, lead, manganese, iron, copper, cobalt, chromium, cadmium and nickel) in water, sediment and different parts of (*Tilapia mossambicus*) fish were analyzed using atomic absorption spectrophotometer. Cobalt, chromium and nickel were not detected in any of the samples while other metals are more concentrated in the sediment and fish parts than water. The heavy metals concentration determined were below the deleterious level while the water qualities were within the standard limit for drinking water. There were evidence of bioconcentration of the metals in fish parts with factors for zinc, manganese, iron and lead ranging between 20.6- 77.7, 11.0-60.0, ND-126.3 and ND-10.0, respectively.

Key words: Sediment, water, fish parts, heavy metals, *Tilapia mossambicus*

INTRODUCTION

The availability of portable water is an indispensable feature for preventing diseases and improving the quality of life (Oluduro and Aderiye, 2007). Natural water contains some types of impurities whose nature and amount vary with source of water. Metals are introduced into aquatic system through several ways which includes weathering of rocks and leaching soils, dissolution of aerosol particles from the atmosphere and from several human activities, including mining, processing and the use of metal based materials (Ipinmoroti and Oshodi, 1993; Adeyeye, 1994; Asaolu *et al*., 1997). Metals after entering the water may be precipitated, adsorbed on solid surface, remains soluble, suspended in water or may be taken up by fauna and flora and eventually, accumulated in marine organisms that are consumed by human being (Asaolu *et al*., 1997).

The presence of metal pollutant both in fresh and marine water has been found to disturb the delicate balance of the aquatic ecosystem (Asaolu and Olaofe, 2005). Fish are notorious for their ability to concentrate metals in their body tissue and since they play important role in human nutrition they need to be screened to ensure that unnecessarily high levels of some toxic metals are not being transferred to man through fishes (Kakulu and Osibanjo, 1988; Adeyeye, 1996). The increased use of metal-based fertilizer in agricultural revolution of the government could result in continued rise in concentration of metal pollutants in fresh water reservoir due to the water run-off. Little attention has been paid to the comparative study of metal concentration in these matrices (sediment, water and fish). However a study is necessary to assess the metal level of pollution in water, sediment and fish parts in Ureje dam in south-west, Nigeria.

Ureje dam is a major source of water supply in Ado-Ekiti, a town in the south-west of Nigeria. The dam was built in 1961. Water from this dam is being processed and supplied to the public for various purposes. Also fishes from this dam are being sold to public for human consumption. Since the establishment of the dam there are few information concerning the monitoring of the concentrations of heavy metals in water, sediment and fish from the dam. Therefore, this work will provide information on the concentrations and bioconcentration factors of some heavy metals in water, sediment and fish from the dam and the result obtained would provide information on the level of the heavy metals in the dam.

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MATERIALS AND METHODS

Sample Collection

Samples for this analysis were collected during the raining season of 2006 (July).

Representative water sample were taken below the water surface from the dam using one litre acid leached polythene bottle. The samples were stored in deep freezer prior to analysis. The sediment samples were collected by divers at the point where the water samples were taken, these were stored in a polythene bag which have been washed and leached accordingly. Four pieces of fresh fish (*Tilapia mossambicus*) were bought from fishermen at the dam site. The scales were removed, carefully washed and stored prior to analysis.

Sample Treatment

Five milliliter of hydrochloric acid was added to 250 mL of water sample and evaporated to 25 mL. The concentrate was transferred into a 50 mL standard flask and made to mark with distilled water (Parker, 1972).

The sediment samples were air dried and then sieved using 200 mm mesh. Five gram of the sediment sample in each case was put into 150 mL conical flask. A mixture of 15 mL nitric acid, 2 mL perchloric acid and 15 mL hydrofluoric acid were added and placed on hot plate at a temperature of 85°C for three hours (Nwajei and Gagophien, 2000). On cooling, the digest were filtered into 100 mL standard flask and made up to the mark with distilled water.

The fish samples were separated into eyes, head, gills, flesh and intestine. Different parts of the fish samples were dried in an oven at 105°C, blended and sample ranging between 0.30-1.93 g were accurately weighed for digestion. The fish parts were digested with concentrated nitric acid and 72% perchloric acid in the ratio 5:3, the solutions were placed on a temperature controlled water bath for three hours. On cooling, the digest were filtered into 100 mL standard flask and made up to the mark with 0.5% nitric acid (Asaolu *et al*., 1997). The filtrates from water, sediment and fish parts were analyzed for heavy metals using atomic absorption spectrophotometer (Buck model 200A). The instrument was calibrated for each metal determined using a standard solution of the metal.

RESULTS AND DISCUSSION

In the water sample only Zn, Mn, Fe and Pb were detected while Cu, Ni, Co, Cr and Cd were not detected. Iron has the highest value of 0.08 mg L^{-1} while lead has the least value of 0.01 mg L^{-1} in the water sample (Table 1). Among those metal detected in the sediment sample, iron has the highest concentration of 7.64 mg kg^{-1} while cobalt has the least value of 0.01 mg kg^{-1}. This observation is similar to those reported by several authors in their study of heavy metal concentration in the three matrices (Asaolu *et al*., 1997; Asaolu and Olaofe, 2005; Adeyeye *et al*., 1994, 1996); Ipinmoroti and Oshodi, 1993; Kakulu and Osibanjo, 1988). It has also been reported that iron occurs at high levels in Nigerian soils (Ali, 1978; Kakulu and Osibanjo, 1988; Asaolu and Olaofe, 2005).

Table 1: Levels of heavy metals in water (mg L^{-1}) and sediment (mg kg^{-1} dry weight)

Metals	Sediment	Water	Mean±SD	CV (%)
Zn	5.23	0.03	2.63±3.68	139.8
Mn	1.20	0.02	0.61±0.83	136.1
Cu	1.70	ND	0.85±0.92	108.1
Fe	7.64	0.08	3.86±5.35	138.6
Ni	ND	ND	ND	ND
Cd	2.02	ND	1.01±0.71	70.30
Co	0.01	ND	0.01±0.0	ND
Cr	ND	ND	ND	ND
Pb	1.02	0.01	0.52±0.65	125.00

ND: Not detected, SD: Standard Deviation, CV: Coefficient of variation

Table 2: Levels of heavy of metals (mg kg^{-1} dry weight) in fish parts of *Tilapia mossambicus* and water (mg L^{-1})

Metals	Water	Flesh	Head	Gills	Intestine	Eyes	Mean±SD	CV (%)
Zn	0.03	1.02	2.33	0.73	2.01	0.62	1.12±0.88	78.6
Mn	0.02	1.20	0.44	0.49	0.22	ND	0.40±0.40	100.0
Cu	ND	ND	0.03	ND	ND	ND	ND	ND
Fe	0.08	2.21	2.61	5.00	10.10	ND	3.33±3.49	106.7
Ni	ND	ND	ND	ND	ND	ND	ND	ND
Cd	ND	0.51	0.25	0.87	0.90	ND	0.42±0.31	73.8
Co	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND	ND	ND
Pb	0.01	ND	0.04	0.08	1.00	0.05	0.20±0.38	190.0

ND: Not detected

The values of metal concentrations in water reported in this work are below the maximum allowable values for drinking water (WHO, 1999) showing that the water can be treated for domestic purposes.

Cobalt, Nickel and Chromium were not detected in any of the fish parts. Cu that was not detected in water samples but was found in the head of the fish sample at a concentration of 0.03 mg kg^{-1} which is within the permissible limit of FEPA (0.05 mg L^{-1}). Iron, zinc and lead show the highest concentrations in the various fish parts (Table 2). Iron was found to range between 2.21-10.10 mg kg^{-1}, zinc ranged between 0.62-2.33 mg kg^{-1} and lead ranged between ND- 1.00 mg kg^{-1}, while Cadmium ranged between ND-0.90 mg kg^{-1}. The presence of Cd in sediment and fish parts may be as a result of industrial activities in Ado-Ekiti being a State capital. These values exceed the limits of WHO and FEPA (0.03 mg kg^{-1}). Lead is toxic even at low concentration and has no known function in biochemical process (Asaolu, 2002). Sources of lead include storage batteries, ammunition and type metal, antiknock compounds in petrol (Crosby, 1977). The onset of lead pollution of surface water in Nigeria has been reported and the major source being the use of leaded gasoline, run-off water from battery charger and mechanic workshop (Mombershora *et al*, 1983; Osibanjo and Ajayi, 1980).

The high concentrations of zinc and iron in the fish parts could be associated with the fact that these metals are naturally abundant in Nigeria soil and since no matter the source of the metal, the final depositories are the aquatic system (Kakulu and Osibanjo, 1988; Okoye *et al*., 1989; Asaolu and Olaofe, 2005; Nwajei and Gagophien, 2000; Nwajei and Oruvwuje, 2001). A high concentration of iron in the intestine and gills of the fish sample indicate that the fish during feeding makes use of the gills and stores the particles in the intestine. Similar observation has been reported by Adeyeye (1994) when studying different parts of *Illisha africana* fish in a pond in Ondo-State. In processing fish for consumption, both intestine and gills are discarded; this will reduce the injection of lead and cadmium from fish source into the human system.

The results of Table 3 indicate that the concentrations of heavy metals in the sediment and fish parts were higher than those of water, also the result of the fish parts were higher than those of sediment samples. The various percentage coefficient of variation (CV) gives an indication of unequal distribution of the metals in the three matrices. The high value of heavy metals in the fish sample suggests that the fish was capable of concentrating these metals in their body from the aquatic environment. Fishes are notorious for their ability to concentrate heavy metals in their muscles (Varshney, 1991). Some of these metals might be involved in heamatopoesis while others might be involved in regulation of metabolic processes, therefore they need to be carefully screened to ensure that unnecessarily high levels of some toxic metals are not being transferred to human being through fish. The results obtained are similar to those obtained by several researchers when studying metals in an aquatic environment (Asaolu *et al*., 1997; Asaolu and Olaofe, 2005; Adeyeye, 1996; Nwajei and Oruvwuje, 2001).

The bioconcentration factors for zinc ranged between 20.6-77.7±44.7, for manganese it ranged between 11.0-60.0±23.5, for iron it ranged between ND-126.3±49.8, for lead it ranged between ND-10.0±5.4 (Table 4).

Table 3: Levels of heavy metals in water (mg L^{-1}), sediment (mg kg^{-1} dry weight) and fish parts of *Tilapia mossambicus* (mg kg^{-1} dry weight)

Metals	Water	Sediment	Flesh	Head	Gills	Intestine	Eyes	Mean±SD	CV (%)
Zn	0.03	5.23	1.02	2.33	0.73	2.01	0.62	1.71±1.70	99.4
Mn	0.02	1.20	1.20	0.44	0.49	0.22	ND	0.51±0.46	90.2
Cu	ND	1.70	ND	0.03	ND	ND	ND	0.88±1.17	133.0
Fe	0.08	7.64	2.21	2.61	5.00	10.10	ND	3.95±3.48	88.2
Ni	ND	ND	ND	ND	ND	ND	ND	ND	Nd
Cd	ND	2.02	0.51	0.25	0.87	0.90	ND	0.65±0.60	92.3
Co	ND	0.01	ND	ND	ND	ND	ND	ND	Nd
Cr	ND	ND	ND	ND	ND	ND	ND	ND	Nd
Pb	0.01	1.02	ND	0.04	0.08	1.00	0.05	0.31±0.43	138.7

ND: Not detected; ND: Not determined

Table 4: Bioconcentration factors of heavy metals in the fish parts

Metals	Flesh	Head	Gills	Intestine	Eyes	Mean±SD	CV (%)
Zn	34.0	77.7	24.3	67.0	20.6	44.7±23.2	51.9
Mn	60.0	22.0	24.5	11.0	ND	23.5±19.3	82.1
Cu	ND	ND	ND	ND	ND	ND	ND
Fe	27.6	32.6	62.5	126.3	ND	49.8±41.2	82.7
Ni	ND	ND	ND	ND	ND	ND	ND
Cd	ND	ND	ND	ND	ND	ND	ND
Co	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND	ND
Pb	ND	4.0	8.0	10.0	5.0	5.4±2.7	50.00

ND = Not Detected

The level of metals in fishes is an indication of the level of metal pollution of the water from which they are caught (Adeyeye, 1996).

In conclusion, a lot of variation was observed in the levels of heavy metals as determined in water, sediment and fish samples. The metal concentrations were generally higher in the sediment followed by the fish and least in the water. Since the fish was determined on dry weight basis, one may conclude that the levels of these metals in the sample do not poses any health hazard; however there is a need for continuous monitoring of the pollution status of the dam because of the increased human activities around the dam.

REFERENCES

Adeyeye, E.I., 1994. Determination of heavy metals in *Illisha africana* fish, associated water and soil sediments from some fish ponds. Int. J. Environ. Stud., 45: 231-240.

Adeyeye, E.I., 1996. Determination of major elements in *Illisha africana* fish, associated water and soils sediments from some fresh water ponds. Bangladesh J. Sci. Ind. Res., 1: 171-184.

Ali, H., 1978. Distribution of micronutrients in Ibadan soils. M.Sc. Thesis. University of Ibadan, Nigeria (Unpublished).

Asaolu, S.S., K.O. Ipinmoroti, C.E. Adeeyinwo and O. Olaofe, 1997. Interrelationship of heavy metal concentration in water, sediment and fish samples from Ondo State Coastal Area, Nig. Afr. J. Sci., 1: 55-61.

Asaolu, S.S., 2002. Determination of some heavy metals in *Oreochromis niloticus, Claria gariepinus* and *Synodontis* sp. from the coastal water of Ondo State, Nigeria. Pak. J. Sci. Ind. Res., 45: 17-19.

Asaolu, S.S. and O. Olaofe, 2005. Biomagnification's of some heavy and essential metals in sediment, fishes and crayfish from Ondo State Coastal Region, Nigeria. Pak. J. Sci. Ind. Res., 48: 96-102.

Crosby, N.T., 1977. Determination of metals in food. A review. The Analyst, 102: 225-268.

Ipinmoroti, K.O. and A.A. Oshodi, 1993. Determination of trace metals in fish, associated water and soil sediments from fish ponds. Discovery Innovat., 5: 135-138.

Kakulu, S.E. and O. Osibanjo, 1988. Trace heavy metal pollutional status in sediments of Niger Delta area. Nig. J. Chem. Soc., 13: 9-11.

Nwajei, G.E. and P.O. Gagophien, 2000. Distribution of heavy metals in sediments of Lagos Lagoon. Pak. J. Sci. Ind. Res., 43: 338-340.

Nwajei, G.E. and J.U. Oruvwuje, 2001. Assessment of heavy metals in *Clarins buthopogon* (fish) parts and *Nymphaea lotus* (Aquatic plant) in River Niger, Delta State of Nigeria. Pak. J. Sci. Ind. Res., 44: 333-337.

Mombershora, C.O., O. Osibanjo and S.O. Ajayi, 1983. Pollution studies on Nigerian Rivers the onset of lead pollution of surface waters in Ibadan. Environ. Int., 9: 81-84.

Oluduro, A.O. and B.I. Aderiye, 2007. Efficacy of *Moringa oleifera* seed extract on the micro flora of surface and underground water. J. Plant Sci., 2: 453-458.

Okoye, B.C.O., O.A. Afolabi and E.A. Ajoa, 1989. Heavy metals in the Lagos Lagoon sediment. Int. J. Environ. Stud., 37: 35-42.

Osibanjo, O. and S.O. Ajayi, 1980. Trace metal levels in tree barks as an indicator of pollution. Environ. Int., 4: 236-244.

Parker, R.C., 1972. Water Analysis by Atomic Absorption Spectroscopy. Varian tectron, Switzerland, pp: 20-30.

Varshney, C.K., 1991. Water pollution and Management. Wiley Eastern Ltd., New Delhi, pp: 74-93.

WHo, 1999. Guideline for drinking water quality. 2nd Edn., Recommendation. World Health Organization. Geneva, Vol .1, pp: 30-113.